GE
Grid Solutions

R650 Recloser Controller

Instruction Manual

Firmware version: 8.0X
EnerVista 650 Setup version: 8.0x
GE publication code:1601-0707-A2 (GEK-131023A)

WORLDWIDE 10 YEAR WARRANTY

REGISTERED ISO 9001 GE MULTILIN

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GE Multilin R650 Feeder Protection System instruction manual for revision GEK-131023A.

Part number: GEK-131023A (March 2018)

R650 Recloser Controller

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R650 Recloser Controller

Chapter 1: Getting Started

1.1 Important procedures

Use this chapter for initial setup of your new R650 Recloser Controller.

1.1.1 Cautions and warnings

To help ensure years of trouble free operation, please read through the following chapter for information to help guide you through the initial installation procedures of your new relay.

Before attempting to install or use the relay, it is imperative that all warnings and cautions in this manual are reviewed to help prevent personal injury, equipment damage, and/or downtime.

The following safety and equipment symbols are used in this document.

⚠DANGER **Indicates a hazardous situation which, if not avoided, will result in death or serious injury.**

⚠WARNING **Indicates a hazardous situation which, if not avoided, could result in death or serious injury.**

⚠CAUTION **Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.**

NOTICE Indicates practices not related to personal injury.

1.1.1.1 General cautions and warnings

WARNING **Ensure that all connections to the product are correct so as to avoid accidental risk of shock and/or fire, for example such as can arise from high voltage connected to low voltage terminals.**

- **Follow the requirements of this manual, including adequate wiring size and type, terminal torque settings, voltage, current magnitudes applied, and adequate isolation/clearance in external wiring from high to low voltage circuits.**
- **Use the device only for its intended purpose and application.**
- **Ensure that all ground paths are uncompromised for safety purposes during device operation and service.**
- **Ensure that the control power applied to the device, the AC current, and voltage input match the ratings specified on the relay nameplate. Do not apply current or voltage in excess of the specified limits.**
- **Only qualified personnel are to operate the device. Such personnel must be thoroughly familiar with all safety cautions and warnings in this manual and with applicable country, regional, utility, and plant safety regulations.**
- **Hazardous voltages can exist in the power supply and at the device connection to current transformers, voltage transformers, control, and test circuit terminals. Make sure all sources of such voltages are isolated prior to attempting work on the device.**
- **Hazardous voltages can exist when opening the secondary circuits of live current transformers. Make sure that current transformer secondary circuits are shorted out before making or removing any connection to the current transformer (CT) input terminals of the device.**
- **For tests with secondary test equipment, ensure that no other sources of voltages or currents are connected to such equipment and that trip and close commands to the circuit breakers or other switching apparatus are isolated, unless this is required by the test procedure and is specified by appropriate utility/plant procedure.**
- **When the device is used to control primary equipment, such as circuit breakers, isolators, and other switching apparatus, all control circuits from the device to the primary equipment must be isolated while personnel are working on or around this primary equipment to prevent any inadvertent command from this device.**
- **Uses an external disconnect to isolate the mains voltage supply.**

WARNING **LED transmitters are classified as IEC 60825-1 Accessible Emission Limit (AEL) Class 1M. Class 1M devices are considered safe to the unaided eye. Do not view directly with optical instruments.**

CAUTION **When conducting local maintenance use the "Local" setting "OFF" along with the HOT line tag feature as a secondary means of protection and isolation. This recommendation is in addition to local safety requirements such as LOTO.**

NOTICE This product is rated to Class A emissions levels and is to be used in Utility, Substation Industrial environments. Not to be used near electronic devices rated for Class B levels.

Figure 1-1: Front view of R650 unit

1.1.1.2 Communication board withdrawal/insertion

⚠WARNING **MODULE WITHDRAWAL AND INSERTION SHALL ONLY BE PERFORMED BY DULY QUALIFIED SERVICE PERSONNEL. FOR PERSONAL SECURITY PURPOSES, BEFORE ACCOMPLISHING ANY WITHDRAWAL OR INSERTION OPERATION, THE RELAY MUST BE POWERED OFF AND ALL THE REAR TERMINALS MUST BE POTENTIAL FREE. THE RELAY MUST BE GROUNDED USING THE REAR GROUNDING SCREW.**

The modular design of the relay allows for the withdrawal and insertion of the communication module.

Figure 1-2: Module withdrawal/insertion shows the location of communication modules on the rear part of the relay. Qualified personnel must carry out the insertion or extraction of the communication boards only after disconnecting the relay auxiliary voltage and ensuring that all the rear terminals are potential free.

Communication boards are installed on the rear of the unit, with upper port reserved for the asynchronous communications board and CAN bus, and the lower port for the ETHERNET board.

Before performing any of these actions, control power must be removed from the relay and all the rear terminals must be potential free. A grounded antistatic wristband must be used when manipulating the module in order to avoid electrostatic discharges that may cause damage to the electronic components.

WITHDRAWAL: Loosen the small screws that keep the faceplate in place and extract the module.

INSERTION: Insert the module and press it firmly in the case, until it is completely fixed. After this, bolt the faceplate screws and replace the control power. Check that the relay is fully operative.

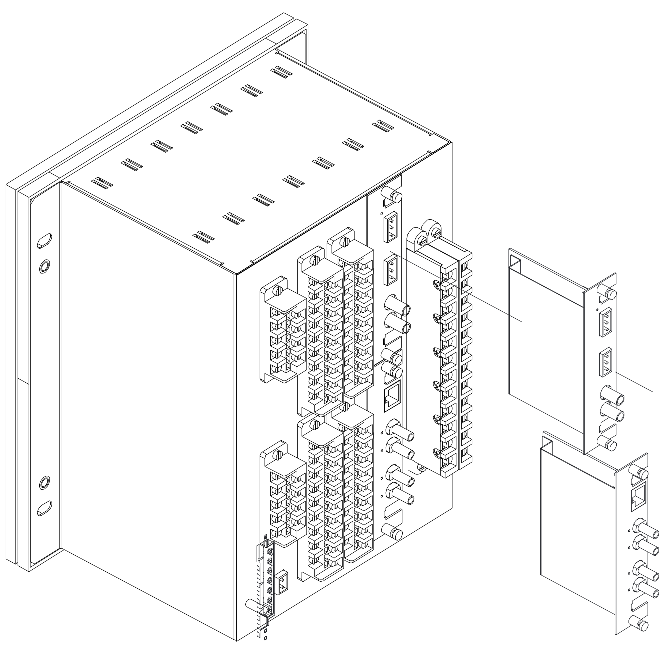


Figure 1-2: Module withdrawal/insertion

GE Multilin will not be responsible for any damage to the relay, connected equipment or personnel whenever these safety rules are not followed.

1.1.1.3 Magnetic module terminals

The transformer module for the LEA voltage inputs and CTs is already connected to a female connector screwed to the case. The current inputs incorporate shorting bars, so that the module can be extracted without the need to short-circuit the currents externally. It is very important, for safety reasons, not to change or switch the terminals for CTs and LEA voltage inputs.

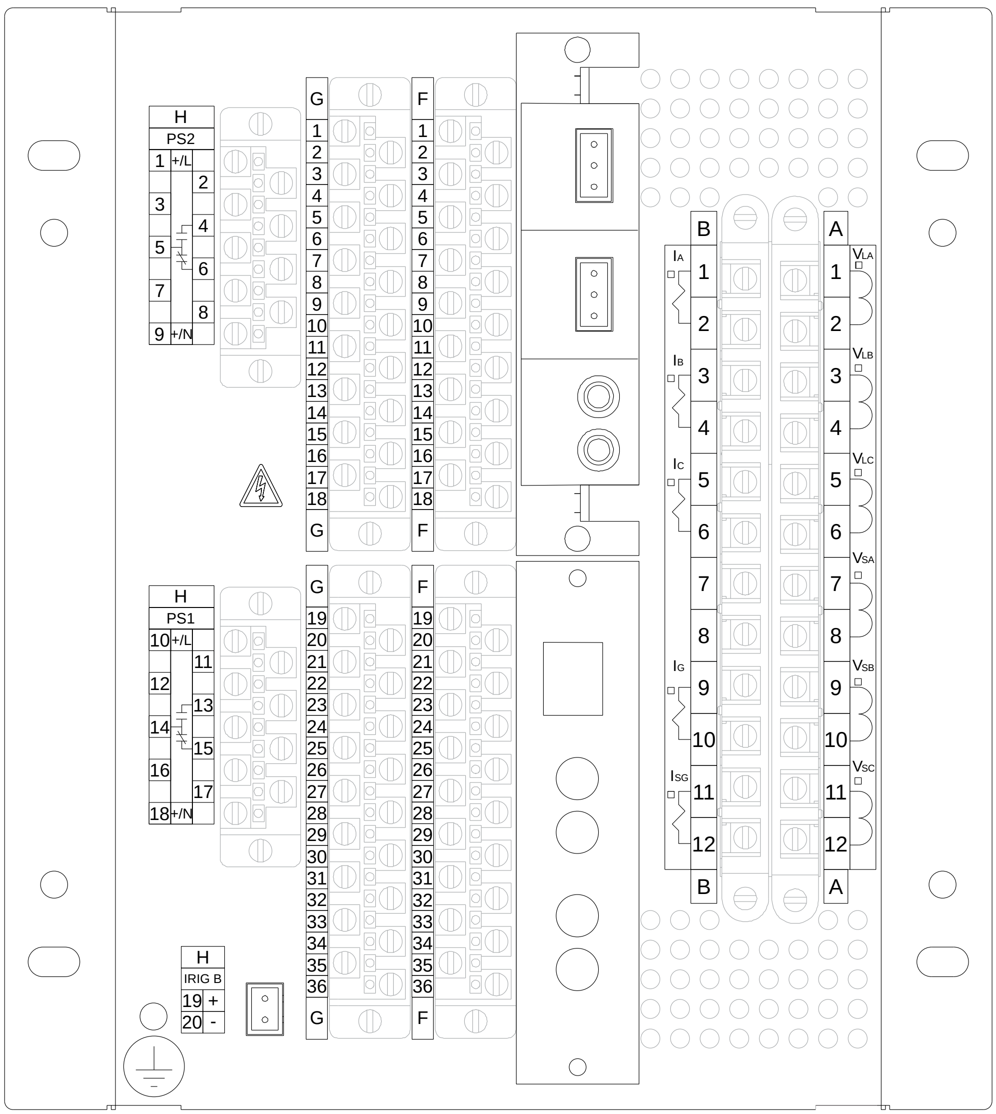


Figure 1-3: Rear view of R650 unit

GE Multilin will not be responsible for any damage of the relay, connected equipment or personnel whenever these safety rules are not followed.

1.1.2 Inspection checklist

1. Unwrap the relay and inspect the relay for physical damage.
2. View the nameplate and verify that the correct model has been ordered and delivered. The model number is at the top.

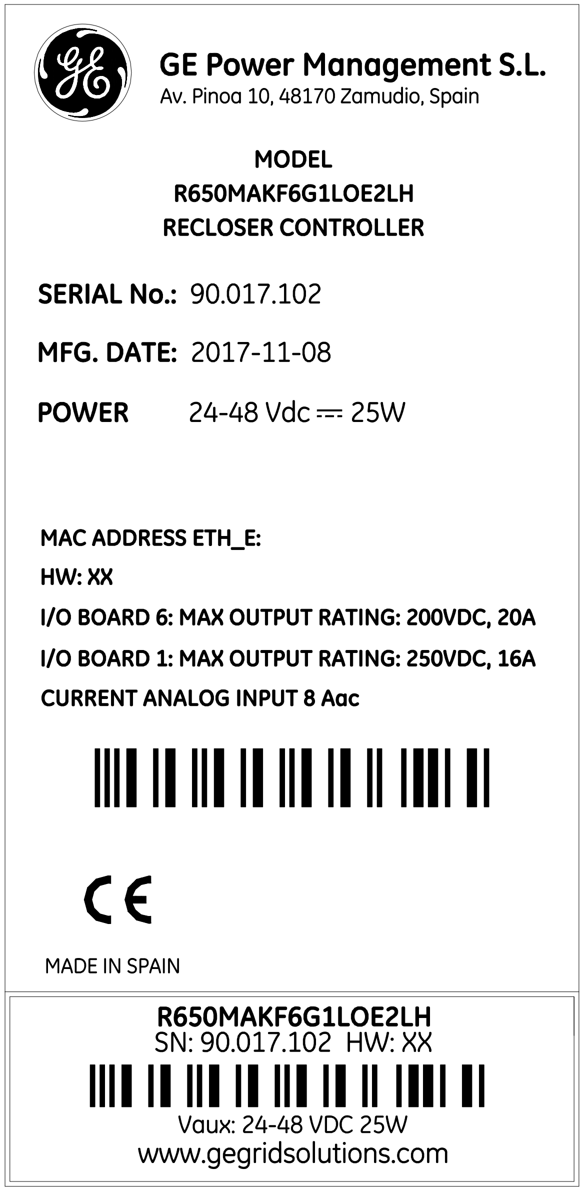


Figure 1-4: Identification label (A4454P65)

Please ensure that you received the following items with your relay:

- Mounting screws for fixing the relay to a cabinet
- GE EnerVista™ DVD (includes the EnerVista 650 Setup software and manuals in PDF format)
- Wiring diagram.
- Certificate of Compliance

For product information, instruction manual updates, and the latest software updates, please visit the GE Multilin Home Page: http://www.gegridsolutions.com/multilin

Note: If there is any physical damage detected on the relay, or any of the contents listed are missing, please contact GE Grid Solutions, Multilin immediately:

EUROPE, MIDDLE EAST AND AFRICA:

GE Grid Solutions
Av. Pinoa, 10
48170 Zamudio, Vizcaya (SPAIN)
Tel.: (34) 94-485 88 54
Fax: (34) 94-485 88 38
E-mail: multilin.tech.euro@ge.com

AMERICA, ASIA AND AUSTRALIA:

GE Grid Solutions
650 Markland Street
Markham, Ontario
Canada L6C 0M1
North America toll-free: +1 800 547 8629
Tel.: +1 905 927 7070
Fax: +1 905 927 5098
E-mail: multilin.tech@ge.com

⚠CAUTION **The information provided herein is not intended to cover all the details of the variations of the equipment, nor does it take into account the circumstances that may be present in your installation, operating or maintenance activities.**

Should you wish to receive additional information, or for any particular problem that cannot be solved by referring to the information contained herein, please contact General Electric, Grid Solutions.

1.1.3 Safety instructions

The R650 ground screw shown in Figure 1-5: Location of grounding screw must be correctly grounded.

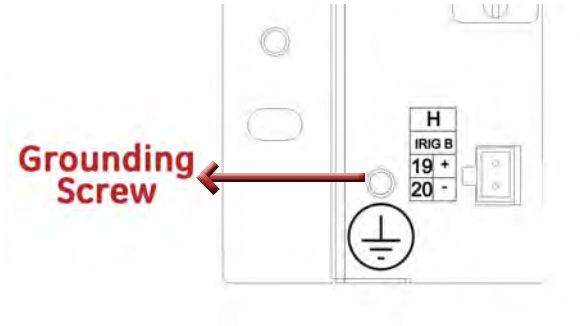


Figure 1-5: Location of grounding screw

Before communicating with the R650 through the front USB port, ensure that the computer's power supply is grounded. When using a laptop, it is recommended that the power supply be disconnected. In many cases the laptop may not be correctly grounded either due to the power supply or to the connector cables used.

GE Multilin will not be responsible for any damage to the relay or connected equipment when this basic safety rule is not followed.

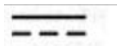
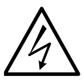
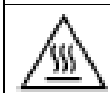
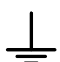
1.1.3.1 General safety instructions

⚠CAUTION

- **Failure to observe and follow the instructions provided in the equipment manual(s) could cause irreversible damage to the equipment and could lead to property damage, personal injury and/or death.**
- **Before attempting to use the equipment, it is important that all danger and caution indicators are reviewed.**
- **Beware of potential hazards, wear personal protective equipment and carefully inspect the work area for tools and objects that may have been left inside the equipment.**
- **Test/Installation/Service personnel must be familiar with general device test practices, safety precautions and follow standard ESD precautions to avoid personal injury or equipment damage.**
- **Caution: Hazardous voltages can cause shock, burns or death.**
- **Before performing visual inspections, tests, or periodic maintenance on this device or associated circuits, isolate or disconnect all hazardous live circuits and sources of electric power.**
- **Before working on CTs, they must be short-circuited**
- **In addition to the safety precautions mentioned all electrical connections made must respect the applicable local jurisdiction electrical code.**
- **All recommended equipment that should be grounded must have a reliable and un-compromised grounding path for safety purposes, protection against electromagnetic interference and proper device operation. Keep all ground leads**
- **Equipment grounds should be bonded together and connected to the facility's main ground system for primary power.**
- **Keep all ground leads as short as possible.**
- **At all times, equipment ground terminal must be grounded during device operation.**
- **While the equipment manual may suggest several safety and reliability steps, safety precautions must be used in conjunction with the safety codes in force at your location.**
- **LED transmitters are classified as IEC 60825-1 Accessible Emission Limit (AEL) Class 1M. Class 1M devices are considered eye safe to the unaided eye. Do not view directly with optical instruments**
- **It is the responsibility of the user to check the equipment ratings and installation instructions prior to commissioning, service or maintenance.**
- **Use a lift system with side rails/bucket to reduce a fall hazard as opposed to other means when installing or servicing.**
- **Failure to shut equipment power off prior to removing the power connections could expose user to dangerous voltages causing injury or death.**
- **Do not remove the voltage terminal blocks or disconnect the voltage input wires when the voltage phases are live. The voltage inputs must be de-energized prior to any servicing.**

1.1.3.2 Warning symbols

The following table explains the meaning of warning symbols that may appear on the device or in this manual.

	The relevant circuit is direct current. Le circuit principal est à courant continu.
	The relevant circuit is alternating current. Le circuit principal est à courant alternatif.
	**CAUTION**: Refer to the documentation for important operating and maintenance instructions. Failure to take or avoid a specified action can result in loss of data or physical damage. **AVERTISSEMENT**: Se réferer à la documentation pour l'entretien et l'utilisation. L'absence ou èviter de prender des mesures spècifiques peut entraîner des pertes de données ou même causer des dommages physiques.
	**WARNING**! Dangerous voltage constituting a risk of electric shock is present within the unit. Failure to take or avoid a specified action can result in physical harm to the user. **AVERTISSEMENT**! Tensions dangereuses comportant un risque de choc électrique sont presents dans l'equipement. L'absence ou èviter de prender des mesures spècifiques peut causer des dommages physiques à l'utilisateur.
	**CAUTION**: Class 1M Laser (IEC 60825-1 Safety of laser products) DO NOT VIEW DIRECTLY WITH OPTICAL INSTRUMENTS. **AVERTISSEMENT**: Laser de classe 1M (IEC60825-1) ÉVITER DE REGARDER DIRECTEMENT LE DISPOSITIF QUI ÉMET LE LASER OPTIQUE.
	**CAUTION**: Hot surface. **AVERTISSEMENT**: Surface chaude.
	Earth (Ground) Terminal. Terminal de terre (masse).
	Protective Earth Terminal. Terminal de terre de protection.

Note: Read all instructions included in package before using your product. Additional safety information Product Safety Supplement document available at; http://www.gegridsolutions.com/ProductSafety/

1.2 Overview

1.2.1 Introduction to the 650 family of relays

The GE 650 family relay is a new generation of digital and multifunction equipment that is easily incorporated into automation systems, at both the station and enterprise levels.

1.2.2 Hardware architecture

1.2.2.1 R650 basic design

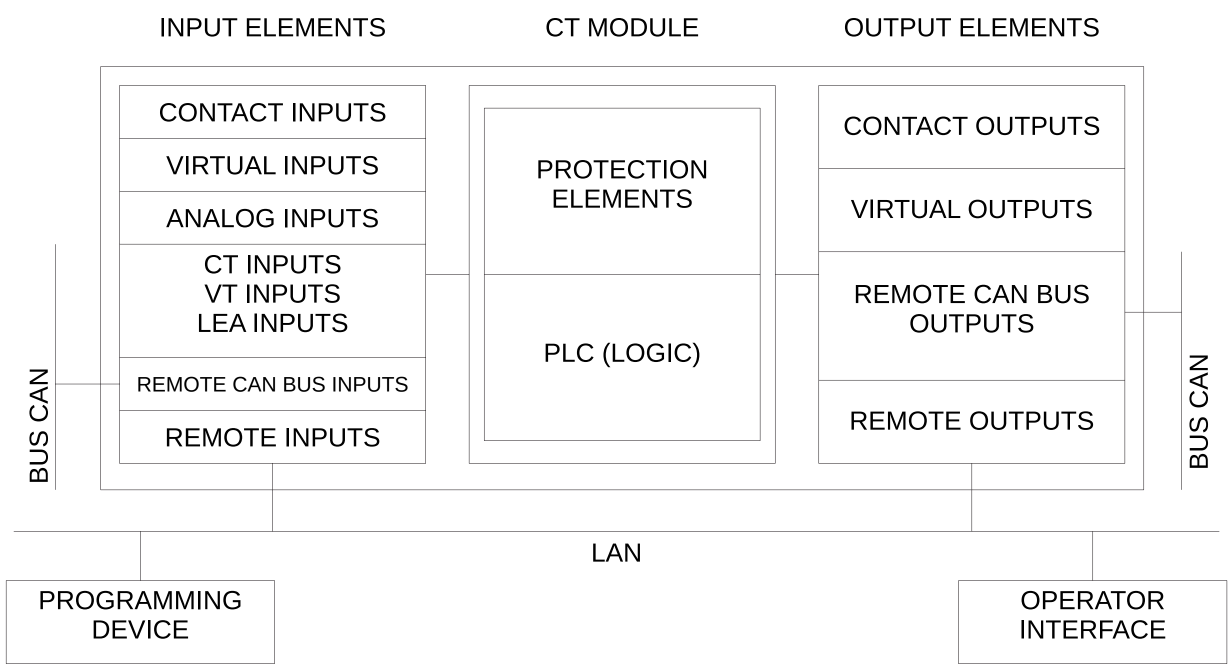
The 650 is a digital-based device containing a central processing unit (CPU) that handles multiple types of input and output signals. The 650 family can communicate over a local area network (LAN) with an operator interface, a programming device, or another 650 device.

The **CPU module** contains firmware that provides protection elements in the form of logic algorithms, as well as programming logic gates, timers, and latches for control features.

Input Elements accept a variety of analog or digital signals from the field. The 650 isolates and converts these signals into logic signals used by the relay.

Output Elements convert and isolate the logic signals generated by the relay into digital signals that can be used to control field devices.

Figure 1-6: 650 concept block diagram



1.2.2.2 R650 signal type

Contact Inputs/Outputs: Digital signals.

CT, VT, and LEA inputs: Signals coming from the current and voltage inputs, used for monitoring the power system signals.

Remote CAN Bus Inputs/Outputs: Signals associated with physical input/output contacts from a Remote Digital Input/ Output Module (CIO) connected to the 650 unit via the CAN Bus existing in options X, Y, Z, C and M for rear serial communication board 1.

PLC: Programmable Logic Controller. Control module that enables the unit configuration (assignment of inputs/outputs) and the implementation of logic circuits.

Protection Elements: Relay protection elements, for example: Overcurrent, overvoltage, etc.

Remote inputs and outputs: Provide a means of sharing digital point state information between remote devices using IEC 61850 GSSE and GOOSE messages.

Analog Inputs: Signals associated with transducers.

1.2.3 Communications architecture

A dedicated serial port is used for communication between the main processor and the human-machine interface. The serial connection provides immunity against electromagnetic disturbances, thus increasing system safety.

All 650 units incorporate one USB port on the front of the relay. They can also incorporate up to two additional communication modules on the rear.

One of the modules provides asynchronous serial communications, using different physical media (RS485 + cable remote CAN bus I/O, plastic or glass fiber optic) depending on the selected model. The module incorporates two identical ports, COM1 and COM2. The COM2 port is multiplexed with the front port. Additionally, this module may incorporate a port for CAN bus communications, used for the connection to the remote CAN Bus I/O module. This feature increases the I/O capability by up to 100% if the maximum number of I/Os available inside the relay is not enough for a specific application. Available options are:

Table 1-1: Rear serial communications board 1

Board Code	Functionality
F	Without additional communication ports
A	Two RS485 ports
P	Two Plastic F.O. ports
G	Two Glass F.O. ports
X	Two RS485 ports and a CAN port for remote CAN bus Inputs/Outputs
Y	Two Plastic F.O. ports and a CAN port for remote CAN bus Inputs/Outputs (fiber)
Z	Two Glass F.O. ports and a CAN port for remote CAN bus Inputs/Outputs (fiber)
C	CAN port for remote CAN Bus I/O (cable)
M	RS485 + RS485 port and a CAN port for remote CAN Bus I/O (cable)

The other module provides Ethernet communications (ETH Port), using 10/100BaseTX (self-negotiable speed) or 100BaseFX connectors, depending on the selected model. The most complete models include a double redundant 100BaseFX fiber optic port.

Available Options are:

Table 1-2: REAR ETHERNET COMMUNICATIONS BOARD 2

J	PRP, 1588, 10/100 Base TX* + Redundant 100 Base FX
K	PRP, HSR, RSTP, 1588, 10/100 Base TX* + Redundant 100 Base FX
L	PRP, 1588, 10/100 Base TX + Redundant 100 Base TX
M	PRP, HSR, RSTP, 1588, 10/100 Base TX + Redundant 100 Base TX

Internal communication with input and output modules is performed via an internal CAN Bus, independent of the one used for remote CAN Bus I/Os. This provides increased communication speed, and acknowledgement of modules, abnormalities, etc. As this is a serial port supporting a communications protocol, it provides immunity against external or internal disturbances.

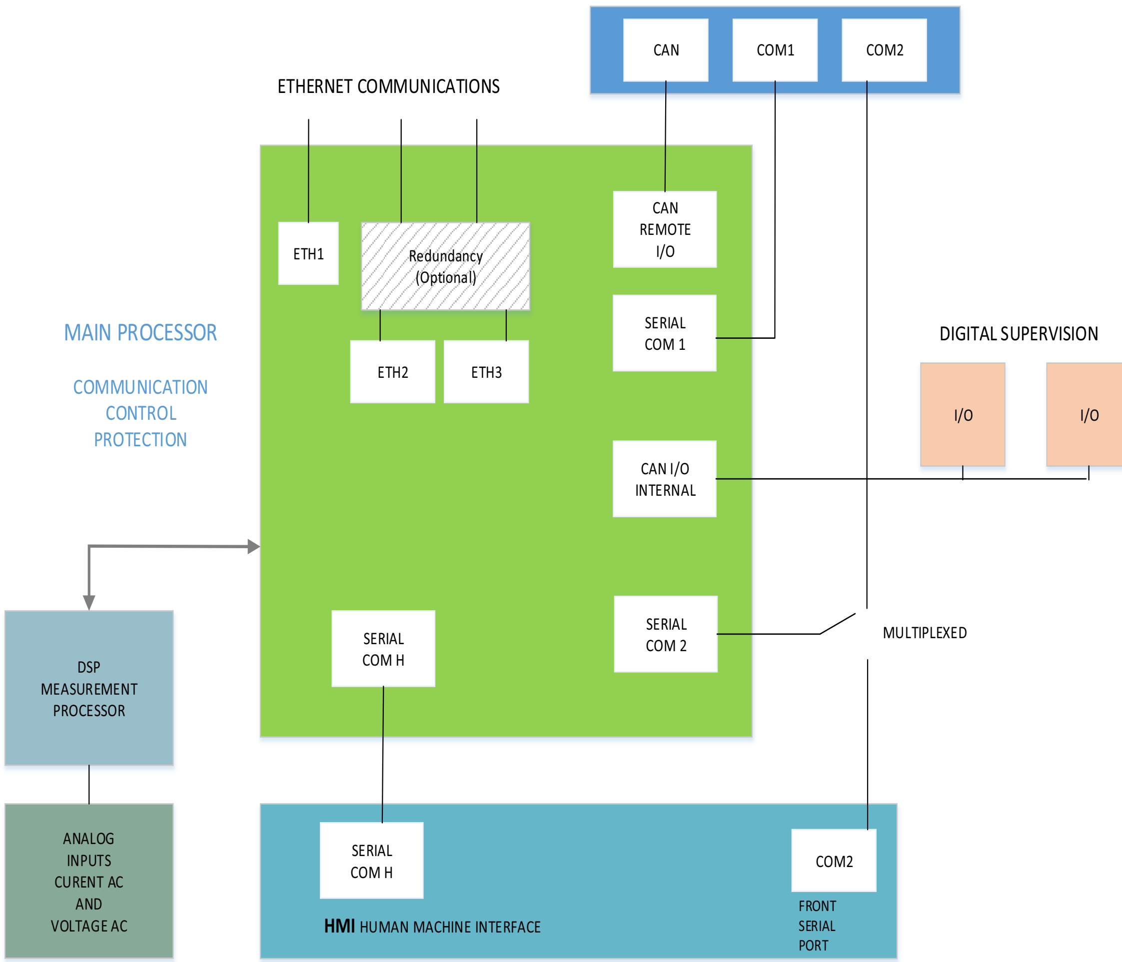


Figure 1-7: Communications architecture (B6816F2)

1.3 EnerVista 650 Setup software

1.3.1 System requirements

The relay front panel or the EnerVista 650 Setup software can be used to communicate with the relay. The software interface is the preferred method to edit settings and view actual values because the computer monitor can display more information.

The minimum system requirements for the EnerVista 650 Setup software are as follows:

- Pentium® 4 (Core Duo recommended).
- Windows® XP with Service Pack 2 (Service Pack 3 recommended), Windows 7, or Windows 8
- 1 GB of RAM (2 GB recommended).
- 500 MB free hard drive space (1 GB recommended).
- 1024 x 768 display (1280 x 800 recommended).
- USB serial and/or Ethernet port for communications with the relay.

1.3.2 Installation

After ensuring the minimum requirements for using EnerVista 650 Setup are met (see previous section), obtain the software from the GE EnerVista DVD, or download from: http://www.gegridsolutions.com/multilin/ as follows:

1. Insert the GE EnerVista DVD into the DVD drive of your computer.
2. Click **Install Now** and follow the installation instructions to install the complimentary EnerVista software.
3. When installation is complete, start the EnerVista Launchpad application.
4. Click **IED Setup** in the **Launch Pad** window.

Figure 1-8: Launchpad window

5. Click **Add Product** and select the “R650 Recloser Controller” relay from the Install Software window as shown below. Select the “Web” option to ensure the most recent software release, or select “CD” if you do not have a web connection, then click **Add Now** to list software items for the R650.

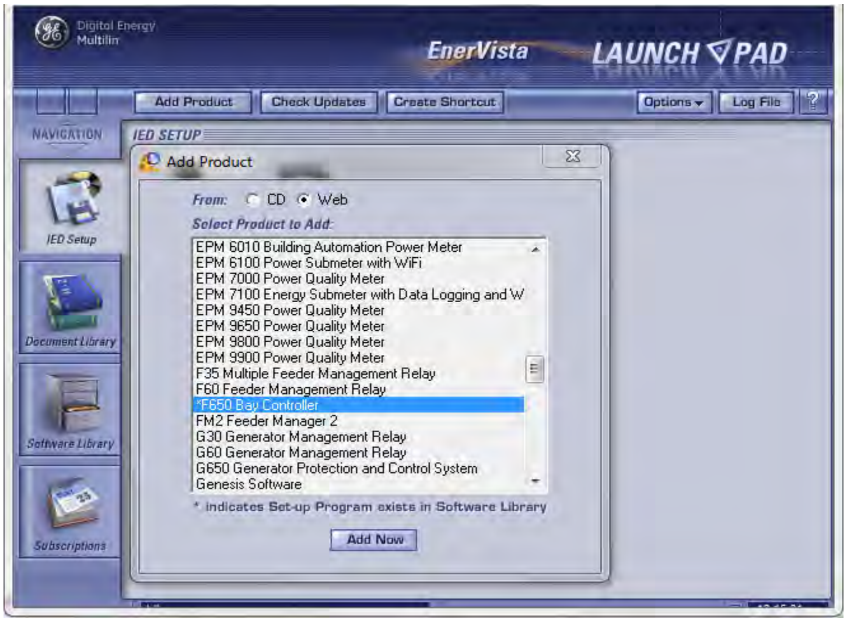


Figure 1-9: Add Product window

6. EnerVista Launchpad obtains the installation program from the Web or CD. Once the download is complete, double-click the installation program to install the EnerVista 650 Setup software.
7. Follow the on-screen instructions to install the EnerVista 650 Setup software. When the **Welcome** window appears, click **Next** to continue with the installation.

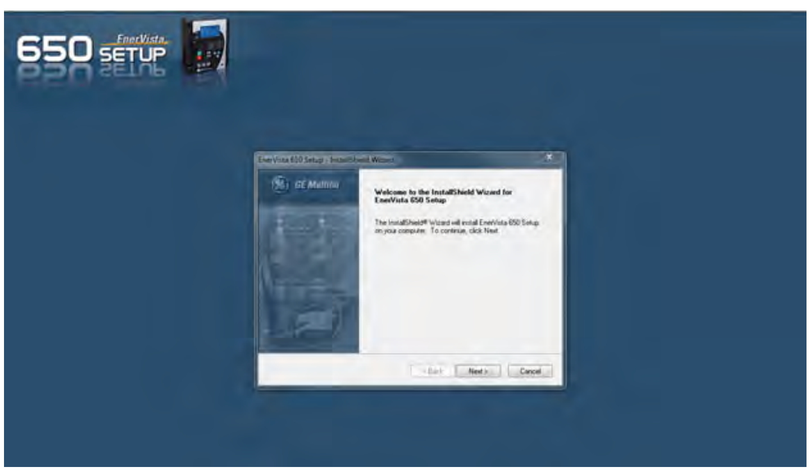


Figure 1-10: EnerVista 650 Setup installation

8. When the **Choose Destination Location** window is displayed, change the installation directory id needed by clicking **Change...** and typing in the complete path name including the new directory name. Click **Next** to continue with the installation.

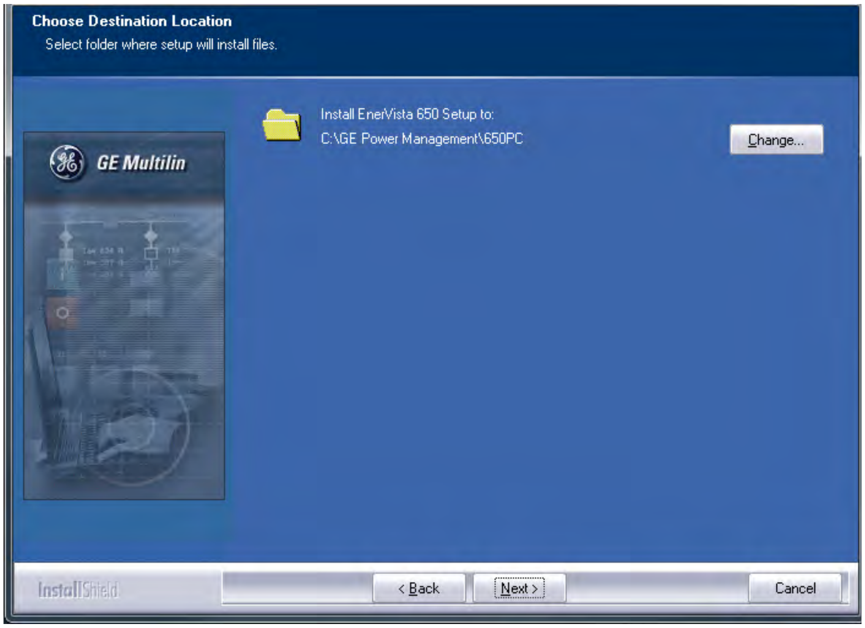


Figure 1-11: EnerVista 650 Setup installation cont.

9. The default program group containing the application is added to as shown in the **Selected Program Folder** window. Click **Next** to begin the installation process, and all the necessary program files are copied into the selected directory.

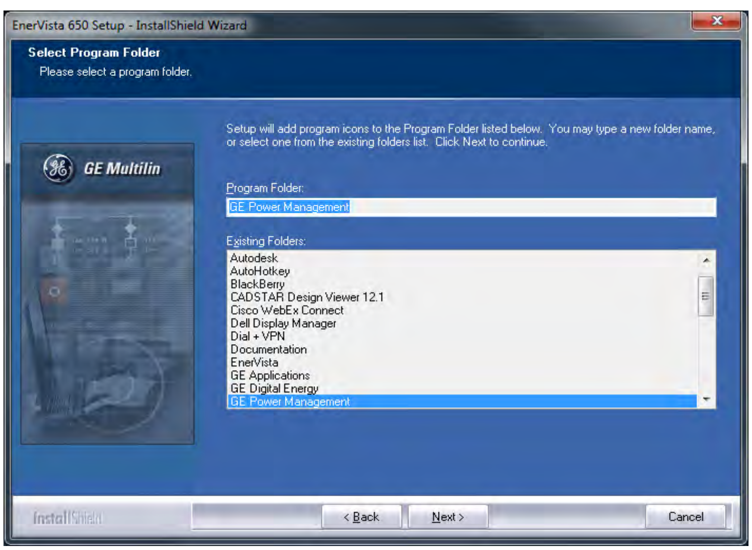


Figure 1-12: Select program folder

10. To complete the installation, select the desired language for startup.

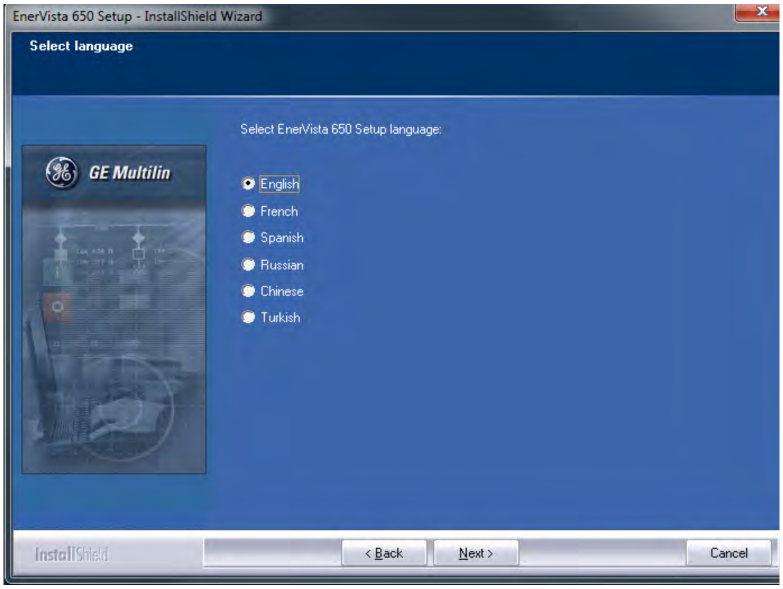


Figure 1-13: Language window

11. Click **Finish** to end the installation. The R650 device has been added to the list of installed IEDs in the EnerVista Launchpad window, as shown below.

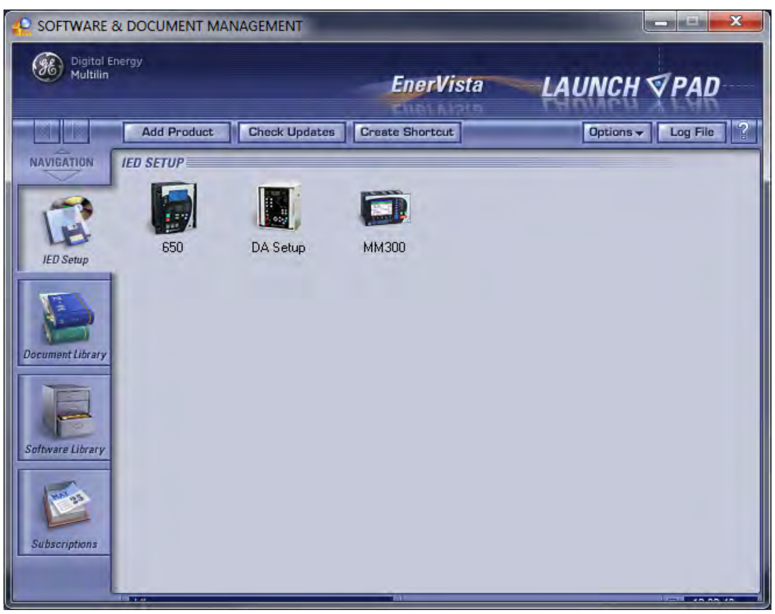


Figure 1-14: EnerVista Launchpad

1.3.3 Connecting EnerVista 650 Setup to the R650

This section is intended as a quick start guide to using the EnerVista 650 Setup software. Refer to section 4.1 in this manual for more information about the EnerVista 650 Setup software interface.

1.3.3.1 Configuring an Ethernet connection

Before starting, verify that the Ethernet network cable is properly connected to the Ethernet port on the back of the relay.

1. Install and start the latest version of the EnerVista 650 Setup software (available from the GE EnerVista DVD or online from http://www.gegridsolutions.com/multilin (see previous section for installation instructions).
2. Go to **Communication > Computer**.
3. Select **Control Type** as **MODBUS TCP/IP** from the drop-down list. This option displays a number of interface parameters that must be entered for proper Ethernet communications.
4. Enter the relay IP address (from **Setpoint > Product Setup > Communication Settings > Network > IP Address**) in the **IP Address** field in **MODBUS TCP/IP SETUP**.
5. Enter the relay ModBus address (from **Setpoint > Product Setup > Communication Settings > ModBus Protocol > ModBus Address COM1/COM2 setting**) in the Unit Identifier (Slave Address) field.
6. Enter the ModBus port address (from **Setpoint > Product Setup > Communication Settings > ModBus Protocol > ModBus Port Number** setting) in the ModBus Port field.
7. The Device has now been configured for Ethernet communications. Click **ON** to begin communicating.

1.3.3.2 Configuring the USB connection

Before starting, verify that the USB Cable, is properly connected to the USB port on the front panel of the relay.

1. Install and start the latest version of the EnerVista 650 Setup software (available from the GE EnerVista DVD or online from http://www.gegridsolutions.com/index.htm (see previous section for installation instructions).
2. Go to **Communication > Computer** and enter the following data referred to communications:
3. Under **Control Type** select **No Control Type** from the drop-down list.
4. Enter the relay Slave Address (**Setpoint > Product Setup > Communication Settings > ModBus Protocol**) in the Slave Address field. The default value is 254.
5. Enter the physical communications parameters (Baud rate and parity settings) from the **Setpoint > Product Setup > Communication Settings > Serial Ports** menu. Default values are 19200 for baud rate and none for parity.
6. The unit has now been configured for communications. Click **ON** to begin communicating.

1.4 650 hardware

1.4.1 Mounting & wiring

Refer to Chapter 3. Hardware for detailed mounting and wiring instructions.

1.4.2 650 communications

The Enervista 650 Setup software communicates with the relay via the faceplate USB port or the rear RS485/Ethernet ports. To communicate via the USB port a male A / male B USB shielded wire is needed

To communicate via the R650 rear RS485 port from a PC RS232 port, the GE Multilin RS232/RS485 converter box is required. This device (catalog number F485) connects to the computer using a “straight-through” serial cable. A shielded twisted-pair (20, 22 or 24 AWG according to American standards; 0.25, 0.34 or 0.5 mm^2 according to European standards) connects the F485 converter to the R650 rear communication port.

To minimize communication errors that can be caused by external noise, a shielded twisted pair is recommended. In order to avoid loops where external currents can flow, the cable shield must be grounded at one end only.

The converter box (-, +, GND) terminals are connected to the relay (SDA, SDB, GND) terminals respectively. For long communications cables (longer than 1 km), the RS485 circuit must be terminated in an RC network (i.e. 120 ohm, 1 nF). This circuit is shown in Figure 1-16: RS485 connection for 650 units, associated with the text Zt(*).

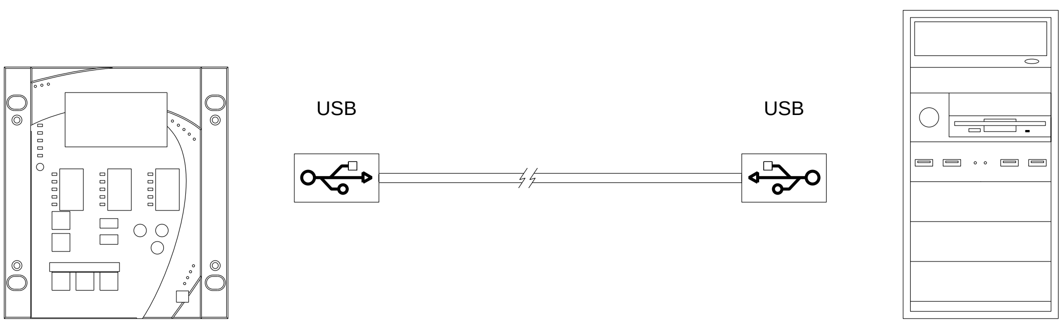


Figure 1-15: Relay- PC connection for RS232 front port

To minimize errors from noise, the use of shielded twisted pair wire is recommended. For correct operation, polarity must be respected, although a different polarity will not damage the unit. For instance, the relays must be connected with all RS485 SDA terminals connected together, and all SDB terminals connected together. This may result in confusion, as the RS485 standard refers to terminals “A” and “B”, although many devices use terminals labeled “+” and “-“.

As a general rule, terminals labeled “A” should be connected to terminals “-“, and terminals “B” to “+”. The GND terminal should be connected to the common wire inside the shield, when provided. Otherwise, it should be connected to the shield. Each relay should also be daisy chained to the next relay in the system. A maximum of 32 relays can be connected in this manner without exceeding driver capability; for larger systems, additional serial channels must be added. It is also possible to use commercially available repeaters to increase the number of relays on a single channel. Do not use other connection configurations.

Lightening strikes and ground surge currents can cause large momentary voltage differences between remote ends of the communication link. For this reason, surge protection devices are provided internally. To ensure maximum reliability, all equipment should have similar transient protection devices installed.

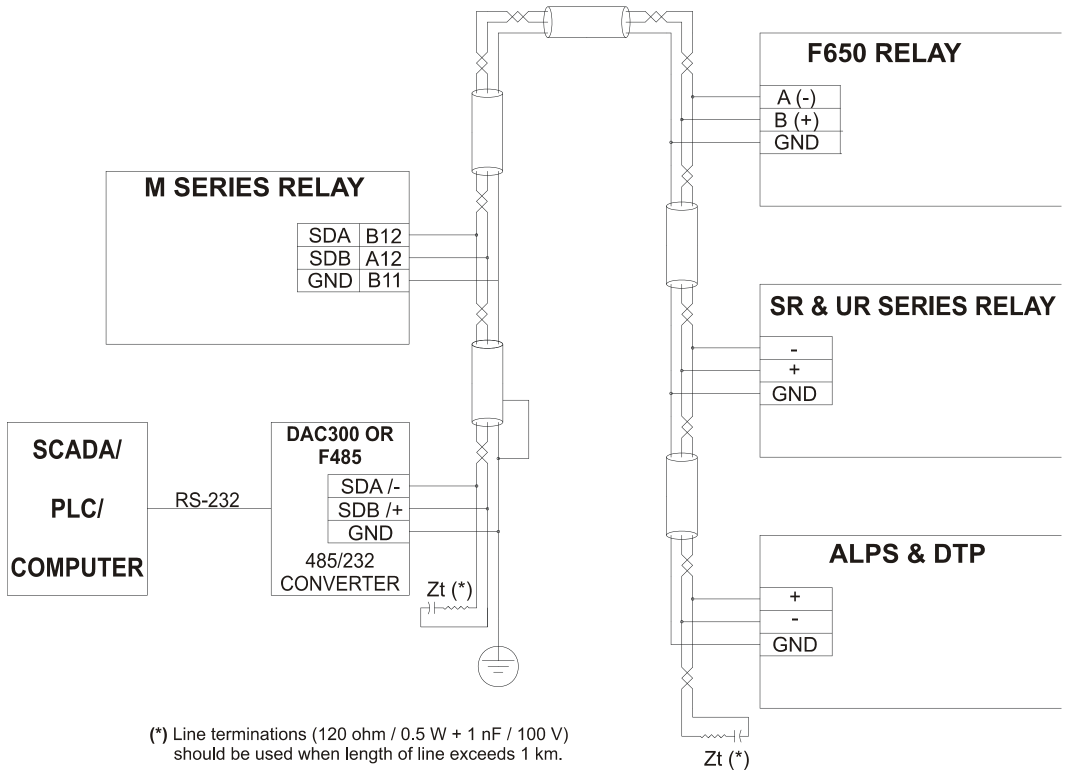


Figure 1-16: RS485 connection for 650 units

To communicate through the R650 rear Ethernet port from a PC, a crossover cable is required. If the connection is performed through a hub or a switch, a direct Ethernet cable is required.

1.4.3 Faceplate display

All messages are displayed on a 20x4 character LCD display. An optional graphic display is also available. Messages are displayed in different languages depending on the model and configuration settings.

1.4.4 Maintenance

1.4.4.1 General maintenance

The R650 requires minimum maintenance once it is commissioned into service. R650 is a microprocessor based relay and its characteristics do not change over time; as such no further functional tests are required. While the R650 performs continual self-tests, it is recommended that maintenance be scheduled with other system maintenance. This maintenance can involve in-service, out-of-service, or unscheduled maintenance.

If it is concluded that the relay or one of its modules is of concern, contact GE Multilin or one of its representative for prompt service.

1.4.4.2 In-service maintenance

1. Visual verification of the analog value integrity such as voltage and current (in comparison to other devices in the system).
2. Visual verification of active alarms, relay display messages and LED indications.
3. Visual inspection for any damage, corrosion, dust or loose wires.
4. Event recorder file download with further event analysis.

1.4.4.3 Out-of-service maintenance

1. Check wiring connections for firmness.
2. Analog value (current, voltages, analog inputs) injection test and metering accuracy verification. Calibrated test equipment is required.
3. Protection element setpoint verification (analog values injection or visual verification of setting file entries against relay settings).
4. Contact inputs and outputs verification. This test can be conducted by direct change of state forcing or as part of the system functional testing.
5. Visual inspection for any damage, corrosion or dust.
6. Event recorder file download with further events analysis.

NOTICE To avoid deterioration of electrolytic capacitors, power up units that are stored in a de-energized state once per year, for one hour continuously.

1.4.4.4 Unscheduled maintenance

Unscheduled maintenance such as during a disturbance causing system interruption:

- View the event recorder and oscillography or fault report for correct operation of inputs,outputs and elements.

1.4.5 Storage

Store the unit indoors in a cool, dry place. If possible, store in the original packaging. Follow the storage temperature range outlined in the Specifications.

NOTICE To avoid deterioration of electrolytic capacitors, power up units that are stored in a de-energized state once per year, for one hour continuously.

1.4.6 Repairs

The firmware and software can be upgraded without return of the device to the factory.

For issues not solved by troubleshooting, the process to return the device to the factory for repair is as follows:

- Contact a GE Grid Solutions Technical Support Center. Contact information is found in the first chapter.
- Obtain a Return Materials Authorization (RMA) number from the Technical Support Center.
- Verify that the RMA and Commercial Invoice received have the correct information.
- Tightly pack the unit in a box with bubble wrap, foam material, or styrofoam inserts or packaging peanuts to cushion the item(s). You may also use double boxing whereby you place the box in a larger box that contains at least 5 cm of cushioning material.
- Ship the unit by courier or freight forwarder, along with the Commercial Invoice and RMA, to the factory.
- Fax a copy of the shipping information to the GE Grid Solutions service department. Customers are responsible for shipping costs to the factory, regardless of whether the unit is under warranty.

Use the detailed return procedure outlined at

https://www.gegridsolutions.com/multilin/support/ret_proc.htm

The current warranty and return information are outlined at

https://www.gegridsolutions.com/multilin/warranty.htm

1.4.7 Disposal

The R650 is intended to be part of defective large-scale stationary industrial tools and large-scale fixed installations. This product cannot be disposed of as unsorted municipal waste in the European Union. For proper recycling return this product to your supplier or a designated collection point. For more information go to www.recyclethis.info.

R650 Recloser Controller

Chapter 2: Product Description

2.1 R650 Overview

The R650 is a recloser controller and has been designed to deliver optimum performance for Distribution Network Operators. The R650 achieves precise and efficient recloser functionality through the intelligent design of the integration between the controller device and the recloser. Bespoke driving electronics for individual recloser devices ensure that there is minimal delay between the R650 output signals and the breaker operation. This 'best in class' speed of operation is achieved using minimal power, thereby ensuring true multiple shot capability. The R650 then goes beyond its high-performance functionality by providing power system engineers with the data, measurement accuracy, and visibility needed for comprehensive asset management. The R650's advanced asset monitoring and diagnostic capabilities link elegantly with a number of Distribution automation tools, and provide Network Operators with both the fundamentals of efficient and reliable network restoration, and the visibility to replace reactive actions with proactive actions.

The complete range of Industry-required protection elements is embedded in the R650, including the full range of Overcurrents, Sensitive Directional Power, Wattmetric Zero Sequence Directional, Negative Sequence Time Overcurrent, and Neutral Instantaneous Overcurrent.

For communications, the R650 has redundant Ethernet and Fiber port options and supports a wide range of industry standard protocols such as IEC 61850, DNP 3.0 serial, DNP 3.0 TCP/IP, IEC 60870-5-101, IEC 60870-5-103, IEC 60870-5-104, Mosbuc RTU and Modbus TCP/IP.

The R650 IEDs use flash memory technology which allows field upgrading as new features are added:

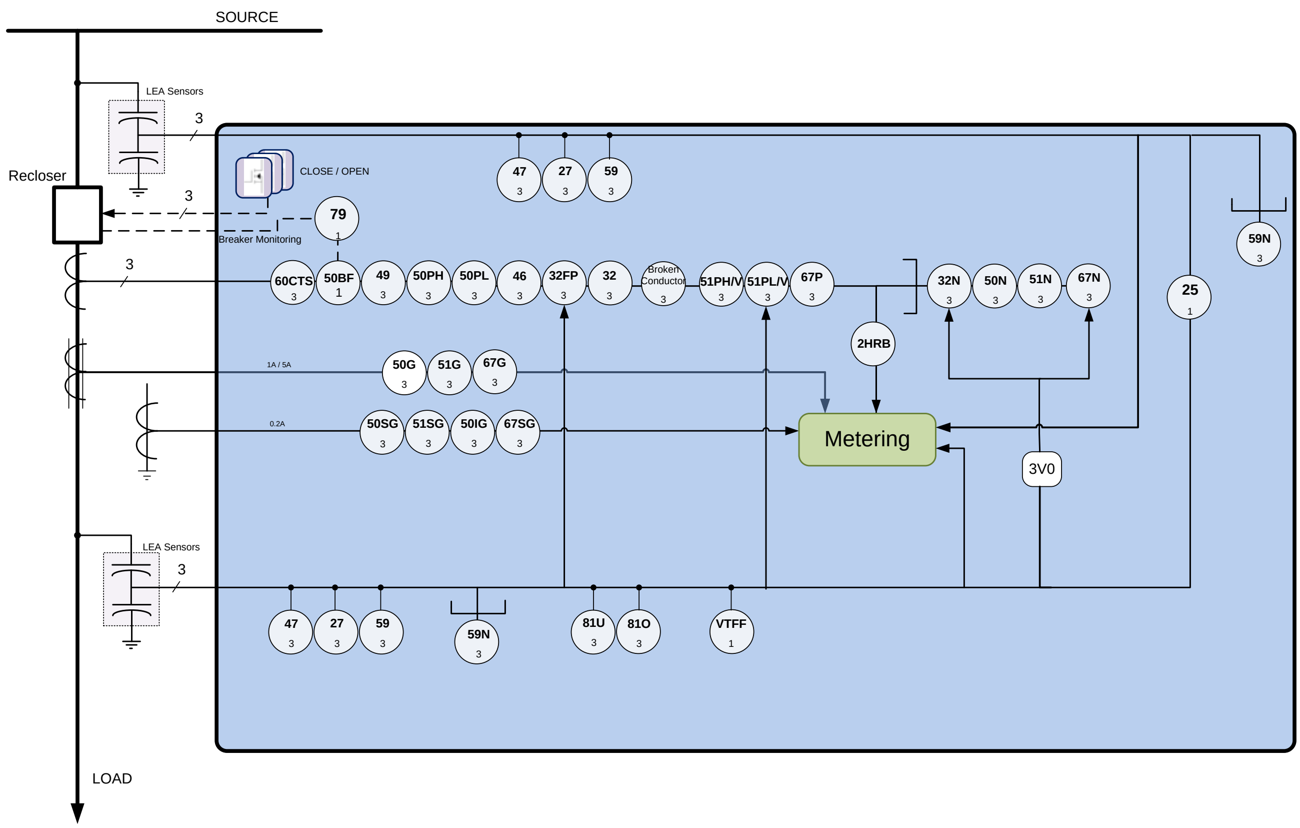


Figure 2-1: FUNCTIONAL BLOCK DIAGRAM

2.2 ANSI device numbers and functions

Main features available in the relay are gathered in tables below

DEVICE NUMBER	PROTECTION & CONTROL FUNCTIONS
25	Synchronism Check
27	Source/Load Undervoltage
32	Sensitive Directional Power
32FP	Forward Power
32N	Wattmetric Zero-Sequence Directional
46	Negative Sequence Time Overcurrent
47	Negative Sequence Voltage
49P	Thermal Model
50 BF	Breaker Failure
50PH/PL	Phase Instantaneous Overcurrent (High/Low)
50N	Neutral Instantaneous Overcurrent
50G	Ground Instantaneous Overcurrent
50SG	Ground Instantaneous Overcurrent for sensitive ground systems (measured from 5th current transformer input)
50IG	Isolated Ground Instantaneous Overcurrent (measured from 5th current transformer input)
51N	Neutral Time Overcurrent
51G	Ground Time Overcurrent
51SG	Sensitive Ground Time Overcurrent
51PH/V	Voltage Restraint Phase Time Overcurrent
51PL/V	Voltage Restraint Phase Time Overcurrent
59	Source/Load Overvoltage
59N	Source/Load Neutral Overvoltage
67P	Phase Directional Overcurrent
67N	Neutral Directional Overcurrent
67SG	Sensitive Ground Directional Overcurrent
79	Autoreclose (Four shot recloser)
81 U/O	Under/Over Frequency
N/A	Broken Conductor
VTFF	VT Fuse Failure Detection
60CTS Failure	Current Transformer Failure
2nd Harmonic Inhibit	Second Harminic Inhibit

2.3 Other device functions

INPUTS/OUTPUTS
11 Analog Inputs: 5 current inputs (3 for phases, 1 for ground, 1 for sensitive ground), 6 LEA voltage inputs (3 source side, 3 load side)
Digital Programmable Contact Inputs (up to 64)
Digital Programmable Contact Outputs (up to 16)
32 Latched Virtual Inputs 32 Self-Reset Virtual Inputs
Virtual Outputs (up to 512)
3 outputs for the Viper-ST recloser with coil supervision
Remote Inputs/Outputs (GSSE and GOOSE messages)
Analog Inputs (dCmA)

METERING
Metering Current for phases, ground and sensitive ground inputs
Voltages phase to phase and phase to ground
Real, Reactive and Apparent Power and Power Factor
Three Phase Energy
Frequency
Sequence components of currents and voltages
Pulse Counters
Analog Comparators
Digital Counters

COMMUNICATIONS
USB port in HMI option E, Two rear RS485/fibre optic ports, 10/100 TX and 100 FX Mbps Ethernet port
ModBus Communications RTU and over TCP/IP
DNP Multimaster (3.0 Level 2)
IEC 870-5-104
ModBus User Map
IEC 61850 protocol
IEC 870-5-103 protocol
IEC 870-5-101 protocol

USER INTERFACE
Alphanumerical display (4x20)
Graphic display (16 x 40)
User Programmable LEDs (15)
User Programmable Keys (up to 5)
Easy menu management
Configurable One-Line Diagram (Graphic model only)
Phasor Diagram (available in EnerVista 650 Setup)

RECORDS
Data Logger
Demand
Event Recorder (up to 128 configurable events)
Fault Locator and Fault report (up to 10 records)
Oscillography (up to 20 records)
Snapshot Events (up to 1023)

OTHERS
Recloser Wear Monitor
IRIG-B synchronization/SNTP/ IEEE 1588
Logic Equations (PLC Editor)
Operations (up to 32)
Web Server Application
Cold Load Pickup (CLP)

2.4 Order codes

R650 units are supplied as ½ 19" rack, 6 units high, containing the following modules: power supply, CPU, I/O modules, communication modules. The required information to completely define an R650 model is shown on Table 2–1:

Table 2-1: Order codes

R650	-	-	-	F	-	G	-	-	-	-		-	DESCRIPTION
	B												Basic Display
	M												Enhanced Display
													REAR SERIAL COMMUNICATIONS BOARD 1
		F											None
		A											Redundant RS485
		P											Redundant plastic fiber optic
		G											Redundant glass fiber optic
		X											Redundant RS485 + fiber remote CAN bus I/O
		Y											Redundant plastic fiber optic + fiber remote CAN bus I/O
		Z											Redundant glass fiber optic + fiber remote CAN bus I/O
		C											Cable Remote CAN bus I/O
		M											RS485 + cable Remote CAN bus I/O
													REAR ETHERNET COMMUNICATIONS BOARD 2 (see Note 1)
			L										PRP, 1588, 10/100 Base TX*+ Redundant 100 Base TX
			M										PRP, HSR, RSTP, 1588, 10/100 Base TX*+ Redundant 100 Base TX
			J										PRP, 1588, 10/100 Base TX* + Redundant 100 Base FX
			K										PRP, HSR, RSTP, 1588, 10/100 Base TX* + Redundant 100 Base FX
													I/O BOARD IN SLOT F
					1								16 Digital Inputs + 8 Outputs
					2								8 Digital Inputs + 8 Outputs + 2 Trip / Close circuit supervision circuits
					4								32 Digital Inputs (see Note 2)
					5								16 Digital Inputs + 8 Analog Inputs (see Note 2)
					6								Driving Electronics for Viper-ST + 8 Digital Inputs
													I/O BOARD IN SLOT G
							0						None
							1						16 contact inputs + 8 Outputs
							4						32 Digital Inputs
							5						16 Digital Inputs + 8 Analog Inputs
													AUXILIARY VOLTAGE
								LO					24-48 Vdc (range 19.2 – 57.6)
								HI					110-250 Vdc (range 88 – 300) 120-230 Vac (range 96 – 250)
								LR					Redundant LO
								HR					Redundant HI
													LANGUAGE
									E				English/English
													COMMUNICATION PROTOCOL
										2			Modbus RTU, TCP/IP, DNP 3.0 Level 2, IEC 60870-5-104, IEC 60870-5-103, IEC 60870-5-101
										7			IEC 61850 Edition 2, Modbus RTU & TCP/IP, DNP 3.0 Level 2, IEC 60870-5-104, IEC 60870-5-103, IEC 60870-5-101
													VOLTAGE AND CURRENT ANALOG MEASUREMENTS
											L		LEA/ Standard CT- 6x LEA Phase Voltage Inputs + 3 Phase Current Inputs VT/CT + 1 Ground Current Input +1 Sensitive Ground Current

													ENVIRONMENTAL PROTECTION
												N	Without Harsh (Chemical) Environment Conformal Coating
												H	Harsh (Chemical) Environment Conformal Coating

Notes:

(*) TX*: ETH E port is only intended for maintenance purposes.

(1) Advanced functionality available in Rear Ethernet Board 2:

Options J, L: PRP, IEEE 1588 PTP, and IEC 61850 Edition 2.0 including Digital counters, DFT, 16 Switchgear, 16 CILO nodes, and XSWI node BlkOpn/BlkCls mapping.

Options K, M: HSR, RSTP, PRP, IEEE 1588 PTP, and IEC 61850 Edition 2.0 including Digital counters, DFT, Max numbers of starts, Cold Load Pickup, 16 Switchgear, 16 CILO nodes, and XSWI node BlkOpn/BlkCls mapping.

(2) Order code option F4 requires option G4 or G5. Order code option F5 requires option G5.

2.4.1 CIO Modules

For applications requiring a high number of inputs and outputs, R650 units can be connected to a CIO module (Remote CAN bus I/O module) for using up to 2 additional boards.

R650 units allow monitoring and configuring these I/O boards as if they were internal boards, located on slots F and G. In this case, slots are labeled as H and J.

The required information to completely define a CIO Module is shown on Table 2–2:.

Table 2-2: Order code for CIO module

CIO	H	-	J	-	-		DESCRIPTION
							I/O BOARD IN SLOT H
		1					16 Digital inputs + 8 outputs
		2					8 Digital Inputs + 8 Outputs + 2 trip/close circuit supervision circuits
		4					32 Digital Inputs
		5					16 Digital Inputs + 8 Analog Inputs
							I/O BOARD IN SLOT J
				0			None
				1			16 Digital inputs + 8 outputs
				4			32 Digital Inputs (See Note 1)
				5			16 Digital Inputs + 8 Analog Inputs (See Note 1)
							AUXILIARY VOLTAGE
					LO		24-48 Vdc (range 19.2 – 57.6)
					HI		110-250 Vdc (range 88 – 300) 120-230 Vac (range 96 – 250)
							ENVIRONMENTAL PROTECTION
						H	Harsh (Chemical) Environment Conformal Coating

(1) The digit selected for option J must be equal or higher than the digit selected for option H for models including boards 4 and 5.

CIOH1J5**: is a valid selection

CIOH5J1**: is an invalid selection

2.5 Technical specifications

NOTICE **TECHNICAL SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE**

2.5.1 Protection

Phase and Ground protection functions use currents measured through CT inputs for performing internal calculations, while the Neutral protection functions use the current calculated from three phase currents.

The sensitive ground protection functions are usually used for applications where the neutral is completely isolated. These functions use current measured though the sensitive ground current input. This CT has a sensitivity 10 time higher than standard CT inputs (Connected to 1A and 5A CT) and its current withstand is lower.

PHASE TIME OVERCURRENT (51PH/51PL)

Current Input:	phasor (without harmonics) or RMS
Rated Current:	for connection to 1 or 5 A CTs
Pickup Level:	0.05 to 20.00 × CT in steps of 0.01 × CT
Dropout Level:	97% to 98% of the pickup level
Level Accuracy:	values at nominal frequency: ±0.5% of the reading ± 10 mA from 0.05 to 10.00 A ±1.5% of the reading for higher values
Curve Shape:	IEEE extremely/very/moderately inverse IEC A/B/C/long-time inverse/short time inverse curve IAC extremely/very/moderately inverse ANSI extremely/very/normally/moderately inverse I^2t Definite time Rectifier curve FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial):	0.00 to 900.00 s in steps of 0.01 s
Reset Type:	instantaneous or time delayed, according to IEEE
Timing Accuracy:	Operate at > 1.03 times the pickup ±3% of operate time or 50 ms (whichever is greater)
Voltage Restraint:	selectable by setting
Saturation Level:	48 times the pickup level
Snapshot Events:	selectable by setting

GROUND TIME OVERCURRENT (51G)

Current Input: ....phasor (without harmonics) or RMS
Rated Current: ....for connection to 1 or 5 A CTs
Pickup Level: ....0.05 to 20.00 × CTg in steps of 0.01 × CTg
Dropout Level: ....97% to 98% of the pickup level
Level Accuracy: ....values at nominal frequency:
±0.5% of the reading ± 10 mA from 0.05 to 10.00 A
±1.5% of the reading for higher values
Curve Shape: ....IEEE extremely/very/moderately inverse
IEC A/B/C/long-time inverse/short time inverse curve
IAC extremely/very/moderately inverse
ANSI extremely/very/normally/moderately inverse
I^2t
Definite time
Rectifier curve
FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial): ....0.00 to 900.00 s in steps of 0.01 s
Reset Type: ....instantaneous or time delayed, according to IEEE
Timing Accuracy: ....Operate at > 1.03 times the pickup ±3% of operate time or 50 ms (whichever is greater)
Saturation Level: ....48 times the pickup level
Snapshot Events: ....selectable by setting

NEUTRAL TIME OVERCURRENT (51N)

Current Input: ....fundamental phasor (without harmonics) or RMS
Pickup Level: ....0.05 to 20.00 × CT in steps of 0.01 × CT
Dropout Level: ....97% to 98% of the pickup level
Level Accuracy: ....values at nominal frequency:
±0.5% of the reading ± 10 mA from 0.05 to 10.00 A
±1.5% of the reading for higher values
Curve Shape: ....IEEE extremely/very/moderately inverse
IEC A/B/C/long-time inverse/short time inverse curve
IAC extremely/very/moderately inverse
ANSI extremely/very/normally/moderately inverse
I^2t
Definite time
Rectifier curve
FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial): ....0.00 to 900.00 s in steps of 0.01 s
Reset Type: ....instantaneous or time delayed, according to IEEE
Timing Accuracy: ....Operate at > 1.03 times the pickup ±3% of operate time or 50 ms (whichever is greater)
Saturation Level: ....48 times the pickup level
Snapshot Events: ....selectable by setting

SENSITIVE GROUND TIME OVERCURRENT (51SG)

Current Input:	phasor (without harmonics) or RMS
Rated Current:	for connection to 1 or 5 A CTs
Pickup Level:	0.025 to 2.000 × CTsg in steps of 0.001 × CTsg
Dropout Level:	97% to 98% of the pickup level
Level Accuracy:	values at nominal frequency: ±1.5% of the reading ± 1 mA from 0.005 to 16.000 A
Curve Shape:	IEEE extremely/very/moderately inverse IEC A/B/C/long-time inverse/short time inverse curve IAC extremely/very/moderately inverse ANSI extremely/very/normally/moderately inverse I^2t Definite time Rectifier curve FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial):	0.00 to 900.00 s in steps of 0.01 s
Reset Type:	instantaneous or time delayed, according to IEEE
Timing Accuracy:	Operate at > 1.03 times the pickup ±3% of operate time or 50 ms (whichever is greater)
Saturation Level:	48 times the pickup level
Snapshot Events:	selectable by setting

PHASE AND GROUND INSTANTANEOUS OVERCURRENT (50PH/50PL/50G)

Current Input:	phasor (without harmonics) or RMS
Rated Current:	for connection to 1 or 5 A CTs
Pickup Level:	0.05 to 20.00 × CT in steps of 0.01 × CT (phase) 0.05 to 20.00 × CTg in steps of 0.01 × CTg (ground)
Dropout Level:	97% to 98% of the pickup level
Level Accuracy:	values at nominal frequency: ±0.5% of the reading ± 10 mA from 0.05 to 10.00 A ±1.5% of the reading for higher values
Overreach:	< 2%
Trip Delay:	0.00 to 900.00 s in steps of 0.01 s
Reset Delay:	0.00 to 900.00 s in steps of 0.01 s
Operate Time:	< 50 ms at 3 × pickup at 50 Hz, typically
Timing Accuracy:	at 0 ms time delay (no intentional delay): 50 ms at non-zero time delay: ±3% of operate time or 50 ms (whichever is greater)
Snapshot Events:	selectable by setting

NEUTRAL INSTANTANEOUS OVERCURRENT (50N)

Current Input:	fundamental phasor (without harmonics)
Pickup Level:	0.05 to 20.00 × CT in steps of 0.01 × CT
Dropout Level:	97% to 98% of the pickup level
Level Accuracy:	values at nominal frequency: ±0.5% of the reading ± 10 mA from 0.05 to 10.00 A ±1.5% of the reading for higher values
Overreach:	< 2%
Trip Delay:	0.00 to 900.00 s in steps of 0.01 s
Reset Delay:	0.00 to 900.00 s in steps of 0.01 s
Operate Time:	< 50 ms at 3 × pickup at 50 Hz, typically
Timing Accuracy:	at 0 ms time delay (no intentional delay): 50 ms at non-zero time delay: ±3% of operate time or 50 ms (whichever is greater)
Snapshot Events:	selectable by setting

SENSITIVE GROUND INSTANTANEOUS OVERCURRENT (50SG)

Current Input: ....phasor (without harmonics) or RMS
Rated Current: ....for connection to 1 or 5 A CTs
Pickup Level: ....0.025 to 2.000 × CTsg in steps of 0.001 × CTsg
Level Accuracy: ....values at nominal frequency:
±1.5% of the reading ± 1 mA from 0.005 to 16.000 A
Overreach: ....< 2%
Trip Delay: ....0.00 to 900.00 s in steps of 0.01 s
Reset Delay: ....0.00 to 900.00 s in steps of 0.01 s
Operate Time: ....< 50 ms at 3 × pickup at 50 Hz, typically
Timing Accuracy: ....at 0 ms time delay (no intentional delay): 50 ms
at non-zero time delay: ±3% of operate time or 50 ms
(whichever is greater)
Snapshot Events: ....selectable by setting

ISOLATED GROUND INSTANTANEOUS OVERCURRENT (50IG)

Current Input: ....fundamental phasor (without harmonics)
Voltage Input: ....fundamental phasor (without harmonics)
Current Pickup Level: ....0.005 to 0.400 × CTg in steps of 0.001 × CTg
Voltage Pickup Level: ....0.02 to 0.400 × VT in steps of 0.001 × VT
Dropout Level: ....97% to 98% of the pickup level
Level Accuracy: ....±1.5% of the reading ± 1 mA from 0.005 to 16.000 A
Trip Delay: ....0.00 to 900.00 s in steps of 0.01 s
Time to Instantaneous: ....0.00 to 900.00 s in steps of 0.01 s
Operate Time: ....< 50 ms at 3 × pickup at 50 Hz, typically
Timing Accuracy: ....at 0 ms time delay (no intentional delay): 50 ms
at non-zero time delay: ±3% of operate time or 50 ms
(whichever is greater)
Snapshot Events: ....selectable by setting

NEGATIVE SEQUENCE TIME OVERCURRENT (46)

Current Input: ....fundamental phasor (without harmonics)
Pickup Level: ....0.05 to 20.00 × CT in steps of 0.01 × CT
Dropout Level: ....97% to 98% of the pickup level
Level Accuracy: ....values at nominal frequency:
±0.5% of the reading ±10 mA from 0.05 to 10.00 A
±1.5% of the reading for higher values
Curve Shape: ....IEEE extremely/very/moderately inverse
IEC A/B/C/long-time inverse/short time inverse curve
IAC extremely/very/moderately inverse
ANSI extremely/very/normally/moderately inverse
I^2t
Definite time
Rectifier curve
FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial): ....0.00 to 900.00 s in steps of 0.01 s
Reset Type: ....instantaneous or time delayed, according to IEEE
Timing Accuracy: ....Operate at > 1.03 times the pickup ±3% of operate time or 50 ms
(whichever is greater)
Saturation Level: ....48 times the pickup level
Snapshot Events: ....selectable by setting

PHASE DIRECTIONAL (67P)

Directionality:	forward and reverse selectable by setting
Polarizing:	quadrature voltage: ABC seq: Phase A (VBC), Phase B (VCA), Phase C (VAB) ACB seq: Phase A (VCB), Phase B (VAC), Phase C (VBA)
Polarizing Voltage Threshold:	0 to 1.25 x VT in steps of 0.01 x VT
Current Sensitivity Threshold:	50 mA
Characteristic Angle:	-90° to +90° in steps of 1°
Block Logic:	permission or block selectable by setting
Angle Accuracy:	±3° for I > 0.1 A and V > 5 Vac
Voltage Memory Time:	0.00 to 3.00 s in steps of 0.01 s
Operate Time:	< 30 ms, typically

GROUND DIRECTIONAL (67G)

Directionality:	forward and reverse selectable by setting
Polarizing:	voltage, current, dual
Polarizing Voltage:	V_N
Polarizing Current:	I_{sg} (measured from 5th current transformer)
Operating Current:	I_g (measured from 4th current transformer)
Polarizing Voltage Threshold:	0 to 1.25 x VT in steps of 0.01 x VT
Polarizing Current Threshold:	0.005 A
Characteristic Angle:	-90° to +90° in steps of 1°
Block Logic:	permission or block selectable by setting
Angle Accuracy:	±3° for I > 0.1 A and V > 5 Vac
Operate Time:	< 30 ms, typically

NEUTRAL DIRECTIONAL (67N)

Directionality:	forward and reverse selectable by setting
Polarizing:	voltage, current, dual
Polarizing Voltage:	V_N
Polarizing Current:	I_{sg} (measured from 5th current transformer)
Operating Current:	I_N
Polarizing Voltage Threshold:	0 to 1.25 x VT in steps of 0.01 x VT
Polarizing Current Threshold:	0.005 A
Characteristic Angle:	-90° to +90° in steps of 1°
Block Logic:	permission or block selectable by setting
Angle Accuracy:	±3° for I > 0.1 A and V > 5 Vac
Operate Time:	< 30 ms, typically

SENSITIVE GROUND DIRECTIONAL (67SG)

Directionality:	forward and reverse selectable by setting
Polarizing:	voltage
Polarizing Voltage:	V_N
Operating Current:	I_{sg} (measured from 5th current transformer)
Polarizing Voltage Threshold:	0 to 1.25 x VT in steps of 0.01 x VT
Characteristic Angle:	-90° to +90° in steps of 1°
Block Logic:	permission or block selectable by setting
Angle Accuracy:	±2° for I > 0.1 A and V > 5 Vac
Operate Time:	< 30 ms, typically

THERMAL MODEL (49)

Current Input: ....fundamental phasor (without harmonics)
Rated Current:...for connection to 1 or 5 A CTs
Pickup Level: ....0.05 to 20.00 × CT in steps of 0.01 × CT
Dropout Level:...97% to 98% of the pickup level
Alarm Level:...1.0% to 110.0% in steps of 0.1%
Level Accuracy: ....values at nominal frequency:
±0.5% of the reading ± 10 mA from 0.05 to 10.00 A
±1.5% of the reading for higher values
Timing Accuracy: ....±3.5% of operating time or 50 ms (whichever is greater)
Heating Constant: ....3.0 to 600.0 minutes in steps of 0.1 minutes
Cooling Constant: ....1.00 to 6.00 times the heating constant, in steps of 0.01
Snapshot Events: ....selectable by setting

PHASE OVERVOLTAGE (59P)

Voltage Input: ....fundamental phasor (without harmonics) of phase-to-phase voltages
Pickup Level: ....0.02 to 1.25 × VT in steps of 0.01 × VT
Dropout Level:...97% to 98% of the pickup level
Level Accuracy: ....±0.5% of the reading from 0.5 to 10.0 V at nominal frequency
Trip Delay:...0.00 to 900.00 s in steps of 0.01 s
Reset Delay: ....0.00 to 900.00 s in steps of 0.01 s
Timing Accuracy: ....±3.5% of operating time or 50 ms (whichever is greater)
Logic: ....Any/Two/All phases logic, selectable by setting
Snapshot Events: ....selectable by setting

PHASE UNDERVOLTAGE (27P)

Voltage Input: ....fundamental phasor of phase-to-ground or phase-to-phase voltages (selectable by setting)
Pickup Level: ....0.02 to 1.25 × VT in steps of 0.01 × VT
Dropout Level:...102% to 103% of the pickup level
Level Accuracy: ....±0.5% of the reading from 0.5 to 10.0 V at nominal frequency
Trip Delay:...0.00 to 900.00 s in steps of 0.01 s
Curve Shapes: ....fixed time or inverse curves
Reset Type: ....instantaneous
Curve Multiplier (Time Dial):...0.00 to 900.00 s in steps of 0.01 s
Timing Accuracy: ....±3.5% of operating time or 50 ms (whichever is greater)
Minimum Voltage Threshold: ....0 to 1.25 × VT in steps of 0.01 × VT
Logic: ....Any/Two/All phases logic, selectable by setting
Supervised by Breaker: ....selectable by setting
Snapshot Events: ....selectable by setting

NEUTRAL OVERVOLTAGE (59N)

Voltage Input: ....fundamental phasor of the neutral voltage
Pickup Level: ....0.02 to 1.25 × VT in steps of 0.01 × VT
Dropout Level:...97% to 98% of the pickup level
Level Accuracy: ....±0.5% of the reading from 0.5 to 10.0 V at nominal frequency
Trip Delay:...0.00 to 900.00 s in steps of 0.01 s
Reset Delay: ....0.00 to 900.00 s in steps of 0.01 s
Timing Accuracy: ....±3.5% of operating time or 50 ms (whichever is greater)
Snapshot Events: ....selectable by setting

NEGATIVE SEQUENCE OVERVOLTAGE (47)

Voltage Input: .... fundamental phasor
Pickup Level:........ 0.02 to 1.25 x VT in steps of 0.01 x VT
Dropout Level: .... 97% to 98% of the pickup level
Level Accuracy: .... ±0.5% of the reading from 0.5 to 10.0 V at nominal frequency
Trip Delay: .... 0.00 to 900.00 s in steps of 0.01 s
Reset Delay: .... 0.00 to 900.00 s in steps of 0.01 s
Timing Accuracy:........ ±3.5% of operating time or 50 ms (whichever is greater)
Snapshot Events: .... selectable by setting

UNDERFREQUENCY (81U)

Pickup Level:........ 20.00 to 65.00 Hz in steps of 0.01 Hz
Dropout Level: .... pickup + 0.03 Hz
Level Accuracy: .... ±0.05 Hz of the reading from 30 to 80 Hz
Trip Delay: .... 0.00 to 900.00 s in steps of 0.01 s
Reset Delay: .... 0.00 to 900.00 s in steps of 0.01 s
Minimum Voltage Threshold:........ 0.05 to 1.25 x VT in steps of 0.01 x VT
Time Delay Accuracy: .... 0 to 7 cycles
Operate Time:........ typically 10 cycles at 0.1 Hz/s change
Snapshot Events: .... selectable by setting

OVERFREQUENCY (81O)

Pickup Level:........ 20.00 to 65.00 Hz in steps of 0.01 Hz
Dropout Level: .... pickup - 0.03 Hz
Level Accuracy: .... ±0.05 Hz of the reading from 30.00 to 80.00 Hz
Trip Delay: .... 0.00 to 900.00 s in steps of 0.01 s
Reset Delay: .... 0.00 to 900.00 s in steps of 0.01 s
Minimum Voltage Threshold:........ 0.05 to 1.25 x VT in steps of 0.01 x VT
Time Delay Accuracy: .... 0 to 7 cycles
Operate Time:........ typically 10 cycles at 0.1 Hz/s change
Snapshot Events: .... selectable by setting

FORWARD POWER (32FP)

Current, Voltage: .... fundamental phasor (primary values)
Number of Stages:........ 2
Pickup Level:........ 0.00 to 10000.00 MW in steps of 0.01 MW
Dropout Level: .... 97% to 98% of the pickup level
Level Accuracy for Primary Magnitudes:........ ±3% of complete range
Trip Delay (Two Stages):........ 0.00 to 900.00 s in steps of 0.01 s
Timing Accuracy:........ ±3.5% of operate time or 50 ms (whichever is greater)
Block Time After Close: .... 0.00 to 900.00 s in steps of 0.01 s
Snapshot Events: .... selectable by setting

DIRECTIONAL POWER (32)

Current, Voltage: .... fundamental phasor (primary values)
Number of Stages:........ 2
Pickup Level:........ -10000.00 to 10000.00 MW (primary values) in steps of 0.01 MW
Characteristic Angle (Two Stages): .... 0.00° to 359.99° in steps of 0.01°
Accuracy for Primary Magnitudes: .... ±3% of complete range
Trip Delay (Two Stages):........ 0.00 to 900.00 s in steps of 0.01 s
Timing Accuracy:........ ±3.5% of operate time or 50 ms (whichever is greater)
Block Time After Close: .... 0.00 to 900.00 s in steps of 0.01 s
Snapshot Events: .... selectable by setting
Operate Time:........ < 45 ms at 50 Hz, typically

WATTMETRIC ZERO-SEQUENCE DIRECTIONAL (32N)

Measured Power: zero sequence
Number of Elements: 6 (3 high level, 3 low level)
Voltage Pickup Level V_N: 0.02 to 1.00 x VT in steps of 0.01 x VT
Level Accuracy for Voltage: ±0.5% of the reading from 0.5 to 10.0 V at nominal frequency
Current Selection: I_N (calculated from phases)
I_G (measured from the 4th current transformer)
OC Pickup Level: 0.002 to 0.400 x CT in steps of 0.001 x CT for In
0.002 to 0.400 x CTg in steps of 0.001 x CTg for Ig
Level Accuracy for Current: ±0.5% of the reading ± 10 mA from 0.05 to 10.00 A
±1.5% of the reading for higher values
OC Pickup Delay: 0.00 to 600.00 s in steps of 0.01 s
Power Pickup Level: 0.001 to 1.200 x CTVT in steps of 0.001 x CTVT
NOTE: A value of x CTVT is a product of the VT voltage as specified in the VOLTAGE PICKUP setpoint description of this element, and CT current as specified for the CURRENT PICKUP setpoint of this element.
Characteristic Angle (MTA): 0° to 360° in steps of 1°
Power Pickup Delay: 0.00 to 600.00 s in steps of 0.01 s
Level Accuracy for Power: ±2.5% of the reading at -0.8 ≤ PF ≤ -1 and 0.8 < PF ≤ 1
Curve Shapes: Inverse Curve
Definite Time
FlexCurve™ A/B/C/D user curves
Curve Multiplier (Time Dial): 0.02 to 2.00 s in steps of 0.01 s
Tripping Time Accuracy: ±3.5% of operate time or 50 ms whichever is greater
Snapshot Events: selectable by setting
Operate Time: < 45 ms at 50 Hz, typically

BROKEN CONDUCTOR (I2/I1)

Pickup Level: 20.0-100.0% (I2/I1 ratio) in steps of 0.1%
Dropout Level: 97% to 98% of the pickup level
Trip Delay: 0.00 to 900.00 s in steps of 0.01 s
Timing Accuracy: ±3.5% of operate time or 50 ms (whichever is greater)
Snapshot Events: selectable by setting
Operation Threshold: 0 to 1.00 x CT in steps of 0.01 x CT

2.5.2 Control

AUTORECLOSE (79)

Schemes: Single pole and three-pole tripping schemes
Number of Shots: Up to 4 reclose attempts per phase before lockout
Dead Time: Independent dead time setting before each shot
adjustable between 0.00 and 900.00 s in steps of 0.01 s.
Condition Permission: Selectable by setting
Condition Time: 0.00 and 900.00 s in steps of 0.01 s
Reset Time: 0.00 and 900.00 s in steps of 0.01 s
Reclaim Time: 0.00 and 900.00 s in steps of 0.01 s
Halt Time: 0.00 and 900.00 s in steps of 0.01 s
Coordination Time: 0.00 and 900.00 s in steps of 0.01 s
Snapshot Events: selectable by setting
Protection settings can be modified after each shot through PLC programming (block signals are available after each shot; AR Halt input, AR Direct To Lockout, AR coordination, AR Skip counter, AR Phase Shot).

SYNCHROCHECK (25)

Dead Source Level:.. 0.00 to 1.25 × VT (S) in steps of 0.01 × VT
Live Source Level: .... 0.03 to 1.25 × VT (S) in steps of 0.01 × VT
Dead Load Level:.. 0.00 to 1.25 × VT (L) in steps of 0.01 × VT
Live Load Level:.. 0.03 to 1.25 × VT (L) in steps of 0.01 × VT
Maximum Voltage Difference: .... 0.02 to 1.25 × VT (L) in steps of 0.01 × VT
Maximum Angle Difference: .... 2.0° to 80.0° in steps of 0.1°
Maximum Frequency Slip:... 10 to 5000 mHz in steps of 10 mHz
Synchronism Time:.. 0.01 to 1.00 s in steps of 0.01 s
Angle Accuracy: .... 3°
Dead Source Function:... None
Dead Source - Dead Load
Live Source - Dead Load
Dead Source - Live Load
Snapshot Events: .... selectable by setting

FUSE FAILURE

Algorithm based on positive sequence of voltage and current
Activation by V_2/V_1 ratio

BREAKER FAILURE (50BF)

Current Input:... Fundamental phasor
Rated Current: .... 1 or 5 A CTs
Trip Mode:... Single-pole or three-pole
Pickup Level for Supervision:.. 0.05 to 20.00 xCT in steps of 0.01 xCT
Pickup Level for High Level: .... 0.05 to 20.00 xCT in steps of 0.01 xCT
Pickup Level for Low Level: .... 0.05 to 20.00 xCT in steps of 0.01 xCT
Pickup Level for Internal Arcing: .... 0.05 to 20.00 xCT in steps of 0.01 xCT
Dropout Level: .... 95% to 98% of the pickup level
Level Accuracy: .... values at nominal frequency:
±0.5% of the reading ± 10 mA from 0.05 to 10.00 A
±1.5% of the reading for higher values
Timing Accuracy:.. ±3.5% of operate time or 50 ms (whichever is greater)
Snapshot Events: .... selectable by setting

CT SUPERVISION FAILURE (60CTS)

Inputs: ....Neutral Current I_N
Neutral Voltage V_N (from three-phase VTs)
Ground Current I_g
Sensitive Ground Current I_{sg}
Time Delay: ....0.00 to 600.00 s in steps of 0.01 s
3IO Level Accuracy:..0.05 to 2.00 × CT in steps of 0.01 × CT
3VO Level Accuracy: ....0 to 1.25 × CT in steps of 0.01 × CT
Ground Current Inhibit: ....0.05 to 2.00 × CTg in steps of 0.01 × CTg
Ground Current Accuracy: ....±0.5% of the reading ± 10 mA from 0.05 to 10.00 A
Sensitive Ground Current Accuracy: ....±1.5% of the reading ± 1 mA from 0.005 to 16.000 A
Operate Time: ....< 20 ms at 60 Hz
< 25 ms at 50 Hz
Snapshot Events: ....selectable by setting

SECOND HARMONIC INHIBIT

Operating Parameter: ....2nd harmonic of phase current (ANY ONE, ANY TWO, ALL THREE, AVERAGE)
Pickup Level: ....0.1 to 40.0% in steps of 0.1%
Dropout Level:..97% of the pickup level or pickup level -0.5%, whichever is greater
Level Accuracy: ....2% or 10 mA
Minimum Current: ....0.05 to 2.00 × CT in steps of 0.01 × CT
Time Delay: ....0.00 to 600.00 s in steps of 0.01 s
Time Delay Accuracy:..±3% of expected time or 1.5 cycles (whichever is greater)
Time Accuracy: ....3% or 1.5 cycles
Snapshot Events: ....selectable by setting

PULSE COUNTERS

Number of Pulse Counters Available: ....up to 8
Multiplier Factor:..0.000 to 65000.000 in steps of 0.001
Overload Factor:..0 to 10000000 in steps of 1
Board Origin:..all available input/output boards in the device. See order code (F, G, H, J)
Input Origin: ....up to 32 (depending on board selection type)

ANALOG COMPARATORS

Analog Input: ....any analog value in the device
Analog Maximum Threshold Value: ....-100000.000 to 100000.000 in steps of 0.001
Analog Minimum Threshold Value: ....-100000.000 to 100000.000 in steps of 0.001
Analog Delay:..0.00 to 900.00 in steps of 0.01
Analog Hysteresis:..0.0 to 50.0 in steps of 0.1
Analog Direction (for activation inside or outside the
deadband: ....IN or OUT

DIGITAL COUNTERS

Function:..Disabled, Enabled
Name:..any 12 alphanumeric characters
Preset: ....-2147483648, 0, +2147483647
Compare:..-2147483648, 0, +2147483647

COLD LOAD PICKUP

Cold Outage Time: ....1 to 1000 minutes in steps of 1 minute
Cold Blocking Time:..1 to 1000 s in steps of 1 s

2.5.3 Recloser Settings

RECLOSER SETTINGS

Reclose Type: Single-pole, three-pole reclosers
Maximum Interrupting kA: 0.00 to 999.99 in steps of 0.1 kA
Maximum Number of Openings: 0 to 65536 in steps of 1
Maximum Number of Openings in One Hour: 0 to 60 in steps of 1
Reclose Wear Monitor Alarm: 20 to 100% of total duty factor

SINGLE-POLE / THREE-POLE TRIP LOGIC

Trip Mode: ONE POLE, THREE POLE
Trip Minimum Seal-in Time: 0.02 to 60.00 s in steps of 0.01 s
Yellow Handle Timer: 0.00 to 60.00 s in steps of 0.01 s
Minimum Current Supervision: 0.05 to 1.00 × CT in steps of 0.01 × CT
Snapshot Events: selectable by setting

SWITCHGEAR

Switchgear: 1 to 16 (configurable in **Relay Configuration**)
Contacts: 52a, 52b, 52a+b
Opening Time: 0 to 30000 ms in step of 1 ms
Closing Time: 0 to 30000 ms in step of 1 ms
Contact A: 52a configurable input from PLC logic state
Contact B: 52b configurable input from PLC logic state
Open Text: Text in Control events for an open condition
Close Text: Text in Control events for a close condition
Error 00 Text: Text in Control events for an 00 error state
Error 11 Text: Text in Control events for an 11 error state
Opening init: Configurable pulse input that initiates the open process
Closing init: Configurable pulse input that initiates the close process
Block Open: Configurable input state for blocking open commands
Block Close: Configurable input state for blocking close commands
Snapshot Events: Selectable by setting (for each switchgear, in **System Setup**)

2.5.4 Monitoring

OSCILLOGRAPHY

Maximum Records: up to 20 oscillography records
Sampling Rate: programmable to 4, 8, 16, 32, or 64 samples per power cycle
Capacity per record: (27592 samples)/(number of oscillos x number of samples/cycle)
Maximum Records: up to 20 oscillography records
Trigger Position: 5% to 95% of total length
Trigger: programmable via PLC
Data: 5 current channels and 4 voltage channels up to 16 digital channels programmable through PLC
Data Storage: non-volatile (flash) memory without battery
Format: International Standard COMTRADE ASCII - IEEE C37.111-1999
Automatic Overwrite: selectable by setting (oscillography records can be concatenated)
Snapshot Events: selectable by setting

FAULT LOCATOR

Method: ....single-ended
Positive Sequence Module: ....0.01 to 250.00 Ohm in steps of 0.01 Ohms
Positive Sequence Angle: ....25 to 90° in steps of 1°
Zero Sequence Module: ....0.01 to 750.00 Ω in steps of 0.01 Ω
Zero Sequence Angle: ....25 to 90° in steps of 1°
Line Length: ....0.0 to 2000.0 in steps of 0.1 km
Accuracy: ....5% (typically)
Show Fault on HMI: ....selectable by setting
Snapshot Events: ....selectable by setting
Maximum Records: ....up to 10 fault report records
Data: ....Fault date and time, pre-fault currents and voltages, fault currents and voltages, fault type, distance to the fault (fault location), line parameters, recloser and breaker status information.
Data Storage: ....In non-volatile (flash) memory without battery available through communications In volatile (RAM) memory available through HMI (if selectable by setting)
Format: ....text in ASCII format

SNAPSHOT EVENTS

Capacity: ....1023 scrolling events
Time-tag: ....1 ms using an internal clock of 100 µs
Timing Accuracy: ....1 ms (using IRIG-B synchronization)
Triggers: ....any element pickup, dropout, or operation
digital input/output change of state
virtual inputs and control events
Data Storage: ....non-volatile (flash) memory without battery

CONTROL EVENTS

Capacity: ....128 events programmable through PLC
Time-tag: ....1 ms plus one PLC cycle using an internal clock of 100 µs. For digital inputs, the debounce time of these digital inputs must be added.
Timing Accuracy: ....1 ms (with IRIG-B synchronization input)
Trigger: ....Any digital signal programmable through the PLC
Alarm: ....Control events can be displayed as an alarm on the alarms panel. Information is always available through **Communications** for all models and in the HMI for models with a graphical display (M in order code).
Data Storage: ....non-volatile (flash) memory without battery
Control events are also displayed in the snapshot events recording

DEMAND

Channels: 9
Parameters: ....Ia (kA RMS), Ib (kA RMS), Ic (kA RMS), Ig (kA RMS), Isg (kA RMS), I2 (kA), P (MW), Q (MVAr) and S (MVA)
Current and Power Method: ....Thermal Exponential, Block Interval, Rolling Demand
Measurements: ....Each channel shows the present and maximum measured value, with date and time for the maximum recorded value.
Samples: ....5, 10, 15, 20, 30, 60 minutes
Accuracy: ....±2%
Trigger Input: ....selectable by setting (operation mode selection for the block interval calculation method)
Snapshot Events: ....selectable by setting

DATA LOGGER

Number of Channels: ....1 to 16
Parameters: ....any available analog actual value
Samples: ....1 second, 1, 5, 10, 15, 20, 30, 60 minutes
Storage Capacity: ....fixed, 32768 measurements

INTERNAL MONITORING - I/O BOARD TYPE 6

Capacitor Voltage:	5 to 165 V Accuracy ±2% of reading or ±0.2% of full scale
Capacitor Voltage Alarm:	80% of voltage setting for external power supply (155 Vdc)
Current Sensors:	3 sensors (one per phase coil) 0 to 30 A Accuracy ±3% of reading

COIL CIRCUIT SUPERVISION - I/O BOARD TYPE 6

Coil Supervisions:	3 coil supervisions (one per phase)
Load for Coil Supervision:	2mA + V/400 kOhm
Operate Time:	100 ms ± 10 ms (normal conditions) 600 ms ± 10 ms (after opening and closing operations)
Reset Delay:	< 10 ms

2.5.5 User-programmable

PLC LOGIC

Programming language:	The logical configuration is performed using graphical functions based on the IEC 61131-3 standard.
Lines of code*:	1000 total equations or 15360 bytes, whichever is greater

(*) Note: Reserved Modbus memory space of PLC equations in text format is up to 15360 bytes. This space is shared with information configured in Enervista at **Setpoint > Relay Configuration**. According to this, the number of PLC equations can be limited by values configured on that section.

Supported operations:	NOT, XOR, OR (2 to 8 inputs), AND (2 to 8 inputs), NOR (2 to 8 inputs), NAND (2 to 8 inputs), Latch (Reset Dominant), Edge Detectors, Timers, Analog Operators. 2 inputs default gates, from 3 to 8 inputs provided in library format.
Libraries:	Logical gates fully programmable by user. Used to create user-programmable logic to be distributed as a single object.
Inputs:	any logical variable, contact or virtual input
Number of Timers:	8 maximum in each logic scheme (provided in library format)

FLEXCURVES

Number:	4 (A through D)
Reset Points:	40 (0 through 1 of pickup)
Operate Point:	80 (0 through 20 of pickup)
Time Delay:	0 to 65535 ms in steps of 1 ms
Saturation Level:	20 x the pickup level

USER-PROGRAMMABLE LEDS

Number:	15 configurable LEDs plus the Ready non-configurable LED
Programmability:	any logical variable, contact, or virtual input
Reset Mode:	self-reset or latched. The first 5 LEDs (red) are latched by hardware, usually configured for trip signals. The following 10 LEDs (yellow and green) are self-reset but can be latched through PLC configuration.
Reset Signal:	The LEDs can be reset by hardware, pressing the front "esc" key for more than 3 seconds or using the LED reset signal through PLC configuration.

USER-DEFINABLE DISPLAYS

Number of Configurable Displays:..................................1: one line diagram fully configurable. In graphical displays only
Number of Fixed Displays: ....6: Metering (selectable between Primary and Secondary values), Snapshot Events (all and new), Alarms, Inputs and Outputs screen with test functionality for inputs and outputs. (In graphical displays only.)
Number of Selectable Displays:..2: Logotype, Metering, or both in scrolling mode can be selected as the default screen in text display for all models (basic and mimic). The metering screen contains current and voltages for phases and ground in primary or secondary values.

USER-PROGRAMMABLE FRONT KEYS

Number of Configurable Keys: 5
Operation: ....Drive PLC operands

2.5.6 Metering

CURRENT

Accuracy (at nominal frequency): ....±0.5% of the reading ± 10 mA from 0.05 to 10.00 A (for phases and ground)
±1.5% of the reading ± 1 mA from 0.005 to 5 A (for sensitive ground)
±1.5% of the reading for higher values
% of Load-to-trip Accuracy: ....±0.5% of full-scale

VOLTAGE

Accuracy: ....±0.5% of reading from 0.5 to 10.0 V at nominal frequency

REAL POWER (WATTS)

Accuracy: ....±2.0% of the reading at $-0.8 \leq PF \leq -1.0$ and $0.8 < PF \leq 1.0$

REACTIVE POWER (VARS)

Accuracy: ....±2.0% of the reading at $-0.2 \leq PF \leq 0.2$

APPARENT POWER (VA)

Accuracy: ....±2.0% of the reading

WATT-HOURS (POSITIVE AND NEGATIVE)

Accuracy: ....±2.0% of the reading
Range:...-2147483 to +2147483 MWh
Parameters:..3-phase only
Update Rate:..100 ms

WAR-HOURS (POSITIVE AND NEGATIVE)

Accuracy: ....±2.0% of the reading
Range:...-2147483 to +2147483 MVArh
Parameters:..3-phase only
Update Rate:..100 ms

FREQUENCY

Accuracy: ....+/- 0.03Hz
From 30 to 80 Hz

Note: Voltage input must be above 0.500 V to start measuring frequency.

ANGLE

Accuracy: ....±3°

2.5.7 Inputs

AC CURRENT INPUTS

CT Ratio:	1.0 to 6000.0 in steps of 0.1
Rated Currents:	Appropriate for 1 or 5 A. R650 has universal range for CT (valid for 1 or 5 A to only one terminal).
Relay Burden:	< 8 mVA at 1 A
	< 200 mVA at 5 A VA
Input Impedance:	< 8 mOhm
Current Withstand:	Continuous at 20 A
	1 s at 500 A for phases and ground
	1 s at 50 A for sensitive ground

LEA VOLTAGE INPUTS

Number of inputs:	6
Secondary Range:	0.5 to 10 V
Ratio:	1.0 to 10000.0 in steps of 0.1
Nominal Frequency:	50/60 Hz
Minimum input impedance:	1 MOhm
Accuracy:	±1.00% of reading or ±1 V whichever is greater
Magnitude Correction factor:	±15.0 % in steps of 0.1%
Phase Angle correction factor:	0 to 359,9° in steps of 0.1°
Voltage withstand:	? VAC continuous

VT TRADITIONAL VOLTAGE INPUTS

Number of inputs:	6
Secondary Range:	20 to 275 V
Ratio:	1.0 to 6000.0 in steps of 0.1
Nominal Frequency:	50/60 Hz
Accuracy:	±1.00% of reading or ±1 V whichever is greater
Voltage withstand:	? VAC continuous

PHASE CURRENT INPUTS

Number of inputs:	3
Range:	0.05 to 160 A primary
Input type:	Combined 1 A / 5 A
Ratio:	1.0 to 6000.0 in steps of 0.1
Frequency:	50 or 60 Hz
Accuracy:	0.05 to 8.00 × CT ±0.5% of reading or ±1% rated current (whichever is greater)
Resolution:	0.1 A

GROUND/SENSITIVE CURRENT INPUT

Number of inputs:	1
Range:	0.005 to 160 A primary
Input type:	Combined 0.2A / 1A / 5A
Ratio:	1.0 to 6000.0 in steps of 0.1
Frequency:	50 or 60 Hz
Accuracy:	0.05 to 8.00 × CT ±0.5% of reading or ±1% rated current (whichever is greater)
Resolution:	0.01 A

CONTACT INPUTS - I/O BOARD TYPE 1 AND 2

Input Activation Threshold: ....10 to 230 Vdc in steps of 1 V (selectable by setting)
Impedance: ....> 100 kΩ
Maximum Error: ....±10% setting or ± 5 V
Load for Voltage Supervision Inputs: ....2 mA + V/100 kΩ
Voltage Threshold for Voltage Supervision Inputs:...< 10 V (fixed)
Debounce Time: ....1 to 50 ms in steps of 1 ms
Recognition Time: ....2 ms (typical)
Timing Resolution: ....1 ms

For Activation Voltage Threshold and Debounce Time there is a single setting for all inputs in the same group (all inputs sharing the same common).

Input Type and Delay Input Time are not grouped; there is a different setting for each input.

Input Type: ....positive-edge/negative-edge/positive/negative
Delay Input Time: ....0 to 60000 ms in steps of 1 ms (input signal time delay)

CONTACT INPUTS - I/O BOARD TYPE 6

Number of Inputs: 6
Input Activation Threshold: ....10 to 230 Vdc in steps of 1 V (selectable by setting for wet input configuration)
Impedance: ....> 100 kΩ
Maximum Error: ....±10% setting or ± 5 V
Debounce Time: ....1 to 50 ms in steps of 1 ms
Recognition Time: ....2 ms (typical)
Timing Resolution: ....1 ms

For Activation Voltage Threshold and Debounce Time there is a single setting for all inputs in the same group (all inputs sharing the same common).

Input Type and Delay Input Time are not grouped; there is a different setting for each input.

Digital Input Contact: ....Dry type / Wet type
Input Type: ....Positive-edge / Negative-edge / Positive / Negative
Delay Input Type: ....0 to 60000 ms in steps of 1 ms
Wetting Voltage: ....+24 Vdc

REMOTE INPUTS (IEC61850 GSSE/GOOSE)

Number of Input Devices: ....32, configured from 64 incoming bit pairs
Number f Remote Devices: 24
Default States on Loss of Comms: ....On, Off, Latest/on, Latest/off

ANALOG INPUTS

Input Impedance: 116Ω
Current Input (mADC): ....0 to -1; 0 to +1; -1 to +1; 0 to 5; 0 to 10; 0 to 20; 4 to 20 (programmable)
Conversion Range: ....-1 to +20 mA
Accuracy: ....±0.2% of full scale
Type: ....passive

IRIG-B INPUT

Amplitude Modulation: ....DC SHIFT = demodulated input (no carrier)
Input Voltage: ....TTL
Input Burden: ....1.5 mA
Input Impedance: ....3.3 kΩ
Minimum Input Voltage: ....2.4 V
Maximum Input Voltage: ....± 24 V
Formats: ....B000 (*) B001, B002 and B003 (*
(*) Signal combinations recognized in accordance with IRIG Standard 200-95
Isolation: ....2 kV

2.5.8 Real time clock

Accuracy:........ typical ±20 ppm
Backup Energy:........ more than 1 week

2.5.9 Outputs

OUTPUTS - I/O BOARD TYPE 1 AND 2

Single Contact Carry continuous: .... 16 A
Make and Carry for 1 s: .... 60 A
Break at L/R of 40 ms: .... 0.3 A DC max. at 125 Vdc
0.25 A DC max. at 250 Vdc
Operate Time:........ < 8 ms
Contact Material: .... silver alloy

Output Logic Type, Output Type and Pulse Output Time are selectable by setting for each output

Output Logic Type:........ positive/negative
Output Type: .... normal/pulse/latch (selectable by setting for each output)
Pulse Output Time:........ 0 to 60000 ms in steps of 1 ms (applicable only to signals sent as pulse type)

Separate operate and reset signals can be configured by any digital signal programmable through the PLC

Contact Outputs (F31-F33, F34-F36) for board type 2 (supervision) in slot F:........ The current seal-in circuit is used for verifying the current condition in a circuit during the time that the tripping contact remains closed. If the current in the tripping circuit is maintained over 500 mA, the function is sealed independently of the status of the function that caused the trip.

COIL ACTUATOR OUTPUTS - I/O BOARD TYPE 6

Number of Coil Actuators: .... 3 (one per phase)
Close Pulse Time:........ 15 to 100 ms (65 ms default)
Open Pulse Time:........ 15 to 100 ms (30 ms default)
Open Maximum Current:........ 5 to 30 A (10 A default)
Close Maximum Current:........ 5 to 30 A (15 A default)
Current Withstand:........ 1 s at 60 A
Operate Time:........ < 1 ms

REMOTE OUTPUTS (IEC61850 GSSE/GOOSE)

Standard Output Points: 32
User Output Points:........ 32

2.5.10 Control power supply

LOW RANGE (LO)

Nominal DC Voltage:	24 to 48 V
Min/Max DC Voltage	19.2 / 57.6 V
Note:	Low range is DC only
Voltage Loss hold-up time:(*)	24 Vdc 30 ms 48 Vdc 100 ms

(*) These figures have been calculated for models with the following characteristic:
- IEC Symbols Graphic display
- Rear Ethernet Communication Board 2: PRP, 1588, 10/100 Base TX+ Redundant 100 Base FX
- F and G I/O Board:
  - Slot F: 8 Digital Inputs + 8 Outputs + 2 Trip / Close circuit supervision circuits
  - Slot G: 16 Digital Inputs + 8 Outputs

ALL RANGES

Power Consumption:	Typical =25 VA, Maximum =45 VA

Display backlight auto power-off mode after 15 minutes without touching any key, in order to ensure long life and minimum consumption

HIGH RANGE (HI)

Nominal DC Voltage:	110 to 250 V
Min/Max DC Voltage	88 / 300 V
Nominal AC Voltage:	120 to 230 V
Min/Max AC Voltage:	102 / 250 V
Voltage Loss Hold-up Time:	200 ms typical 100 ms worst case

INTERNAL FUSE

V:	250 VAC
I:	2.5A
Size:	5 x 20 mm
Type:	Quick acting (F)

UL listed miniature Fuse

2.5.11 Communications

FRONT PORT:

Front port:	**COM2**
Type:	RS232/USB
Baud Rate:	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200 baud
Default Baud Rate:	19200 baud
Protocols:	ModBus® RTU/DNP 3.0
Typical Distance:	3 m
Isolation:	2 kV

ASYNCHRONOUS REAR PORTS:

None or two rear ports (depending on model):	COM1, COM2 (rear COM2 multiplexed with front port)
Type (depending on model):	
Model F	None
Model A	Redundant RS485
Model X	Redundant RS485 + fiber CAN for inputs/outputs module
Model P	Redundant 1mm-plastic F.O.
Model Y	Redundant 1mm-plastic F.O. + fiber CAN for inputs/outputs module
Model G	Redundant multimode glass F.O.
Model Z	Redundant multimode glass F.O. + fiber CAN for inputs/outputs module
Model C	Cable CAN port for I/O module
Model M	Cable CAN port for I/O module (cable) + RS485 (ModBus RTU)
Optic Features for ST Connector Devices:	Wave length: 1300nm Fiber type: multimode 62.5/125 µm or 50/125 µm
Baud Rate:	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200 baud
Default Baud Rate:	19200 baud
Protocols:	ModBus® RTU/DNP 3.0/IEC103
Typical Distance:	1200 m for cooper cable, 1000 m for glass fiber and 50 m for plastic fiber

Isolation:	2 kV

CAN PORT:

Rear Port:	CAN port in models C, M, X, Y, Z for asynchronous rear ports
Type:	Multimode glass F.O. port with ST connectors
Fiber Wavelength:	820 nm
Fiber Type:	multimode 62.5/125 µm or 50/125 µm
Maximum Recommended Length:	300 m for cooper cable and glass fiber
Isolation:	2 kV

ETHERNET PORT:

Rear port:	
For models J, K, L, M:	ETH_E/ ETH_A/ ETH_B
Type (depending on model):	
Model J:	PRP, 1588, 10/100 Base TX* + Redundant 100 Base FX
Model K:	PRP, HSR, RSTP, 1588, 10/100 Base TX* + Redundant 100 Base FX
Model L:	PRP, 1588, 10/100 Base TX* + Redundant 100 Base TX
Model M:	PRP, HSR, RSTP, 1588, 10/100 Base TX* + Redundant 100 Base TX

(*) Note: This Ethernet port (ETH_E) is intended only for maintenance purposes.

10/100BaseTX:	RJ45 connector
100BaseFX:	ST connectors
Wavelength:	1300 nm
Fiber Type:	multimode 62.5/125 µm or 50/125 µm
Protocols:	ModBus® TCP/IP DNP over TCP/IP and UDP/IP IEC 61850 http, ftp, tftp (allow the use of a standard Internet browser)
Typical Distance:	1000 m for glass fiber and 150 m for RJ45 cable
Response Time to ModBus Commands:	10 ms typical
Isolation:	2 kV

Two witness LEDs for transmission and reception are included

SIMPLE NETWORK TIME PROTOCOL (SNTP)

Clock Synchronization error:	<10 ms (typical)

PRECISION TIME PROTOCOL (PTP)

PTP IEEE Std 1588 2008 (version 2)

Power Profile (PP) per IEEE Standard PC37.238TM2011

Slave-only ordinary clock

Peer delay measurement mechanism

PARALLEL REDUNDANCY PROTOCOL (PRP) (IEC 62439-3 CLAUSE 4, 2012)

Ethernet ports:	A and B
Networks:	10/100 MB Ethernet

PARALLEL REDUNDANCY PROTOCOL (HSR) (IEC 62439-3 CLAUSE 5, 2012)

Ethernet ports:	A and B
Networks:	10/100 MB Ethernet

RAPID SPANNING TREE PROTOCOL (RSTP) (IEC 62439-1, IEEE 801.2D)

Ethernet ports:	A and B
Networks:	10/100 MB Ethernet

2.5.12 Optical

Wave length: 1300 nm

Connector types: ST package style

Fiber type: multimode 62.5/125 µm or 50/125 µm

Transmitter characteristics					
Parameter	Min.	Typ.	Max.	Unit	Reference
Output Optical Power BOL 62.5/125 µm, NA = 0.275 Fiber EOL	-19 -20		-14	dBm avg.	Note 1
Output Optical Power BOL 50/125 µm, NA = 0.275 Fiber EOL	-22.5 -23.5		-14	dBm avg.	Note 1
Output Optical Power at Logic “0” State			-45	dBm avg.	Note 2

Receiver characteristics					
Parameter	Min.	Typ.	Max.	Unit	Reference
Input Optical Power Minimum at Window Edge		-33.9	-31	dBm avg.	Note 3
Input Optical Power Minimum at Eye Center		-35.2	-31.8	dBm avg.	Note 4
Input Optical Power Maximum	-14			dBm avg.	Note 3

Notes:

1. These optical power values are measured with the following conditions:

   The Beginning of Live (BOL) to the End of Life (EOL) optical power degradation is typically 1.5 dB per industry convention for long wavelength LEDs. The actual degradation observed in Agilent’s 1300nm LED products is <1 dB, as specified in this data sheet.

   Over the specified operating voltage and temperature ranges.

   With HALT Line State, (12.5 MHz square-wave), input signal.

   At the end of one meter of noted optical fiber with cladding modes removed.

   The average power value can be converted to a peak power value by adding 3 dB. Higher output optical power transmitters are available on special request.

2. The transmitter provides compliance with the need for Transmit_Disable commands from the FDDI SMT layer by providing an Output Optical Power level of <-45 dBm average in response to a logic “0” input. This specification applies to either 62.5/125 µm or 50/125 µm fiber cables.

3. This specification is intended to indicate the performance of the receiver section of the transceiver when Input Optical Power signal characteristics are present per the following definitions. The Input Optical Power dynamic range from the minimum level (with a window time-width) to the maximum level is the range over which the receiver is guaranteed to provide output data with a Bit Error Ratio (BER) better than or equal to 2.5e-10.

   At the Beginning of Life (BOL).

   Over the specified operating temperature and voltage ranges.

4. All conditions for Note 3 apply except that the measurement is made at the center of the symbol with no window time-width.

CAUTION: LED transmitters are classified as IEC 60825-1 Accessible Emission Limit (AEL) Class 1M. Class 1M devices are considered eye safe to the unaided eye. **Do not view directly with optical instruments.**

2.5.13 Environmental

Operating Temperature:........ - 40°C to + 60°C
Storage Temperature: .... - 40°C to + 85°C
Humidity (non-condensing):........ 95%
Altitude: .... up to 2000 m
Class of Equipment:........ I
Equipment Mobility:........ fixed
Overvoltage Category:........ III
Pollution Degree:........ 2

2.5.14 Packaging and weight

Net Weight:........ 5 kg
Packaged Weight: .... 6 kg
Package Dimensions:........ 30 x 40 x 40 cm (D x W x H)

2.5.15 Type tests

CATEGORY	STANDARD	CLASS	TEST
SAFETY	Dielectric voltage withstand	IEC60255-27	2 KV / 2.3 KV
	Impulse voltage withstand	IEC60255-27	5 KV
	Insulation resistance	IEC60255-27	500 V (test level)
EMC	Electrostatic Discharge Immunity	IEC60255-26/IEC61000-4-2	Level 4
	Radiated RF Electromagnetic Field Immunity	IEC60255-26/IEC61000-4-3	Level 3
	Electrical Fast Transient Immunity	IEC60255-26/IEC61000-4-4	Zone A
	Surge Immunity	IEC60255-26/IEC61000-4-5	Zone A
	Conducted RF Immunity	IEC60255-26/IEC61000-4-6	Level 3
	Power magnetic Immunity	IEC60255-26/IEC61000-4-8	Level 5
	Power Frequency Immunity	IEC60255-26/IEC61000-4-16	Zone A
	Damped Oscillatory Wave Immunity	IEC60255-26/IEC61000-4-18	2.5 KV Common Mode 1 KV Diff. Mode
	Voltage Dips & Interruptions	IEC60255-26/IEC61000-4-11/ IEC61000-4-29	Levels based on IEC61000-4-11 & IEC61000-4-29
	Ripple on DC	IEC60255-26/IEC61000-4-17	15% Rated DC value
	Radiated & Conducted Emissions	IEC60255-26/CISPR11/ CISPR22	Class A
MECHANICAL	Sinusoidal Vibration	IEC60255-21-1	Class 1
	Shock & Bump	IEC60255-21-2	Class 1
	Seismic	IEC60255-21-3	Class 2
	Enclosure Protection	IEC60255-27/IEC60529	IP52
CLIMATIC	Cold test (storage)	IEC60068-2-1	-40˚C 16 hrs
	Cold test (operational)	IEC60068-2-1	-20˚C 16 hrs
	Dry heat test (storage)	IEC60068-2-2	85˚C 16 hrs
	Dry heat test (operational)	IEC60068-2-2	60˚C 16 hrs
	Change of Temperature	IEC60068-2-14	5 cycles (3+3) -20˚C/60˚C
	Damp Heat Humidity Cyclic	IEC60068-2-30	6 cycles (12+12) 55˚C @ 93% R.H.
	Damp Heat steady state	IEC60068-2-78	40˚C @ 93% R.H.

Type test report available upon request.

R650 has been designed to comply with the highest existing requirements. More specifically, UNIPEDE recommendations for high voltage substations are followed, even if for most applications such high classes are not required.

The relay complies with ANSI C37.90 standards, and has been designed to comply with international standards.

2.5.16 Approvals

	APPLICABLE COUNCIL DIRECTIVE	ACCORDING TO
CE COMPLIANCE	Low voltage directive	IEC60255-27
	EMC Directive	IEC60255-26
ISO	Manufactured under a registered quality program	ISO9001

2.6 External connections

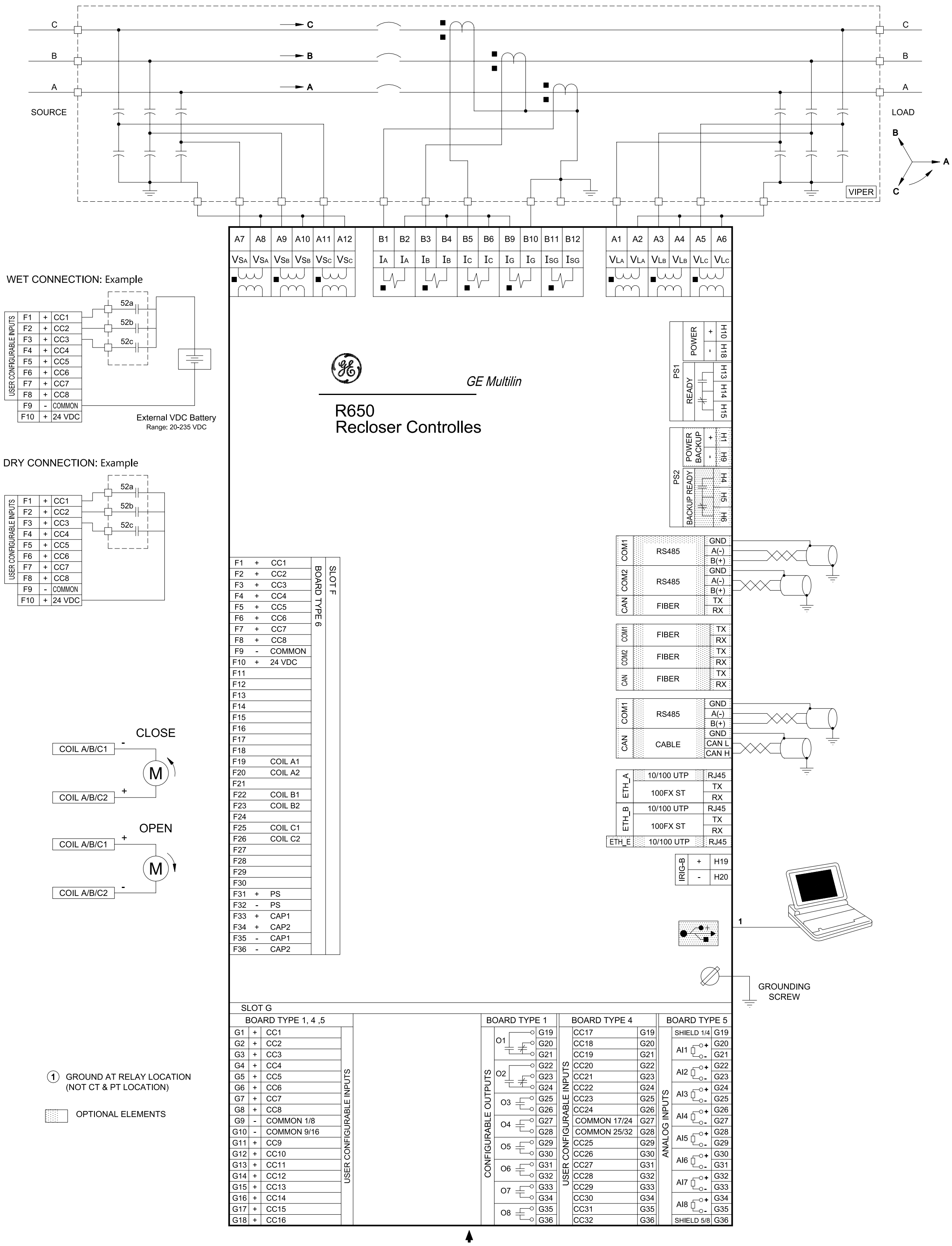


Figure 2-2: R650 wiring diagram (189C4216)

INPUTS / OUTPUTS CONFIGURATION FOR BOARDS F1 AND F2

SLOT F CONFIGURATION (BOARD TYPE 1)

INPUTS F1 (USER CONFIGURABLE INPUTS)

Terminal	Polarity	Input	Function
F1	+	CC1	52b
F2	+	CC2	50P BLOCK
F3	+	CC3	51P BLOCK
F4	+	CC4	67P BLOCK
F5	+	CC5	50G BLOCK
F6	+	CC6	51G BLOCK
F7	+	CC7	79 INITIATE
F8	+	CC8	79 BLOCK
F9	-	COMMON 1/8	COMMON 1/8
F10	-	COMMON 9/16	COMMON 9/16
F11	+	CC9	NOT USED
F12	+	CC10	NOT USED
F13	+	CC11	NOT USED
F14	+	CC12	NOT USED
F15	+	CC13	NOT USED
F16	+	CC14	NOT USED
F17	+	CC15	NOT USED
F18	+	CC16	NOT USED

OUTPUTS F1 (USER CONFIGURABLE OUTPUTS)

Output	Terminals	Function
O1	F19, F20, F21	79 BLOCK
O2	F22, F23, F24	27/59 PICKUP
O3	F25, F26	50/67G PICKUP
O4	F27, F28	51/67G PICKUP
O5	F29, F30	50/67P PICKUP
O6	F31, F32	51/67P PICKUP
O7	F33, F34	RECLOSE
O8	F35, F36	TRIP

SLOT F CONFIGURATION (BOARD TYPE 2)

INPUTS F2

Terminal	Polarity	Input	Function	Group
F1	+	COIL 1 52/a	52/a SUPERVISION	COIL 1
F2	-			COIL 1
F3	+	COIL 1 52/b	52/b SUPERVISION	COIL 1
F4	-			COIL 1
F5	+	CC1	52b	USER CONFIGURABLE INPUTS
F6	+	CC2	50P BLOCK	USER CONFIGURABLE INPUTS
F7	+	CC3	51P BLOCK	USER CONFIGURABLE INPUTS
F8	+	CC4	67P BLOCK	USER CONFIGURABLE INPUTS
F9	-	COMMON 1/4	COMMON 1/4	USER CONFIGURABLE INPUTS
F10	-	COMMON 5/8	COMMON 5/8	USER CONFIGURABLE INPUTS
F11	+	CC5	50G BLOCK	USER CONFIGURABLE INPUTS
F12	+	CC6	51G BLOCK	USER CONFIGURABLE INPUTS
F13	+	CC7	79 INITIATE	USER CONFIGURABLE INPUTS
F14	+	CC8	79 BLOCK	USER CONFIGURABLE INPUTS
F15	+	COIL 2 52/a	52/a SUPERVISION	COIL 2
F16	-			COIL 2
F17	+	COIL 2 52/b	52/b SUPERVISION	COIL 2
F18	-			COIL 2

OUTPUTS F2 (USER CONFIGURABLE OUTPUTS)

Output	Terminals	Function
O1	F19, F20	79 BLOCK
O2	F21, F22	27/59 PICKUP
O3	F23, F24	50/67G PICKUP
O4	F25, F26	51/67G PICKUP
O5	F27, F28	50/67P PICKUP
O6	F29, F30	51/67P PICKUP
I SENS / O7	F31, F32, F33	RECLOSE
I SENS / O8	F34, F35, F36	TRIP

Figure 2-3: Input/output configurations for boards F1 and F2 (189C4216H1)

R650 Recloser Controller

Chapter 3: Hardware

3.1 Module description

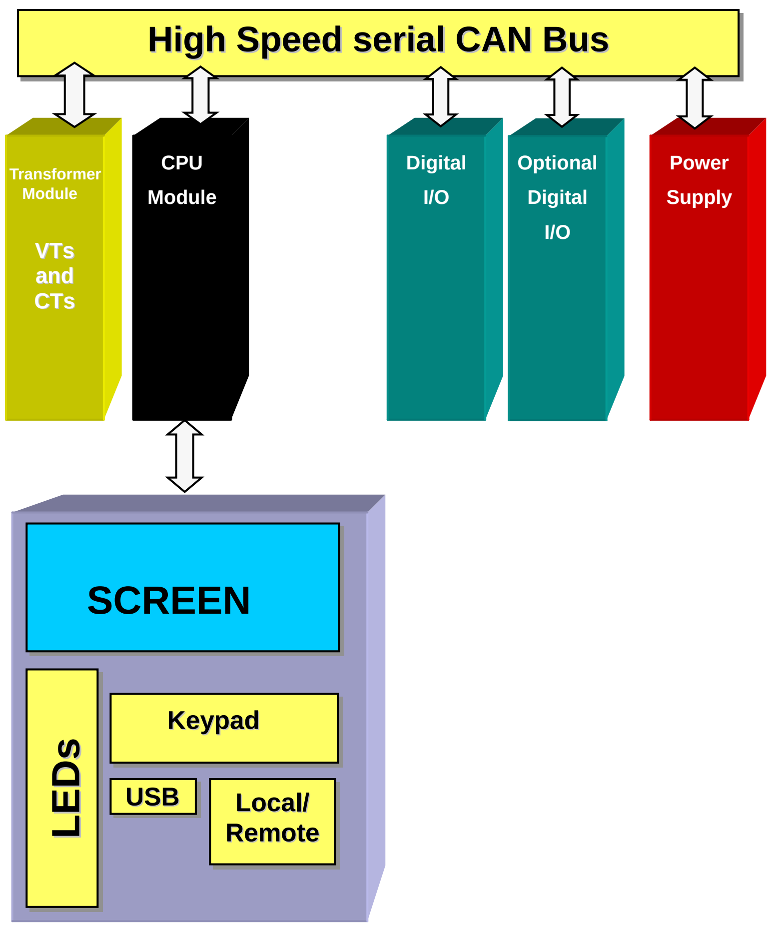


Figure 3-1: Block diagram

R650 units incorporate the following modules:

- **Power supply**, which can be simple or redundant, depending on the selected model
- **Front module with alphanumerical (4 x 20) or optional graphical (16 x 40 characters) display.** It includes the bus on its rear, which communicates with the rest of modules via a high speed CAN bus.
- **Transformer module** with 5 current transformers and 6 LEA voltage inputs.
- **CPU** including a powerful DSP for measure processing as well as synchronous and asynchronous communication accessories.
- **Input/Output module** included in basic unit
- Optionally, a **second I/O module** can be added.

3.2 Power supply

R650 can incorporate a simple or redundant power supply. The main and backup modules are identical.

NOTICE Control power supplied to the relay must be connected to the matching power supply range of the relay. If the voltage is applied to the wrong terminals, damage can occur.

NOTICE The R650 relay contains electrolytic capacitors. These capacitors are well known to be subject to deterioration over time if voltage is not applied periodically. Deterioration can be avoided by powering the relays up once a year.

In the case of a redundant power supply the two modules work in parallel continuously, distributing 50% of the load on each, thus ensuring greater reliability and an instantaneous load transfer from a failed power supply to the backup, without loss of time or module reset.

A contact relay connected to the low voltage side of the power supply monitors this voltage. The three contact terminals, normally open, common, and normally closed, are available at the external connector terminals. The contact monitors the power supply integrity and it is not controlled by the main microprocessor. In order to monitor whether the unit is ready to protect (READY), an auxiliary output contacts in the unit should be programmed. This “fly-back” type power supply provides high efficiency, stability and reliability and is available in two ranges, Hi and Low, in order to optimize efficiency and general performance, including the capability to tolerate auxiliary voltage interruptions (dips).

⚠WARNING **The contact terminals on the power supply should connect to the same circuit used to power on the relay.**

Oversized components highly resistant to temperature are used. For example, all capacitors are specified to stand up to 105°C, transformer components are specially designed to stand up to 180°C, the MOSFET transistor has very low resistance, supports high voltage and is refrigerated by an oversized heat sink. This allows temperatures over the 60°C shown in the Technical Characteristics section, and prolonged overloads such as those occurring at batteries in deep charge mode (much higher than +15% voltage shown in the Technical Characteristics section).

High capacitance capacitors are also used, providing high tolerance to prolonged dips, 100ms, even in the most unfavorable consumption conditions. This allows the relay to continue operating normally without undesired resets leaving protection features offline.

⚠CAUTION **In the case of a blown fuse, replacement should be conducted by authorized/trained personnel only. Use replacement fuses with the same characteristics.**

Fuse Requirements:

V:	250 VAC
I:	2.5A
Size:	5 x 20 mm
Type:	Quick acting (F)

UL listed miniature fuse

Note: Contact technical support for further guidance.

3.3 Driving electronics board

The driving electronics board provides a glueless connectivity between the R650 device and G&W Electric Viper-ST reclosers, without any external auxiliary driver devices. The R650 is only compatible with the Viper-ST.

The main characteristics of this board are:

- 3x Coil Circuit Supervision (one per phase)
- 8 dry/wet configurable digital inputs (DI)
- 24 Vdc wetting voltage
- DI activation voltage threshold from 10 to 230 VDC
- DI configurable debouncing time from 1 to 50 ms
- DI time recognition of 2 ms
- Voltage capacitor supervision
- 3x coil solid state directional outputs drivers
- Configurable close and open pulse delays
- Configurable maximum output currents for opening and closing commands

The external connections of the driving electronics board are shown below:

USER CONFIGURABLE INPUTS	F1	+	CC1
	F2	+	CC2
	F3	+	CC3
	F4	+	CC4
	F5	+	CC5
	F6	+	CC6
	F7	+	CC7
	F8	+	CC8
	F9	-	COMMON
	F10	+	24 VDC
	F11		
	F12		
	F13		
	F14		
	F15		
	F16		
	F17		
	F18		

F19		COIL A1	OUTPUTS
F20		COIL A2	
F21			
F22		COIL B1	
F23		COIL B2	
F24			
F25		COIL C1	
F26		COIL C2	
F27			
F28			
F29			
F30			
F31	+	PS	INPUTS
F32	-	PS	
F33	+	CAP1	
F34	+	CAP2	
F35	-	CAP1	
F36	-	CAP2	

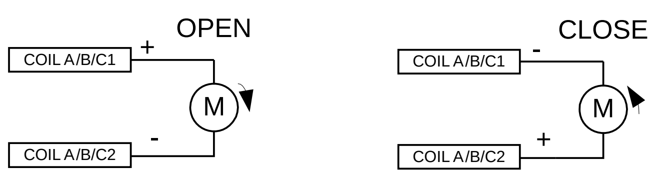


Figure 3-2: Driving electronics board external connections

The next drawing shows an example of the wiring connection of the driving electronics board (F6) to the Viper-ST recloser. Different configurations of CC inputs are also allowed, with the logic assignment configuration of the contact input CC1 / 8 set in the EnerVista 650 Setup software. (**Setpoint -> Inputs/Outputs -> Contact I/O -> Board F**; see 5.6.2 Control settings for input/output.)

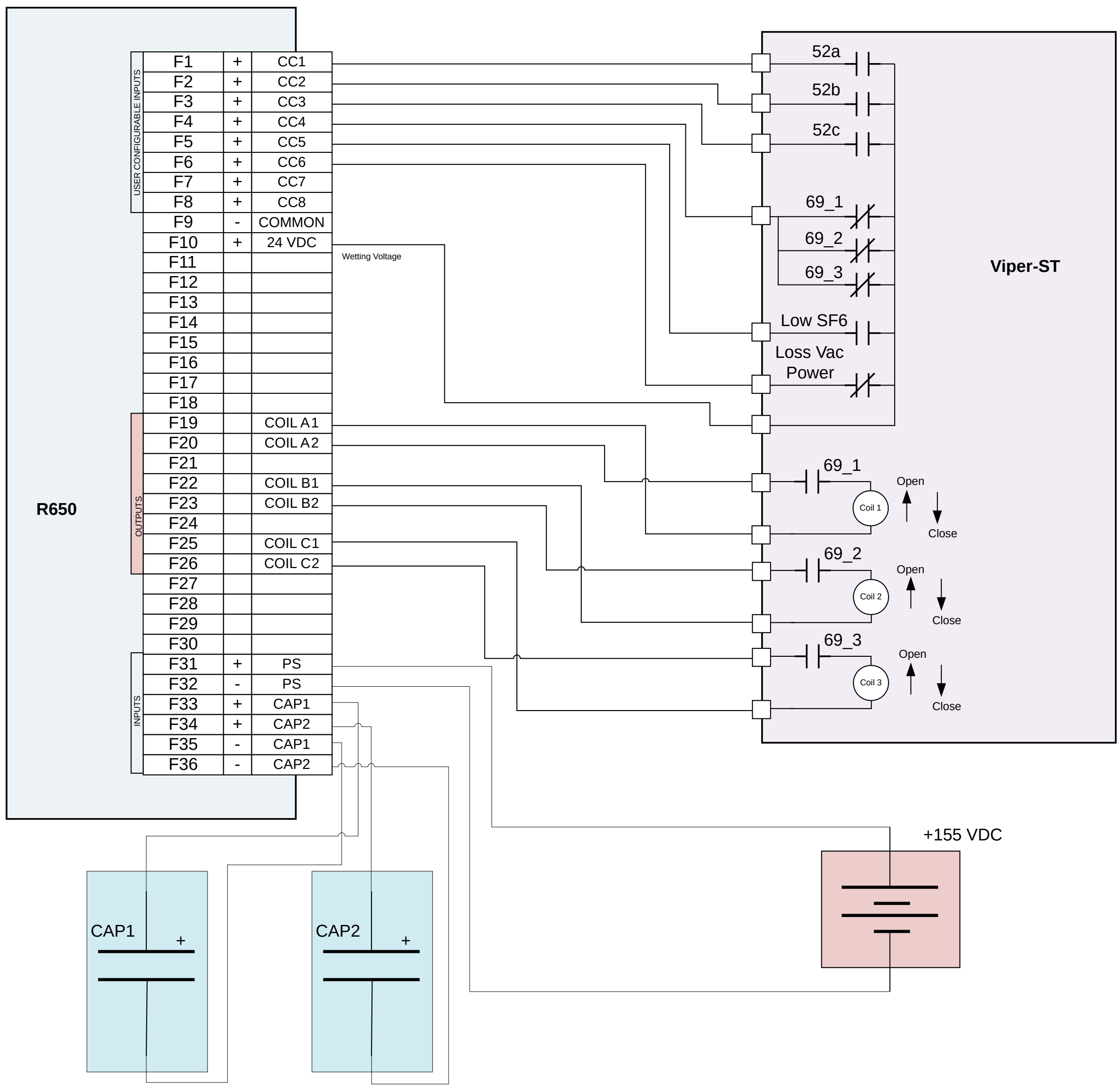


Figure 3-3: Wiring connections, Driving Electronics board to Viper-ST

3.3.1 Configurable digital inputs

The driving electronics board has 8 digital inputs, CC1 to CC8, that are left fully configurable and without a fixed default configuration. These inputs are configured using the EnerVista 650 Setup software (**Setpoints > Inputs/Outputs > Contact I/O > Board F**).

The activation voltage threshold can be selected from 10 to 230 VDC. The driving electronics board also provides a wetting voltage of 24 Vdc. Two possible external connections are provided: Wet connection and dry connection.

3.3.1.1 Wet connection

To use a wet connection, the setting 'Digital Input Contact' should be set to 'Wet Type'. In this configuration, the contact input is fed by an external DC voltage. The setting 'Input activation voltage threshold' provides the minimum voltage to detect the input as activated. An example of the external connection for this configuration is depicted below:

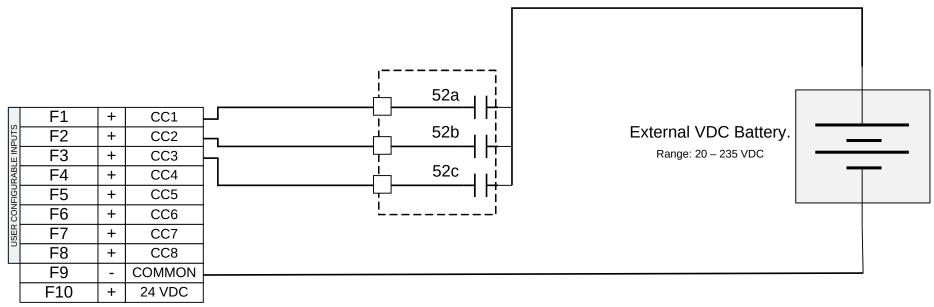
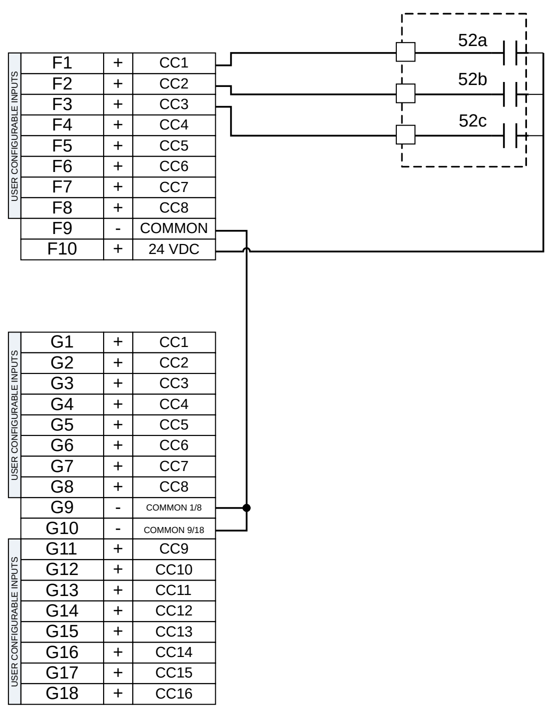


Figure 3-4: Wet type external connection

3.3.1.2 Dry connection

To use a dry connection, the setting 'Digital Input Contact' should be set to 'Dry Type'. In this configuration, the setting 'voltage threshold' is not taken into account. An internal reference threshold of 20 Vdc is set by default, and is exclusively applicable for the driving electronics board. The R650 can also be provided with another auxiliary contact/input board with its own settings.

Thus, in order to use the dry connection for the auxiliary board, the commons of the board should be connected together with the common of the driving electronics, and the Threshold setting of the auxiliary board should be set at 20 Vdc manually. The connections between cards are depicted below.



3.4 Mechanical description

The model number and electrical characteristics of the unit are indicated on the label located on the right side of the relay case.

The metallic case of the unit is highly resistant to corrosion. It is made of stainless steel (AISI 430), coated with an epoxy layer. The rest of the metallic pieces are covered with a high quality resistive coating that has successfully passed at least 96 hours in the salt spray chamber (S/N ASTM B-117).

The front of the relay is made of a thermoplastic, flame retardant (V0, UL94), highly resistive material, which guarantees the unit's immunity to all kinds of EMI/RFI/ESD interferences. There is also an IP52 (IEC 529) protection rating against dust and water through the front and with the relay mounted in the panel.

3.4.1 Mounting

The unit is designed for semi-flush mounting. The relay is secured to the panel with the 4 M6 screws provided with the unit. The front keypad, display, and communications port are easily access on the front of the unit. The wiring is at the rear of the unit. Drilling dimensions are shown on Figure 3-6: Cutout and drilling dimensions

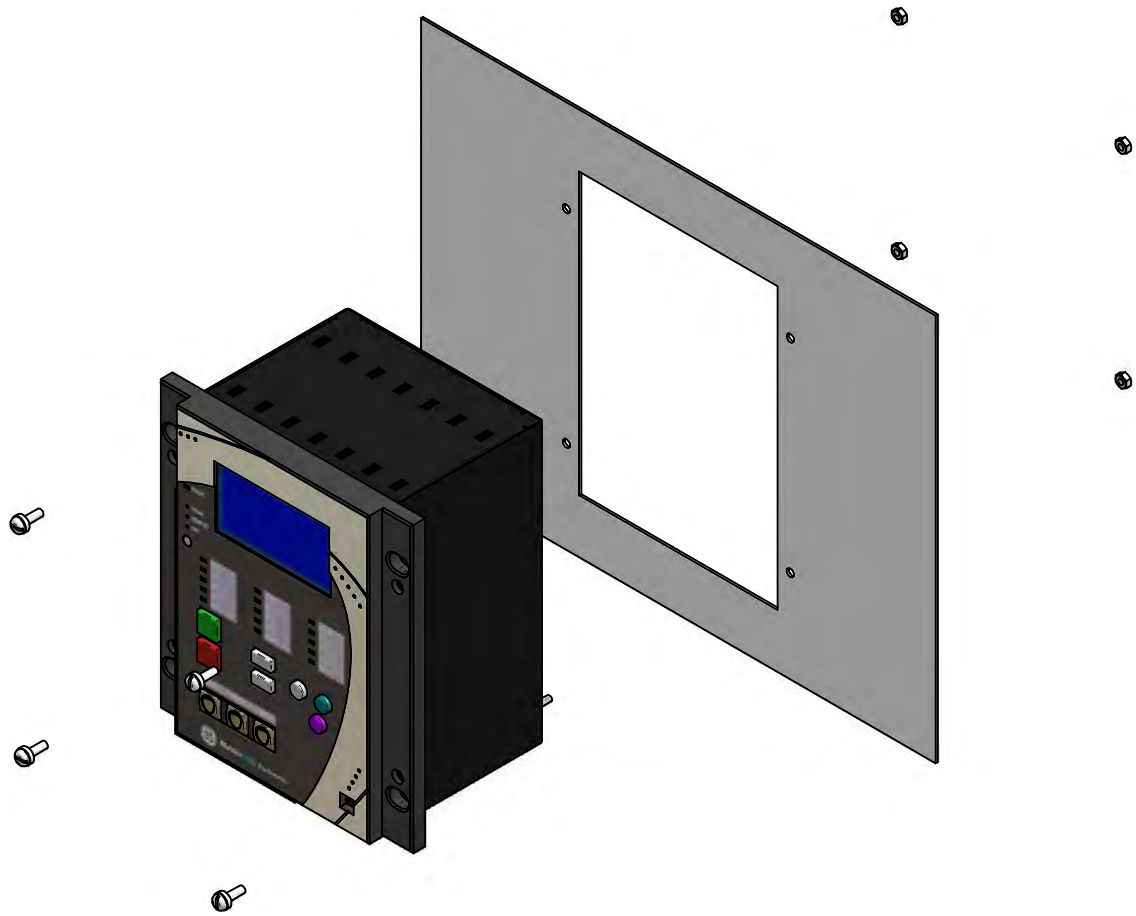


Figure 3-5: Panel mount

The relay width allows the mounting of two units on a standard 19" panel, 8 units high.

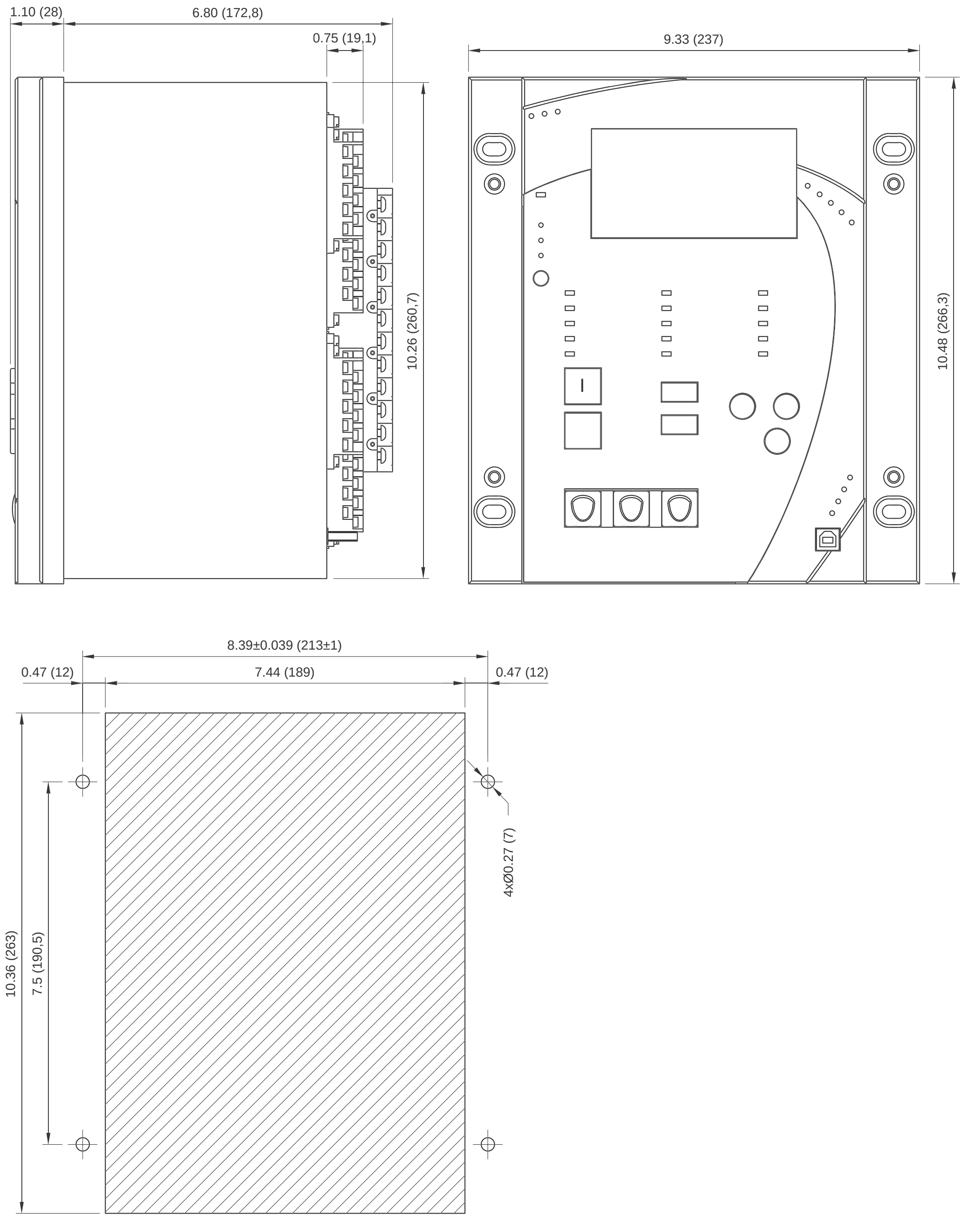


Figure 3-6: Cutout and drilling dimensions

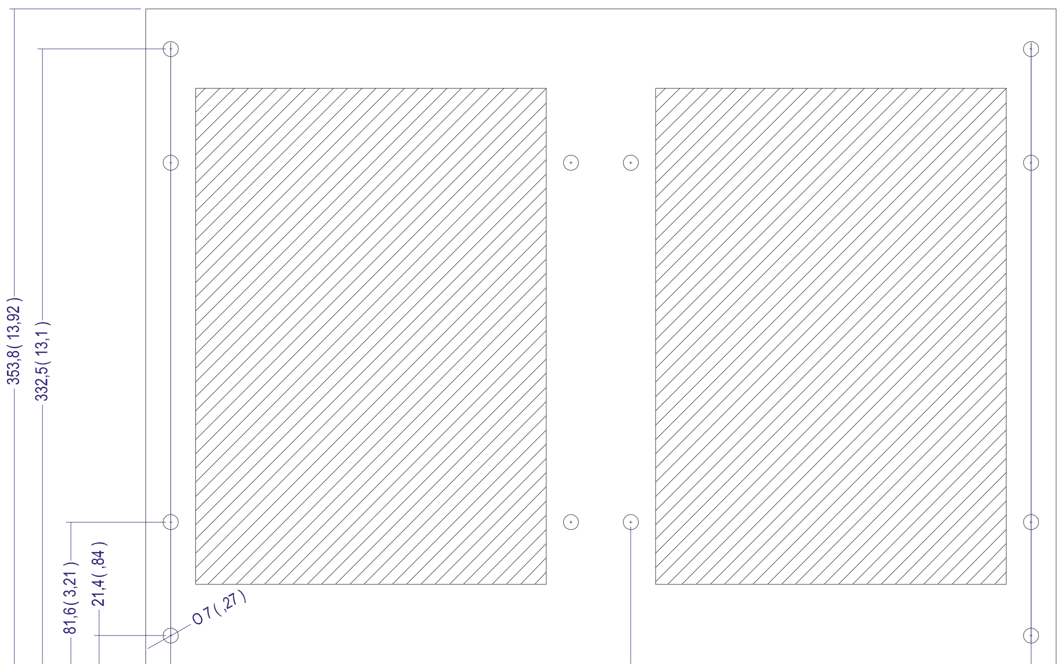


Figure 3-7: 19" rack dimensions 8U high for two relays

3.4.2 Rear description

WARNING

Module withdrawal and insertion may only be performed when control power has been removed from the unit.

Proper electrostatic discharge protection (i.e. a static wrap) must be used when coming in contact with products while the relay is energized.

The relay is wired through the terminal blocks located at the rear of the unit.

The magnetic module, which receives the CT secondary currents and the metering voltages, incorporates a very robust terminal board (columns A and B) The maximum tightening torque for the screws on terminal boards A and B is 1.2 Nm. Current inputs provide automatic shorting of external CT circuits. The maximum recommended cable section for this terminal board, with the appropriate terminal, is 6 mm^2 (AWG 10).

The use of twisted pair wire and/or shielded is recommended for the CT secondary current Isg.

The rest of the terminal blocks, incorporate high quality connectors with the capacity to withstand a rated current of 15 A at 300 V. These terminal blocks admit a cable section of up to 2.54 mm^2 (AWG 12).

The relay should be connected directly to the ground bus, using the shortest practical path. A tinned copper, braided, shielding and bonding cable should be used. As a minimum, 96 strands of number 34 AWG should be used.

The communication boards have different types of connector depending on the selected media: RS485, glass or plastic fiber optic.

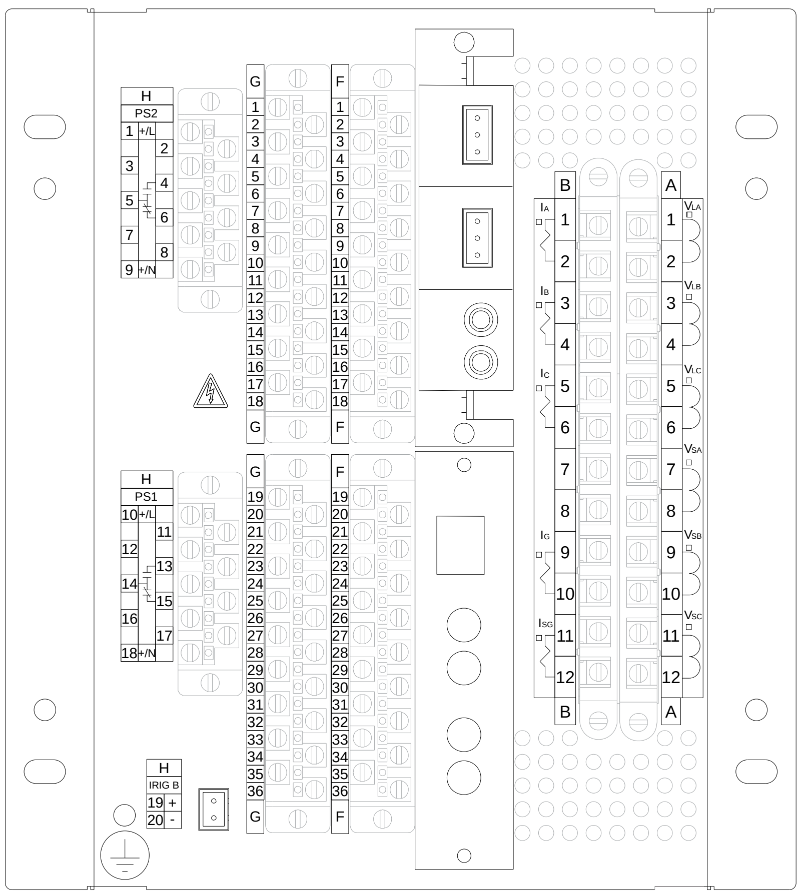


Figure 3-8: Connector locations

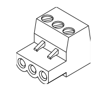
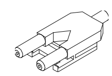
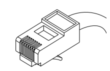
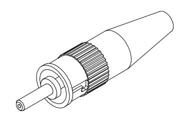
TYPE OF COMMUNICATION	CONNECTOR	
RS485 / CAN cable	Plug-in, 3 poles.	
IRIG B	Plug-in, 2 poles.	
Plastic fiber optic	Versatile Link	
Ethernet 10/100 UTP (10/100BaseTX)	RJ45, Class 5.	
Glass fiber optic (100BaseFX)	ST	
Ethernet 100 FX (100BaseFX)	ST	
CAN Fiber	ST	

Figure 3-9: Communications media selector guide

Communication boards are installed at the rear part of the unit, the upper port being reserved for the asynchronous communications board and CAN, and the lower port for the Ethernet board in any of its configurations.

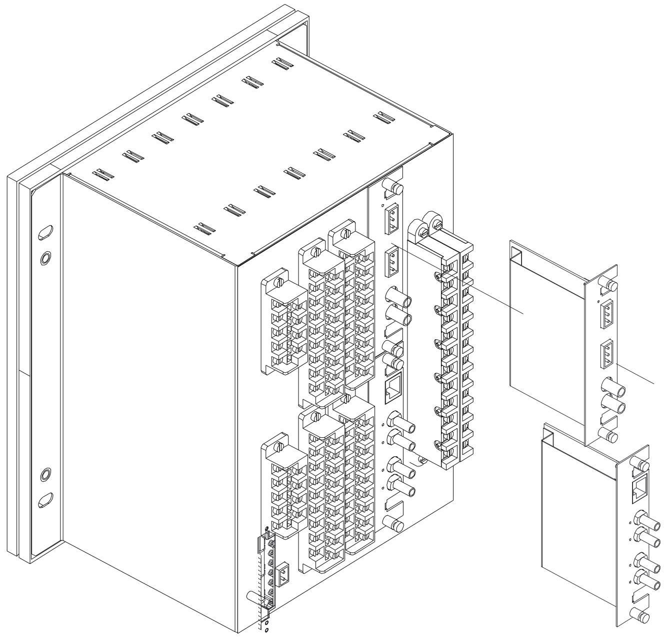


Figure 3-10: Detail of insertion/extraction of communication modules

Note: For R650, only the serial card can be removed

WARNING **The transformer module housing the CTs is already connected to a female connector screwed to the case that incorporates shorting bars in the current inputs, so that it can be extracted without the need to short-circuit the currents externally. It is very important, for safety reasons, not to change or switch the terminals for CTs and voltage inputs.**

A grounded antistatic wristband must be used when manipulating the module in order to avoid electrostatic discharges that may cause damage to the electronic components

WARNING **Special care is required when disconnecting CT wire leads from the terminal block.**
A high voltage potential can occur if a wire is disconnected while a CT is energized.
CT isolation or de-energization is required prior to CT terminal wire removal.

3.5 Wiring

3.5.1 External connections

R650 units can have different options for the F module:

Option 1: Board with 16 digital inputs and 8 outputs.

Option 2: Board with 8 digital inputs, 4 circuit supervision inputs, 6 conventional outputs, and two current sensing outputs

Option 4: Board with 32 digital inputs.

Option 5: Board with 16 digital inputs and 8 analog inputs.

Option 6: Board with 8 digital inputs and 3 outputs for the G&W Viper-ST recloser.

For slot G there are five different options:

Option 0: No board

Option 1: Board with 16 digital inputs and 8 outputs.

Option 4: Board with 32 digital inputs.

Option 5: Board with 16 digital inputs and 8 analog inputs.

The number selected for slot G must be equal or higher than the number selected for option F for models including boards 4 and 5.

3.5.2 Digital inputs with trip circuit supervision

The Option 2 I/O board includes two groups of 4 inputs with one common, in terminals F9 to F10. It also includes 6 auxiliary outputs, in terminals F19 to F30 with normally open contacts and two current sensing (latching) outputs (F31-F33 and F34-F36).

Besides, there are 2 groups of inputs for trip circuit supervision. The first group includes two isolated digital inputs, terminals F1-F2 and F3-F4. The second group, symmetrical and identical to the first, is formed by isolated voltage inputs F15-F16 and F17-F18.

Using voltage detectors and current sensing, it is possible to implement several trip or close circuit supervision schemes, as well as protection of the unit output contact.

NOTICE **In order to implement these schemes, it is not necessary to perform any setting in the unit. Internal functions are always operative. A detailed description of trip circuit supervision is included in chapter 5 in this manual.**

3.6 Transceiver optical power budget vs. link length

Optical Power Budget (OPB) is the available optical power for a fiber optic link to accommodate fiber cable losses plus losses due to in-line connectors, splices, and optical switches. OPB also provides a margin for link aging and unplanned losses due to cable plant reconfiguration and repair.

OPB (dB)		**Fiber optic Cable length (km)**
62.5/125 µm	**50/125 µm**	
11.4	8	0
10.9	7.4	0.3
10.5	7.1	0.5
9.6	6.2	1.0
8.5	5.3	1.5
7.3	4.3	2.0
6	3.3	2.5

R650 Recloser Controller

Chapter 4: Interfaces, Settings & Actual Values

4.1 EnerVista 650 Setup software

4.1.1 Introduction

The EnerVista 650 Setup software provides a graphical user interface (GUI) as one of two direct interfaces with a 650 device. The alternate interface is implemented via the device faceplate keypad and display (see the Human Machine Interface (HMI) section in this chapter).

The EnerVista 650 Setup software interface provides access to configure, monitor, maintain, and trouble-shoot the operation of relay functions, connected over local or wide area communication networks. It can be used while disconnected (offline) or connected (online) with a 650 device. In offline mode, settings files can be created for eventual download to the device. In online mode, real-time communication with the device is supported.

The EnerVista 650 Setup software, provided with every R650 relay, can be run from a computer supporting Microsoft Windows XP(SP 2 or 3), Windows 7 or Windows 8. This chapter provides a summary of the basic EnerVista 650 Setup software interface features. The EnerVista 650 Setup Help File provides details for getting started and using the EnerVista 650 Setup software interface.

The EnerVista 650 Setup software package uses ModBus protocol, and is designed to communicate with a single relay at a time. GE offers different communication software packages, such as GE-POWER, which can be used to communicate simultaneously with several relays.

EnerVista 650 Setup software provides an easy way to configure, monitor and manage all R650 features.

4.1.1.1 Using settings files

The EnerVista 650 Setup software interface supports three ways of handling changes to relay settings:

1. In offline mode (relay disconnected), create or edit relay settings files for later download to communicating relays.
2. In online mode (relay connected), modify any relay settings via relay data view windows, and then save the settings to the relay.
3. Combining online and offline modes, create/edit settings files and then write them to the relay while the interface is connected to the relay.

Settings files are organized on the basis of assigned file names. A settings file contains data pertaining to the following types of relay settings:

- Product Setup
- System Setup
- Protection Elements
- Control Elements
- Inputs/Outputs
- Quick Settings
- Relay Configuration
- Logic Configuration

4.1.1.2 Viewing actual values

You can view real-time relay data such as input/output status and measurements while connected to a relay.

4.1.1.3 Viewing triggered events

In online mode, you can view and analyze data generated by triggered specified parameters, via one of the following:

- **Event Recorder:** The event recorder captures contextual data associated with the last 1023 events, listed in chronological order from most recent to oldest.
- **Oscillography:** The oscillography waveform traces and digital states are used to provide a visual display of power system and relay operation data captured during specific triggered events.

4.1.1.4 Firmware upgrades

The firmware of a R650 device can be upgraded, locally or remotely, via the EnerVista 650 Setup software. Instructions are provided in Chapter 9: Bootcode and firmware upgrade.

Modbus addresses assigned to firmware modules, features, settings, and corresponding data items (i.e. default values, minimum/maximum values, data type, and item size) may change slightly from version to version of firmware.

The addresses are rearranged when new features are added or existing features are enhanced or modified.

4.1.1.5 One line diagrams

You can configure a one line diagram (bay mimic) to be used in relays with a graphical display.

4.1.2 Main screen

The EnerVista 650 Setup software main window includes the following components:

- Title bar
- Main menu bar
- Main icon bar
- Working area
- Status bar

Figure 4-1: EnerVista 650 Setup main screen

4.1.3 Connect to the relay

To start communicating with the relay go to **Communication > Computer** in the main EnerVista 650 Setup menu.

NOTICE Safety instructions must be followed before connecting the computer to the relay. Safety instructions are detailed in section 1.1.3 Safety instructions. Connect the relay ground terminal and the communicating computer to a good grounding. Otherwise, communication may not be viable, or even, in worst cases, the relay and/or the computer can result damaged by overvoltages.

When working online, ensure that all relay communication parameters, such as baud rate, slave ModBus address, etc., match the computer settings before connected to the relay.

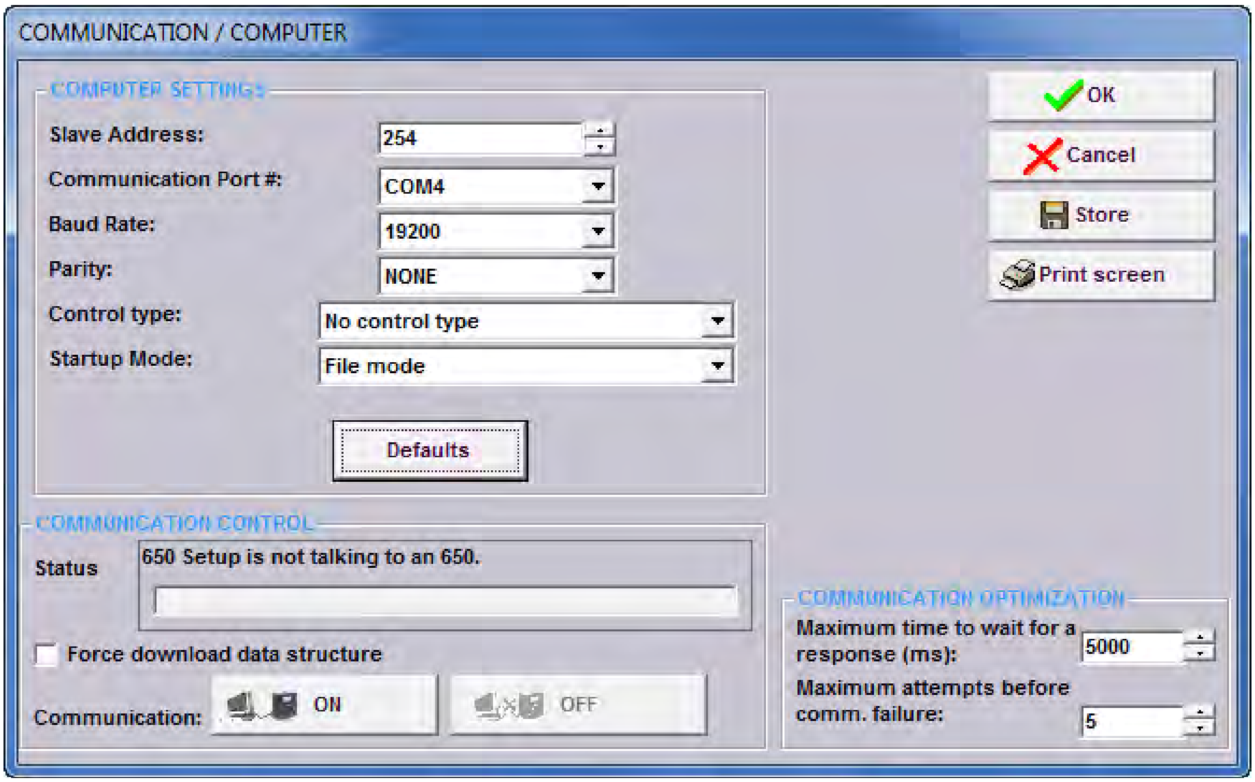


Figure 4-2: Communication parameters menu

The **Communication > Computer** screen is divided in several subsections:

- **Computer settings**: Main communication parameters for serial communication and control type selection.
- **Modbus/TCP Setup** (if ModBus /TCP is selected as control type): Communication parameters for ModBus TCP communication.
- **Communication control**: Device communication status (communicating or not communicating).
- **Communication optimization**: allows optimizing the communication time outs and failure establishing.

4.1.3.1 Computer Settings:

This section shows the communication parameters needed to establish communication with the unit, such as slave address, communication port, baud rate, parity, control type and startup mode.

Baud rate, parity, data bits, stop bits and ModBus slave address for Com2 (RS232 front port and second serial port in the rear communication board) are displayed in the default text on the relay main screen.

ModBus Slave Address: ModBus address used for serial and Ethernet communication; default 254.

Communication ports: Ports used in the computer for serial communication.

Baud Rate: Baud rate for serial communication (from 1200 to 115200 baud in EnerVista 650 Setup, from 300 to 115200 baud in relay).

Parity: Parity for serial communication. None, odd or even can be selected.

Control Type: The available control modes are:

- **No Control Type**, this option selects the serial communication mode, for use with serial communication ports (front port, RS485, or plastic or glass fiber optic).
- **MODBUS/TCP**, this option selects ModBus TCP/IP communication mode, for communication through the Ethernet port. In this case, the top right window shows the typical parameters to be programmed; IP address, port address and unit identifier in the MODBUS TCP SETUP section.
- **MODEM**, this option displays the parameter to set in case of using a modem for the communication, such as Phone number, Time out (sec.), init. command, type of dialing (tones or pulses).

4.1.3.2 Communication Control:

Located at the bottom of the screen, this section shows the status of communication with the relay. When the relay is not communicating, the message "*650 Setup is not talking to an 650*" is shown and the **ON** button is enabled. Click **ON** to start the EnerVista 650 Setup software communicating with the relay.

When the relay is communicating, the message "*650 Setup is now talking to an 650*" is shown and **OFF** is enabled. Click **OFF** to disconnect communications between the relay and PC.

4.1.3.3 Communication Optimization:

Adjusting the parameters in the Communication optimization section can improve communication, although using the default values is recommended in most cases. These parameters are the maximum time to wait for a response in the relay (in ms) and the maximum number of connection attempts to perform before assuming communications failure.

4.1.4 File management menu

File management with EnerVista 650 Setup software:

4.1.4.1 Offline mode

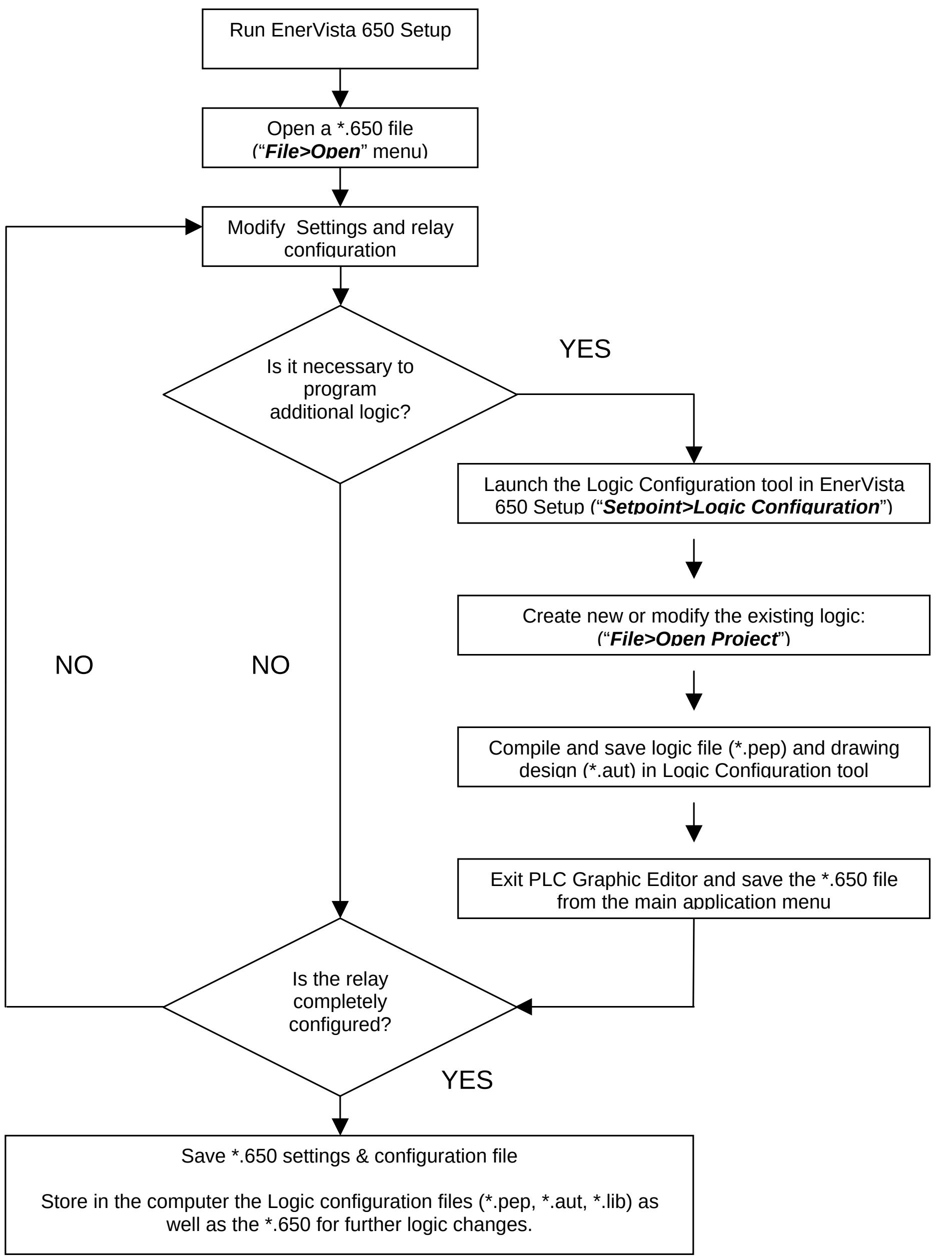


Figure 4-3: Offline mode file management[1]

1. "Relay and logic configuration" and "Protection and Control Settings" must be uploaded to the R650 relay or the device to operate properly

Table 4-1: Types of files generated by EnerVista 650 Setup software, offline:

	Settings & Configuration File *.650	Logic Configuration Files (*.pep, *aut, *.lib)		
		*.pep	*.aut	*.lib
Description	Settings and Configuration Section	Header for Logic project	Graphical edition container. Logic equations (Virtual Outputs) in FDB format.	User programmable logic objects
Created by	EnerVista 650 Setup	Logic configuration graphic editor (PLC Editor)	Logic configuration graphic editor (PLC Editor)	Logic configuration graphic editor (PLC Editor)
Contents	Relay configuration file containing all elements Settings, input/output and LEDs configuration, graphic display configuration, etc. Equations corresponding to the logic created and compiled in the PLC Editor	PLC project file containing the necessary information relative to the relay model, logic libraries included in the project (*.lib), graphic file name (*.aut), etc.	PLC Project file containing all the drawings used by the logic, required by 650 relay based on IEC 61131-3 standard. Functional block diagram (FDB).	Library file to be included as an object in a PLC project. Logic packages that can be stored into libraries and be distributed in different PLC projects.
How to save	EnerVista 650 Setup: File > Save *	PLC Editor: File > Save Project	PLC Editor: File > Save Project	PLC Editor: File > Save Library
How to open	EnerVista 650 Setup: File>Open *	PLC Editor: File > Open Project	PLC Editor: File > Open Project	PLC Editor: File > Library > New Library
How to transfer to relay	Connect with the relay (**Communications > Computer**) Open the created file (**File > Open ***) Send to relay from the menu: **File > Send info to relay** Note that texts used in the configuration of inputs, outputs, etc. are not sent to the relay. The only texts sent to relay are operations, events, and LEDs.	Connect with the relay (**Communications > Computer**) Launch Logic equations Editor (**Setpoint > Logic Configuration**) Open the created PLC project (**File > Open Project**) Compile the project (**Run > Compile**) Now the logic (virtual outputs) can be sent directly to relay (**Run > Send Equations to Relay**). Texts of virtual outputs are not stored in the relay, only in the logic configuration files to be edited.		

When using element libraries (both pre-existing in **File Library > Open Library** or created by the user in **File Library > New Library**), the program creates and manages the corresponding files (*.lib) in a folder named FDB (Functional Block Diagram). These files are used for PLC project compilation. The element library files must be stored with the other logic configuration files that build the PLC project (*.pep, *.aut, *.lib).

Besides sending configuration information to the relay (Settings & configuration in *.650 format), storing the complete set of *.650, *.pep, *.aut and *.lib files inside the relay is recommended (**Communication > Upload info files to relay**). This ensures that logic configuration files are available in future for logic modifications. Even if these files are not used by the relay, they are required to connect to the relay and analyze its configuration. The EnerVista 650 Setup software program manages the logic configuration files globally, so that when the *.pep file is uploaded to the relay, the associated *.aut and *.lib files are also stored.

File storage inside the relay (RECOMMENDED)	**Communication > Upload info files to relay** through Ethernet
Retrieval of files stored in the relay (RECOMMENDED)	**Communication > Download info files from relay** through Ethernet

4.1.4.2 Online mode

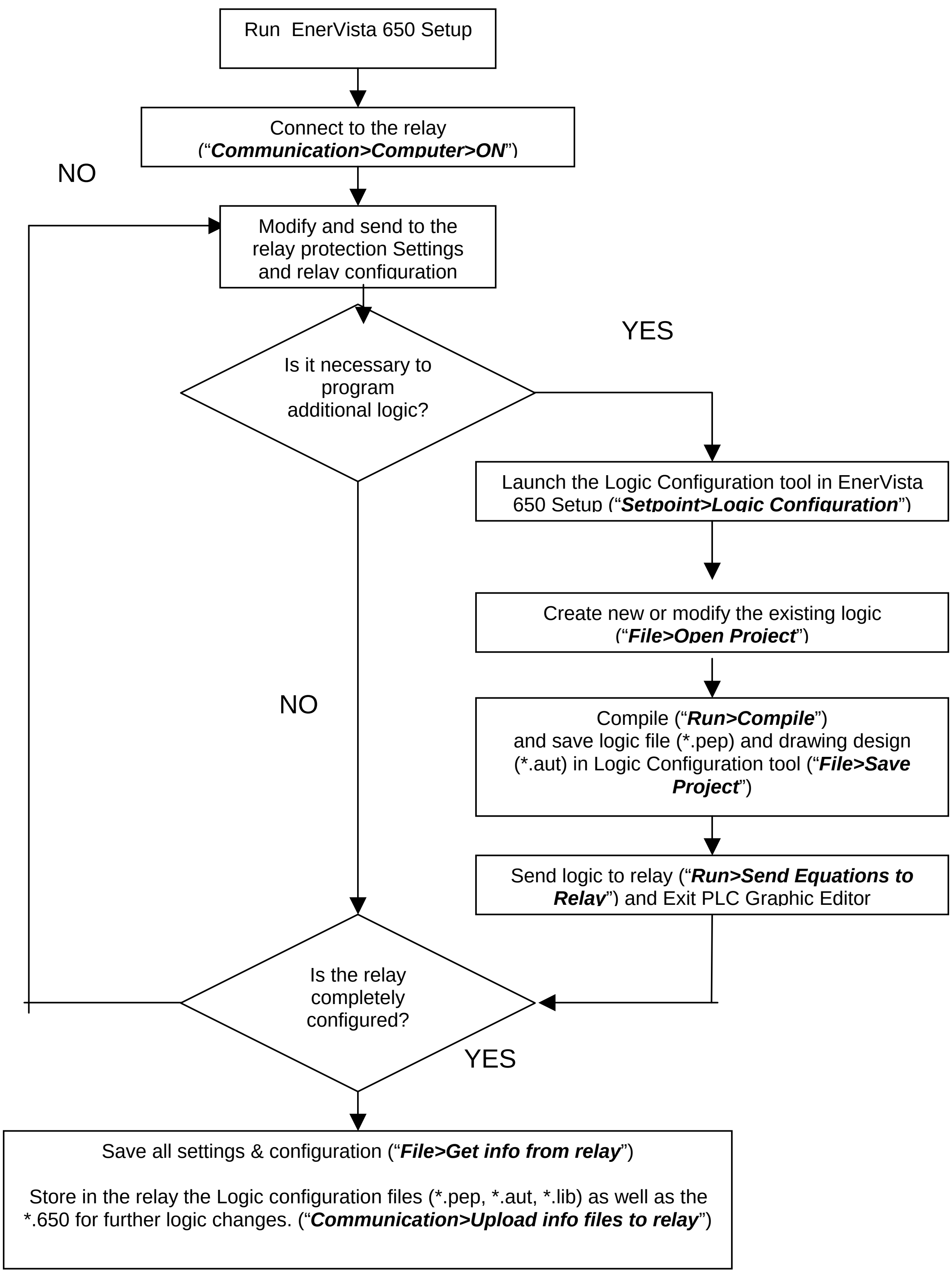


Figure 4-4: Online mode file management

Table 4-2: Types of files generated by EnerVista 650 Setup software, online

	Settings & Configuration File *.650	**Logic Configuration Files (*.pep, *.aut, *.lib)**		
		***.pep**	***.aut**	***.lib**
Description	Settings and Configuration Section	Header for Logic project	Graphical edition container. Logic equations (Virtual Outputs) in FDB format.	User programmable logic objects
Created by	EnerVista 650 Setup	Logic configuration graphic editor (PLC Editor)	Logic configuration graphic editor (PLC Editor)	Logic configuration graphic editor (PLC Editor)
Contents	Relay configuration file containing all elements, settings, input/output and LEDs configuration, graphic display configuration, etc. Equations corresponding to the logic created and compiled in the PLC Editor	PLC project file containing the necessary information relative to the relay model, logic libraries included in the project (*.lib), graphic file name (*.aut), etc.	PLC Project file containing all the drawings used by the logic, required by 650 relay based on IEC 61131-3 standard. Functional block diagram (FDB).	Library file to be included as an object in a PLC project. Logic packages that can be stored into libraries and be distributed in different PLC projects.
How to transfer to relay	Connect with the relay (**Communications > Computer**)	Connect with the relay (**Communications > Computer**)		
	Send settings and configuration from file	Launch 650 Logic equations editor (**Setpoint > Logic Configuration**)		
		Open the created PLC project (**File > Open Project**)		
		Compile the project (**Run > Compile**)		
		Now the logic (virtual outputs) can be sent directly to relay (**Run > Send Equations to Relay**). Texts of virtual outputs are not stored in the relay, only in the logic configuration files to be edited.		
	Modify settings and configuration directly in the relay:			
How to save	EnerVista 650 Setup: **File > Get info from relay**. User definable texts retrieved are operations, events, and LEDs.	PLC Editor:		
		File > Save Project		File > Save Library
		The relay does not provide this information unless the *.pep file is stored in the relay	The relay does not provide this information unless the *.pep file is stored in the relay.	The relay does not provide this information unless the *.pep file is stored in the relay.
		To store the logic configuration files in the relay use the **Communication > Upload info files to relay** option		
How to store in the relay	**Communication > Upload info files to relay** through Ethernet	**Communication > Upload info files to relay** through Ethernet		
How to retrieve from the relay	**Communication > Download info files *from relay*** through Ethernet	**Communication > Download info files from relay** through Ethernet		

REMINDER:
Logic programming support files (*.pep, *.aut, *.lib) CANNOT be retrieved directly from the relay.
It is necessary to do one of the following to store support files: * Store in the PC * Upload to the relay (**Communication > Upload info files to relay**), after which they can be retrieved from the relay

4.1.5 EnerVista 650 Setup menu

The EnerVista 650 Setup menu structure is shown in Table 4-3: EnerVista 650 Setup menu structure. This menu structure applies when communicating with a relay or when offline with a .650 file open.

Unless specified, options are available in both online and offline mode.

(*) indicates options enabled only in online mode. (**) indicates options enabled only in offline mode.

NOTICE The **View > Language** submenu controls the default language for the EnerVista 650 Setup program. This feature is only enabled when the relay is not communicating and no file has been opened.

Table 4-3: EnerVista 650 Setup menu structure

File	Setpoint	Actual	Operations(*)	Communication	IEC 61850 CONFIGURATOR	Security	View	Help
New (**)	Product Setup	Front Panel	Fixed commands	Computer		Login user	Traces	Instruction Manual
Open (**)	System Setup	Status		Modem (*)		Change Password	ModBus Memory Map	GE Multilin on the web
Save (**)	Protection Elements	Metering		Troubleshooting (*)		User Management	Languages (**)	About EnerVista 650 Setup
Save As (**)	Control Elements	Inputs/ Outputs		Calibration (*)				
Close (**)	Inputs/ Outputs Quick Settings	Records (*)		Upgrade Relay (*)				
Config File (* 650) Converter	Quick Reclose / Autoreclose Configuration	Autorecloser / Recloser						
Compare to settings file	Relay Configuration							
Properties (**)				Upgrade 650 Web Server				
	Logic Configuration							
Get info from relay (*)	IEC103 Configuration							
Send info to relay (*)	Clock (*)			Upload info files to relay				
Print Setup (**)				Download info files from relay				
Print Preview (**)								
Print (**)								
Print to file								
PLC Checksum Calculation								
Settings Checksum Calculation								
Order Code								
Exit								

4.1.6 File menu

File

New (**)	Create a new settings and configuration file, with the default relay settings and no configuration
Open (**)	Open a settings and configuration file for offline working.
Save (**)	Save *.650 settings and configuration file
Save As (**)	Save as *.650 settings and configuration file.
Close (**)	Close the opened *.650 file in EnerVista 650 Setup.
Config File (*.650)	Converter Tool to convert the *.650 files from one version to another
Compare to settings file	Compare online unit or opened settings file to another settings file
Properties (**)	File properties for *.650.
Get info from relay (*)	Retrieve the *.650 settings and relay configuration compiled equations from the relay.
Send info to relay (*)	Send and write the *.650 settings and configuration to the relay.
Print Setup (**)	To configure printer settings.
Print Preview (**)	Preview of settings and configuration file printing format.
Print (**)	Launch the *.650 file to be printed.
Print to file (*.xls) (**)	*.650 printed to file in excel format.
PLC Checksum Calculation	Calculate the CRC of PLC equations of the .650 file (When a .650 is uploaded to the relay, the calculate PLC CRC and the actual value of the PLC CRC read from the relay must match).
Settings Checksum Calculation	Calculate the CRC of settings of the .650 file (When a .650 is uploaded to the relay, the calculate Setting CRC and the actual value of the Setting CRC read from the relay must match).
Order code(*)	This allows a model to have special functionality (see model selection) with password requirements. For detailed information see chapter 9.
Exit	Quit the application closing all the open windows.

(*) indicates online only, (**) indicates offline only

4.1.6.1 New, Open, Save, Save as, and Close

In these options, the EnerVista 650 Setup program opens a dialog box (with default path to **Files > Config** program folder) where the setting and configuration files can be selected from offline files. To access this menu, there must be no communication between the PC program and the relay (offline mode).

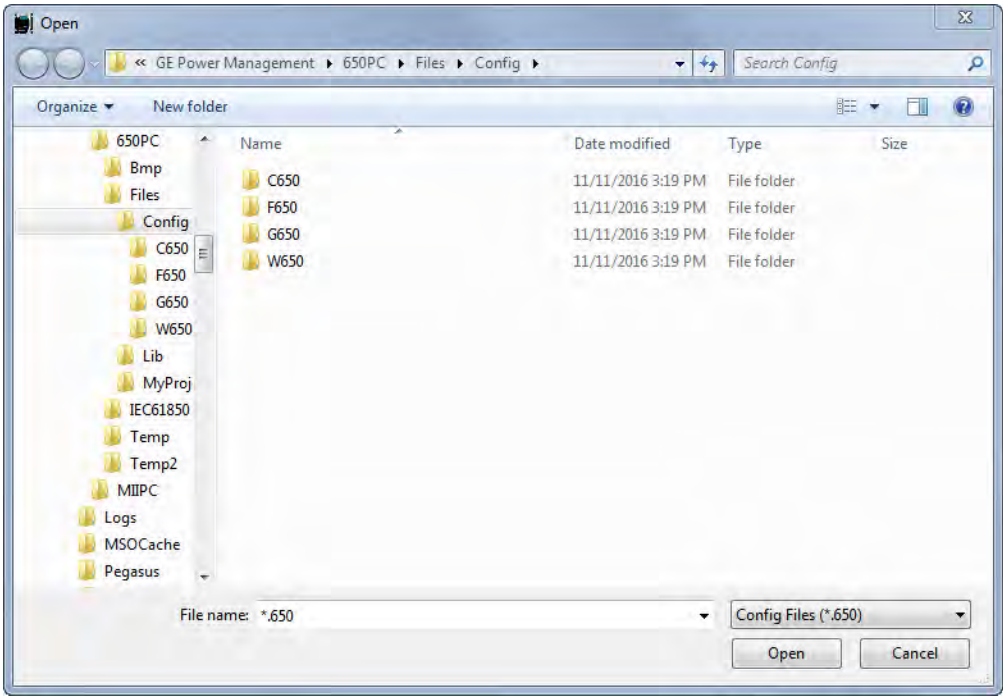


Figure 4-5: Open file menu

Once the *.650 file for the appropriate relay model (FXGX) is selected, the EnerVista 650 Setup program enables the offline options to fully program the unit. The enabled menus in the EnerVista 650 Setup program are: File, Setpoint, Actual, Communication, View and Help.

Offline mode displays the File, Setpoint, Actual, Communication, Security, View and Help submenus in order to program the unit. The Actual values submenus are for structure purposes only. Values are not refreshed while the relay is not communicating.

The **Save as** and **Close** file options are used to save the *.650 file into the computer and to close the current file. To work in offline mode for settings and configuration editing, a new *.650 file can be opened without closing the previous file. The **Close** option is instead used to clear all data in EnerVista 650 Setup program, enabling the **Language**, **Upgrade firmware version** and **Upgrade Operating system** menu options.

4.1.6.2 Configuration file converter

The configuration file converter tool provides automatic conversion of configuration files from and older firmware version to a newer version. In order to convert a configuration file, follow these steps:

1. Working in offline mode, go to **File > Config File (*.650) Converter**
2. Select the file to be converted.
3. After source file selection is complete, select conversion settings. Make the following selections:

Source Model:	Indicates source R650 model and original version of selected file.
Destination model:	Drop-down list of available R650 models and firmware versions. Select a destination model and firmware version. In the bottom part of this section, a brief description of all models affected is displayed in green after selecting one model in the list.
Source file path	Indicates the path where source model file is located.

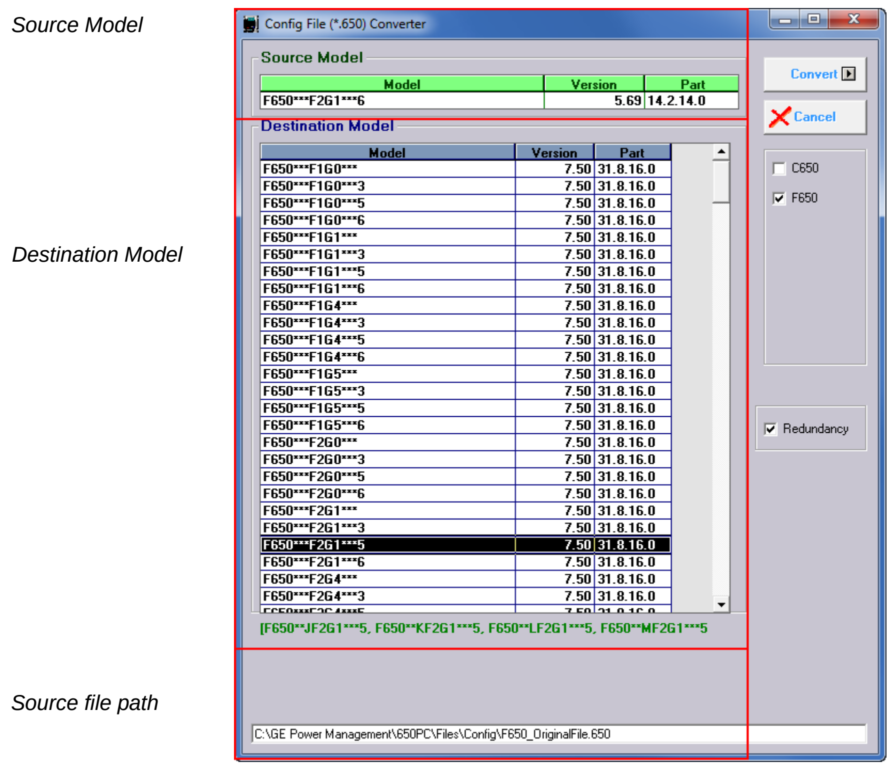


Figure 4-6: Config file (*650) converter menu

It is possible to change the model type (FXGX) using the conversion tool. It must be taken into account that part of the logic can be readjusted to fit the new input and output board selection. Notice also that the external wiring of inputs and outputs boards is different for type 1, 2, 4,5, and 6.

4.1.6.3 Properties

When this option is selected, the program displays the relay model information, firmware version, etc. of the file being edited, as shown:

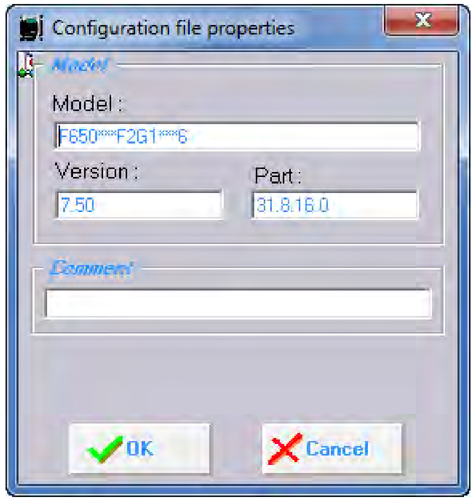


Figure 4-7: File properties menu

4.1.6.4 Print options

The printing options are active only in offline mode with a file open, and not in online mode, connected with the relay.

Print setup

Option to configure the printer options and settings.

Print preview

Option to preview the whole settings and configuration file (*.650) in paper format to be printed as shown:

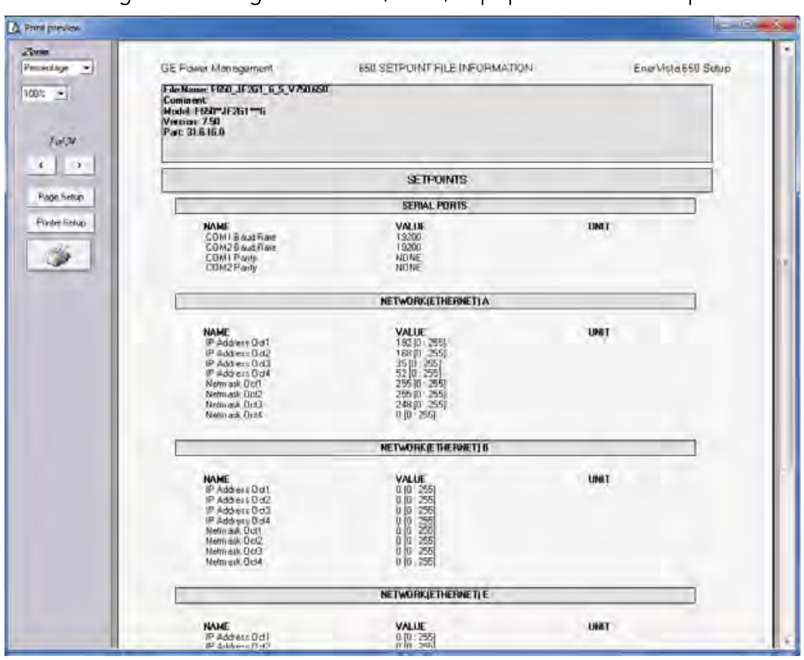


Figure 4-8: Print preview of settings file

Print

Option to print the relay configuration using the PC default (active) printer on port COMx or LPT. This option is active only in offline mode and in file edition (not in online mode while connected to the relay).

Print to file (*xls)

Option to export the configuration file to an Excel file.

4.1.6.5 Compare to settings file

This tool provides an automatic comparison of two different configuration files, or of an online unit to one settings file.

Open the source *.650 file and select the version and model to compare against. The results of the comparison are displayed as shown:

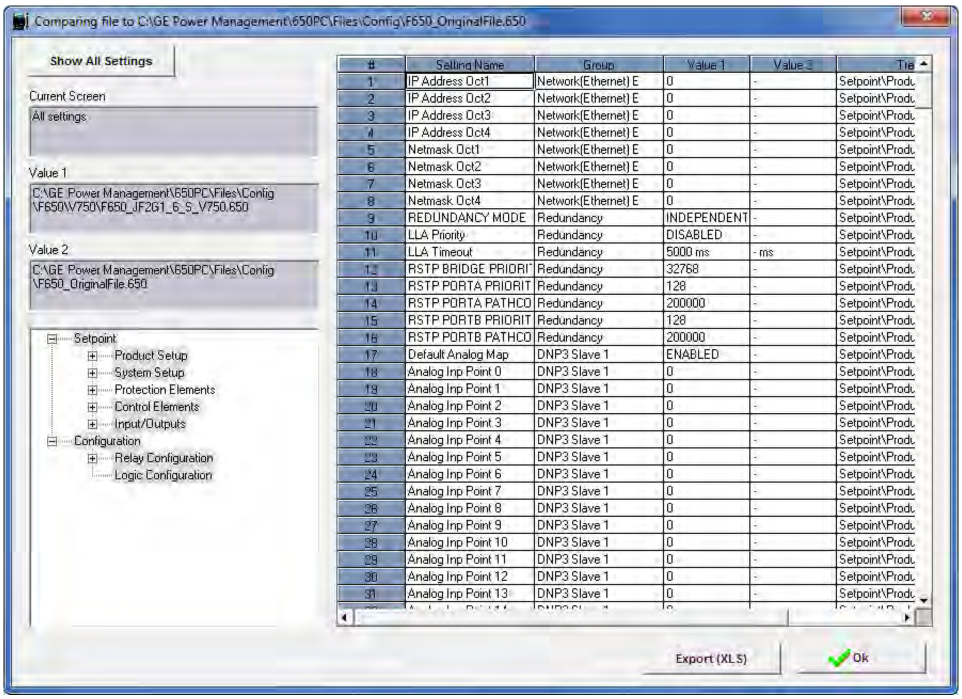


Figure 4-9: Compare to settings file

4.1.6.6 PLC checksum calculation

When working in offline mode, the PLC Checksum calculation option calculates the CRC of the PLC equations and Relay configuration section for the open *.650 file. When a *.650 file is uploaded to the relay, the calculated PLC Checksum and the actual value of the PLC Checksum read from the relay (**Actual values > Status > System Info**) must match.

In order to calculate this checksum, the following sections of the * .650 file are considered:

- All equations compiled in the file and located in EnerVista 650 Setup **Setpoint > Logic configuration**
- Configuration available in the file and located in EnerVista 650 Setup **Setpoint > Relay configuration**, excluding:
  - HMI tab configuration
  - All configured text
  - Opening and closing time in the Switchgear section

4.1.6.7 Setting checksum calculation

When working in offline mode, the Settings Checksum calculation option calculates the CRC of different configured settings for the open *.650 file. When a *.650 file is uploaded to the relay, the calculated Settings Checksum and the actual value of the Settings Checksum read from the relay (**Actual values > Status > System Info**) must match.

In order to calculate this checksum, the following sections of the * .650 file are considered:

- All settings in the relay configuration section (**Setpoint > Relay configuration**) excluding:
  - Those communication settings: **Setpoint > Product Setup > Communication settings > SerialPorts** or **Network (Ethernet)** or **Modbus Protocol** or **Routing**
  - Relay calibration factors
  - Opening and closing time in the Switchgear section

4.1.7 Setpoint menu

Setpoint		
	Product Setup	Communications settings for all protocols and physical mediums. ModBus user map definition, fault report, oscillography, data logger demand settings and time settings.
	System Setup	General settings, source and load voltage sensing settings, current sensing settings, Flex curve definitions, recloser, switchgear, and miscellaneous settings.
	Protection Elements	Phase, neutral, ground, sensitive ground and negative sequence current settings. Voltage element settings and power settings management.
	Control Elements	Setting groups, under- and over-frequency settings, synchrocheck, autoreclose, breaker failure, VT fuse failure, broken conductor, pulse counters, analog comparators, digital counters, cold load pickup and PLC timer masks
	Inputs/Outputs	Contact I/O settings for all boards available in device, remote comms, force outputs and virtual inputs.
	Quick Settings	Menu including key configuration settings such as; Current and Voltage sensing or current protection element.
	Quick Reclose / Autoreclose Configuration	Menu including key configuration settings for the recloser device and the autoreclose element.
	Relay Configuration	Configuration of Outputs, LEDs, Operations, Protection Elements, Oscillography, Control Events, Control Elements, Switchgear, Inputs, Virtual Inputs, Operations and HMI. Whole relay configuration with internal relay signals or user-definable ones as logic (virtual outputs).
	Logic Configuration	Logic configuration graphic editor (PLC Editor). It is a PLC Project file editor that contains all the internal drawings used to make the logic (virtual outputs) based on IEC 61131-3 standard. Functional block diagram (FDB).
	IEC103 Configuration	IEC103 settings for available IEC103 models (3) when communicating through Ethernet with Enervista 650 Setup
	Clock (*)	Relay synchronization to computer clock or to user-definable date and time. Online mode only.

(*) indicates online only, (**) indicates offline only

4.1.7.1 Product setup menu

Product Setup		
	Communication Settings	Serial Ports, Network (Ethernet), ModBus Protocol, DNP Slave, IEC 870-5-104, SNTP settings, PTP1588 and Routing.
	ModBus User Map	ModBus user map definition. The ModBus user map is formed by 256 records, selectable from the complete relay ModBus map.
	Fault Report	Fault report settings. Possibility to show fault reports on HMI screen.
	Oscillography	Oscillography settings (trigger position, samples per cycle, etc.). The trigger and digital channels (up to 16) must be configured in **Setpoint > Relay configuration**.
	Data Logger	Data logger configuration
	Demand	Demand settings. The demand trigger and demand reset signals must be configured in **Setpoint > Relay configuration**
	Time Settings	Time synchronization settings and daylight savings time settings.
	Conf Events	Configurable event settings. Up to 24 configurable event measurements are available.

(*) indicates online only, (**) indicates offline only

4.1.7.2 System setup menu

System Setup		
	General Settings	This screen describes and enables the settings of the power system where the relay operates. Some of these settings are used only for metering values presentation purposes; however, some of them apply directly to the sampling and analog-digital conversion process (rated frequency setting). Therefore, these settings need to be adjusted to fit the system settings.
	Source Volt. Sensing	Setup for the capacitive voltage dividers connected to the relay voltage terminals. Settings for calibration factors are also provided.
	Load Volt. Sensing	Setup for the capacitive voltage dividers connected to the relay voltage terminals. Settings for calibration factors are also provided.
	Current Sensing	Setup menu for the Current Transformers (CTs) connected to the R650 terminals. The setup of the three-phase CTs, the Ground CT, and the Sensitive Ground CT require a selection of primary CT ratings. The secondary CT ratings are selected between 1A or 5A for phases and ground, and fixed at 0.2A for Sensitive Ground Input.
	Flex Curves	The relay incorporates 4 user curves called Flex Curve A, B, C and D. The points for these curves are defined by the user in **Setpoint > System Setup > Flex Curves > Edit Curve** menu in EnerVista 650 Setup. User defined flex curves can be selected as an operation curve in all the time overcurrent functions in the relay.
	Recloser	Configuration of recloser maintenance parameters. Setpoints to select the trip mode between One Pole or Three Pole are also provided.
	Switchgear	Configuration of snapshot events for each switchgear (enable or disable)
	Miscellaneous Settings	Settings related to the relay working mode. Out of service setting, and Local/Remote mode are also included.

(*) indicates online only, (**) indicates offline only

4.1.7.3 Protection elements menu

This option shows all protection elements available in the relay as shown in the following table. There are six setting groups of protection elements. Protection element groups are within each setting group.

Table 4-4: Protection elements menu

Protection Elements		
	Setting Group 1	All protection functions available when setting group 1 is the active group
	Setting Group 2	All protection functions available when setting group 2 is the active group
	Setting Group 3	All protection functions available when setting group 3 is the active group
	Setting Group 4	All protection functions available when setting group 4 is the active group
	Setting Group 5	All protection functions available when setting group 5 is the active group
	Setting Group 6	All protection functions available when setting group 6 is the active group

(*) indicates online only, (**) indicates offline only

Table 4-5: Protection elements in each setting group

Phase Current		
	Phase TOC High	Phase time overcurrent, high level (51PH)
	Phase TOC Low	Phase time overcurrent, low level (51PL)
	Phase IOC High	Phase instantaneous overcurrent, high level (50PH)
	Phase IOC Low	Phase instantaneous overcurrent, low level (50PL)
	Phase Directional	Phase directional unit (67P). Quadrature Voltage for polarization
	Thermal Model	Thermal model or Thermal image unit for phases (49)
Neutral Current		
	Neutral TOC	Neutral time overcurrent (51N)
	Neutral IOC	Neutral instantaneous overcurrent (50N)
	Neutral Directional	Neutral directional unit (67N). Voltage, current and dual polarization.
Ground Current		
	Ground TOC	Ground time overcurrent (51G)
	Ground IOC	Ground instantaneous overcurrent (50G)
	Ground Directional	Ground directional unit (67G). Voltage, current and dual polarization.
Sensitive Ground Current		
	Sensitive Ground TOC	Sensitive ground time overcurrent (51SG).
	Sensitive Ground IOC	Sensitive ground instantaneous overcurrent (50SG).
	Isolated Ground IOC	Isolated ground overcurrent (50IG)
	Sensitive Ground Directional	Sensitive ground directional unit (67SG)
Negative Sequence Current		
	Negative Sequence TOC	Negative sequence time overcurrent (46P)
Source Voltages		
	Phase UV	Phase undervoltage (27P)
	Phase OV	Phase overvoltage (59P)

	Neutral OV	Neutral overvoltage (59N)
	Negative Sequence OV	Negative sequence overvoltage (47)
Load Voltages		
	Phase UV	Phase undervoltage (27P)
	Phase OV	Phase overvoltage (59P)
	Neutral OV	Neutral overvoltage (59N)
	Negative Sequence OV	Negative sequence overvoltage (47)
Power		
	Forward Power	Forward power (32FP), in primary values.
	Directional Power	Directional power (32), in primary values.
	Watt Gnd Flt	Wattmetric ground fault (32N), in secondary values
Frequency		
	Underfrequency	Underfrequency unit (81U).
	Overfrequency	Overfrequency unit (81O).
Miscellaneous		
	Broken Conductor	Broken or fallen conductor detection function (I2/I1). Grouped element. Ratio between the negative sequence current, I2, and the positive sequence current I1. In normal and balanced load situations, this ratio is zero, while in severe load fault conditions, an unbalance is produced and this ratio is increased.

4.1.7.4 Control elements menu

This option shows all protection elements available in the relay as shown in the following table.

Table 4-6: Control elements menu

Control Elements		
	Setting Group	R650 incorporates up to six setting groups. Only one of setting group will be active at a given time. Units grouped under Protection elements section will be the units affected by changing of setting group.
	Synchrocheck	Synchronism check unit (25). Single element.
	Autoreclose	Recloser (79). Single element.
	Breaker Failure	Breaker failure (50BF). Single element.
	VT Fuse Failure	Fuse Failure (VTFF). Single element.
	Pulse Counters	Pulse counters function. 8 counters provided.
	Analog Comparators	Analog comparator function. 20 analog comparators provided.
	Digital Counters	Up to 8 Digital Counters
	Cold Load Pickup	Cold Load Pickup Function. Single element.
	PLC Timer Masks	Configuration of masks that can be assigned to PLC timers
	60 CTS Failure	Current transformer failure function
	2nd HRMC Inhibit	Second harmonic inhibit element to block any other protection element in the presence of second harmonic in the signal.
	Coil Circuit Supervision	Coil circuit supervision

4.1.7.5 Inputs/Outputs menu

Section that contains the settings for all input and output boards and the Force Outputs and Virtual inputs activation tools.

Inputs/Outputs

Contact I/O	Inputs and outputs settings for all boards in R650. The I/O settings configuration can only be performed through EnerVista 650 Setup, not available through the HMI.
Force Outputs (*)	This menu allows activating each contact output in the relay, to facilitate maintenance testing. Online mode only.
Virtual Inputs (*)	This menu allows operating virtual inputs. These variables are used as inputs to logic schemes configured in the relay. Virtual inputs can be operated in a latched mode (32 latched virtual inputs) or in Self-reset mode (32 self reset virtual inputs).
Remote Comms.	This menu allows configuring remote inputs coming from other devices and allow enabling None, GSSE or GOOSE messages. Available for IEC61850 (7) models only.

(*) indicates online only, (**) indicates offline only

4.1.7.6 Quick settings menu

This menu allows quick access to the main Setpoints of the relay.

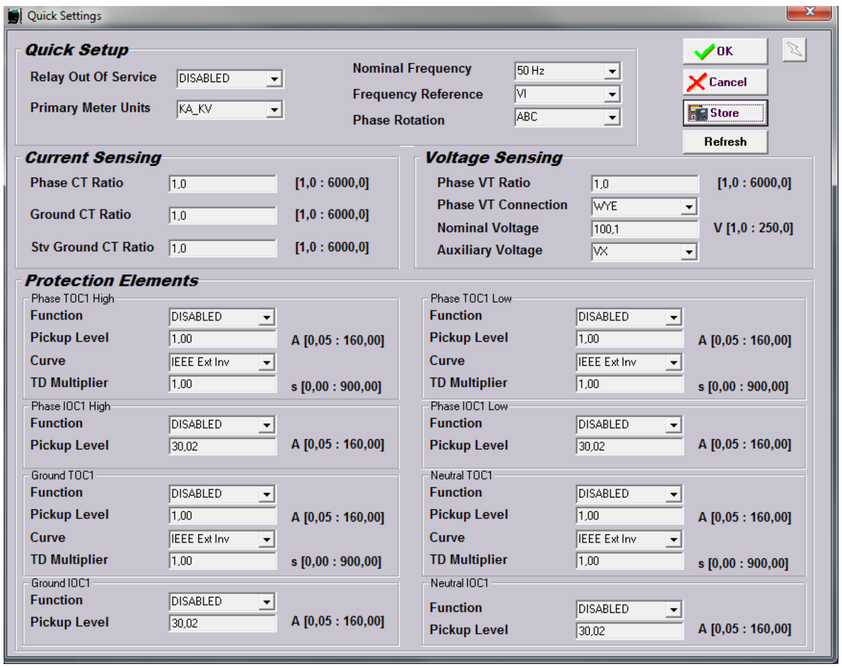


Figure 4-10: Quick Settings

4.1.7.7 Quick Reclose / Autoreclose settings menu

This menu gives access to main settings related with the Recloser and the Autoreclose element.

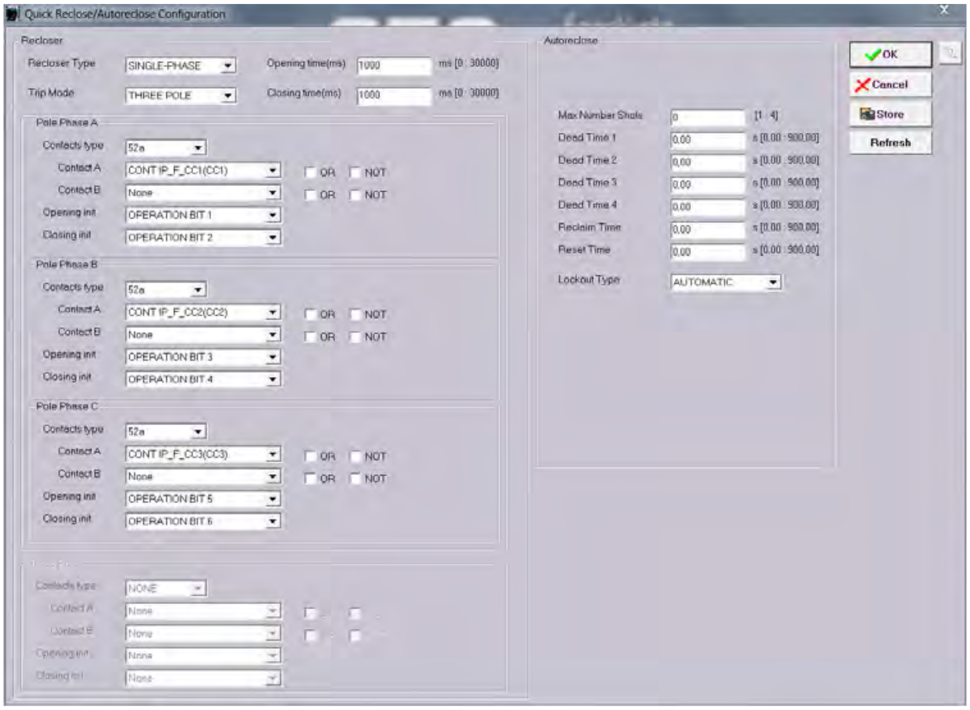


Figure 4-11: Quick Recloser / Autoreclose Settings

4.1.7.8 Relay configuration menu

This is the relay configuration section in which the relay can be configured using internal states or already compiled equation on PLC Editor

.

Relay Configuration		
	Outputs	Configuration of contact output operate and reset signals for all boards.
	LEDs	15 LEDs fully configurable from any logical variable, contact or virtual input. First 5 LEDs are latched by hardware, the rest are self-reset but can be latched through PLC configuration. All 15 LEDs can be latched by setting. The vertical LED label for the relay can be printed from this menu.
	Operations	Configurable operations, up to 32. Operation texts, interlocks, final states, frontal keys, time outs and masters.
	Protection Elements	This tab allows assigning operands (logic signals) as inputs to different protection elements. To block, reset, initiate the different protection elements inputs.
	Control Elements	This tab allows assigning operands (logic signals) as inputs to different control elements.
	AR Control Elements	Configuration of the inputs of the Autoreclose element.
	Oscillography	Trigger and up to 16 digital channels to be included in oscillography records, are programmable from any logical variable, contact or virtual input. Text configuration is only for offline mode. **NOTE:** This screen is used for the configuration of digital channels and oscillography trigger. The rest of parameters, such as function enabling/disabling, sampling rate, number of oscillography files, etc. must be set on the **Setpoint > Product Setup > Oscillography** menu.

Control Events	Up to 128 user programmable events from any logical variable, contact or virtual input. Possibility to display the event as an alarm on the alarms panel. Control events are also displayed in the snapshot events recording. 1 ms time tagging. A control event is a logic signal associated with an operand or combination of operands, that allows following the status of that signal.
Switchgear	Up to 12 configurable switchgear elements. A switchgear element can be a breaker, a line selector switch, a grounding selector switch, a busbar selector switch, etc. This screen allows configuration of type of contacts, opening and closing time, contact assignation and text for events related to switchgear. There are 64 pre-established events for switchgear, which correspond to opening, closing, Error01 and Error11 of the 12 programmable switchgear elements.
Recloser	Configuration of the type of contacts, opening and closing time, contact assignation and text for events related to the recloser.
Remote outputs	Up to 32 DNA bits and 64 user St bits to be transmitted to remote devices over CAN using GSSE messages.
Inputs	Text configuration for offline mode file management for all the contact inputs available in device.
Virtual Inputs	Text configuration for offline mode file management. 32 latched and 32 self reset virtual inputs.
MMI (HMI-Human Machine Interface)	Screen one line diagram configuration. This menu shows a canvas to draw a simplified one-line diagram of a bay in a feeder, line, transformer, etc. The menu includes a library for power elements, metering elements, text and drawings. See an example on the next page.

The following figures show an example of the default factory configuration for R650:

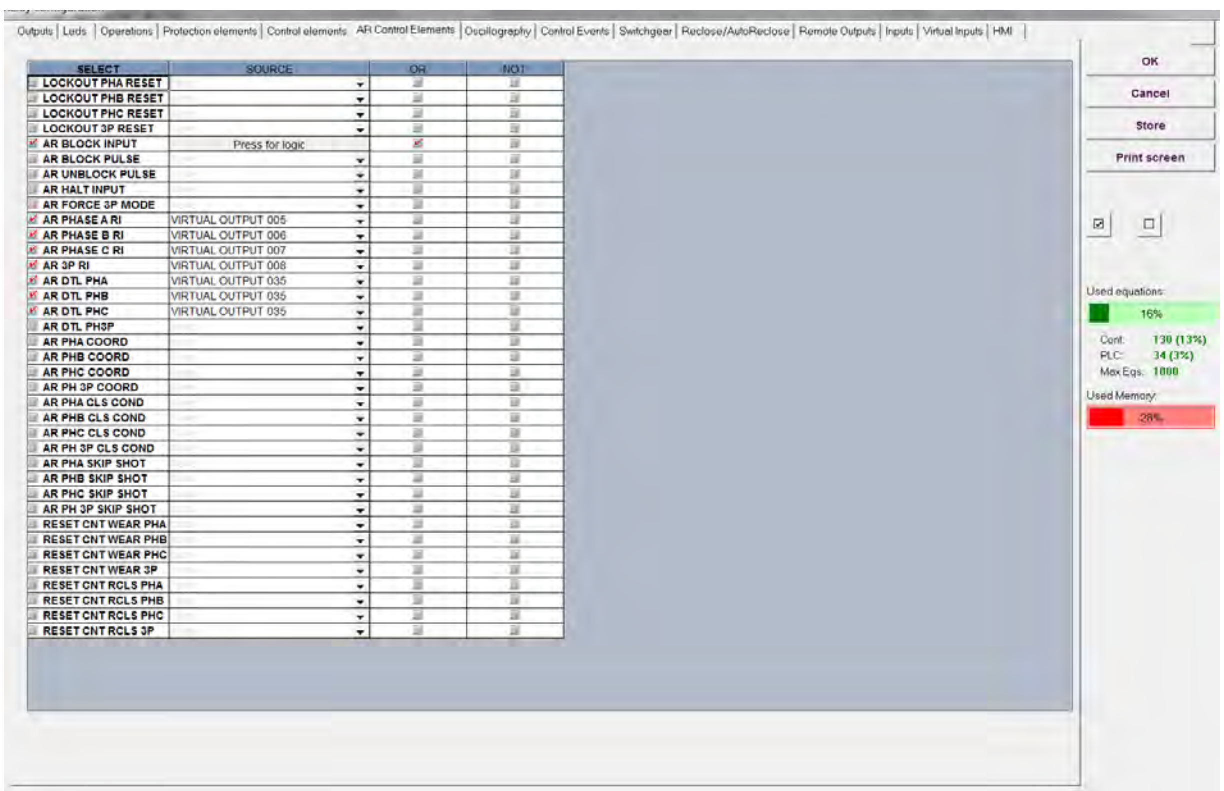


Figure 4-12: Relay configuration

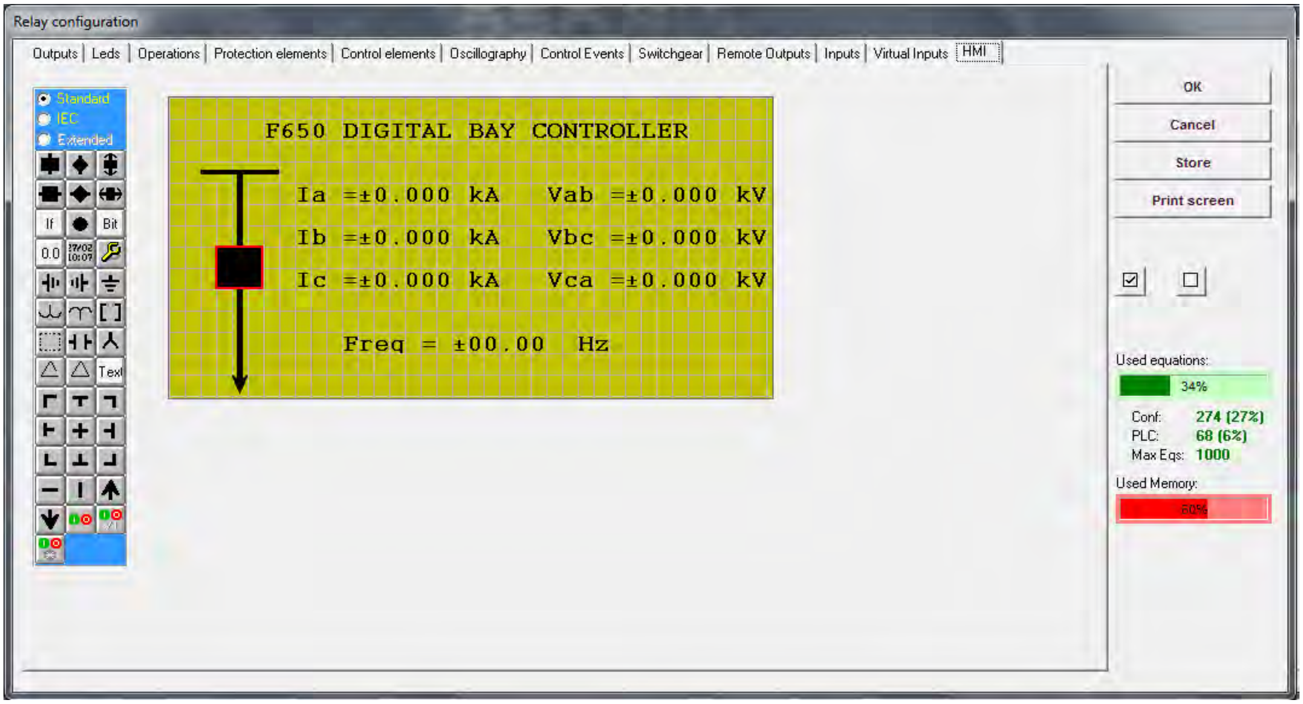


Figure 4-13: HMI configuration

4.1.7.9 Logic Configuration menu

This logic configuration allows creating more complex configurations, using the graphical PLC, than using the tables from Relay Configuration. For file management detailed information go to section 4.1.4 File management menu.

File description:

.pep:Header for Logic project: PLC project file containing the necessary information relative to the relay model, logic libraries included in the project (.lib), graphic file name (*.aut), etc.

*.aut:PLC Project file containing all the drawings used by the logic, required by 650 relay based on IEC 61131-3 standard. Functional block diagram (FDB).

*.lib:User programmable logic objects: Library file to be included as an object in a PLC project. Logic packages that can be stored into libraries and be distributed in different PLC projects.

4.1.7.10 IEC 103 Configuration menu

This menu allows to update the IEC 103 configuration of the unit.

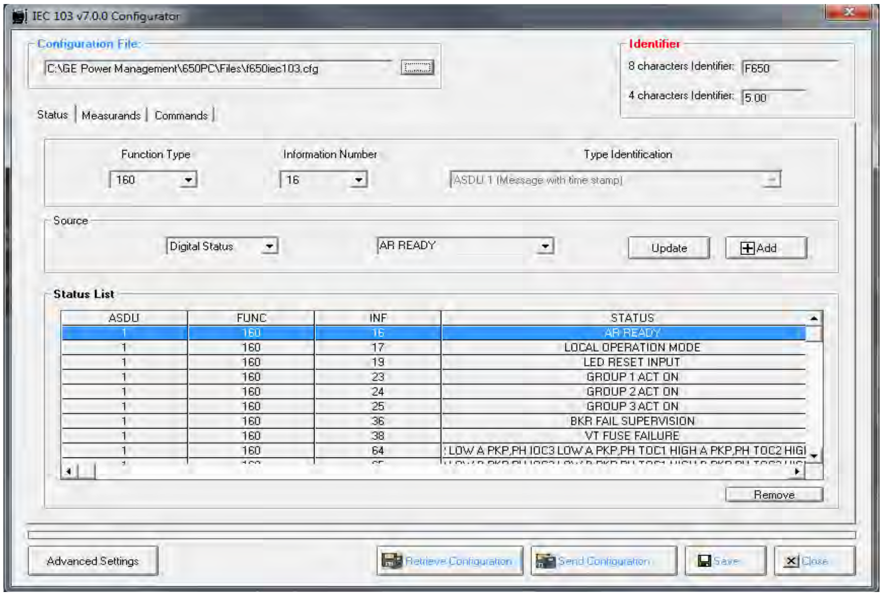


Figure 4-14: IEC 103 Configurator

See chapter 5.13

4.1.7.11 Clock menu

This menu allows updates to the date and time of the relay, either synchronizing them with the PC clock, or entering the information manually.

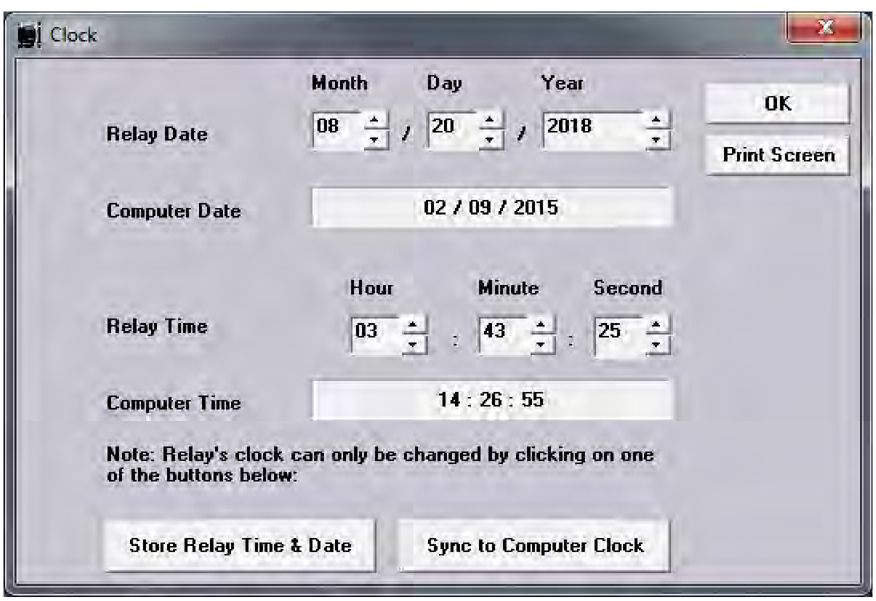


Figure 4-15: Clock

4.1.8 Actual values menu

The menu bar in the main screen of EnerVista 650 Setup software shows the ACTUAL menu option. This option concentrates and displays all the status of protection, control elements, metering, counters information, oscillography, events, fault locator, etc. This section shows only the structure of menus in EnerVista 650 Setup.

Actual		
	Front Panel	The relay front LED status is shown on this menu.
	Status	Protection and control status signals for all available protection functions in device.
	Metering	All metering values available in device. Primary and secondary values, frequency and phasor diagram provided.
	Inputs/Outputs	All input and output status provided. For contact inputs and contact outputs as well as virtual input and virtual output signals.
	Records	Only enabled in online mode, retrieval of all the available records in device. Snapshot events, control events, oscillography and fault reports.
	Reclose / Autorecloser	Main information about the status of the recloser and the Autoreclose element.

4.1.8.1 Front panel

The front panel menu shows the LEDs submenu where all the front LEDs can be monitored.

4.1.8.2 Status

The following menu includes all the available protection status in the device. Location of different menus can vary depending firmware version.

Status		
	Operation Bits	Up to 32 elements. OPERATION BIT XX is (0) when the configured time out for the operation XX expires or when success conditions are met. And it is (1) if operation XX is executed and interlocks are fulfilled.
	Recloser	Recloser status (open, closed or undefined). Maintenance data is also shown here.
	Protection	Status of all the protection units in the device.
	Control Elements	Status of all the control units available in the device.
	Protection Summary	This screen shows a complete list of all protection and control elements in the relay, showing their status (enabled or not).
	Snapshots Events summary	Summary of the snapshot events status (enabled or disabled) for protection, control, inputs and outputs boards and switchgear.
	ModBus User Map	Up to 256 elements. Value in SIGNED INT 16 BIT format of the reading for the selected address configured in **Setpoint > Product Setup > ModBus User Map**
	Switchgear Status	Up to 12 blocks of switchgear status signals for the 12 configurable devices. Status signals such as inputs for A and B contacts, status for A and B, open and close status, error 00 and error 11, open init and close init, fail to open and fail to close signals.
	Calibration	Internal states for calibration. Factory calibration and calibration error signals.
	FlexCurves	Flex curve status for A, B, C and D user curves. (0) if it is not configured, (1) if it is configured. To configure a flex curve go to **Setpoint > System Setup > Flex Curves** menu.
	System Info	This screen can monitor the system parameters and the internal status of the Relay operating system. Not enabled by default, password required
	Records Status	Information related to the different records stored in the Relay, such as: Fault reports, control events, oscillography, data logger, demand, energy, and recloser opening and closing operations.
	SNTP-IRIG_B & PTP 1588	Information related to synchronization via IRIG_B, SNTP or PTP1588.
	Versions	Information related to the different firmware versions and hardware revisions.

Redundancy	Information related to the status of the frames sent through PRP and HSR. Also information related to the status of RSTP port.

4.1.8.3 Metering

The Metering menu includes all the measurements available in the device. Primary and secondary values, and also the data related to the recording functions in the relay

Metering		
	Primary Values	Primary values measurements for currents, voltages, power, energy and demand
	Per Unit Values	Secondary values measurements for currents, voltages.
	Phasor Diagram	Current, voltage and sequence components.
	Frequency	Load and source frequencies.
	Power quality	Harmonics and THD for current, source and load voltages.

4.1.8.4 Inputs/Outputs menu

The Inputs/Outputs menu includes all the inputs and outputs signals available in the device. Contact and virtual type.

inputs/outputs		
	Contact Inputs	Status of digital inputs in the Relay for each board according to the relay model.
	Contact Output Status	Status of digital outputs in the Relay for each board according to the relay model.
	Contact Outputs Operates	Status (activated or not) of the variables used to operate a contact output. To configure these signals go to **Setpoint > Relay Configuration > Outputs** menu.
	Contact Outputs Resets	Status (activated or not) of the variables used to reset a contact output. To configure these signals go to **Setpoint > Relay Configuration > Outputs** menu. This output reset Command is only effective if **latch** is selected for **Output Type** setting on the I/O board, thus the contact output has been configured to emulate function 86 (latching relay).
	IO Board Status	Status of I/O boards. This status provides if the hardware it is OK (boards matching relay model, correctly inserted in their tracks, in good state and communicating through the internal CAN bus).
	Virtual Inputs	Status of Virtual inputs latched (32) and self-reset (32).
	Virtual Outputs	Status of virtual outputs (configured in PLC Editor). Up to 512.
	Remote Outputs	States of remote outputs for IEC61850 models.
	Remote Inputs	Status of remote device and remote inputs for IEC61850 models.
	Analog Inputs (*)	Measurements coming from analog inputs (DCMA)
	Virtual Output Latched	Status of Virtual Output Latched (configured in PLC Editor). Up to 16.
	Virtual Output Analogues	Status of Virtual Output Analogues configured in PLC Editor). Up to 49 float values and 49 integer values can be used.

(*) indicates online only, (**) indicates offline only

4.1.8.5 Records menu

The Records menu is only available in online mode and includes the possibility to retrieve all the records available in the device. By serial or Ethernet.

Records (*)		
	Event recorder (*)	Retrieval and visualization of snapshot event (all and new), control events and alarm panel. By serial or Ethernet (ModBus RTU or TCP/IP)
	Waveform capture (*)	Retrieval of oscillography files, by Ethernet.
	Fault Report (*)	Retrieval and visualization of fault report files, by Ethernet.
	Data logger (*)	Retrieval and visualization of data logger files. Only by Ethernet.

(*) indicates online only, (**) indicates offline only

4.1.9 Operations menu

Option only available in online mode, showing all the operations previously configured in the relay with their corresponding texts, which must be different from the default text (Op_X not configured).

operations		
	Operation 1 (*)	Entry to first operation (with its corresponding text)
	...	...
	Operation 32 (*)	Entry to 32nd operation (with its corresponding text)

(*) indicates online only, (**) indicates offline only

4.1.10 Communications menu

The communication menu includes the computer screen to start communicating with the relay, the different update procedures available in device: firmware, operating system, web server and other file storing capabilities (upload and download info files to/from relay).

For more detail information go to section 4.1.3 Connect to the relay for communication menus description and to section 5 for flash memory update procedures.

Communication		
	Computer	Menu to start communication with the relay.
	Modem (**)	Configure the unit for remote communications via modem, using a telephone line. This is only available if the relay is not communicating and if modem has been selected under **Communication > Computer** control type.
	Troubleshooting (*)	Read/write to ModBus addresses, for verifying communications and access to different positions in the ModBus memory map. Only available if the communication has already been established.
	Calibration (*)	Retrieve the unit calibration settings and storing them in a file (with extension *.cal). For reading or storing the calibration settings in the relay go to **Communications > Calibration > Get** or **Set** calibration settings and select the intended calibration file. The calibration retrieval process must be performed before updating the operating system. When the firmware and bootcode are updated, all the data in the relay is deleted, including the factory calibration settings. When only the firmware is updated (for versions higher than 1.50), the calibration settings are automatically saved in the relay.
	Upgrade relay (**)	Upgrade firmware version (Ethernet connection): Update the relay firmware through Ethernet communication . Firmware is related to the relay internal program, designed by GE Multilin, which performs the protection and control functions, and which is run by the relay main microprocessor.
	Upgrade 650 web server	Upgrade 650 web server (Ethernet connection):Go to Communications > Upgrade 650 web server. The relay web server application can be updated to further versions (if available) using this menu without modifying the relay operating system.
	Upload info files to relay	Upload info files to relay (Ethernet connection): This functionality is used to store setting files (*.650) inside the relay, as well as auxiliary files used by the programmable logic graphical editor (*.pep, *.aut, *.lib).
	Download info files from relay	Download info files from relay (Ethernet connection): This functionality is used for retrieving the files (*.650 and *.pep, *.aut, *.lib) that have been previously stored in the relay flash memory.

(*) indicates online only, (**) indicates offline only

⚠CAUTION **CAREFULLY READ THE FLASH MEMORY UPDATE PROCEDURE DESCRIBED IN SECTION "BOOT CODE AND FIRMWARE" AND CLOSE ALL RUNNING APPLICATIONS BEFORE PERFORMING FIRMWARE AND OPERATING SYSTEM UPDATES.**

NOTICE

*.650 files contain protection, control settings, relay configuration and compiled logic equations. This file can be retrieved from the relay, using the **File > Get info from relay** option in EnerVista 650 Setup (through serial or Ethernet communication). **File > Send info to relay** option stores this *.650 file in the relay.

*.pep, *.aut and *.lib files contain the logic configuration projects necessary to modify the logic (virtual outputs) in the relay. These files can be stored in the relay, using the **Communication > Upload info files to relay** option in EnerVista 650 Setup (through Ethernet communication). They can be retrieved using **Communication > Download info files to relay** option in EnerVista 650 Setup program (Ethernet communication). Take into account that the *.pep, *.aut and library files are necessary to modify the PLC logic (virtual outputs). Without these files setting and configuration can be modified but not logic equations (virtual outputs). It is advisable to use the **Communication > Upload info files to relay** option to store these logic configuration files into the relay.

*.pep, *.aut and *.lib files contain the logic configuration projects necessary to modify the logic (virtual outputs) in the relay. These files can be stored in the relay, using the **Communication > Upload info files to relay** option in EnerVista 650 Setup (through Ethernet communication). They can be retrieved using **Communication > Download info files to relay** option in EnerVista 650 Setup program (Ethernet communication). Take into account that the *.pep, *.aut and library files are necessary to modify the PLC logic (virtual outputs). Without these files setting and configuration can be modified but not logic equations (virtual outputs). It is advisable to use the **Communication > Upload info files to relay** option to store these logic configuration files into the relay.

An example of **Communication > Troubleshooting follows**:

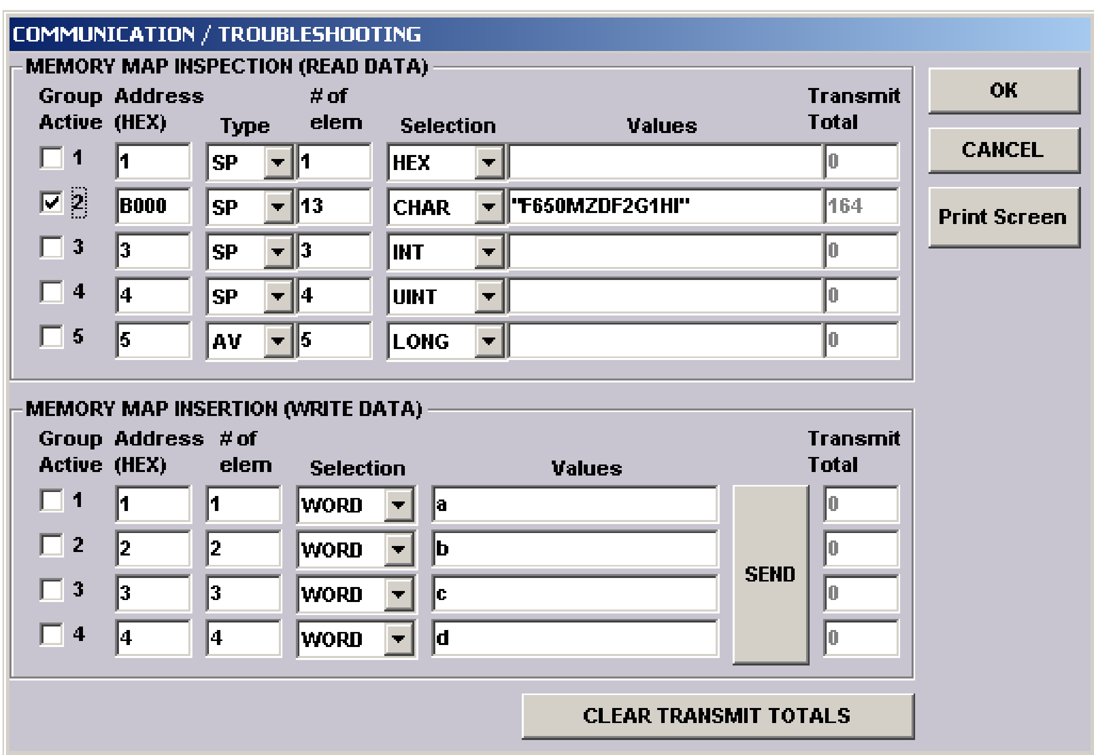


Figure 4-16: Communication troubleshooting example

4.1.11 Security menu

The security menu includes all the menus related to security control in EnerVista 650 Setup. EnerVista 650 Setup security users and passwords are not related to passwords in HMI. Each security level has its own access for HMI management and EnerVista 650 Setup management.

Security		
	Login User (*)	Log on menu for EnerVista 650 Setup. Enabled after security control has been enabled in user management menu.
	Change Password (*)	Menu to change passwords and establish password recovering questions.
	User Management (*)	User management dialog box.

(*) indicates online only, (**) indicates offline only

4.1.12 View menu

The view menu includes the computer screen to start communicating with the relay, the different update procedures available in device: firmware, operating system, web server and other file storing capabilities (upload and download info files to/from relay).

The ModBus memory map is detailed in the complete instruction manual (English only) and can be obtained from EnerVista 650 Setup program.

View		
	Traces (*)	ModBus communication traces between the EnerVista 650 Setup and the relay.
	ModBus Memory map	Complete ModBus memory map description.
	Languages (**)	Option to change the EnerVista 650 Setup default language. Only available if the relay is not communicating and no file (*650) is open.

(*) indicates online only, (**) indicates offline only

4.1.13 Help menu

Complete instructions manual and data about EnerVista 650 Setup release.

Help		
	Instruction Manual	Instructions manual in the language selected in **View > Languages**.
	GE Multilin on the Web	GE Multilin web page link.
	About EnerVista 650 Setup	Release version and date of the EnerVista 650 Setup program.

4.2 Human-machine interface (HMI)

The HMI interface consists of several functional panels. The faceplate can be unscrewed to allow easy access to the removable modules. There is a removable dust cover that protects the front USB Communications port. The following figure shows the HMI in R650

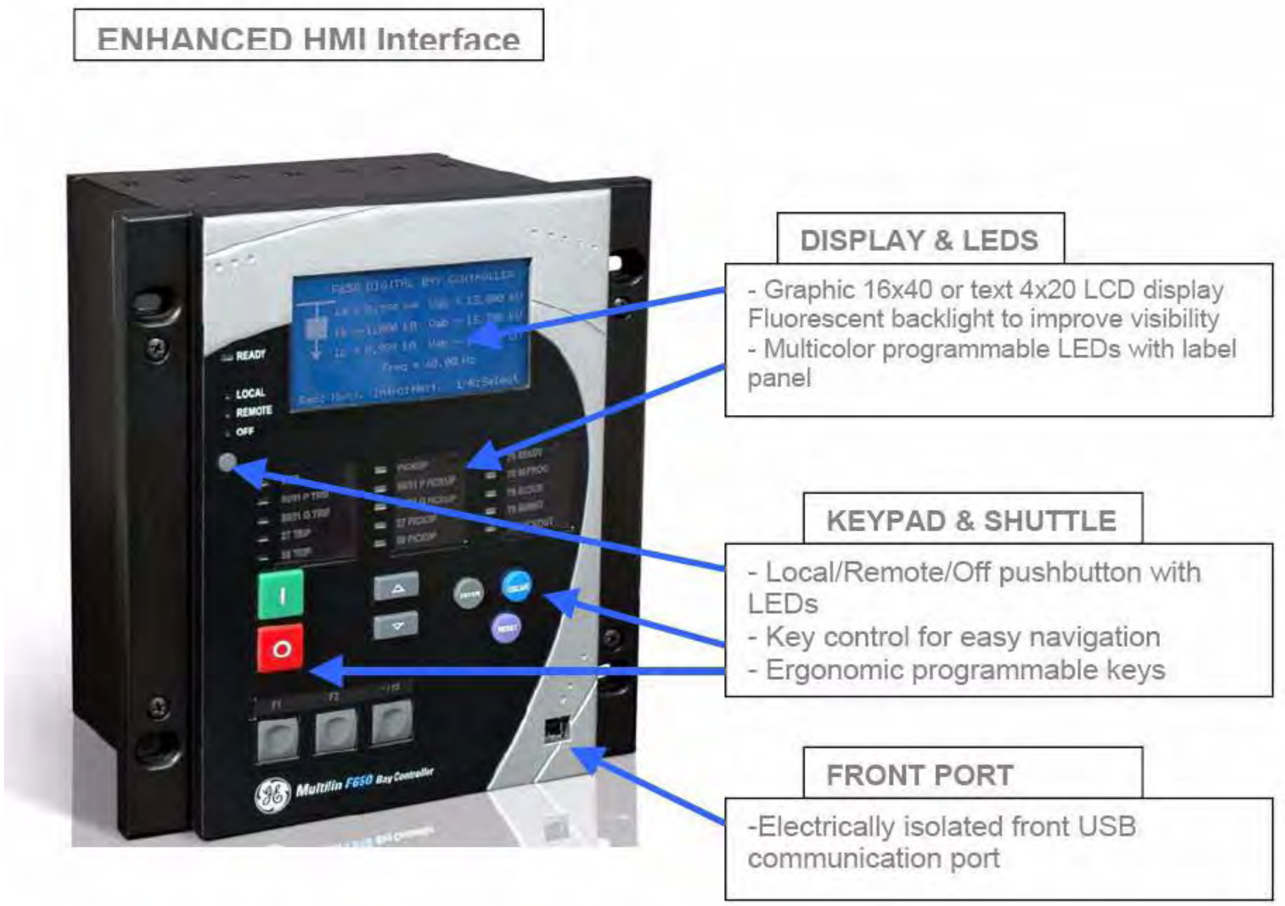


Figure 4-17: Enhanced HMI interface

4.2.1 Display

R650 units are available with two different options for the front display. The first option is an alphanumerical display of 4 lines with 20 characters each, and the second option is a graphical display of 16 lines with 40 characters each (128x240 pixels).

The boot code and firmware versions can be seen in the relay text main screen, this screen is the default screen in the text menu for all models: After the text "R650", appears the relay firmware version (8.00 in the example), and between brackets the boot program version (8.00 in the example), followed by "General Electric", the relay model and the default front port (COM2) communication parameters.

R650 8.00 (8.00)
General Electric
R650MAKF6G1LOE7LH
19200N81: MODBUS: 254

Figure 4-18: Text main screen

4.2.2 LED indicators

The relay provides 16 LED indicators, 15 user programmable plus one non-configurable LED (READY) that shows if the relay is in service.

Programmable LEDs are divided into groups of 5 LEDs, each of the groups having a different color. The first group of LED indicators is latched by hardware (red), usually configured for trip signals. The second group (yellow) and third group (green) of LED indicators are self-reset and will reset once the condition has been cleared. These LEDs can also be latched using logic through PLC configuration. All 15 LEDs are latched through relay settings.

The ESC key is used to reset any latched LED indicator, once the condition has been cleared. Keep the ESC button pressed for more than 3 seconds; all LEDs light up, verifying their correct operation. When releasing the ESC key, all indicators programmed with memory, such as tripping LEDs, are reset.There is also a reset LEDs button dedicated for this purpose.

The latched conditions can also be reset via communications using the LED reset input (to configure this signal go to **Setpoint > Relay Configuration > Control Elements > LED RESET INPUT**). By default this LED reset input signal is set to LEDS RESET operation.

4.2.3 Pushbuttons

The front panel provides:

Push buttons: keypad (5 user programmable plus ESC/ESCAPE non configurable), keypad for easy navigation, command pushbutton to select operations mode.

USB port: intended for connection to a portable PC.

4.2.3.1 Keypad

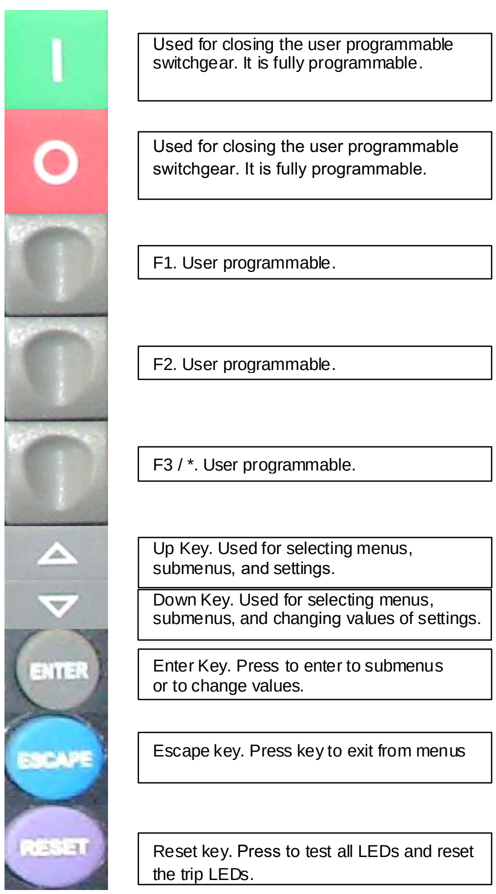
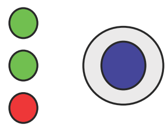


Figure 4-19: Enhanced keypad description

4.2.3.2 Command push button

The unit incorporates a command pushbutton located at the top left, with three options: local, remote, and off. The first option (LOCAL) allows executing operations in local mode (HMI, front port, and rear COM2 port). The second option (REMOTE) allows operation execution only through remote communications (COM1 and ETH_1/ETH2 or ETH_E/ETH_A/ETH_B (Depending on model)). The third option (OFF) blocks the execution of operations. Each position is identified with an LED indicator, as follows:

LOCAL operations (green)
REMOTE operations (green)
OFF (red)



Press the command button to switch from local to remote operations mode and vice versa. OFF status (operation inhibited for maintenance and safety) can be reach pressing the commands pushbutton during several seconds (local-remote-off sequence).

The local-remote-off sequence can be also available through communications (see chapter 5.8), with a configurable signal that can be set in the **Setpoint > Relay Configuration > Control Elements** screen.

4.2.4 Screen contrast

Backlight level regulation can be performed by using the keypad. The Reset button must be pressed at the same time that the up or down key is pressed to increase or decrease the contrast.

4.2.5 Text menus

4.2.5.1 Navigation

Text menu is available for all models, this is the main menu for visualizing actual values, metering, changing settings, etc. through the HMI. In models with graphical display besides this text main menu there are several screens providing more performance for control purposes.

Press the enter key to enter the main menu, starting from the standby screen (default main screen). The default main screen can be accessed pressing ESC key until it appears. In all the navigation press the enter key to select the desired header display (top-level menu). Each press of the enter key advances through the main heading pages as illustrated below. To return to previous menus press the ESC key. To move inside the top-level menu without changing to other low levels, use up/down keys.

When pressing the up/down keys the selected menu is marked by a single scroll bar character. The mark (**>**) in the right part of any menu means that contains more than one level.

Figure 4-20: Text menu navigation Shows an example of main menu navigation:

Symbol	Action Performed	Navigation in menu
ENTER	Press Enter Key	Enter next level
ESCAPE	Press ESC key	Exit to previous level
⇧⇩	Up / down keys	Move up and down in the same level
■	Menu selection	Menu selection
>	More menus to display	More menus to display

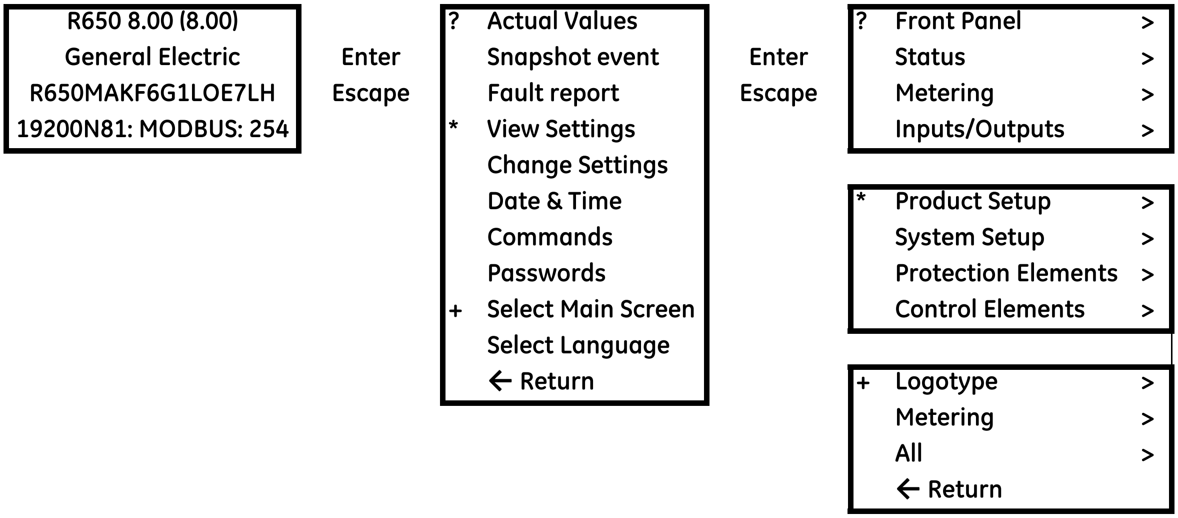


Figure 4-20: Text menu navigation

4.2.5.2 Text menu hierarchy

The structure of HMI text menu is similar to the EnerVista 650 Setup menu in the actual values and settings (view and change) menus. The main menu shows the following options:

Name	Description	Navigation in menu
Actual Values	Actual values of all the signals available in device. Status of protection and control elements, measurements, inputs and outputs, etc.	Press enter key to enter next level. Press ESC to return to default main screen.
Snapshot events	Visualization of all snapshot events in text mode (two screens for each snapshot event). In graphical displays there can be seen in a dedicated screen.	Press enter key to visualize snapshot events in text menu. Press ESC to return to default main screen.
Fault Report	Fault reports information available in HMI (two screens for each fault report)	Press enter key to enter next level. Move Up/ Downto see all the available fault reports in device. Press enter key to enter particular information for fault report selected.
View Settings	Visualization of all protection and control settings available in device.	Press enter key to enter next level. Move Up/Down to select submenu. Press ESC to return to previous level.
Change Settings	Menu accessing all protection and control settings available in device. Inputs and outputs settings, relay configuration and logic configuration are not available in HMI, only via EnerVista 650 Setup software.	Press enter key to enter next level. Move Up/Down to select submenu. Press esc to return to previous level.
Date & Time	Date and time visualization and modification.	First mode is visualization. Press enter key again to start modification in date and time. Press ESC to return to previous level.
Commands	Operations execution in local mode.	Move Up/Down to pre select operation. Press enter key to select and confirm. Press ESC to return to previous level.
Password	Password menu for settings and commands	Move Up/Down to select submenu. Press enter key to enter next level. Press ESC to return to previous level.
Select Main Screen	Selection of default main screen in text menu.	Move Up/Down to select the default main screen type. Press enter key to confirm.
Select Language	Language selection. Between default language (see order code) and English.	Move Up/Down to select the default language. Press senter key to confirm selection. Switch the relay off and on.
< - return	Return to previous level	Press enter key to return to previous level.

4.2.5.3 Actual Values

The Actual Values menu option in HMI concentrates and displays all the status of protection, control elements, metering, counters information, oscillography, events, fault locator, etc.

Front Panel >		
	LEDs	
Status >		
	Operation Bits	
	Recloser	Single - Three Pole Recloser States
	Protection >	Protection Blocks Phase Current Neutral Current Ground Current Sens. Ground Current Neg. Seq. Current Thermal Model Source Voltage Load Voltage Power Frequency Miscellaneous
	Control Elements >	Synchrocheck Autoreclose Breaker Failure VT Fuse Failure Setting Groups Pulse Counters Analog Comparators Digital Counters Cold Load Pickup 60CTS Failure 2nd HRMC Inhibit Coil Circuit Superv
	Switchgear Status >	Switchgear 1 Switchgear... Switchgear 12
	FlexCurves	
	System Info	
	Records Status >	Fault Reports Control Events Oscillography Data logger Demand Energy RCL Last Statistics RCL Mean Statistics
	SNTP-IRIG_B-PTP	
	Redundancy	
Metering >		
	Primary Values >	Current Source Voltage Load Voltage Power Energy Demand
	Per Unit Values >	Current Source Voltage Load Voltage
	Frequency	

	Power Quality >	Current Harmonics Source Voltage Harmonics Load Voltage Harmonics
Inputs/Outputs >		
	Contact Inputs >	Board F/ Board G/ Board H/ Board J
	Cont. Output St. >	Board F/ Board G/ Board H/ Board J
	Cont. Output Op. >	Board F/ Board G/ Board H/ Board J
	Cont. Output Rs. >	Board F/ Board G/ Board H/ Board J
	IO Board Status	
	Virtual Inputs >	Virtual Inp.Latched Virtual Inp.SR
	Virtual Outputs	
	Remote Outputs (for IEC61850 models only) >	DNA User St GOOSE Dig Outputs
	Remote Inputs for IEC61850 models only)>	Remote Input Remote Devices GOOSE Dig Inputs GOOSE Analog Inputs
	Analog Inputs >	Board F/ Board G/ Board H/ Board J
	Virtual out. Latched	
	Virtual out. Analogue	

To enter this menu press the enter key when the option Actual Values is selected in main menu. A secondary level is displayed with different sublevels as shown on. Pressing Up/down keys select the next level to be displayed, press the enter key again to enter in next level and press ESC key to return to previous level if desired. This navigation is performed the same for all the menus in Actual Values. Once the last sublevel is reached, move up and down to visualize the actual values selected.

One example of data screen for actual values is shown in Figure 4-21: Actual values screen data.

First Line: Header of last level in actual values (Phase Current in the example)

Second Line: Data identifier (in the example PH IOC1 HIGH A, is the pickup signal for the first instantaneous overcurrent function level high for phase A).

Third line: Status of the displayed actual value.

Fourth Line:Relative position in the menu (it is the first value of 114)

Phase Current
PH IOC1 HIGH A PKP
OFF
(1/114)

Figure 4-21: Actual values screen data

In the Actual Values menus are different types of data; each type of data displays its particular status type (on and off, 0 or 1, OK or fail, analog values, etc.)

4.2.5.4 Snapshot events

To enter this menu press the enter key when the option Snapshot events is selected in main menu (). In this menu all the snapshot events stored can be displayed.

Snapshot events are changes in the relay internal status.

One snapshot event is displayed in two text screens:

The first screen display the status, date and time of the snapshot event: the snapshot event identifier, its status, event number and the date and time of the occurrence. If the snapshot event identifier does not fit the first line, the whole text is shown using as well the second line alternating with the status and event number.

The second screen displays currents and voltages in primary values for that particular snapshot event. Ia, Ib, Ic and Ig for currents and Vab, Vbc, Vca and V0 for voltages. To access the metering screen in snapshot events menu, press the enter key from the snapshot event first screen. To exit from the metering screen press ESC.

To select different snapshot events to be displayed, press the up-down keys to select the snapshot event and then press the enter key to enter the metering screen. Press esc to exit the metering screen and return to snapshot events menu.

Figure 4-22: Snapshot event navigation HMI shows an example of snapshot events navigation:

R650 8.00 (8.00) General Electric R650MAKF6G1LOE7LH 19200N81: MODBUS: 254	Press the enter key from the default main screen and enter in the main text menu.
Enter Escape	
Actual Values ■ Snapshot event Fault report View Settings	Press up-down keys until a single scroll bar character (o) appears in the left part of Snapshot event header. Press the enter key to enter in the snapshot events menu.
Enter Escape	
Breaker Closed ON > St: ON (4/479) Time: 16:35:02.027 Date: 04/May/2017	Select the snapshot event to display using the up/down keys.
⇧⇩	
Isolated Gnd3 Block> > St: OFF (5/479) Time: 16:35:01.995 Date: 04/May/2017	Once selected the snapshot event, identifier, status, date and time are displayed. In the second line St: is showing the status and the relative snapshot index from the whole recorded number. Third and fourth lines are used to display the time and date of the snapshot event.
Enter Escape	
Ia 0.000 Vab 0.000 Ib 0.000 Vbc 0.000 Ic 0.000 Vca 0.000 Ig 0.000 V0 0.000	Pressing the enter key the metering screen for the snapshot event is displayed. To exit from this screen press the ESC key and return to the snapshot events menu.

Figure 4-22: Snapshot event navigation HMI

4.2.5.5 Fault report

To enter the **Fault Report** menu, press the enter key when the option Fault report is selected in main menu (). This menu displays information about the last ten faults recorded in the relay.

The relay HMI can handle fault reports stored in the relay in two different ways:

1. Show fault warning messages on the HMI display when the fault is produced. This option is disabled by default. To enable the display of warning messages from the HMI go to the menu **Change Settings > Product Setup > Fault Report > Show Fault On HMI** and select **Enable**.
2. Save information from the last ten faults in the relay. View in the **HMI Fault Report** menu

In the first option, when a fault occurs a warning message is displayed including information about the fault in two screens, one with general fault information, and a second with the measured values at the time the fault occurred.

The fault-warning message must be acknowledged before performing any other operation. In the event of several consecutive faults, the HMI shows the most recent fault, all faults (up to a maximum of ten faults) must be acknowledged.

In the second option, fault reports can be viewed through the HMI Fault Report menu accessed by pressing the enter key. The display shows information from the last ten faults, including both general information and metering screens for each fault. Displayed information starts with the most recent fault, and previous faults can be viewed with the up/down keys.

Displayed information is stored in the relay volatile memory, so if the relay is turned off this information is lost, as also happens if a **Clear Fault Report** command is executed. However, saved fault reports stored in the relay non-volatile memory remain after the Fault reset, and can be obtained from the relay using the EnerVista 650 Setup software, **Actual > Records > Fault report**.

If there is no fault report available through the display, the relay shows a **Fault report not available** message.

The format of the displayed screens is as follows:

Actual Values **Snapshot event** ■ **Fault report** **View Settings**	Select the Fault report menu in text menu
Enter **Escape**	
Fault Report #1 **NAF dist: 0.00** **Time: 16:35:02.027** **Date: 23/Feb/2017**	If there is more than one fault record press the up-down keys and select the desired record to be displayed.
⇧⇩	
Fault Report #2 **NAF dist: 0.00** **Time: 16:47:03.052** **Date: 23/Feb/2017**	First screen with general fault information: Fault report #number, fault type, distance and date and time.
Enter **Escape**	
Fault Report #2 **Ia 0.000 Vab 0.000** **Ib 0.000 Vbc 0.000** **Ic 0.000 Vca 0.000**	Second screen with metering data for that fault record. All this data is a summary from the fault report file that can be retrieved via EnerVista 650 Setup software.

Figure 4-23: Fault report navigation in HMI

Possible fault types are as follows:

GROUND	Ground faults
	AG phase A to ground ABG phase AB to ground BG phase BG to ground BCG phase BCG to ground CG phase CG to ground CAG phase CAG to ground
PHASE	Phase to phase faults
	AB phase A to phase B BC phase B to phase C CA phase C to phase A
3PHASE	Three-phase faults (shown on the display as 3PH)
NAF	Fault type not calculated

4.2.5.6 View settings menu

To enter this menu press the enter key when the option **View Settings** is selected in main menu (o). A secondary level is displayed with different sublevels. Pressing up-down keys, select the next level to be displayed (o), press the enter key again to enter in next level and press the ESC key to return to previous level if desired. This navigation is performed the same for all the menus in "View Settings". Once the last sublevel is reached, move up and down to see the available settings.

MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL	MAIN SETTINGS MENU
Product Setup >				
	Communication >			
		Serial Ports		
		Ethernet >	Ethernet A Ethernet B Ethernet E Redundancy	
		ModBus Protocol		
		DNP3 Slave >	DNP3 Slave 1..3	
		IEC 870-5-104		
		SNTP		
		PTP 1588		
		Routing		
		IEC 870-5-101		
	Fault Report			
	Oscillography			
	Demand			
	Time Settings			
System Setup >				
	General Settings			
	Source Volt. Sensing			
	Load Volt. Sensing			
	Current Sensing			
	Recloser >	Recloser Settings		
		Single / Three -Pole		
	Misc. settings			

MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL	MAIN SETTINGS MENU
Protection Element >				
	Setting Group X >			
		Phase Current >		
			Phase TOC High >	Phase TOC High 1..3
			Phase TOC Low >	Phase TOC Low 1..3
			Phase IOC High >	Phase IOC High 1..3
			Phase IOC Low >	Phase IOC Low 1..3
			Phase Directional >	Phase Directional 1..3
			Thermal Model >	Thermal Model 1..3
		Neutral Current >		
			Neutral TOC >	Neutral TOC 1..3
			Neutral IOC >	Neutral IOC 1..3
			Neutral Dir >	Neutral Dir 1..3
		Ground Current >		
			Ground TOC >	Ground TOC 1..3
			Ground IOC >	Ground IOC 1..3
			Ground Dir >	Ground Dir 1..3
		Sens. Ground Curr >		
			Sens. Ground TOC >	Sens. Ground TOC 1..3
			Sens. Ground IOC >	Sens. Ground IOC 1..3
			Isolated Gnd IOC >	Isolated Gnd IOC 1..3
			Sens. Ground Dir. >	Sens. Ground Dir. 1..3
		Neg. Seq. Current >		
			Neg. Seq. TOC >	Neg. Seq. TOC 1..3
		Source Voltages >		
			Phase UV >	Phase UV 1..3
			Phase OV >	Phase OV 1
			Neutral OV >	Neutral OV 1..3
			Neg. Seq. OV >	Neg. Seq. OV 1..3
		Load Voltages >		
			Phase UV >	Phase UV 1..3
			Phase OV >	Phase OV 1
			Neutral OV >	Neutral OV 1..3
			Neg. Seq. OV >	Neg. Seq. OV 1..3
		Power >		
			Forward Power >	Forward Power 1..3
			Directional Power >	Directional Power 1..3
			Watt Gnd Flt >	Watt Gnd Flt 1..3
		Frequency >		
			Underfrequency >	Underfrequency 1..3
			Overfrequency >	Overfrequency 1..3

MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL	MAIN SETTINGS MENU
		Miscellaneous >		
			Broken Conductor >	Broken Conductor 1..3
Control Elements >				
	Setting Group			
	Synchrocheck			
	Autoreclose			
	Breaker Failure			
	VT Fuse Failure.			
	Pulse Counters			
	Analog Comparators			
	Digital Counters			
	Cold Load Pickup			
	PLC Timer Masks			
	60 CTS Failure			
	2nd HRMC Inhibit			
	Coil Circuit Superv.			

4.2.5.7 Change Settings

To enter this menu press the enter key when **Change Settings** is selected in main menu. A secondary level is displayed with different sublevels. Press up-down keys, select the next level to be displayed, press the enter key again to enter in next level and press ESC key to return to previous level if desired. This navigation is performed the same for all the menus in **Change Settings**. Once the last sublevel is reached, move up and down to visualize the settings selected.

To change a particular setting, press the enter key on the setting to be modified. After selecting the setting, the value for that setting appears between brackets. Choose the new value moving up and down. After selecting the appropriate value press again the enter key to fix that value. To save the new settings, go to the end of the menu press the down key, and select **Press Enter to save settings**. Press the enter key inside this menu to save the new settings.

Snapshot event Fault report View settings □ Change settings	Select the menu Change settings and press the enter key to enter in the next sublevel.
Product Setup > □ System Setup > Protection Elements > Control Elements >	If there is more than one sublevel, select the next sublevel by pressing the up-down keys or rotating and pressing the enter key until the last level is reached.
□ General Settings Breaker > <– return	Press the enter key in the function to be modified
Phase CT Ratio 1 -- [1:6000:1]	-> Group of settings -> Setting to be modified -> Value -> Range and step
Phase CT Ratio 1 20 [1:6000:1]	Pressing the enter key, value appears between brackets and can be modified pressing the up-down keys. Pressing the enter key again, the new value is accepted.
Press Intro to save settings	Once all settings inside the group have been modified, go to the last screen pressing the down key. The new settings are then active in the relay.

Figure 4-24: Change settings in HMI

4.2.5.8 Date & time

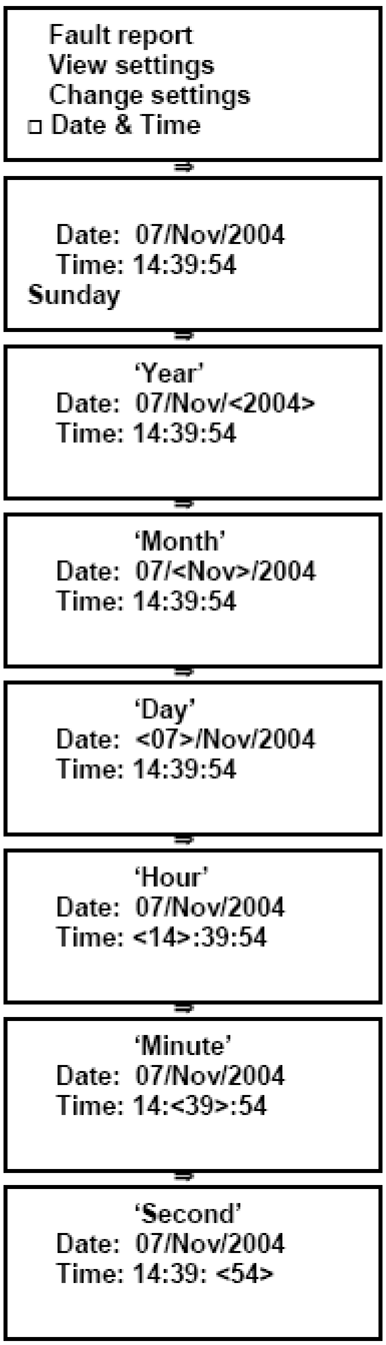
The "Date & Time" menu shows the relay date and time information in the following format:

DST: Daylight Saving Time information

Date:Day/Month/Year

Time:Hour:Minutes:Seconds

To modify date and time, press the enter key. The relay shows the year between brackets at the top of the screen. By pressing the up-down keys, reach the desired value for the year, and press the enter key to select and store that value. After the year, the relay shows the month. Proceed as in the case of the year. The date & time modification sequence is as follows:



Press the up-down key to select the "Date and Time" menu and press to enter in it

The date and time data appear in the format described above.

Pressing the enter key the year can be modified pressing up-down key, after selecting the desired value, press again the enter key to store the value.

"Year"

Date:Day/Month/**<Year>**

Time:Hour:Minutes:Seconds

After storing the value for Year, Month appears between brackets and can be modified

"Month"

Date:Day/<**Month>**/Year

Time:Hour:Minutes:Seconds

After storing the value for Month, Day appears between brackets and can be modified

"Day"

Date:<**Day**>/Month/Year

Time:Hour:Minutes:Seconds

After storing the value for Day, Hour appears between brackets and can be modified

"Hour"

Date:Day/Month/Year

Time:<**Hour**>:Minutes:Seconds

After storing the value for Hour, Minutes appears between brackets and can be modified

"Minute"

Date:Day/Month/Year

Time:Hour:<**Minute**>:Seconds

After storing the value for Minutes, Seconds appears between brackets and can be modified

"Second"

Date:Day/Month/Year

Time:Hour: Minute:<**Seconds**>

Once this sequence is completed, these values remain stored in the relay, and the display once again shows the date at the bottom of the text screen.

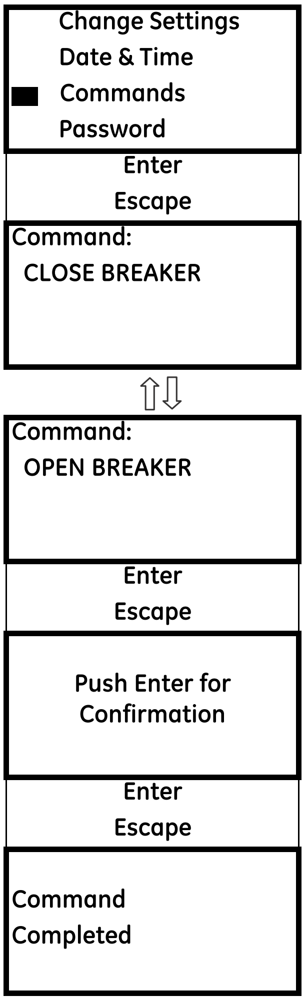
Figure 4-25: Change date & time in HMI

4.2.5.9 Commands

Commands are configured using EnerVista 650 Setup, and they can be executed using the pushbuttons on the relay front.

Use the EnerVista 650 Setup software to configure up to 32 commands with a descriptive text. When executing the operations from the relay front panel, the operation description is displayed.

Example of commands (operations) executions via HMI



Press the enter key when **Commands** is selected in the display (o).

All the previously configured commands are displayed. Press up-down keys to move through the available commands. Press ESC to return to previous level.

Press the enter key to pre-select the operation to execute.

When the message **Push Enter for Confirmation** appears, press the enter key to confirm.

Once the command has been performed or the time out has expired the **Command completed** message is shown on the display.

Figure 4-26: Commands in HMI

4.2.5.10 Passwords

The R650 units incorporate independent passwords for protection and control, in order to prevent unauthorized keypad and display access to the relay.

Settings Password:

This password restricts access to settings changes in the relay protection elements.

Commands Password:

This password restricts access to executing operation commands through the keypad and display.

If the Commands Password is activated, when the user tries to execute an operation, the relay requests this password. When using single-line diagrams for graphical display models, all objects are not operational until the password is entered, either by logging in to **Login Pwd Commands**, or by entering the password in the **Commands** menu.

Relay settings view, measures, and other monitored information are not password-protected, and can be accessed by all users.

The password menu is located at the **Password** option in the relay text menu. This menu includes the following options:

"Login Pwd Settings"

"Logout Pwd Settings"

"Change Pwd Settings"

"Login Pwd Commands"

"Logout Pwd Commands"

"Change Pwd Commands"

"Forgot Password?"

Among the available options in this menu, there are three types of functionality:

Login: For entering the password, either for settings or commands, and enable access to settings or commands. Once entering the password the relay is no longer password protected, and access is enabled to settings modification or commands execution.

Logout: Once the necessary setting changes or operation commands have been executed, the user can log out, so that the relay is password protected again.

Change: Setting or modifying the desired password.

Service Command:

Passwords are restricted for Settings change and Commands execution. To password-protect the relay, it is first necessary to set the desired password, using the corresponding **Change Pwd...** menu. The default password is **0000**. This password provides access to the whole relay functionality.

Once a new password has been set, the user must log in to access the protected functionality; otherwise, the relay requests the password when trying to change settings or execute commands. Once the password is entered the relay is unprotected (as if the user had logged in), and remains so for 15 minutes of inactivity or until the user logs out.

Password range

The valid range for R650 passwords is a number from 0000 to 9999.

The default password is 0000, which provides access to the whole relay functionality. This is the default option for enabling relay use without using passwords.

Entering passwords (Login PWD)

This operation is the same for both the settings and commands passwords. The only difference is the access menu. For entering the password, the user must access the **Login** menus inside the **Password** menu.

Login Pwd Settings or *Login Pwd Commands:*

The relay requests the password with the following message on the screen:

Setting passwd.

Login: < 1000 >

To enter the password, press the up-down key and establish the desired number. Once entered, the selected password between brackets has been entered, the relay shows the message **"Processing passwd. Wait..."**. If the password is correct, the relay allows access to the settings change or command execution. It is not necessary to enter the password every time a change is to be performed. The relay requests the password again after 15 minutes of inactivity. This period of time is the same that takes the relay to turn off the display backlighting.

Logging out (Logout PWD)

To disable access to settings and commands, the user must logout.

Logout Pwd Settings or *Logout Pwd Commands:*

For safety reasons, the relay automatically logs out the active user 15 minutes after the last keypad action.

Changing the password (Change PWD commands)

To set a password in the relay, both for settings and commands, the corresponding menu must be accessed inside the **Password** menu:

Change Pwd Settings or *Change Pwd Commands:*

To change the password, the user must first log in with the existing password; if the relay has the default factory password, this would be 0000.

The relay requests the existing password with the following message:

(Setting or Command) passwd.

Login: < 0000 >

Once the existing password has been acknowledged, the new password must be entered:

(Setting or Command) passwd.

New passwd: < 1000 >

Once the new password has been entered, the relay returns to the general Passwords menu.

Service Command for password recovery

In the event of losing all passwords, the Service Command allows the customer to reset both Settings and Commands HMI Passwords.

1.- Customer must call the customer support service.

2.- A secret key will be provided by customer support to facilitate the reset

3.- At the moment, the HMI has no passwords for Settings and Commands. The customer can reintroduce new passwords.

4.2.5.11 Select main screen

The relay display offers the possibility to select the default main screen. For this purpose, access **Select Main Screen** through the HMI. This menu includes the following options:

Logotype

This option selects as main screen the relay logotype including the firmware and boot code versions, the relay model and the communication parameters for local port COM2.

R650 8.00 (8.00)
General Electric
R650MAKF6G1LOE7LH
19200N81: MODBUS: 254

Figure 4-27: Default logotype screen

Metering

This option shows a Metering screen including the phase and ground currents as well as phase-to-phase voltage, and zero sequence voltage values, all of them in primary values.

Ia	0.000	Vab	0.000
Ib	0.000	Vbc	0.000
Ic	0.000	Vca	0.000
Ig	0.000	V0	0.000

Figure 4-28: Default metering screen

All

This option alternates in time the two previous options.

4.2.5.12 Select language

Option only available for versions 1.70 or higher than 5.20.

The relay display offers the possibility to select the default language for the relay. For this purpose, access the "***Select language***" menu located at the end of the main menu through the HMI. This menu sets the default language of the relay between English (always available) and second language selected in the relay model.

4.2.6 Graphic display

4.2.6.1 One-line diagram

In models with graphic display default main screen is the single-line diagram. This single-line diagram can be configured using EnerVista 650 Setup software by choosing the **HMI** menu inside **Relay Configuration** (**Setpoint > Relay Configuration > HMI**).

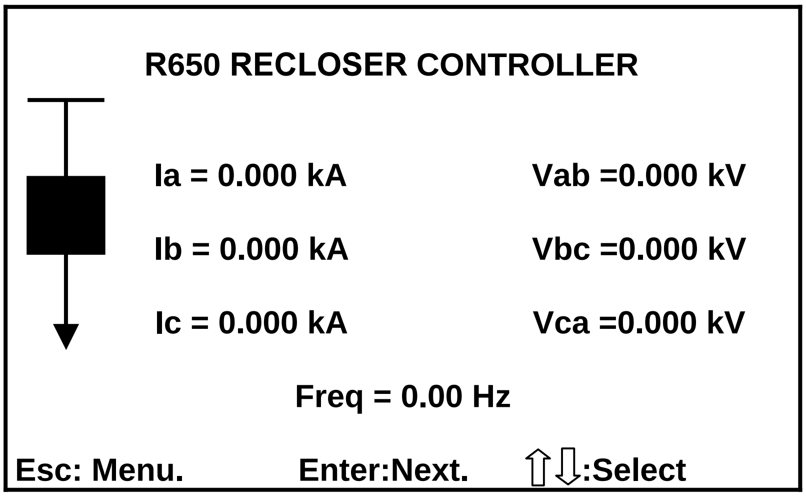


Figure 4-29: One-line diagram

The bottom of the display shows a legend that indicates the possible selections that can be made from this screen.

Esc: Menu. **Enter: Next.** **⇧⇩ : Select.**

The meaning of these options is as follows:

Esc: Menu.

Press the ESC key to access the relay main menu, similar to the one displayed by the text-display model (R650B).

Press the ESC key again and the menu selection screen (Actual Values, Snapshot events, etc.) is displayed. This main menu screen is identical to the one described for the text display, with functionality described in section 4.2.5 Text menus.

Intro: Next.

Press the enter key to access the next graphical screen, which in this case corresponds to the primary metering values screen.

⇧⇩ : Select

Once the different switchgear elements have been configured using EnerVista 650 Setup, they can be operated from the graphic display.

If a single-line diagram has been configured in the EnerVista 650 Setup software, in the HMI option inside the ***Relay Configuration*** menu, the different switchgear elements configured for the display are operative from the graphic display. By pressing the up-down key, the cursor moves among the elements and blinks on each of them. When an element is selected by pressing the enter key, the relay indicates the command to be executed, and waits for the command to be confirmed by pressing the enter key.

The following sections describe only the operation of screens that are specific for the graphic display models.

4.2.6.2 Metering screen

The Metering screen displays relay analog measures in their primary values. Available metering values are as follows:

Metering Screen.		Total metering 53
Phasor Ia Primary		0.000 KA
Phasor Ib Primary		0.000 KA
Phasor Ic Primary		0.000 KA
Phasor Ig Primary		0.000 KA
Phasor Isg Primary		0.000 KA
RMS Ia Primary		0.000 KA
RMS Ib Primary		0.000 KA
RMS Ic Primary		0.000 KA
RMS Ig Primary		0.000 KA
RMS Isg Primary		0.000 KA
I0 Primary		0.000 KA
Enter: Next.	ESC: Prev	⇧⇩:Scroll.

Figure 4-30: METERING SCREEN

As in the rest of graphical display screens, the bottom shows a legend indicating the possible options. In this case, the options are:

Enter: Next.Esc: Prev. ⇧⇩ : Scroll.

Intro: Next.

Pressing the enter key to access the next screen, in this case the ALL EVENTS screen.

Esc: Prev.

Pressing the ESC key returns to the previous screen (One-line diagram)

⇧⇩ : Scroll.

Pressing the up-down key to access all the Metering values in the screen.

METERING SCREEN ANALOG MEASURES IN PRIMARY VALUES				
Phasor Ia Primary	V0 Primary	Source V0 Primary	Phase A Real PwrPri	Positive MVarhour
Phasor Ib Primary	V1 Primary	Source V1 Primary	Phase B Reactive PwrPri	Negative MVarhour
Phasor Ic Primary	V2 Primary	Source V2 Primary	Phase B Apparent PwrPri	Positive MWatthour
Phasor Ig Primary	Vab Primary	Source Vab Primary	Phase B Real PwrPri	Negative MWatthour
Phasor Isg Primary	Vbc Primary	Source Vbc Primary	Phase C Reactive PwrPri	
Phasor In Primary	Vca Primary	Source Vca Primary	Phase C Apparent PwrPri	
RMS Ia Primary	Vn Primary	Source Vn Primary	Phase C Real PwrPri	
RMS Ib Primary	Va Primary	Source Va Primary	3 Phase Reactive PwrPri	
RMS Ic Primary	Vb Primary	Source Vb Primary	3 Phase Apparent PwrPri	
RMS Ig Primary	Vc Primary	Source Vc Primary	3 Phase Real PwrPri	
RMS Isg Primary	Pos MVarhour Freeze	Load Frequency Primary	Phase A Power FactorPri	
I0 Primary	NegMVarhour Freeze	Source Frequency Primary	Phase B Power FactorPri	
I1 Primary	PosMWatthour Freeze	Phase A Reactive PwrPri	Phase C Power FactorPri	
I2 Primary	Neg MWatthour Freeze	Phase A Apparent PwrPri	3 Phase Power FactorPri	

4.2.6.3 All events screen

This screen shows all events that have been produced in the relay. The top of the screen shows its name (All Events), and the relative and total number of events contained in the screen.

All Events (1/1023)

This legend means that there are a total of events stored in the relay, and that the cursor is located on event number 1. The information shown on this screen for each event is as follows:

"Hour:Minute:Second:Millisecond" "Event text" "Event status (ON/OFF)"

All Events (1/1023).

- [Ready LED ON] -

16:11:08.035	Ready LED ON	ON
16:11:08.017	Breaker Closed ON	ON
16:11:08.005	Isolated Gnd3 Block OFF	OFF
16:11:08.005	Isolated Gnd2 Block OFF	OFF
16:11:08.005	Isolated Gnd1 Block OFF	OFF
16:11:08.005	Sens Gnd TOC3 Block OFF	OFF
16:11:08.005	Sens Gnd TOC2 Block OFF	OFF
16:11:08.005	Sens Gnd TOC1 Block OFF	OFF
16:11:08.005	Ground TOC3 Block OFF	OFF
16:11:08.005	Ground TOC2 Block OFF	OFF
16:11:08.005	Ground TOC1 Block OFF	OFF

Esc: Prev. Enter: Menu. ⇧⇩: Scroll.

Figure 4-31: All events screen

The screen legend options are:

Esc: Prev. Enter: Menu. ⇧⇩ : Scroll.

Esc: Prev.

Pressing the ESC key returns to the previous screen (Metering screen)

Intro: Menu.

Pressing the enter key accesses the Events menu that offers the following options at the bottom of the screen:

To access the different options in the snapshot events graphic menu, move the cursor from up to down or from left to right. The selected option is displayed in upper case and between brackets. To access the selected option, press the enter key again.

<NEXT>

Accesses the next available graphic screen (Events , New)

<PREV>

Returns to the general events graphic menu (All Events)

<RELOAD>

Updates all events stored in the relay and returns to the general events screen.

<DETAILS>

Provides access to metering values, and date and time related with the event.

The top of the screen displays a legend with the event text, followed by the date and time, the event status (ON or OFF), and the event index number related to the complete list of events in the relay, for example (1/1023). The rest of information provided by the Details screen corresponds to the relay measures in the moment of the event. Metering values provided in the events are secondary, and voltage values correspond to phase-to-ground voltage.

	Ready LED ON	
Date: 07/Nov/2014		St:ON
Time: 16:11:08.035		(1/1023)
Phasor Ia Primary		0.000
Phasor Ib Primary		0.000
Phasor Ic Primary		0.000
Line Frequency		0.000
Phasor Ig Primary		0.000
Phasor Isg Primary		0.000
I0 Primary		0.000
I1 Primary		0.000
Enter: Meters.	ESC: Prev	⇧⇩: Scroll.

Figure 4-32: Snapshot events details screen

To navigate this screen, follow the legend at the bottom of the screen:

Enter: Meters. **ESC: Prev.** ⇧⇩ **: Scroll.**

Intro: Meters.

To access the metering values in the moment of the event, press the enter key. A new metering screen is displayed, containing the primary metering values in the snapshot event, such as:

Phasor Ia Primary	I2 Primary
Phasor Ib Primary	Vab Primary
Phasor Ic Primary	Vbc Primary
Load Frequency Primary	Vca Primary
Phasor Ig Primary	V1 Primary
Phasor Isg Primary	V2 Primary
I0 Primary	V0 Primary
I1 Primary	3 Phase Power Factor

The values shown can be configured in **Setpoints > Product Setup > Conf Events**.

Once inside the Metering screen, a new legend is shown for each event (Intro or ESC: Prev. U-D (L-R: Scroll); press ESC return to the Event Details screen, and press the up-down key to access all the metering values contained in the metering screen of the selected event.

ESC: Prev.

Press the ESC key from the event detail screen to return to the all events screen.

⇧⇩ **: Scroll.**

Pressing the up-down key moves among all the events contained in the all events screen, allowing a preview of the details for each of them.

<AT>

When this option is selected, the system marks the event where the cursor is located. A relative time stamp is performed, in such a way that the selected event, marked with an asterisk (*) between the time and the event name is set with a relative time of 00:00:00:000 on the top line of the event screen, together with its relative index, and the rest of events in the screen shows a date/time that relates to the marked event. This operation mode allows a quick inspection of the relative time passed between several events, which is very useful for analyzing events in the field. The corresponding legend to this relative event-marking screen is as follows:

Esc: Out At.

The relative event marking is eliminated and the system returns to the general events screen.

Enter: Tag event.

Places the cursor on a different event by pressing the up-down key. Pressing the enter key changes the relative mark to that new event.

4.2.6.4 New events screen

This screen shows the new events that have been produced in the relay since the last time the New Events screen was read. The top of the screen shows a "**New Events**" legend, and the relative and total number of events contained.

Navigation through the different menus in this New Events screen is similar to the one described in the previous section for All Events. The main difference is that in the case of new events it is necessary to select the ***RELOAD*** submenu to update the screen with new events that have been produced, while in the All Events screen, this refreshment is automatic.

After the new events have been read, selecting the ***Reload*** menu, results in the system showing a ***<No new events available.>*** message, indicating that there are no more new events available since the last reading.

4.2.6.5 Alarms panel

Alarms panel can be viewed in all R650 models using communication software EnerVista 650 Setup, however, only models with graphic display allow access to the alarms panel from the HMI.

The first line shows the relative and total number of alarms existing in that screen. The relative number refers to the alarm on which the cursor is located, and the total number refers to the total amount of alarms available. The second line on this screen shows an index that indicates the number of the configured control event that corresponds to the displayed alarm, followed by the alarm text configured in the **Control Events** menu inside the **Relay Configuration** option (***Setpoint > Relay Configuration > Control Events***).

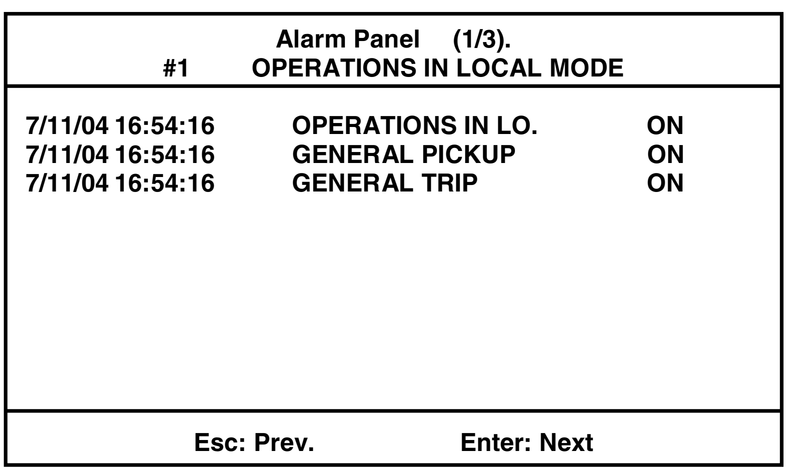


Figure 4-33: Alarms panel in HMI

The rest of the screen shows the different alarms produced in the relay with the date and time when the corresponding event was produced, followed by the alarm identification text, and its status, active (ON) or inactive (OFF).

In the previous example, the produced alarm is the change to local of the execution of operations (OPERATIONS IN LOCAL MODE), the date and time when this event has been produced, and its status (ON):

The bottom of the screen shows the legend that indicates how to navigate through the different options available in the screen.

ESC: Prev.Enter: Next.

ESC: Prev.

Pressing the ESC key, the system returns to the previous New Events screen.

Enter: Next.

Press the enter key to access the available alarms menu, which include the following options.

To access the different options provided by the alarms graphic menu, the user must press the up-down key. The selected option is displayed in upper case and between brackets. To access the selected option, the enter key must be pressed.

<NEXT>

This option provides access to the next available graphic screen (I/O boards)

<PREV>

The system returns to the previous New Events screen.

<ACK>

This option acknowledges the alarm on which the cursor is located.

<ACK ALL>

This option acknowledges all alarms. Alarm acknowledgement through the graphic HMI is considered as through communication port COM2, as it is considered to be Local in both cases.

When an alarm has been acknowledged, a selection mark appears to the right of its status. Inactive alarms disappear from the screen once they are acknowledged.

4.2.6.6 Input/output monitoring screen

This is the last screen available in the graphic display. This screen allows viewing the status of the relay inputs and outputs, as well as emulate inputs (for verification of the logic, or related functions), and contact outputs (to verify wiring).

The format of this screen is shown on the figure below.

The first line shows the name of the screen "I/O Cards", followed by the type and description of the board where the cursor is located, which appears between selection marks **> <** and blinking.

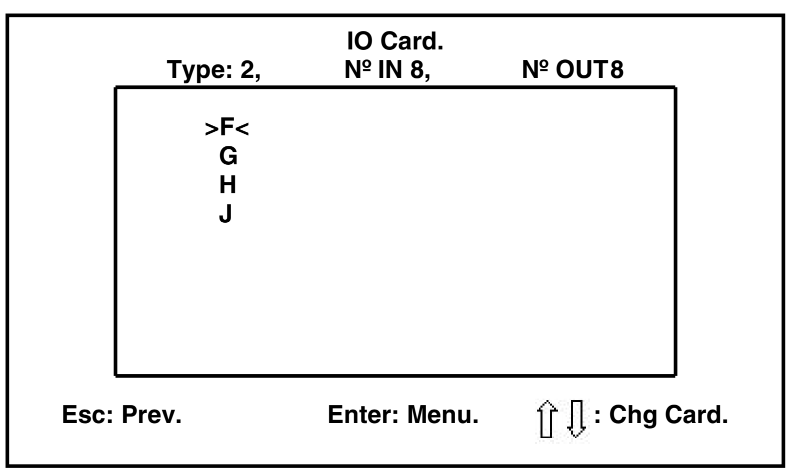


Figure 4-34: INPUTS/OUTPUTS GENERAL SCREEN

The navigation legend on this screen is as follows:

Esc: Prev. **Enter: Menu.** **: ⇧⇩ Chg Card**

Esc: Prev.

This option returns to the previous screen (Alarms Panel).

Enter: Menu.

This option provides access to the selected I/O board menu:

This menu includes the following options.

Next

View

Test Input

Test Output

As in previous screens, to access the different options provided by the inputs/outputs graphic menu, press the up-down key. The selected option is displayed in upper case and between brackets. To access the selected option, the enter key must be pressed.

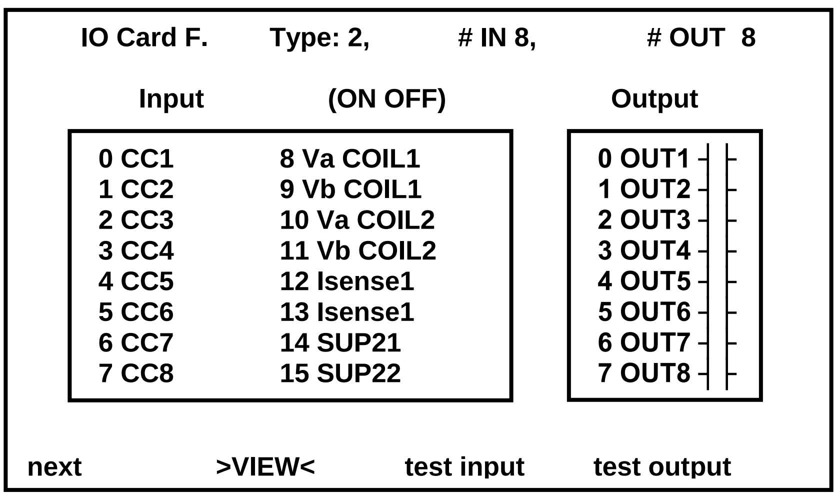


Figure 4-35: Input/output viewing screen

<NEXT>

This option brings the system back to the one-line diagram.

<VIEW>

This option shows the real status of all inputs and outputs in the selected board. Depending on the type of board, with or without supervision, the screen varies depending on the board characteristics.

The first line of this screen shows the slot where the board is located, **F**, **G**, **H** or **J**, and the type of board. The view menu differentiates inputs and outputs; the active status (ON) is represented by the lighting of the corresponding input or output.

The legend at the bottom of the screen indicates how to navigate:

Esc: Prev. **Enter: Menu.** **⇧⇩ : Chg Card**

Esc: Prev.

Returns to the general I/O screen

Enter: Menu.

Provides access to the I/O menu (next, view, test input, test output).

⇧⇩ **: Chg Card**

Pressing the up-down key provides access to the status of inputs/outputs for the different boards available in the relay.

<TEST INPUT>

This option allows testing the input activation (in emulation mode). The displayed screen is similar to the viewing screen, but the different relay inputs can be operated.

This screen shows the **Input** name lit up, showing that this is an Input emulation mode.

The first relay input appears blinking and between brackets; select a different input by pressing up-down key. When the enter key is pressed, the selected input is activated. Navigation through this screen is indicated by the following legend:

Esc: Exit Text. **Enter: Chg Input.**

Esc: Exit Text.

The ESC option returns to the general I/O board menu.

Enter: Chg Input.

Pressing the enter key on the blinking input, this input is activated in emulation mode.

Note: input emulation can only be executed through the TEST INPUT tool on the graphic display.

<TEST OUTPUT>

This option allows testing the output activation in emulation mode. The displayed screen is similar to the viewing screen, but the different relay contact outputs can be operated to test the wiring.

This screen shows the **Output** name lit up, showing that this is an output emulation mode.

The first relay output appears blinking and between brackets; select a different output by pressing the up-down key. When the enter key is pressed, the selected output is activated. Navigation through this screen is indicated by the following legend:

Esc: Exit Text. **Enter: Chg Output.**

Esc: Exit Text.

The ESC option returns to the general I/O board menu.

Enter: Chg Output.

Pressing the enter key on the blinking output, this output is activated in emulation mode.

Note: Output emulation can be executed through the TEST OUTPUT tool on the graphic display, and also through communications using EnerVista 650 Setup software for all R650 models.

⇧⇩ : Chg Card

Pressing the up-down key allows to change the selected I/O board in the main I/O screen.

4.3 Web server

4.3.1 Home

The web server in the R650 can be accessed running the Windows explorer, and typing http://xxx.xxx.xx.xxx, where xxx.xxx.xxx.xxx is the relay IP address, which must be configured in **Setpoint > Product Setup > Communication Settings > Ethernet**.

The main screen of the R650 web server shows the different monitoring possibilities for snapshot events, events, alarms, oscillography, fault reports, data logger and metering values provided by the relay through the web.

In order to access the different functions provided by the web server, click the list name on the left side of the screen.

The web server supports different web server screen languages: English, French, Spanish, Russian and Chinese by pressing the language button on the top right corner of the main window. Take into account that this selection only changes the language in the web server screen, all the relay texts, such as snapshot events, control events, etc. are in the language selected in the relay (see section 4.2.5.12 Select language in this manual).

Figure 4-36: Web server main screen

4.3.2 Snapshot events

The Snapshot events screen shows all Snapshot events produced in the relay. This screen is refreshed automatically every minute.

The information provided in this screen includes: first, the relative event index, the lowest index corresponding to the most recent event; next, the event text that shows the reason for the event, its status, active (ON) or inactive (OFF), and finally the date and time when the event was produced.

The bottom of the screen shows a Metering screen; clicking on one of the events, the associated metering values are shown on that screen.

Figure 4-37: Snapshot events screen

4.3.3 Control events

The control events screen provides access to all events that have been configured in the Control Events screen inside the **Relay Configuration** menu of EnerVista 650 Setup.

Figure 4-38: Control events screen

Unlike the case of Snapshot events, in this screen the highest index corresponds to the most recent event. The information provided is the control event index, the text that has been associated with the event when configured, its status, active (ON) or inactive (OFF), and its date and time.

4.3.4 Alarms

The alarms screen provides access to alarms configured in the relay. As in the case of snapshot events and control events, this screen allows only to view the alarms, but not to acknowledge them.

Figure 4-39: Alarms screen

4.3.5 Oscillography

The oscillography screen allows obtaining from the relay available oscillography records in that moment.

This screen includes two windows. The first window shows oscillography records available in the relay, identified by an index, being the highest index the most recent record (oscillography record No 6 in the example below).

Figure 4-40: Oscillography screen

When the oscillography record to retrieve is clicked, the window on the right shows a description of the record header, indicating its date, time, and the most relevant parameters of the record. Once a record is selected, it is required to press the ***Download*** button. The system then opens a window to allow saving the files in Comtrade format on the PC hard drive. Once the records have been saved, the system prompts to open the GE-OSC tool (Comtrade record viewer) to view the downloaded files.

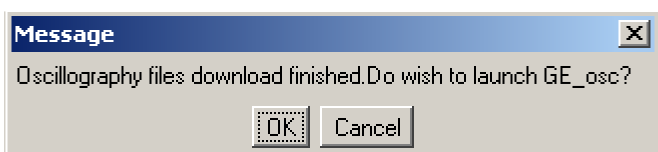


Figure 4-41: GE-osc launch screen

4.3.6 Fault report

The fault report screen provides access to the last 10 fault reports obtained by the relay. These records are stored according to an index that marks their position among all records produced in the relay, with a range from 1 to 999, returning to 1 in case of exceeding the limit of 999. As in the case of oscillography records, the highest index corresponds to the most recent record.

In the fault report, oscillography and data logger screens, the system requests acceptance of a safety-warning message.

Figure 4-42: Fault report screen

The information provided in this screen includes the date and time when the fault was registered, fault calculations such as distance to the fault, type of fault, date and time, and the line parameters, as well as the recloser and breaker status during the fault.

This screen shows also prefault and fault voltage and current primary values. At the top of the screen, associated with the trigger event number there is a button labeled as **INFO**. This button displays at the bottom of the screen the events produced before and after the fault report trigger, providing useful information about the moment when the fault was produced.

To obtain a text file with all the fault report information, press the ***Download*** option and save the file in the computer.

4.3.7 Data logger

The data logger screen allows viewing the data logger first and last value retrieval date and allows downloading the data record files in Comtrade format, by pressing the ***Download*** option. Stored files can be viewed later using any Comtrade format viewer.

Figure 4-43: Data logger screen

R650 Recloser Controller

Chapter 5: 3Setpoints

5.1 Overview

5.1.1 Setpoint main menu

Table 5-1: Setpoint main menu in EnerVista 650 Setup software:

Product Setup		
	Communication	
		Serial Ports
		Network (Ethernet)
		ModBus Protocol
		DNP3 Slave
		IEC 870-5-104
		SNTP
		IEC 870-5-103
		PTP 1588
		Routing
		IEC 870-5-101
	ModBus User Map	
	Fault Report	
	Oscillography	
	Data Logger	
	Demand	
	Time Settings	
	Conf Events	
System Setup		
	General settings	
	Source Voltage Sensing	
	Load Voltage Sensing	
	Current Sensing	

- Protection Elements
  - Flex Curves
  - Recloser
    - Recloser Settings
    - Single - Three Pole
  - Switchgear
  - Miscellaneous Settings
  - Setting Group 1
  - Setting Group 2
  - Setting Group 3
  - Setting Group 4
  - Setting Group 5
  - Setting Group 6

Note: All six Setting Groups have the same menu options, as shown below.

- Phase Current
  - Phase TOC High
  - Phase TOC Low
  - Phase IOC High
  - Phase IOC Low
  - Phase Directional
  - Thermal Model
- Neutral Current
  - Neutral TOC
  - Neutral IOC
  - Neutral Directional
- Ground Current
  - Ground TOC
  - Ground IOC
  - Ground Directional
- Sensitive Ground Current.
  - Sensitive Ground TOC
  - Sensitive Ground IOC
  - Isolated Ground IOC
  - Sensitive Ground Directional
- Negative Sequence Current
  - Negative Sequence TOC
- Source Voltages
  - Phase UV
  - Phase OV
  - Neutral OV
  - Negative Sequence OV
- Load Voltages
  - Phase UV
  - Phase OV
  - Neutral OV
  - Negative Sequence OV
- Power
  - Forward Power
  - Directional Power
  - Watt Gnd Flt

		Frequency	
			Underfrequency
			Overfrequency
		Miscellaneous	
			Broken Conductor
Control Elements			
	Setting Group		
	Synchrocheck		
	Autoreclose		
	Recloser Failure		
	VT Fuse Failure		
	Pulse Counters		
	Analog Comparators		
	Digital Counters		
	Cold Load Pickup		
	PLC Timer Masks		
	60 CTS Failure		
	2nd HRMC Inhibit		
	Coil Circuit Supervision		
Input/Outputs			
	Contact I/O		
		Board F	
		Board G	
		Board H	
		Board J	
	Force Outputs.		
	Virtual Inputs		
	Remote Comms (Available for IEC61850 models only).		

5.2 Product setup

5.2.1 Communication settings

5.2.1.1 Serial ports

Baud rate and parity for COM1 and COM2 serial communication ports.

Product Setup > Communication settings >Serial Ports			
Name	Default Value	Step	Range
COM1 Baud Rate	19200	N/A	[300 : 115200]
COM2 Baud Rate	19200	N/A	[300: 115200]
COM1Parity	NONE	N/A	[NONE:ODD:EVEN]
COM2Parity	NONE	N/A	[NONE:ODD:EVEN]

5.2.1.2 Network (Ethernet)

The Network settings are the Ethernet communication parameters for Port A, Port B and Port E. Depending on the order code, up to three different Ethernet addresses can be used, The ModBus Slave address used by Ethernet ports is the one set for COM2.

Table 5-2: Network settings

PRODUCT SETUP > COMMUNICATION SETTINGS >NETWORK (ETHERNET) NETWORK (ETHERNET)A> NETWORK (ETHERNET)B> NETWORK (ETHERNET) E > REDUNDANCY				
NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
IP Address Oct1	0	N/A	[0 : 255]	
IP Address Oct2	0	N/A	[0 : 255]	
IP Address Oct3	0	N/A	[0 : 255]	
IP Address Oct4	0	N/A	[0 : 255]	
Netmask Oct1	0	N/A	[0 : 255]	
Netmask Oct2	0	N/A	[0 : 255]	
Netmask Oct3	0	N/A	[0 : 255]	
Netmask Oct4	0	N/A	[0 : 255]	

IP ADDRESS: This setting sets the ports IPv4 address in standard IPV4 format. Note that this setting is only valid on port B if port A's REDUNDANCY is set to INDEPENDENT.

NETMASK: This setting sets the ports IPv4 subnet mask in standard IPV4 format. Note that this setting is only valid on port B if port A's REDUNDANCY is set to INDEPENDENT.

Table 5-3: Redundancy settings

PRODUCT SETUP > COMMUNICATION SETTINGS > NETWORK (ETHERNET) > REDUNDANCY			
NAME	DEFAULT VALUE	STEP	RANGE
REDUNDANCY MODE	INDEPENDENT	N/A	[INDEPENDENT; LLA; PRP; HSR; RSTP; DAISY_CHAIN]
LLA Priority	DISABLED	N/A	[ENABLED; DISABLED]
LLA Timeout	5000	N/A	[0 : 600000]
RSTP BRIDGE PRIORITY	32768	N/A	[0 : 61440]
RSTP PORT A PRIORITY	128	N/A	[0 : 240]
RSTP PORT A PATHCOST	200000	N/A	[0 : 2000000]
RSTP PORT B PRIORITY	128	N/A	[0 : 240]
RSTP PORT B PATHCOST	200000	N/A	[0 : 2000000]

REDUNDANCY MODE: This setting is available only if the hardware has multiple ports. The setting determines if ports A and B operate in redundant or independent mode. Different options are liste below:

- -**Independent**: In non-redundant mode, port A and B operate independently with their own MAC, IP address, mask and gateway.

  NOTE: When using more than one Ethernet port, each port must be configured to belong to a different network, otherwise communications becomes unpredictable.

  NOTE 2: When non-redundant mode is selected, MAC address assigned to port A is the same as MAC address assigned to port E but increased in one unit and MAC address assigned to port B is the same as MAC address assigned to port A but increased in one unit.

  E.g (MAC_portE: 00AFF40A24DA, MAC_portA:00AFF40A24DB, MAC_portB: 00AFF40A24DC)

- **LLA (Link Loss) operation**: The operation of ports A and B are as follows:

  Ports A and B use port A's MAC and IP address settings while port B is in standby mode in that it does not actively communicate on the Ethernet network but monitors its link.

- **PRP (Parallel Redundancy Protocol):** ports A and B use the same MAC (physical device) address and combine information at the link layer. It is intended to only be used if the two ports are connected to separate parallel LAN's. In this mode of operation both ports cannot be connected to the same LAN. The receiving devices process the first frame received and discard the duplicate through a link redundancy entity (LRE) or similar service that operates below layer 2. Aside from LRE, PRP uses conventional Ethernet hardware but both ports must know they are in PRP. Both ports of PRP devices operate with the same Internet Protocol (IP) addresses for traffic that uses IP Management protocols such as Address Resolution Protocol (ARP).

- **HSR (High-availability Seamless Redundancy):** ports A and B use the same MAC (physical device) address and combine information at the link layer. It is intended to work in a ring topology. In this mode of operation port A is connected to other device´s port B, and port B is connected to other device´s port A provided that ring topology is respected. The receiving devices process the first frame received and discard the duplicate through a link redundancy entity (LRE) or similar service that operates below layer 2. Aside from LRE, HSR uses conventional Ethernet hardware but both ports must know they are in HSR. Both ports of HSR devices operate with the same Internet Protocol (IP) addresses for traffic that uses IP Management protocols such as Address Resolution Protocol (ARP).

- **RSTP (Rapid Spanning Tree Protocol):** ports A and B use the same MAC (physical device) address and can operate with different network topologies. The device operates only with one IP address through these 2 ports

- **DAISY CHAIN:** ports A and B use the same MAC (physical device) address and operate by chaining one device with the next one. Note that it is important not to create a loop in this topology. Both ends of the chain can be connected to different networks. The device operates only with one IP address through these 2 ports.

NOTE 3: When LLA/PRP/HSR or PRR mode is selected, MAC addresses assigned to port A and B are the same between them and a consecutive value of MAC address assigned to port E.

E.g (MAC_portE: 00AFF40A24DA, MAC_portA:00AFF40A24DB, MAC_portB: 00AFF40A24DB)

NOTA 4: When LLA/PRP/HSP/RSTP or DAISY CHAIN mode is selected, the IP configured at **Product Setup > Communication Settings > Network (Ethernet) > Network (Ethernet) A** is the one used by both ports (A and B) to communicate in these modes.

LLA PRIORITY: If this setting is set to enabled, the port A has the priority. If PORTA's LLA detects a problem with the link, communications is switched to Port B. Port B is, in effect, acting as a redundant or backup link to the network for port A.

LLA TIMEOUT: This setting is active only when the LLA PRIORITY is set to ENABLED. When the link on primary port is detected again after it fails, there is LLA TIMEOUT (ms) monitoring time for the health of the network. During this time, the secondary port remains active. If primary network is healthy for more than LLA TIMEOUT value, the switch over to primary port is automatic.

RSTP BRIDGE PRIORITY: Specifies the switch (bridge) priority value. This value is used along with the switch MAC address to determine which switch in the network is the root device. Lower values mean higher priority. The value ranges from 0 to 65535, with a default of 32768.

RSTP PORTA PRIORITY: This is to determine which ports are used for forwarding. Lower the number means higher priority. Value ranges from 0 to 255. Default is 128**.**

RSTP PORTA PATHCOST: This is the assigned port cost value used for the switch to determine the forwarding points. Values range from 1 to 2000000. The lower the value, the lower the cost and hence the preferred route.

RSTP PORTB PRIORITY: This is to determine which ports are used for forwarding. Lower the number means higher priority. Value ranges from 0 to 255. Default is 128**.**

RSTP PORTB PATHCOST: This is the assigned port cost value used for the switch to determine the forwarding points. Values range from 1 to 2000000. The lower the value, the lower the cost and hence the preferred route.

For this setting change to take effect, a reboot is required.

5.2.1.3 MODBUS protocol

ModBus Slave Addresses for serial and Ethernet communication and the ModBus port number used for ModBus TCP/IP. For more detailed information go to appendix B in this manual.

Product Setup > Communication settings >ModBus ProtocoL			
Name	Default Value	Step	Range
ModBus Address COM1	254	1	[1 : 255]
ModBus Address COM2	254	1	[1 : 255]
ModBus Port Number	502	1	[0 : 65535]

5.2.1.4 DNP3 slave

Physical port, Slave Address for DNP, IP Addresses for Masters, TCP/UDP Port, Unsolicited Response parameters, Analog scale factors and deadbands, message fragment size, Binary input block. For more detailed information go to appendix C in this manual.

Table 5-4: DNP protocol settings

Product Setup > Communication settings >DNP3 Slave DNP3 Slave 1 > DNP3 Slave 2 > DNP3 Slave 3			
Name	Default Value	Step	Range
Physical Port	NONE	N/A	[COM1:COM2:NETWORK]
Address	255	1	[0 : 65534]
IP Addr Client1 Oct1	0	1	[0 : 255]
IP Addr Client1 Oct2	0	1	[0 : 255]
IP Addr Client1 Oct3	0	1	[0 : 255]
IP Addr Client1 Oct4	0	1	[0 : 255]
IP Addr Client2 Oct1	0	1	[0 : 255]
IP Addr Client2 Oct2	0	1	[0 : 255]
IP Addr Client2 Oct3	0	1	[0 : 255]
IP Addr Client2 Oct4	0	1	[0 : 255]
IP Addr Client3 Oct1	0	1	[0 : 255]
IP Addr Client3 Oct2	0	1	[0 : 255]
IP Addr Client3 Oct3	0	1	[0 : 255]
IP Addr Client3 Oct4	0	1	[0 : 255]
IP Addr Client4 Oct1	0	1	[0 : 255]
IP Addr Client4 Oct2	0	1	[0 : 255]
IP Addr Client4 Oct3	0	1	[0 : 255]
IP Addr Client4 Oct4	0	1	[0 : 255]
IP Addr Client5 Oct1	0	1	[0 : 255]
IP Addr Client5 Oct2	0	1	[0 : 255]
IP Addr Client5 Oct3	0	1	[0 : 255]
IP Addr Client5 Oct4	0	1	[0 : 255]
TCP/UDP Port	20000	1	[0 : 65535]
Unsol Resp Function	DISABLED	N/A	[DISABLED – ENABLED]
Unsol Resp TimeOut	5	1	[0 : 60]
Unsol Resp Max Ret	10	1	[0 : 255]
Unsol Resp Dest Adr	200	1	[0 : 65535]
Current Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]
Voltage Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]
Power Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]
Energy Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]
PF Scale Factor	0.00001	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]
Other Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]
Current Deadband	30000	1	[0 : 65535]
Voltage Deadband	30000	1	[0 : 65535]
Power Deadband	30000	1	[0 : 65535]
Energy Deadband	30000	1	[0 : 65535]
PF Deadband	30000	1	[0 : 32767]

Product Setup > Communication settings >DNP3 Slave DNP3 Slave 1 > DNP3 Slave 2 > DNP3 Slave 3			
Name	Default Value	Step	Range
Other Deadband	30000	1	[0 : 65535]
Msg Fragment Size	240	1	[30 : 2048]
Binary Input Block 1	CTL EVENTS 1-16	N/A	
Binary Input Block 2	CTL EVENTS 17-32	N/A	
Binary Input Block 3	CTL EVENTS 33-48	N/A	
Binary Input Block 4	CTL EVENTS 49-64	N/A	
Binary Input Block 5	CTL EVENTS 65-80	N/A	
Binary Input Block 6	CTL EVENTS 81-96	N/A	
Binary Input Block 7	CTL EVENTS 97-112	N/A	
Binary Input Block 8	CTL EVENTS 113-128	N/A	
Binary Input Block 9	SWITCHGEAR 1-8	N/A	
Binary Input Block 10	SWITCHGEAR 9-16	N/A	
Default Analog Map	ENABLED	N/A	[DISABLED - ENABLED - EXTENDED]
Analog Input Point 0	End of list	N/A	
Analog Input Point 1	End of list	N/A	
Analog Input Point 2	End of list	N/A	
Analog Input Point 3	End of list	N/A	
Analog Input Point 4	End of list	N/A	
Analog Input Point 5	End of list	N/A	
Analog Input Point 6	End of list	N/A	
Analog Input Point 7	End of list	N/A	
Analog Input Point 8	End of list	N/A	
Analog Input Point 9	End of list	N/A	
Analog Input Point 10	End of list	N/A	
Analog Input Point 11	End of list	N/A	
Analog Input Point 12	End of list	N/A	
Analog Input Point 13	End of list	N/A	
Analog Input Point 14	End of list	N/A	
Analog Input Point 15	End of list	N/A	
Analog Input Point 16	End of list	N/A	
Analog Input Point 17	End of list	N/A	
Analog Input Point 18	End of list	N/A	
Analog Input Point 19	End of list	N/A	
Analog Input Point 20	End of list	N/A	
Analog Input Point 21	End of list	N/A	
Analog Input Point 22	End of list	N/A	
Analog Input Point 23	End of list	N/A	
Analog Input Point 24	End of list	N/A	
Analog Input Point 25	End of list	N/A	
Analog Input Point 26	End of list	N/A	
Analog Input Point 27	End of list	N/A	
Analog Input Point 28	End of list	N/A	
Analog Input Point 29	End of list	N/A	
Analog Input Point 30	End of list	N/A	
Analog Input Point 31	End of list	N/A	

5.2.1.5 IEC 60870-5-104

Communication settings for IEC 60870-5-104 protocol. For detailed information go to Appendix D in this manual.

Table 5-5: IEC 60870-5-104 protocol settings

Product Setup > Communication settings >IEC 870-5-104			
Name	Default Value	Step	Range
Function	DISABLED	N/A	[DISABLED-ENABLED]
TCP Port	2404	1	[1 : 65535]
Common Addr of ASDU	255	1	[0 : 65535]
Cyclic Meter Period	0	1	[0 : 3600]
Synchronization Event	0	1	[0 : 3600]
IEC104 NET1 CLI1 OCTET1	0	N/A	[0 : 255]
IEC104 NET1 CLI1 OCTET2	0	N/A	[0 : 255]
IEC104 NET1 CLI1 OCTET3	0	N/A	[0 : 255]
IEC104 NET1 CLI1 OCTET4	0	N/A	[0 : 255]
IEC104 NET1 CLI2 OCTET1	0	N/A	[0 : 255]
IEC104 NET1 CLI2 OCTET2	0	N/A	[0 : 255]
IEC104 NET1 CLI2 OCTET3	0	N/A	[0 : 255]
IEC104 NET1 CLI2 OCTET4	0	N/A	[0 : 255]
Function 2	DISABLED	N/A	
TCP Port 2	2404	1	[0 : 65535]
Common Addr of ASDU 2	255	1	[0 : 65535]
IEC104 NET2 CLI1 OCTET1	0	N/A	[0 : 255]
IEC104 NET2 CLI1 OCTET2	0	N/A	[0 : 255]
IEC104 NET2 CLI1 OCTET3	0	N/A	[0 : 255]
IEC104 NET2 CLI1 OCTET4	0	N/A	[0 : 255]
IEC104 NET2 CLI2 OCTET1	0	N/A	[0 : 255]
IEC104 NET2 CLI2 OCTET2	0	N/A	[0 : 255]
IEC104 NET2 CLI2 OCTET3	0	N/A	[0 : 255]
IEC104 NET2 CLI2 OCTET4	0	N/A	[0 : 255]
CURRENT SCALE FACTOR	1		[0,00001; 0,0001; 0,001; 0,01; 0,1; 1; 10; 100; 1000; 10000]
VOLTAGE SCALE FACTOR	1		
POWER SCALE FACTOR	1		[0 : 65535]
ENERGY SCALE FACTOR	1		[0 : 65535]
PF SCALE FACTOR	0.00001		[0.00001-0.0001-0.001-0.1-1-10-100-1000-10000]
OTHER SCALE FACTOR	1		[0 : 65535]
CURRENT DEADBAND	30000		[0 : 65535]
VOLTAGE DEADBAND	30000		[0 : 65535]
POWER DEADBAND	30000		[0 : 65535]
ENERGY DEADBAND	30000		[0 : 65535]
PF DEADBAND	30000		[0 : 32767]
OTHER DEADBAND	30000		[0 : 65535]
IEC104 IOA BINARIES	1000		[0 : 65535]
IEC104 IOA DOUBLE POINTS	1500		[0 : 65535]
IEC104 IOA ANALOGS	2000		[0 : 65535]
IEC104 IOA COUNTERS	4000		[0 : 65535]
IEC104 IOA COMMANDS	3000		[0 : 65535]
IEC104 IOA ANALOG PARAMETERS	5000		[0 : 65535]

5.2.1.6 SNTP

Product Setup > Communication settings >SNTP> SNTP1/SNTP2			
Name	Default Value	Step	Range
Function	DISABLED	N/A	[DISABLED – ENABLED]
UDP Port	123	1	[1 : 65535]
Server Ip Oct1	0	1	[0 : 255]
Server Ip Oct2	0	1	[0 : 255]
Server Ip Oct3	0	1	[0 : 255]
Server Ip Oct4	0	1	[0 : 255]

The R650 supports the Simple Network Time Protocol specified in RFC-2030. With SNTP, the R650 can obtain the clock time over an Ethernet network. The R650 acts as an SNTP client to receive time values from an SNTP/NTP server, usually a dedicated product using a GPS receiver to provide an accurate time. Three different modes of SNTP operation are supported. These modes are unicast, broadcast and anycast.

If SNTP functionality is enabled at the same time as an IRIG-B source is connected to the R650, the IRIG-B signal provides the time value to the R650 clock for as long as a valid signal is present. If the IRIG-B signal is removed, the time obtained from the SNTP server is used.

To use SNTP in unicast mode, **Server IP Oct1...4** must be set to the SNTP/NTP server IP address. Once this address is set and the **Function** setting is "UNICAST", the R650 attempts to obtain time values from the SNTP/NTP server. Since many time values are obtained and averaged, it generally takes forty seconds until the R650 clock is synchronized with the SNTP/NTP server. It may take up to one minute for the R650 to signal an SNTP FAIL state if the server is offline.

To use SNTP in broadcast mode, set the **Function** setting to "BROADCAST". The R650 then listens to SNTP messages sent to the "all ones" broadcast address for the subnet. The R650 waits up to eighteen minutes (>1024 seconds) without receiving an SNTP broadcast message before signalling an SNTP FAIL state.

To use SNTP in anycast mode, set the **Function** setting to "ANYCAST". Anycast mode is designed for use with a set of cooperating servers whose addresses are not known beforehand by the client. The R650 sends a request to a multicast group address assigned by IANA for NTP protocol. This address is 224.0.1.1 and a group of SNTP/NTP servers listens to it. Upon receiving a request each server sends a unicast response to the SNTP/NTP client. The R650 relay binds to the first unicast message received from any server. Then it continues operating with SNTP/NTP server in unicast mode. Any further responses from other SNTP/NTP servers are ignored. In unicast mode of operation the chosen time server can go offline, in that case it takes about one minute for the R650 to signal an SNTP FAIL state and to switch again to anycast mode to try to find another time server. In anycast mode the R650 tries to send multicast messages up to five minutes before signalling an SNTP FAIL state.

The R650 relay does not support the multicast mode of SNTP functionality.

R650 accepts time synchronization from up to two different SNTP servers. In order to define number of SNTP servers to be used, different settings for each SNTP server must be configured in the R650. SNTP1 or/and SNTP2 tab settings shall be configured.

If only one SNTP server is used to synchronize the relay, SNTP1 tab settings is filled with its corresponding settings. If two SNTP servers are used, SNTP1 and SNTP2 tabs are filled as follow:

- SNTP1 tab contains settings for the main SNTP server.
- SNTP2 tab contains settings for the back-up SNTP server.

If two SNTP servers are configured, R650 operation mode is described as follow:

Scenario	Expected behaviour
SNTP1 server= Available SNTP2 server= Available	R650 shall be synchronized by SNTP1 server. No alarm
SNTP1 server= Available SNTP2 server= Not Available	R650 shall continue to be synchronized by SNTP1 server No alarm
SNTP1 server= Not Available SNTP2 server= Available	If SNTP1 server fails, R650 shall get synchronization from SNTP2 server. When SNTP1 server recovers, R650 shall switch to be synchronized by SNTP1 server. No alarm
SNTP1 server= Not Available SNTP2 server= Not Available	"Not Synchronized" Alarm appears in local copy

NOTE: SNTP settings take effect after rebooting the device.

5.2.1.7 IEC 870-5-103 protocol settings

Communication settings for IEC 60870-5-103 protocol. For more detailed information go to 5.13 Section in this manual.

Product Setup > Communication settings >IEC 870-5-103			
Name	Default Value	Step	Range
COMM Port	NONE	N/A	[NONE - COM1]
Slave Number	1	1	[0 : 254]
Synchronization Timeout	30 min	1	[0 : 1440]

If COMM Port is set to NONE, IEC 870-5-103 communication protocol is not available.

If the user sets a value different from 0 in the Synchronization Timeout setting, when this timer expires without receiving a synchronization message, the Invalid bit is set in the time stamp of a time-tagged message.

5.2.1.8 PTP IEEE 1588 protocol settings

PRODUCT SETUP > COMMUNICATION SETTINGS > PTP 1588			
Name	Default Value	Step	Range
PTP FUNCTION	DISABLE	N/A	[DISABLE - ENABLE]
PORTA DELAY ADDER	0	1	[0 : 60000]
PORTA DELAY ASYM	0	1	[-1000 : 1000]
PORTB DELAY ADDER	0	1	[0 : 60000]
PORTB DELAY ASYM	0	1	[-1000 : 1000]
STRICT POWER PROFILE	DISABLED	N/A	[DISABLED - ENABLED]
PTP DOMAIN NUMBER	0	1	[0 : 255]
PTP VLAN PRIORITY	4	1	[0 : 7]
PTP VLAN ID	0	1	[0 : 4095]
PTP EPOCH	UTC SINCE 2000	N/A	[UTC SINCE 2000; UTC SINCE 1970; UTC SINCE 1900]

The R650 relay supports IEEE 1588 version 2.

The relay meets the time accuracy requirements of IEC 61850-5-Ed2 clause 11.1.3.3 time synchronization class T5 (± 1 μs) and of the IEEE Std. PC37.118.1 Draft 1.6 clause 4.3 (± 1 μs), given an error-free PP input and stable temperature

The relay resynchronizes to a grandmaster slewing at ±2 μs/s when the rate of change of frequency stabilizes. It may become unsynchronized when the ramp starts or stops.

The relay only supports Peer-To-Peer delay mechanism.

PTP FUNCTION

While this port setting is selected to disabled, PTP is disabled on this port. The relay does not generate or listen to PTP messages on this port.

PORT A, B PATH DELAY ADDER

The time delivered by PTP is advanced by the time value in this setting prior to the time being used to synchronize the relay's real time clock. This is to compensate to the extent practical for time delivery delays not compensated for in the network. In a fully compliant PP network, the peer delay and the processing delay mechanisms compensate for all the delays between the grandmaster and the relay. In such networks, this setting should be zero.

In networks containing one or more switches and/or clocks that do not implement both of these mechanisms, not all delays are compensated, so the time of message arrival at the relay is later than the time indicated in the message. This setting can be used to approximately compensate for this delay. However, as the relay is not aware of network switching that dynamically changes the amount of uncompensated delay, there is no setting that is always completely correct for uncompensated delay. A setting can be chosen to reduce the worst-case error to half of the range between minimum and maximum uncompensated delay, if these values are known.

PORT A, B PATH DELAY ASYMMETRY

Range: -1 000 ... +1 000 ns

Default: 0

This setting corresponds to "delayAsymmetry" in PTP, which is used by the peer delay mechanism to compensate for any difference in the propagation delay between the two directions of a link. Except in unusual cases, the two fibers are of essentially identical length and composition, so this setting should be set to zero.

In unusual cases where the length of the link is different in different directions, this setting should be set to the number of nanoseconds the Ethernet propagation delay to the relay is longer than the mean of path propagation delays to and from the relay. For instance, if it is known say from the physical length of the fibers and the propagation speed in the fibers that the delay from the relay to the Ethernet switch it is connected to is 9 000 ns and the that the delay from the switch to the relay is 11 000 ns, then the mean delay is 10 000 ns, and the path delay asymmetry is +1 000 ns.

STRICT POWER PROFILE

Power profile (IEEE Std C37.238™-2011) requires that the relay only select as a grandmaster power profile compliant clocks, that the delivered time have worst-case error of ±1 μs, and that the peer delay mechanism be implemented. With the strict power profile setting enabled, the relay only selects master clocks displaying the IEEE_C37_238 identification codes. It uses a port only when the peer delay mechanism is operational. With the strict power profile setting disabled, the relay uses clocks without the power profile identification when no power profile clocks are present, and uses ports even if the peer delay mechanism is non-operational.

This setting applies to all of the relay's PTP capable ports.

PTP DOMAIN NUMBER

This setting should be set to the domain number of the grandmaster-capable clock(s) to be synchronized to. A network may support multiple time distribution domains, each distinguished with a unique domain number. More commonly, there is a single domain using the default domain number zero.

This setting applies to all of the relay's PTP capable ports.

PTP VLAN PRIORITY

This setting selects the value of the priority field in the 802.1Q VLAN tag in request messages issued by the relay's peer delay mechanism. In compliance with PP the default VLAN priority is 4, but it is recommended that in accordance with PTP it be set to 7.

Depending on the characteristics of the device to which the relay is directly linked, VLAN Priority may have no effect.

This setting applies to all of the relay's PTP capable ports.

PTP VLAN ID

This setting selects the value of the ID field in the 802.1Q VLAN tag in request messages issued by the relay's peer delay mechanism. It is provided in compliance with PP. As these messages have a destination address that indicates they are not to be bridged, their VLAN ID serves no function, and so may be left at its default value.

Depending on the characteristics of the device to which the relay is directly linked, VLAN ID may have no effect.

This setting applies to all of the relay's PTP capable ports.

PTP EPOCH

This setting sets the reference point from which time is measured.

NOTE: PTP settings take effect after rebooting the device.

5.2.1.9 Routing

A default route and a maximum number of 6 static routes may be configured. The default route is used as the last choice, if no other route towards a given destination is found.

PRODUCT SETUP > COMMUNICATION SETTINGS > ROUTING		
Name	Default Value	Step
Default RT GWY Oct1	10	[0 : 255]
Default RT GWY Oct2	3	[0 : 255]
Default RT GWY Oct3	32	[0 : 255]
Default RT GWY Oct4	1	[0 : 255]
Static RT1 IP Oct1	0	[0 : 255]
Static RT1 IP Oct2	0	[0 : 255]
Static RT1 IP Oct3	0	[0 : 255]
Static RT1 IP Oct4	0	[0 : 255]
Static RT1 Mask Oct1	0	[0 : 255]
Static RT1 Mask Oct2	0	[0 : 255]
Static RT1 Mask Oct3	0	[0 : 255]
Static RT1 Mask Oct4	0	[0 : 255]
Static RT1 GWY Oct1	0	[0 : 255]
Static RT1 GWY Oct2	0	[0 : 255]
Static RT1 GWY Oct3	0	[0 : 255]
Static RT1 GWY Oct4	0	[0 : 255]
Static RT2 IP Oct1	0	[0 : 255]
Static RT2 IP Oct2	0	[0 : 255]
Static RT2 IP Oct3	0	[0 : 255]

PRODUCT SETUP > COMMUNICATION SETTINGS > ROUTING		
Name	Default Value	Step
Static RT2 IP Oct4	0	[0 : 255]
Static RT2 Mask Oct1	0	[0 : 255]
Static RT2 Mask Oct2	0	[0 : 255]
Static RT2 Mask Oct3	0	[0 : 255]
Static RT2 Mask Oct4	0	[0 : 255]
Static RT2 GWY Oct1	0	[0 : 255]
Static RT2 GWY Oct2	0	[0 : 255]
Static RT2 GWY Oct3	0	[0 : 255]
Static RT2 GWY Oct4	0	[0 : 255]
Static RT3 IP Oct1	0	[0 : 255]
Static RT3 IP Oct2	0	[0 : 255]
Static RT3 IP Oct3	0	[0 : 255]
Static RT3 IP Oct4	0	[0 : 255]
Static RT3 Mask Oct1	0	[0 : 255]
Static RT3 Mask Oct2	0	[0 : 255]
Static RT3 Mask Oct3	0	[0 : 255]
Static RT3 Mask Oct4	0	[0 : 255]
Static RT3 GWY Oct1	0	[0 : 255]
Static RT3 GWY Oct2	0	[0 : 255]
Static RT3 GWY Oct3	0	[0 : 255]
Static RT3 GWY Oct4	0	[0 : 255]
Static RT4 IP Oct1	0	[0 : 255]
Static RT4 IP Oct2	0	[0 : 255]
Static RT4 IP Oct3	0	[0 : 255]
Static RT4 IP Oct4	0	[0 : 255]
Static RT4 Mask Oct1	0	[0 : 255]
Static RT4 Mask Oct2	0	[0 : 255]
Static RT4 Mask Oct3	0	[0 : 255]
Static RT4 Mask Oct4	0	[0 : 255]
Static RT4 GWY Oct1	0	[0 : 255]
Static RT4 GWY Oct2	0	[0 : 255]
Static RT4 GWY Oct3	0	[0 : 255]
Static RT4 GWY Oct4	0	[0 : 255]
Static RT5 IP Oct1	0	[0 : 255]
Static RT5 IP Oct2	0	[0 : 255]
Static RT5 IP Oct3	0	[0 : 255]
Static RT5 IP Oct4	0	[0 : 255]
Static RT5 Mask Oct1	0	[0 : 255]
Static RT5 Mask Oct2	0	[0 : 255]
Static RT5 Mask Oct3	0	[0 : 255]
Static RT5 Mask Oct4	0	[0 : 255]
Static RT5 GWY Oct1	0	[0 : 255]

PRODUCT SETUP > COMMUNICATION SETTINGS > ROUTING		
Name	Default Value	Step
Static RT5 GWY Oct2	0	[0 : 255]
Static RT5 GWY Oct3	0	[0 : 255]
Static RT5 GWY Oct4	0	[0 : 255]
Static RT6 IP Oct1	0	[0 : 255]
Static RT6 IP Oct2	0	[0 : 255]
Static RT6 IP Oct3	0	[0 : 255]
Static RT6 IP Oct4	0	[0 : 255]
Static RT6 Mask Oct1	0	[0 : 255]
Static RT6 Mask Oct2	0	[0 : 255]
Static RT6 Mask Oct3	0	[0 : 255]
Static RT6 Mask Oct4	0	[0 : 255]
Static RT6 GWY Oct1	0	[0 : 255]
Static RT6 GWY Oct2	0	[0 : 255]
Static RT6 GWY Oct3	0	[0 : 255]
Static RT6 GWY Oct4	0	[0 : 255]

The redundancy communications comes with the capability of setting a number of static routes and one default route, which is used instead of default gateway.

Default RT GWY:

This setting sets the gateway of the default route to be used by IP traffic sent from the relay, if no other route towards a given IP destination is found.

Note that this setting is only valid on port B if port REDUNDANCY is set to INDEPENDENT.

Static RTX IP: This setting sets the destination IPv4 route.

Static RTX MASK: This setting sets the IP mask associated with the route.

Static RTX GWY: This setting sets the gateway to reach the destination IP route.

Important Notes:

1. Host routes are not supported at present.
2. The route mask has IPv4 mask format. In binary this should be a set of contiguous bits of 1 from left to right, followed by one or more contiguous bits of 0.
3. The route destination and mask must match.
   - This can be verified by checking that RtDestination & RtMask == RtDestination
   - Example of good configuration: RtDestination= 10.1.1.0; Rt Mask= 255.255.255.0
   - Example of bad configuration: RtDestination = 10.1.1.1; Rt Mask= 255.255.255.0

4) The route destination must not be a connected network.

5) The route gateway must be on a connected network. This rule applies to the gateway address of the default route as well.

5.2.1.10 IEC 60870-5-101

Communication settings for IEC 60870-5-101 protocol. For detailed information go to Appendix E in this manual.

Table 5-6: IEC 60870-5-101 protocol settings

Product Setup > Communication settings >IEC 870-5-101			
Name	Default Value	Step	Range
IEC101 COM1	DISABLED	N/A	
Common Addr ASDU1	255	1	[0 : 65535]
Link Address1	255	1	[0 : 65535]
IEC101 COM2	DISABLED	N/A	
Common Addr ASDU2	255	1	[0 : 65535]
Link Address2	255	1	[0 : 65535]
ASDU Addr Size	2	1	[1 : 2]
COT Size	1	1	[1 : 2]
IOA Size	2	1	[1 : 3]
Link Addr Size	1	1	[1 : 2]
Cyclic Meter Period	0	1	[0 : 3600]
Synchronization Event	0	1	[0 : 1400]
CURRENT SCALE FACTOR	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]
VOLTAGE SCALE FACTOR	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]
POWER SCALE FACTOR	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]
ENERGY SCALE FACTOR	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]
PF SCALE FACTOR	0.00001	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]
OTHER SCALE FACTOR	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]
CURRENT DEADBAND	30000	N/A	[0 : 65535]
VOLTAGE DEADBAND	30000	N/A	[0 : 65535]
POWER DEADBAND	30000	N/A	[0 : 65535]
ENERGY DEADBAND	30000	N/A	[0 : 65535]
PF DEADBAND	30000	N/A	[0 : 65535]
OTHER DEADBAND	30000	N/A	[0 : 65535]
IOA BINARIES	1000	N/A	[0 : 65535]
IOA DOUBLE POINTS	1500	N/A	[0 : 65535]
IOA ANALOGS	2000	N/A	[0 : 65535]
IOA COUNTERS	4000	N/A	[0 : 65535]
IOA COMMANDS	3000	N/A	[0 : 65535]
IOA ANALOG PARAM	5000	N/A	[0 : 65535]

5.2.2 MODBUS user map settings

The ModBus user map definition. 256 records, selectable from the complete relay ModBus map, from the ModBus user map. For more detailed information go to appendix B in this manual.

Product Setup > ModBus User Map			
Name	Default Value	Step	Range
Address 00	0000		[0000 : FFFF]
Address 01	0000		[0000 : FFFF]
...			...
Address 254	0000		[0000 : FFFF]
Address 255	0000		[0000 : FFFF]

5.2.3 Fault report settings

The fault report module defines the type of fault (three-phase, phase-to-phase, phase-to-ground), and the distance to the fault. The fault activation signal (FAULT REPORT TRIGG) is programmed at **Setpoint > Relay Configuration > Control Elements**.

The fault report provides fault date, fault type and fault location information.

Information referred to the last ten faults is stored as fault report and available to the user through the EnerVista 650 Setup software or the web server application. Each fault report includes the following information:

- Fault date and time
- Pre-fault current and voltage in primary values
- Fault current and voltages in primary values
- Fault type
- Distance to the fault (fault location)
- Line parameters
- Recloser and recloser status information

As an option, the Relay offers the possibility to display a fault-warning message on the relay HMI (selectable by setting).

5.2.3.1 Fault report settings

Setpoint > Product Setup > Fault Report				
Setting Description	Name	Default Value	Step	Range
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Positive sequence impedance module	Pos Seq Module	3.00	0.01 Ohm	[0.01 : 250.00]
Positive sequence impedance angle	Pos Seq Angle	75	1 Deg	[25 : 90]
Zero sequence impedance module	Zero Seq Module	9.00	0.01 Ohm	[0.01 : 750.00]
Zero sequence impedance angle	Zero Seq Angle	75	1 Deg	[25 : 90]
Line length	Line Length	100.0	0.1 km	[0.0 : 2000.0]
Display fault on HMI	Show Fault On HMI	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]
CT Direction	CT Direction	REVERSE	N/A	REVERSE-FORWARD

Function permission (Function): Enabling this setting allows to create a fault report when the FAULT REPORT TRIGG is activated.

Positive sequence impedance module (Pos Seq Module): Value, in ohms, of the line positive sequence impedance module.

Positive sequence impedance Angle (Pos Seq Angle): Value, in degrees, of the line positive sequence angle.

Zero sequence impedance module (Zero Seq Module): Value, in ohms, of the line zero sequence impedance module.

Zero sequence impedance Angle (Zero Seq Angle): Value, in degrees, of the line zero sequence angle.

Line Length: The metering element in kilometers.

Show Fault On HMI: This setting enables or disables the option to display faults on the Relay HMI.

Snapshot Events: This setting enables or disables the snapshot event generation for the fault report element.

CT Direction: Direction of the phase current transformers.

Forward: The polarity of he current transformers is as the R650 wiring diagram.

Reverse: The polarity of the current transformers is inverted. Voltage and current are 180° out of phase.

States associated with the fault report (**Actual >Status>Records Status > Fault Reports**), are shown on Table 5-7: Fault report states

Table 5-7: Fault report states

FAULT REPORT STATES
FAULT REPORT TRIGG
CLEAR FAULT REPORTS
FAULT DATE
FAULT TYPE
FAULT LOCATION
FAULT REPORT NUMBER

FAULT REPORT TRIGG: The activation of this state initiates the calculation of the fault location and the generation of the corresponding report.

CLEAR FAULT REPORTS: The activation of this state produces the removal of all faults stored in the relay. Additionally, all active faults on the HMI display are acknowledged. This signal is programmed at "***Setpoint>Relay Configuration>Control Elements***".

FAULT DATE: Date and time of the last fault.

FAULT TYPE: Type of the last fault produced (3PHASE, AG, BG, CG, AB, ABG, BC, BCG, CA, CAG, NAF). NAF indicates that the type of fault has not been calculated.

FAULT LOCATION: Calculated distance to the last fault (the metering element is the same used for setting the line length).

FAULT REPORT NUMBER: Number of the fault report file saved in the relay's non-volatile memory, associated with the last fault produced.

5.2.3.2 Fault report retrieval

Fault report files can be retrieved using the EnerVista 650 Setup software, or the web server at "http:\\relay IP address".

To obtain fault reports using the EnerVista 650 Setup software, go to **Actual > Records > Fault report**. The top of the window shows the number of the last fault report stored by the device (Fault Record Number). Click **View header** to see the header of the record selected under **Select Record**.

Click **Download** to retrieve the file and save in a selected folder. The file name is "FLTxxx.TXT", where xxx is the corresponding record number. Fault report retrieval uses either serial communication (ModBus RTU) or Ethernet (ftp, tftp).

Fault reports are stored in the relay's non-volatile memory, so they are accessible from the EnerVista 650 Setup software or the relay's web server. The fault report is a text file named FLTxxx.txt where xxx is the record number, with a range of 001 to 999. Only files from the 10 last faults are stored. If there are already ten files stored and a new fault occurs, the new fault overwrites the oldest one. If **Show Fault on HMI** is enabled, real-time fault information is also displayed on the HMI.

When a fault is produced and a warning message is displayed on the HMI, fault information alternates between two separate screens: one with general information, and a second with the fault metering values. This screen needs to be acknowledged by the user to exit the fault report screen. If several consecutive faults are produced, the HMI displays the most recent one. Each stored fault needs to be acknowledged (up to a maximum of 10 faults). The HMI menu offers an option to view the last 10 faults produced, with both the general information screen and the metering screen available for each fault.

5.2.4 Oscillography settings

Oscillography records contain waveforms captured at the sampling rate as well as other relay data at the point of trigger. This trigger can be configured with a programmable logic operand.

Oscillography records are stored in COMTRADE ASCII - IEEE C37.111-1999 standard format.

The oscillography module is in charge of storing the instantaneous values of the 9 analog signals and the 16 programmable digital signals at **Setpoint > Relay Configuration > Oscillography** in fault conditions (OSCILLO TRIGGER signal activation).

All oscillography records store all analog signals (fixed) plus 16 digital signals (programmable). The order of storage in the case of analog signals is as follows:

Analog 1 IA channel.

Analog 2 IB channel.

Analog 3 IC channel.

Analog 4 IG channel.

Analog 5 ISG channel.

Analog 6 Load Va or Vab channel, depending on the selected configuration at **Setpoint > System Setup > Load Voltage Sensing > Phase VT Connection.**

Analog 7 Load Vb or Vbc channel, depending on the selected configuration at **Setpoint > System Setup > Load Voltage Sensing > Phase VT Connection**.

Analog 8 Load Vc or Vca channel, depending on the selected configuration at **Setpoint > System Setup > Load Voltage Sensing > Phase VT Connection**.

Analog 9 Source Va or Vab channel, depending on the selected configuration at **Setpoint > System Setup > Source Voltage Sensing > Phase VT Connection**.

Analog 10 Source Vb or Vbc channel, depending on the selected configuration at **Setpoint > System Setup > Source Voltage Sensing > Phase VT Connection**.

Analog 11 Source Vc or Vca channel, depending on the selected configuration at **Setpoint > System Setup > Source Voltage Sensing > Phase VT Connection**.

The 16 digital channels and the oscillography trigger signal are programmable using the EnerVista 650 Setup software at **Setpoint > Relay configuration > Oscillography**. Each digital channel can be associated with a single status or to a logic status. In this last case, the logic must be configured using the PLC Editor tool, at **Setpoint > Logic Configuration** inside EnerVista 650 Setup. The oscillography trigger signal can be a single status or a configured logic.

5.2.4.1 Oscillography settings

Setpoint > Product Setup > Oscillography				
Setting Description	Name	Default Value	Step	Range
Function Permission	Function	ENABLED	N/A	[DISABLED – ENABLED]
Prefault	Trigger Position	30	1%	[5 : 95]
Samples per cycle	Samples/Cycle	64	N/A	[4 – 8 – 16 –32 – 64]
Maximum number of oscillos	Max. Number Osc.	4	1 oscillo	[1 : 20]
Automatic oscillography overwrite	Automatic Overwrite	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Function Permission (Function): Enabling this setting allows to create an oscillography record when the "**TRIGGER OSCILLO**" signal is activated.

Trigger Position: This setting defines the prefault data (in percentage) stored every time a new oscillo is produced.

Samples/Cycle: This setting defines the number of samples per cycle stored in each oscillography record.

Maximum Number of Oscillos (Max. Number Osc.):

1 to 20 oscillography records can be selected.

Automatic Overwrite: This setting allows chained oscillographies during the fault (TRIGGER OSCILLO signal activated). The oscillography module is reset once the data has been completely stored in Flash memory and the TRIGGER OSCILLO state is deactivated.

Snapshot Events: This setting enables or disables snapshot event generation for the oscillography element.

Oscillography files calculations

The overall maximum samples capacity is allocated for 27594 samples. The size of each oscillography file depends on the configured number of oscillographies and is evenly distributed based on the maximum samples value using these formulas:

Number of samples per oscillography = (27594 samples)/(Max. Number Osc. setpoint)

Number of cycles per oscillography = (Number of samples per oscillography)/(Samples / Cycle setpoint).

NOTICE After a change in oscillography settings all oscillography files stored on the flash memory are erased.

EXAMPLE

For a Max. Number Osc. of 4, each record stores 27594 / 4 = 6898 samples per stored oscillo.

If we set the Samples /Cycle setpoint to 64 samples per cycle, each record stores up to 6898 / 64 = 107.78 signal cycles. This value expressed in terms of time is:

For 50 Hz: 204.79 cycles x 20 ms/cycle = 4095.8 ms.

For 60 Hz: 204.79 cycles x 16.67 ms/cycle = 3413 ms.

5.2.4.2 Oscillography states

OSCILLOGRAPHY STATES
OSC DIG CHANNEL 1
OSC DIG CHANNEL 2
OSC DIG CHANNEL 3
OSC DIG CHANNEL 4
OSC DIG CHANNEL 5
OSC DIG CHANNEL 6
OSC DIG CHANNEL 7
OSC DIG CHANNEL 8
OSC DIG CHANNEL 9
OSC DIG CHANNEL 10
OSC DIG CHANNEL 11
OSC DIG CHANNEL 12

OSC DIG CHANNEL 13
OSC DIG CHANNEL 14
OSC DIG CHANNEL 15
OSC DIG CHANNEL 16
OSCILLO TRIGGER
NUMBER OF TRIGGERS
CYCLES PER RECORD
AVAILABLE RECORDS

OSC DIGITAL CHANNEL XX: These states are configured at "***Setpoint>Relay configuration>Oscillography***". Each of these states can be associated with a protection state or to a virtual output. Each oscillography record reflects the changes experienced by this state during the record.

OSCILLO TRIGGER: The activation of this state produces the oscillography record capture. Each record uses a percentage of its capacity to store prefault information. This percentage is selected in the Trigger Position setting, and the rest of the record's capacity stores post-fault information.

NUMBER OF TRIGGERS: This is the number of the most recent oscillography record stored in the relay. The record is stored in COMTRADE format. The range is 0 to 999.

CYCLES PER RECORD: This state displays the number of cycles that are stored in each oscillography record. Although the number of cycles can be a decimal number, the record represents only the integer part.

AVAILABLE RECORDS: This shows the number of records stored in the relay, which can be retrieved by serial communication (ModBus RTU) or Ethernet (ftp, tftp). The range is 0 to 20.

5.2.4.3 Oscillography file retrieval

Oscillography files can be retrieved using the EnerVista 650 Setup software, or the web server at "http:\\relay IP address".

To obtain the oscillography records using the EnerVista 650 Setup software, go to "***Actual>Records>Waveform capture***". The top of the window shows the number of the last oscillography record stored by the device (Newest Record Number), followed by the maximum number of oscillos available (Available Records in Device). Click **View header** to show the header of the record selected at **Select Record**.

Click **Download** and the three files (*.DAT, *.HDR, *.CFG) that form the oscillography record in the COMTRADE standard are retrieved and viewed automatically if the GE-OSC software is installed in the computer. Retrieved oscillography records can be viewed using any Comtrade viewer. The EnerVista 650 Setup software stores oscillography records in the folder ".\EnerVista 650 Setup\files\osc" by default, in the same directory where the program is installed. The file names are "OSCxxx.DAT", "OSCxxx.CFG", "OSCxxx.HDR", where xxx is the corresponding record number. The oscillography record retrieval uses serial communication (ModBus RTU) or Ethernet (ftp, tftp).

5.2.5 Data logger settings

The R650 data logger can store information from up to 16 analog channels, among all channels available in the relay, with a selectable sampling rate. The memory of the data logger is fixed at 64 Kilobytes with two bytes needed per channel. The selected channels take all available memory space, therefore, the number of days of storage depends on the selected number of channels and sampling rate.

5.2.5.1 Data logger settings

Setpoint > Product Setup > Data Logger				
Setting Description	Name	Default Value	Step	Range
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Data logger Rate	Data Logger Rate	1 s	N/A	[1 s, 5 min., 10 min., 15 min., 20 min., 30 min., 60 min.]
Data Logger analog channels X	Data Logger Chnl X	None	N/A	[None; any available measurement]
Data logger Scale for channel X	Data logger Scale X	1 s	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]

Function permission (Function): This must be enabled to start storing information.

Data Logger Rate: the data logger can be configured in rates of 1 second, and 5, 10, 15, 20, 30 and 60 minutes

Data Logger Analog Channel X (Data Logger Chnl X): Analog Channels programmable in the data logger. The **X** value has a range from 0 to 16.

Data logger Scale for channel X: Scale factor for individual X channels. Data selected in each channel is saved in a signed 16 bit integer, which provides a range of –32,768 to 32,767

Any setting change in the Data Logger erases all stored information.

5.2.5.2 Data logger associated states

States associated with the data logger module (**Actual >Status>Records Status>Data logger**) are shown in the table below:

DATA LOGGER STATES
OLDEST SAMPLE TIME
NEWEST SAMPLE TIME
DATA LOGGER CHANNELS
DATA LOGGER DAYS

OLDEST SAMPLE TIME: The Date/time of the oldest state with 6 characters. This is the time that corresponds to the oldest sample. This value remains constant until the available memory capacity is exceeded. Afterwards, this value changes according to the sampling rate (Data Logger Rate).

NEWEST SAMPLE TIME: The Date/time of the newest state with 6 characters. This is the time when the most recent sample was taken. This value is updated according to the sample rate selected.

If no channel has been selected, these settings do not change.

DATA LOGGER CHANNELS: This state shows the number of channels selected.

DATA LOGGER DAYS: This state shows the number of days that can be stored. It depends on the Data Logger Rate setting, and on the number of channels selected.

5.2.5.3 Data logger file format and retrieval

File Retrieval

Data logger files can be retrieved using the EnerVista 650 Setup software, or the web server at "http:\\relay IP address".

For obtaining the data logger files using the EnerVista 650 Setup software, the user must access "***Actual>Records>Data Logger***". The top of the window shows the date when the oldest sample was taken, and then the date when the newest sample was taken.

This screen shows the measurements stored for the different channels through the time.

Clicking on the "Download" button, all the information contained in the file can be read.

Clicking on the "Save" button, the data logger files (*.DAT, *.CFG) are retrieved in COMTRADE format, and saved by default in the folder "...\EnerVista 650 Setup\files\osc", using "DLGxxx.DAT", "DLGxxx.CFG" names, where xxx is the corresponding record number. **Data logger files can be retrieved only by Ethernet via 650PC software or by webserver via tftp.**

File Format

Data logger information is made of two text files: configuration file (datalogger.cfg), and data file (datalogger.dat).

5.2.6 Demand settings

5.2.6.1 Metering values and settings

The demand calculation is made according to the following primary parameters:

Table 5-8: Primary demand values

PRIMARY DEMAND VALUES	STEP
IA (RMS)	KA
IB (RMS)	KA
IC (RMS)	KA
IG (RMS)	KA
ISG (RMS)	KA
I2	KA
Three phase active power (W)	MW
Three phase reactive power (VAR)	MVAr
Apparent power (VA)	MVA

*Note: The step depends on the selected "Primary Meter Units" in System Setup > General Settings (A_V; KA_KV)

Different integration methods can be selected to calculate current and power values.

Calculated demand values are as follows:

Table 5-9: Demand calculated values

DEMAND CALCULATED VALUES		
DEMAND IA	DEMAND IG	DEMAND W
DEMAND IA MAX	DEMAND IG MAX	DEMAND W MAX
DEMAND IA DATE	DEMAND IG DATE	DEMAND W DATE
DEMAND IB	DEMAND ISG	DEMAND VAR PWR
DEMAND IB MAX	DEMAND ISG MAX	DEMAND VAR MAX
DEMAND IB DATE	DEMAND ISG DATE	DEMAND VAR DATE
DEMAND IC	DEMAND I2	DEMAND VA PWR
DEMAND IC MAX	DEMAND I2 MAX	DEMAND VA MAX

DEMAND IC DATE	DEMAND I2 DATE	DEMAND VA DATE

The relay measures current demanded on each phase, ground and sensitive ground, negative sequence and three-phase demand for real, reactive and apparent power. Current and Power methods can be chosen separately. Settings are provided to disable certain measuring techniques. These techniques are used by many utilities for statistical or control purposes.

Demand module settings are as follows:

Table 5-10: Demand settings

Setpoint > Product Setup > Demand				
Setting Description	Name	Default Value	Step	Range
Function permission	Demand Function	DISABLED	N/A	[DISABLED – ENABLED]
Demand method for current values	CRNT Demand Method	THERMAL EXPONENTIAL	N/A	[BLOCK INTERVAL - ROLLING DEMAND - THERMAL EXPONENTIAL]
Demand method for Power values	POWER Demand Method	THERMAL EXPONENTIAL	N/A	[BLOCK INTERVAL - ROLLING DEMAND - THERMAL EXPONENTIAL]
Demand interval	Demand Interval	5 Minutes	N/A	[5 – 10 – 15 – 20– 30–60]
Trigger Enabled	Trigger Enabled	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Function permission (Function): This setting enables the demand function.

Demand Method for Current values (CRNT Demand Method): Selection of the demand calculation method for current values. Available methods are Thermal Exponential, Block interval, and Rolling Demand.

Demand Method for Power values (POWER Demand Method): Selection of the demand calculation method for power values. Available methods are Thermal Exponential, Block interval, and Rolling Demand.

Demand Interval: Integration interval. Available intervals are 5, 10, 15, 20, 30, 60 minutes. Measurement integration is performed in the period adjusted in the Demand Interval setting.

Demand Trigger: Operation mode selection for the Block Interval calculation method. This operation mode depends on the “Trigger Enabled” setting. If trigger enabled is set as disabled, measurement integration is made in the Demand Interval period. If trigger enabled is enabled, measurement integration is made during the time interval between two consecutive pulses of the input assigned as DEMAND TRIGGER INP,. This input is set at ***Setpoint > Relay configuration > Protection Elements***

Snapshot Events: This setting enables or disables the snapshot event generation for the demand element.

5.2.6.2 Demand calculation methods

Calculation Method 1: Thermal Exponential

This method simulates the action of an analog peak recording thermal demand meter. The relay measures the magnitude for each phase (or three-phase, depending on the case) every second, and it assumes that the magnitude remains the same until the next update. It calculates the equivalent thermal demand using the following equation:

$$d(t) = D(1 - e^{-Kt})$$

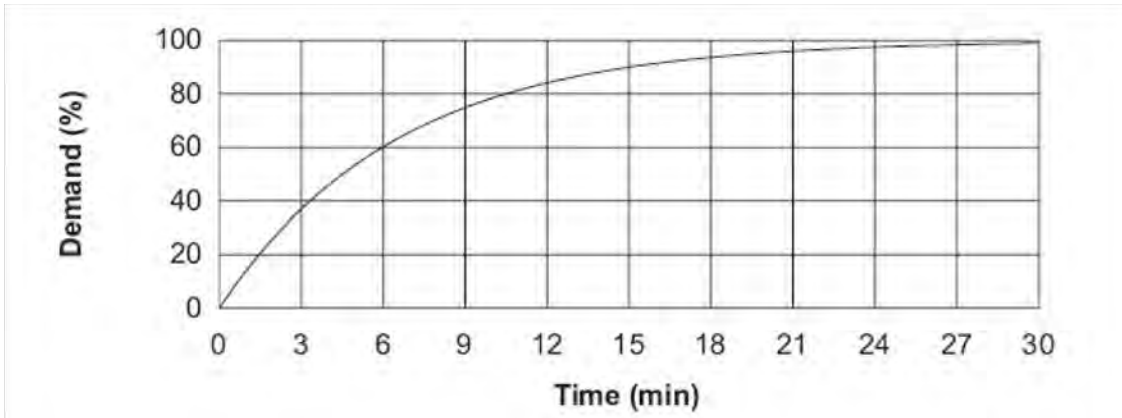
Where:

D Input signal (constant).

d(t) Demand value after applying the input value during time t (in minutes)

K 2.3 / thermal 90% response time

Illustrated bellow is the curve with a 90% characteristic time of 15 minutes. A setting establishes the time to reach 90% of a steady-state value, just as the response time of an analog instrument. A steady-state valve applied for twice the response time indicates 99% of the value.



Calculation Method 2: Rolling Demand.

This method calculates the linear average of the quantity over the set demand time interval. The calculation is made every second. The value is updated every minute and indicates the demand over the time interval just preceding the time of update.

Calculation Method 3: Block Interval

The Block Interval operation mode depends on the "Trigger Enabled" setting.

Calculation Method 3a: Block Interval – With trigger setting DISABLED.

This method consists on integrating the measurements during the time period specified in the DEMAND INTERVAL setting. The calculation is made every second and the demand value is the average of all values produced during the time interval. The time interval is chosen in the DEMAND INTERVAL setting. The interval demand value is shown once this time has expired.

If, for example, the setting indicates 15 minutes for integration, the demand value update is made every 15 minutes (although the calculation is made every second). This method calculates a linear average of the magnitude.

Calculation Method 3b: Block Interval – With trigger setting ENABLED.

The demand value is given by integration of the measurement during the time between two consecutive pulses in the input assigned. The input is assigned to DEMAND TRIGGER in Relay Configuration. The integration is made every second with each new measure.

In case the interval between two consecutive pulses exceeds 60 minutes, the relay calculates the demand after 60 minutes from the last pulse, this measure is updated in the status and a new demand count starts. This method calculates a linear average of the magnitude.

Figure 5-1: Response to different demand methods shows the behavior of the demand, depending on the Selected setting for demand calculation.

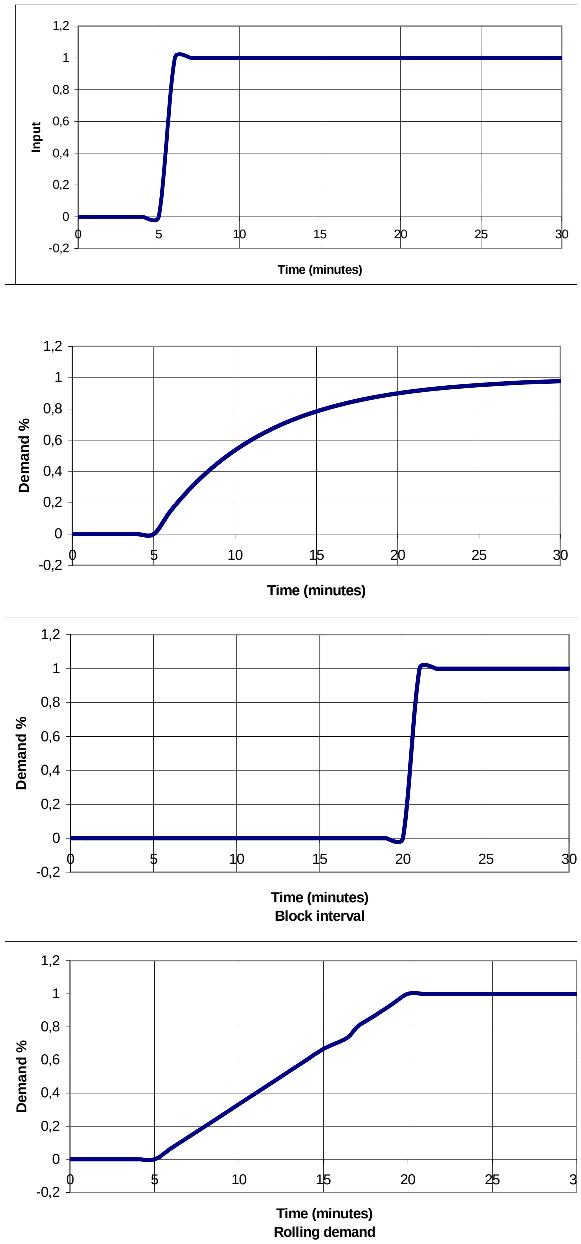


Figure 5-1: Response to different demand methods

5.2.6.3 Demand function measurements and states

Demand values are available at ***Actual > Metering > Primary Values > Demand***.

Table 5-11: Demand measurements

Name	Default Value	Step
DEMAND IA	0.000	KA
DEMAND IA MAX	0.000	KA
DEMAND IA DATE	01-Jan-2000 00:00:00.000	
DEMAND IB	0.000	KA
DEMAND IB MAX	0.000	KA
DEMAND IB DATE	01-Jan-2000 00:00:00.000	
DEMAND IC	0.000	KA
DEMAND IC MAX	0.000	KA
DEMAND IC DATE	01-Jan-2000 00:00:00.000	
DEMAND IG	0.000	KA
DEMAND IG MAX	0.000	KA
DEMAND IG DATE	01-Jan-2000 00:00:00.000	
DEMAND ISG	0.000	KA
DEMAND ISG MAX	0.000	KA
DEMAND ISG DATE	01-Jan-2000 00:00:00.000	
DEMAND I2	0.000	KA
DEMAND I2 MAX	0.000	KA
DEMAND I2 DATE	01-Jan-2000 00:00:00.000	
DEMAND W	0.000	MW
DEMAND W MAX	0.000	MW
DEMAND W DATE	01-Jan-2000 00:00:00.000	
DEMAND VAR PWR	0.000	MVAr
DEMAND VAR MAX	0.000	MVAr
DEMAND VAR DATE	01-Jan-2000 00:00:00.000	
DEMAND VA PWR	0.000	MVA
DEMAND VA MAX	0.000	MVA
DEMAND VA DATE	01-Jan-2000 00:00:00.000	

*Note: The step depends on the selected "Primary Meter Units" in System Setup > General Settings (A_V; KA_KV)

Demand measurements for **current values** are as follows:

DEMAND I**X** This is the demanded value every minute or every integration period, depending on the selected settings.

DEMAND I**X** MAX Demanded maximeter; it stores the Maximum demand value until a demand reset is issued.

DEMAND I**X** DATE Date of the Maximum demand value

Being **X** the phase considered in each case.

Demand measurements for **power values** are as follows:

DEMAND **Y** This is the demanded value every minute or every integration period, depending on the selected settings

DEMAND **Y** MAX Demanded maximeter; it stores the Maximum demand value until a demand reset is issued.

DEMAND **Y** DATE Date of the Maximum demand value.

Being **Y** the power considered in each case.

W	Three-phase active power
VAR	Three-phase reactive power
VA	Three-phase apparent power

The maximum demanded value is stored in non-volatile memory. It is not cleared when the relay is turned off. When the relay is turned on again, the maximum values are updated.

States associated with the demand (**Actual > Status > Records Status > Demand**) are the following:

Table 5-12: Demand associated values

DEMAND ASOCIATED STATES
DEMAND TRIGGER INP
DEMAND RESET INP

Besides the previously considered demand measures, two states are used for demand control:

DEMAND TRIGGER INP Bit type state, Programmable at **Setpoint>Relay Configuration>Protection Elements** in the EnerVista 650 Setup software. This signal is used by the Block Interval demand method.

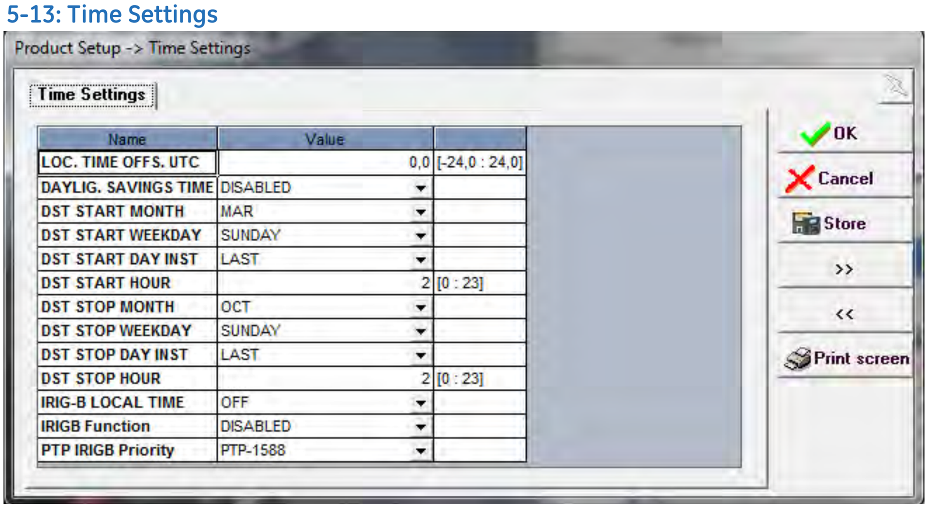
DEMAND RESET INP Bit type state, programmable at **Setpoint>Relay Configuration>Protection Elements** in the EnerVista 650 Setup software. When this bit is activated, the demand measures are reset. All stored values are reset to zero (for demand dates, this value represents January 1st, 2000).

5.2.7 Time Settings

The date and time can be synchronized to a known time using the SNTP protocol, IRIG-B protocol (when it provides UTC Time) or IEEE1588 and the TIME SETTINGS allow setting the date and time provided by these protocols to the proper local time on the Real Time Clock.

When there is no SNTP protocol enabled, IRIG-B protocol is not set to UTC Time or IEEE1588 synchronization, the TIME SETTINGS are not used in the Real Time Clock but are still used to calculate the UTC Time (i.e., for the IEC61850 protocol), but its behavior is not assumed correct in several critical hour changes because of Daylight Savings Time getting effective. In these configuration cases, it is recommended to disable Daylight Savings Time.

Table 5-13: Time Settings



Name	Value	
LOC. TIME OFFS. UTC	0,0	[-24,0 : 24,0]
DAYLIG. SAVINGS TIME	DISABLED	
DST START MONTH	MAR	
DST START WEEKDAY	SUNDAY	
DST START DAY INST	LAST	
DST START HOUR	2	[0 : 23]
DST STOP MONTH	OCT	
DST STOP WEEKDAY	SUNDAY	
DST STOP DAY INST	LAST	
DST STOP HOUR	2	[0 : 23]
IRIG-B LOCAL TIME	OFF	
IRIGB Function	DISABLED	
PTP IRIGB Priority	PTP-1588	

The TIME SETTINGS settings are as follows:

LOC. TIME OFFS. UTC:

Is used to specify the local time zone offset from Universal Coordinated Time (Greenwich Mean Time) in hours.

DAYLIG. SAVINGS TIME:

Allow the unit clock to follow DST rules of the local time zone.

DST START MONTH:

Allow to set the start month of the DST from January to December

DST START WEEKDAY

Allow to set the start weekday of the DST from Monday to Sunday

DST START DAY INST:

Allow to set the start day instance from First, Second, Third, Fourth or Last

DST START HOUR

Allow to set the starting hour of the DST (in local time)

DST STOP MONTH

Allow to set the stop month of the DST from January to December

DST STOP WEEKDAY

Allow to set the stop weekday of the DST from Monday to Sunday

DST STOP DAY INST

Allow to set the stop day instance from First, Second, Third, Fourth or Last

DST STOP HOUR

Allow to set the stop hour of the DST (in local time)

IRIG-B LOCAL TIME:

Determines, in case of being enabled, if the IRIG-B protocol would carry the date in local time or else in UTC Time.

IRIG-B FUNCTION:

Setting for enable or disable the IRIG-B protocol

PTP IRIG-B PRIORITY:

If two or more time sources are setup the time source with the higher priority shown in the table below is used where 1 is considered to be the highest priority. Note that the time source priority of PTP and IRIG-B can be swapped. Setting changes become active after reboot.

The R650 is capable of receiving a time reference from several time sources in addition to its own internal clock for the purpose of time stamping events, transient recorders and other occurrences within the relay. The accuracy of the time stamp is based on the time reference that is used. The R650 supports an internal clock, SNTP, IRIG-B and 1588 as potential time references.

Regarding the PTP, R650 acts as an ordinary clock, with only Sync and Pdelay_Req messages.

Table 5-14: Synchronization priority table

Time source	Priority
PTP	1*

IRIG-B	2*
SNTP	3
Internal Clock	4

The priority of IRIG B and PTP can be swapped

Note:
Synchronization by IEC103, DNP, Modbus and IEC104 is not going to be issued if there is a synch source from IRIG-B, SNTP or PTP.

5.2.8 Configurable Event Settings

The R650 supports up to 24 configurable event measurements.

When the configurable event settings are changed (**Setpoint > Product Setup > Conf Events**), any recorded events already stored in the buffer are cleared to avoid confusion.

NOTICE Before reading the configurable events, check the settings to confirm which measurements are being recorded, since the settings can be changed.

Table 5-15: s

Setpoint > Product Setup > Conf Events				
Setting Description	Name	Default Value	Step	Range
Configurable event 1	EVENT METERING 1	None	N/A	
...	...			
Configurable event 24	EVENT METERING 24	None	N/A	

5.3 System setup

The R650 controller device measures up to 11 channels. The channel's distribution is:

- Five currents inputs: three Phase current inputs, one each Ground/Sensitive ground current input.
- Six AC voltage inputs: Six LEA sensors.
- Three voltage sensors are used to measure the phase voltages of the source side, while the other three sensors are connected to measure the load voltages. These two set of 3-phase voltages are needed to detect voltage loss in both side of the recloser. Automatic restorations use the measured voltage in both sides of the recloser to coordinate with other devices located across the protected distribution line.

During normal loading conditions the three phase currents and voltages are well balanced. The controller is using the currents and the selected voltages that can be measured from the Load or the source side to compute the electrical power (apparent, active, and reactive).

5.3.1 General settings

This section determines the settings of the element configuration regarding its connection to the power system.

Setpoint > System Setup > General settings		
Name	**Default Value**	**Range**
Device Name	R650_1	[<20 ASCII characters]
Nominal Frequency	50 Hz	[50 Hz; 60 Hz]
Phase Rotation	ABC	[ABC; ACB]
Voltage Set Reference	Load Side (VLx)	[Load Side (VLx); Source Side (VBx)]
Frequency Reference	VI	[VI; VII; VIII]
Primary Meter Units	KA_KV	[KA_KV; A_V]
Snapshot Events	DISABLED	[DISABLED; ENABLED]

Nominal Frequency: This setting establishes the nominal frequency of the power system. This setting affects all RMS and DFT values calculated by the device.

Phase Rotation: This setting defines the phase sequence of the power system

Voltage Set Reference: This setting indicates the reference's channel for the power, energy and frequency calculations. Load Side corresponds to voltage channel inputs defined as VLx (VL_A, VL_B, VL_C) whereas Source Side corresponds to the voltage channel inputs defined as VBx (VB_A, VB_B, VB_C).

Frequency Reference: This setting indicates the reference channel for frequency measurement. This setting affects the frequency measured from the Load and Source side voltage channels.

The R650 calculates the frequency based on the selected channel. However, when the three phase voltages are connected and higher than the minimum voltage, the frequency is extracted from the three phases by applying the Park-Clarke transformation for a better estimation of the frequency and the rate of change measurements.

Primary Meter Units: This setting indicates the unit used for the actual values of the voltages and currents.

KA-KV - The measured values are expressed in kiloAmperes and kiloVolts.

A_V - The measured values of voltage and current are expressed in Amperes and Volts.

Snapshot Events: This setting enables or disables snapshot event generation.

5.3.2 Source and Load Voltage Sensing

Setpoint > System Setup > Source Voltage Sensing			
Name	**Default Value**	**Step**	**Range**
Source VT Ratio	1		[1 : 10000]
Voltage Rated Secondary	8.0	0.1 V	[0.5 ; 10.0]
Phase Angle (*)	0.0 º	0.1 º	[0.0 º: 359.9º]
Phase VT Connection	WYE	N/A	[WYE – DELTA]
Sensor 1 Magnitude Correction (*)	0.0% fo	0.1% fo	[-50.0: 50.0]
Sensor 1 Phase Angle Correction (*)	0.0 º	0.1 º	[0.0 º: 359.9º]
Sensor 2 Magnitude Correction(*)	0.0% fo	0.1% fo	[-50.0: 50.0]
Sensor 2 Phase Angle Correction (*)	0.0 º	0.1 º	[0.0 º: 359.9º]
Sensor 3 Magnitude Correction (*)	0.0% fo	0.1% fo	[-50.0: 50.0]
Sensor 3 Phase Angle Correction (*)	0.0 º	0.1 º	[0.0 º: 359.9º]

Setpoint > System Setup > Load Voltage Sensing			
Name	**Default Value**	**Step**	**Range**
Source VT Ratio	1	1	[1 : 10000]
Voltage Rated Secondary	8.0	0.1 V	[0.5 ; 10.0]
Phase Angle (*)	0.0 º	0.1 º	[0.0 º: 359.9º]
Phase VT Connection	WYE	N/A	[WYE – DELTA]
Sensor 1 Magnitude Correction (*)	0.0% fo	0.1% fo	[-50.0: 50.0]
Sensor 1 Phase Angle Correction (*)	0.0 º	0.1 º	[0.0 º: 359.9º]
Sensor 2 Magnitude Correction(*)	0.0% fo	0.1% fo	[-50.0: 50.0]
Sensor 2 Phase Angle Correction (*)	0.0 º	0.1 º	[0.0 º: 359.9º]
Sensor 3 Magnitude Correction (*)	0.0% fo	0.1% fo	[-50.0: 50.0]
Sensor 3 Phase Angle Correction (*)	0.0 º	0.1 º	[0.0 º: 359.9º]

Source/Load VT Ratio: This setting describes VT Ratio of the voltage sensors connected to the R650.

Voltage Rated Secondary: Enter the nominal voltage specifies of the secondary side of the voltage sensors.

NOTICE The value set under this setting is used as the base for per unit calculation.

Phase Angle (*): Enter the phase shift of secondary voltage related to the primary voltage. Due to the transformation algorithms used for some sensors, the secondary side would keep a shifted angle regards to the primary voltage. The information of the shifted error provided by the sensor at nominal frequency system has to be set in this setpoint.

Phase VT Connection: This setting defines the type of VT connection, Wye or delta.

Sensor # Magnitude Correction: The R650 uses magnitude and phase correction factors to correct for manufacturing tolerances in the line-sensing equipment.

This setting specifies the correction magnitude that must be applied for the measurement taken from the VT1/2/3 input. The magnitude correction factor is calculated by applying the equation::
Calculated VT1/2/3 Voltage = (1 + VT1/2/3 Magnitude 100) x Measured VT1/2/3 Voltage

Sensor # Phase Angle Correction: This setting provides the leading phase shift for fine corrections that should be applied on the voltage measured by the sensor to compensate for angle errors.

5.3.3 Current Sensing

Setpoint > System Setup > Current Sensing			
Name	**Default Value**	**Step**	**Range**
Phase CT Primary	1000.0 A	0.1 A	[1.0 : 6000.0]
Phase CT Secondary	1 A	N/A	[1 A; 5 A]
Ground CT Primary	1000.0 A	0.1 A	[1.0 : 6000.0]
Ground CT Secondary	1 A	N/A	[1 A; 5 A]
Stv Gnd CT Primary	50.0 A	0.1 A	[1.0 : 6000.0]
Stv Gnd CT Secondary	0.2 A	N/A	[0.2 A]

Phase CT Primary: Enter the rated primary current used in the actual feeder in Amperes.

Phase CT Secondary: Enter the rated secondary current used in the actual feeder in Amperes.

NOTICE The value set under this setting is used as the base for per unit calculation.

Ground CT Primary: Enter the rated primary current used for ground input in Amperes.

Ground CT Secondary: Enter the rated secondary current used for ground input in Amperes.

Stv Gnd CT Primary: Enter the rated primary current used for sensitive ground current input in Amperes.

Stv Gnd CT Secondary: Fixed at 0.2A.S

The sensitive ground current input [0.2A] is intended for use either with a CT in a source neutral of a high-impedance grounded system, or on ungrounded systems. On ungrounded systems it is connected residually with the phase current inputs.

The sensitive ground current input can be connected to a Zero Sequence CT for increased sensitivity and accuracy when physically possible in the system.

The Sensitive Ground input must only be used on systems where the maximum ground current does not exceed 500 A.

NOTICE The value set under this setting is used as the base for per unit calculation.

5.3.4 FlexCurve settings

The relay incorporates 4 user curves called Flex Curve A, B, C and D. The points for these curves are defined by the user in ***"Setpoint>System Setup>Flex Curves"*** menu in EnerVista 650 Setup. User defined flex curves can be selected as an operation curve in all the time overcurrent functions in the relay.

In the flex curves menu there are 120 points to define a user curve. 40 points for reset (from 0 to 0.98 times the pickup value) and 80 for operate (from 1.03 to 20 times the pickup).

Table 5-16: FlexCurve settings

Setpoint > System Setup > Flex Curves Flex Curves A > Flex Curves B> Flex Curves C > Flex Curves D				
Setting Description	Name	Default Value	Step	Range
Values for reset points 0.00 pkp	Time 0.00xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]
Values for reset points 0.05 pkp	Time 0.05xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]
...	...	...	...	...
Values for reset points 0.97 pkp	Time 0.97xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]
Values for reset points 0.98 pkp	Time 0.98xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]
Values for operation points 1.03 pkp	Time 1.03xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]

Values for operation points 1.05 pkp	Time 1.05xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]
...	...	...	...	...
Values for operation points 19.50 pkp	Time 19.50xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]
Values for operation points 20.00 pkp	Time 20.00xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]

The definition of the curve points can be introduced directly in the Flex Curve settings menu. Alternatively they can be created using the graphical tool provided by clicking **Edit Curve** in the Flex curves menu in EnerVista 650 Setup.

In the user curve edit screen (see Figure 5-2: FlexCurves edition), a base curve can be selected, from the Standard Curves menu. This curve is used as a template to create the user curve. Once the standard curve is viewed, it is possible to make the user curve (operate, reset or both) reconcile the standard curve, using the **Flex curve > set flex curve from the standard curve**, and then modifying any of the points by editing in the table the corresponding value.

The user can also view a different curve model to the one the FlexCurve has been adapted to, and compare both models to adopt the most appropriate values in each case. If once the user curve has been configured, the user wants to store the information, the "***Flex Curve > Exit with Data***" menu must be selected. If the results are not to be saved, the ***Exit without Data*** option must be selected. Now, calculated points must be saved in the Flex Curve using the "Store" option.

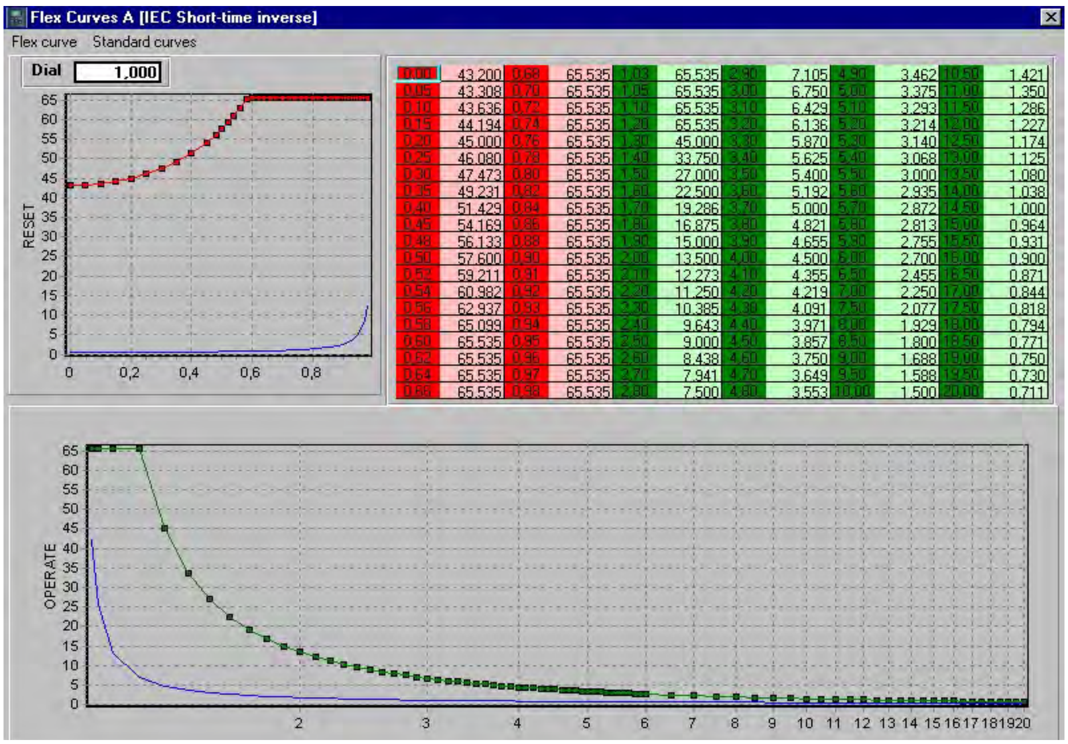


Figure 5-2: FlexCurves edition

5.3.5 Recloser

5.3.5.1 Recloser settings

The R650 supports two types of reclosers:

- Three separate **single-pole reclosers**. Each pole can be managed independently from others. This type of recloser is arranged with three separates coils, one coil per phase. Each phase has open and close commands and separate open and closed states.
- **Three-pole reclosers**. The three poles of this recloser are managed by one coil. Open and close commands operate the three phases of the recloser simultaneously.

The recloser used by the R650 controller is selected under the RECLOSE TYPE setting. Internally, within the R650 each pole of the recloser is managed as separate switchgear.

The configuration of each pole of the recloser is done under the Reclose/Autoreclose pane. This pane allows the parametrization of the recloser inputs, openings and closing times and the open and close initiations.

By evaluating the configured inputs of each pole of the recloser, the relay constructs the possible states. All states are depicted in the next table. The table also shows the equivalences among the states provided for switchgears and the states of the recloser.

SWITCHGEAR #	SINGLE-PHASE	THREE-PHASE
SWITCH # OPEN	RCL PH A/B/C OPEN	RCL 3P OPEN
SWITCH # CLOSED	RCL PH A/B/C CLOSED	RCL 3P CLOSED
SWITCH # 00 | 11 ERROR	RCL PH A/B/C UNDEFINED	RCL 3P UNDEFINED
SWGR # FAIL TO CLOSE	RCL FAIL TO CLOSE PH A/B/C	RCL FAIL TO CLOSE 3P
SWGR # FAIL TO OPEN	RCL FAIL TO OPEN PH A/B/C	RCL FAIL TO OPEN 3P
SWITCH # NO DEFINED	RCL NOT DEFINED PH A/B/C	RCL NOT DEFINED 3P

The next diagram summarizes the configuration of the recloser by RECLOSER/recloser settings and the SWITCHGEAR configuration. See the logic diagram for a better understanding of how the states of the recloser are formed.

As can be seen in the logic, for single phase reclosers the relay provides the open, close and the undefined states per each phase. For three-phase reclosers only one state is provided to indicate the open, closed and undefined condition.

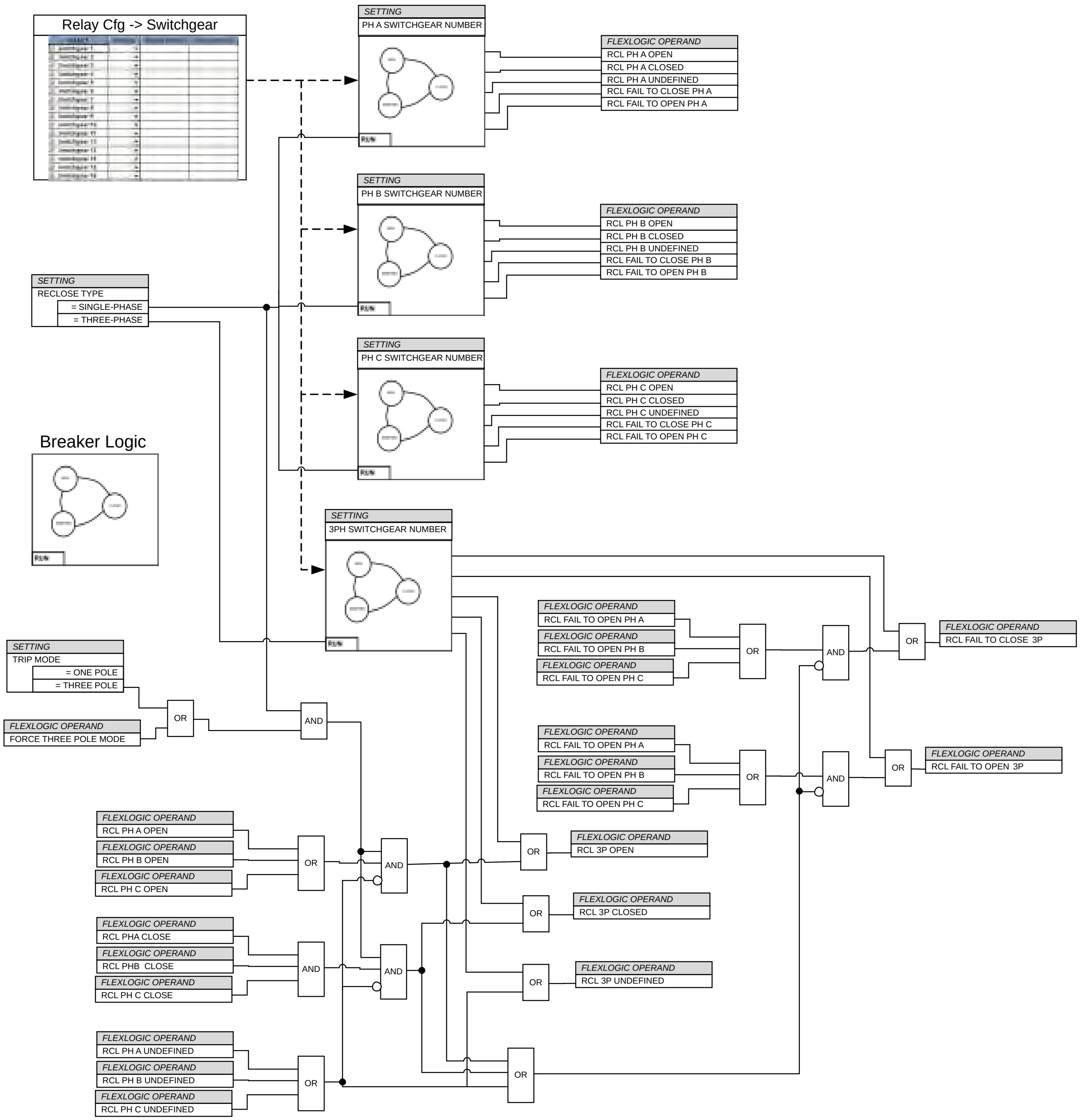


Figure 5-3: Reclose Recloser logic diagram

There are special cases when the open and close commands for single-phase reclosers should be performed synchronously. Under these conditions, the Autoreclose feature should be forced to open and close the three pole of the recloser at the same time.

In order to do that, the three pole states of the recloser will be constructed from the individual single-phase configurations as shown in the logic.

These states are formed when the recloser is forced to trip in "THREE POLE" mode. The TRIP MODE setting is located in SETPOINT-> SYSTEM SETUP->RECLOSER/recloser->SINGLE/THREE POLE TRIPS.

For three-pole trip mode, the auto-recloser is automatically configured to work based on the 3P states of the switchgear.

This working mode can also be forced by the "FORCE THREE POLE MODE" input. Once this input is raised, the auto-recloser is forced to work in three-phase mode.

Some applications can allow single phase reclosing only under particular temporary seasons or periods of time when the system is transferred low power flow. These applications might require a way to change dynamically the tripping logic and the auto-reclosing's work approach. For these special cases, this input can be used to dynamically force to single-phase reclosers work as a three phases recloser.

Apart from these states, the Relay Configuration->Switchgear pane provides the configuration and setting for each switchgear. See Switchgear Settings for further description.

Setpoint > System Setup > Recloser > Recloser Settings			
Name	**Default Value**	**Step**	**Range**
RECLOSER TYPE	THREE-PHASE	N/A	[THREE-PHASE ; SINGLE-PHASE]
MAX OPENINGS 1 HOUR	1	N/A	[1 ; 60]
RCL WEAR MONITOR FN	DISABLED	N/A	[ENABLED ; DISABLED]
RCL WEAR MONITOR AL	100.0		[20.0 : 100.0]
INT DUTY CURRENT 1	2.00	0.01 kA	[0 : 999.99]
INT DUTY OPER 1	44	1	[0: 65000]
INT DUTY CURRENT 2	6.00	0.01 kA	[0 : 999.99]
INT DUTY OPER 2	56	1	[0: 65000]
INT DUTY CURRENT 3	12.00	0.01 kA	[0 : 999.99]
INT DUTY OPER 3	16	1	[0: 65000]
MAX NUMBER OPENINGS	10000	1	[0: 65000]
MAX INTERRUPTING KA	12.50	0.01 kA	[0 : 999.99]
STATISTIC INT NUMBER	5	1	[5 ; 60]
SNAPSHOT EVENTS	DISABLED	N/A	[ENABLED ; DISABLED]

RECLOSER TYPE: The RECLOSE TYPE setpoint specifies the type of recloser controlled by the R650: SINGLE PHASE reclosers or THREE PHASE reclosers.
For SINGLE PHASE reclosers, three separate switchgears should be used, one per each phase of the recloser. Under this configuration, the opening and closing of each phase is controlled separately from the rest of phases. A full description of the configuration would be shown hereinafter.
For THREE PHASE reclosers, one switchgear is used to the control of the opening and closing of the three phase recloser.

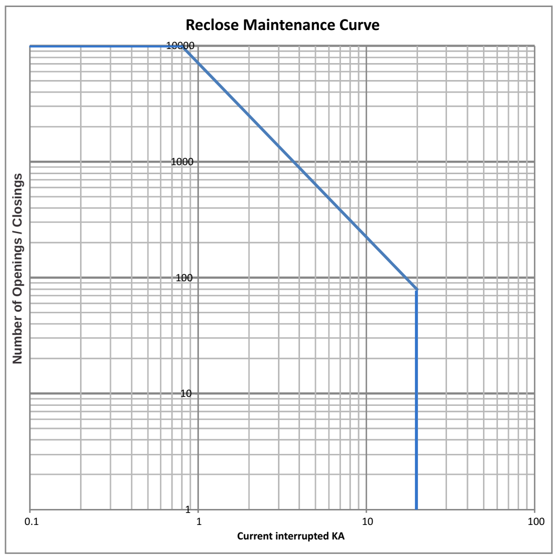
MAX OPENINGS 1 HOUR: This sets the maximum number of openings per phase allowed in the relay during one hour; once this value is exceeded, the corresponding alarm per phase signals will be activated; these values are updated and reset after one hour. Once the maximum number of openings per hour is reached, the value is not incremented with additional openings within the hour.

RCL WEAR MONITOR FN: This setting enables the reclose contact wear monitor feature. The reclose wear monitor is computed by taking into account the current that flows previously to the opening of the recloser. The monitor feature algorithm uses the reclose standard ANSI/IEEE C37.61 -1973 to evaluate the wear of the recloser.

The wear characteristic in the ANSI C37.61, 'Recloser Wear Maintenance Curve' in this document, is calculated based on the equation:

$$N_{\max} = \frac{TotalDutyFactor}{(InterruptingCurrent)^{1.5}}$$

This equation can be shown graphically where the interrupted current (KA) is on the horizontal axis, and the maximum allowed operations on the vertical axis. The shape of this graphic follows a linear trend on a logarithmic sheet:



This curve defines the maximum numbers of operations allowed for a specific interrupted current before the maintenance of the recloser shall be performed.

The 'reclose maintenance' equation is taken out from the test 'fault interrupting duty cycle' provided by manufacturer's recloser. The 'duty cycle' is a standardized opening and closing test sequence based on the standard ANSI C37.60. It defines the minimum capability of a recloser to interrupt several numbers of faults at three different current values. Under this type of test, the manufacturer provides the total duty factor that limits the number of operations of the recloser before maintenance.

As an example, for VIPER-S recloser, the next table shows the fault interrupting duty cycle provided by G&W Electric:

Percent of Maximum: Interrupting Rating	Approx. Interrupting: Current Amps	No. of Fault: Interruptions
15-20%	2000	44 (88)*
45-55%	6000	56 (112)*
90-100%	12000	16 (32)*
Total Number of Fault Interruptions: 116 (232)*		

(*) The duty test is established at half-life. Recloser standards allow the manufacturer to test only to "half-life" because of the expense time and test required of the complete duty cycle of a vacuum recloser.

Other needed parameters to complete the definition of the curve are: Maximum symmetrical interrupting current in KA, mechanical endurance operations and maximum design voltage.

For G&W VIPER-S specifications these parameters are:

SELECTION OF RATINGS	IEEE/IEC		
Maximum Design Voltage, kV	15.5	27	38
Interrupting Current, kA rms sym.	12.5	12.5	12.5
Mechanical Endurance, Operations	10k	10k	10k

Based on the ANSI C37.61 -1973 (Guide for the application operation and maintenance of automatic circuit reclosers), the total wear duty factor is derived from the first table as:

Wear duty cycle at 20% -> (0.20 x 12.5 KA)1.5 x 88 operations = 550

Wear duty cycle at 50% -> (0.50 x 12.5 KA)1.5 x 112 operations = 4375

Wear duty cycle at 100% -> (0.50 x 12.5 KA)1.5 x 32 operations = 1250

Total wear duty factor = 550 + 4375 + 1250 = **6175**.

In our example, in order to calculate the number of allowed operations before maintenance at a given rated current, the total wear duty factor must be added into the equation:

Maximum operations (at current X KA) = 6175 / (current in KA)1.5

For instance, in order to calculate the maximum number of operations allowed at 6KA:

Maximum operations at 6KA (50% of maximum interrupting current) = 6175 / 62 = 172 operations.

Where for 12.5 KA (100 % of interrupting current), the equation yields to 6175/144 = 43 operations.

The 'total wear duty factor' expresses the maximum accumulated value before maintenance. Thus, this value can be considered as 100% of the capacity of the recloser to perform opening and closing operations.

Wear monitoring

The R650 provides the states 'RCLS PHA/B/C/3P WEAR MON' that measure the accumulated wear duty per phase at each opening in percentage of total wear duty. When 100% value is reached, meaning the maximum wear capacity is achieved, the alarm RCLS PHA/B/C/3P WEAR ALARM is raised.

The R650 accumulates the wear duty cycle at each operation by measuring the flowing current values previously to the opening of the recloser.

The wear duty 'wd (%)' value at each opening is calculated as percentage of the total duty factor by means of next equation:

$$wd(\%) = 100\frac{(InterruptingCurrent)^{1.5}}{TotalDutyFactor} = 100\frac{InterruptingCurrent^{1.5}}{6175}$$

For instance, if the reclose is opened at 6KA, using the previous equation, the wd(%) value is 0.238 %. After the opening operation, the total accumulated wear measurement will be increased by 0.238 %.

The wear monitoring curve is limited by the maximum number of allowed mechanical operations and the maximum interrupting current in KA.

The maximum number of allowed operations is provided by manufacturer. For VIPER-S recloser this parameter is located in the third raw of the second table, as 'mechanical endurance'.

Therefore, the minimum wd(%) value that can be accumulated at each operation would be provided by this parameter.

In the R650 settings, this value should be set under the parameter MAX. NUMBER OF OPENINGS.

For G&W VIPER-S recloser, this magnitude is represented as a horizontal line at a value of 10000 in the 'reclose maintenance curve'. The intersection of both curves stablishes which is the minimum current where the equation is applied.

For the G&W VIPER-S maintenance curve: $10000 = 6175 / I^{1.5} \rightarrow I = 0.7251$ KA.

For operations at current values lower than 0.7251 KA, the minimum accumulated wd(%) is limited by the maximum number of openings line. Thus, the wd(%) can be easily expressed by means of next equation:

$$wd(\%) = \frac{100}{MaxNumberOfOP}$$

For our example, wd(%) = 100 / 10000 = 0.01 %. That is similar to use the current 0.7251 KA in the wear maintenance equation: $wd(\%) = 100 \times 0.7251^{1.5} / 6175 = 0.01\%$.

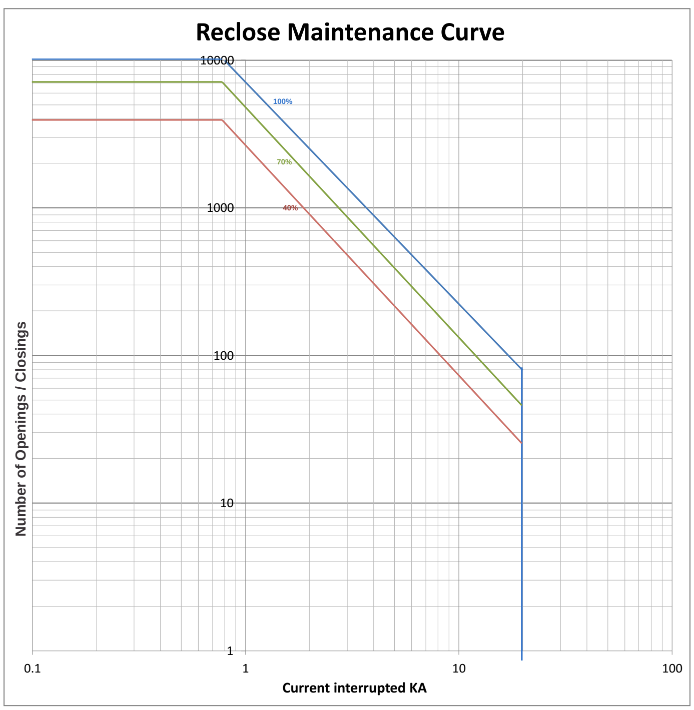
As has been expressed, the equation is also limited by the maximum interrupted current. In our example this value corresponds to 12.5 KA. This is represented as a vertical line that cuts the monitoring curve in 12.5 KA.

For operations at higher levels of 12.5 KA, the monitoring wear alarm will raise after opening, regardless of the previous accumulated value.

RCL WEAR MONITOR AL:

The wear alarm is raised when the accumulated 'RCLS PHA/B/C WEAR MON' reaches the value programmed under this setting. The accumulated wear monitoring values cannot be increased more than 100%.

The next figure shows the wear monitor capability at 40, 70 and 100%.



INT DUTY CURRENT 1/2/3:

INT DUTY OPER 1/2/3:

The IEEE C37.60 - 1981 standardized the test required for reclosers in order to provide their life before maintenance. The values obtained under this test are represented by the fault interrupt duty cycle table. The next table show the values obtained from three manufacturers:

	Type WE (OIL)		Type VSA 12 (VACUUM)		Type G&W VIPER-S (VACUUM)	
Current in % of interrupting rating	**Interrupt rating (KA)**	**Nº of Fault interruptions**	**Interrupt rating (KA)**	**Nº of Fault interruptions**	**Interrupt rating (KA)**	**Nº of Fault interruptions**
15-20%	10 KA	28	12 KA	88	12.5 KA	44 (88)
45-55%	10 KA	20	12 KA	112	12.5 KA	56 (112)
90 -100 %	10 KA	10	12 KA	32	12.5 KA	16 (32)
Total operations		58		232		232

The 'interrupt duty cycle' compounds three rows. The first row indicates the number of operations tested by interrupting from 15 to 20 % of the maximum interrupting current allowed for the recloser. The second one expresses the number of operations tested at 45 to 55 % of the interrupting rating. The third row contains the number of operations tested from 90 to 100%.

According with Appendix C of ANSI C37.61 -1973, the accumulations of these operations provides the 'total duty factor' of the recloser. This parameter specifies which the maximum duty cycle is before maintenance.

The R650 provides up to 3 possible settings to introduce the pair Current interrupting rating and Number of operations.

Based on these parameters, the R650 then extracts the 'Reclose Maintenance curve' as explained earlier.

Note: A value of 0 KA in the interrupting duty current or 0 duty operations disables this pair of points for the total duty calculation.

MAX NUMBER OPENINGS: This is the maximum number of openings allowed by the recloser. This value corresponds to the maximum mechanical endurance operations allowed by the recloser. The R650 uses this parameter to limit the number of operations for low interrupted currents.
A zero value set in this setting inhibits this characteristic.

MAX INTERRUPTING KA: This setting stabilizes the maximum interrupted current of the recloser. This value limits the Recloser maintenance curve for higher interrupted currents.

STATISTIC INTEGRATION NUMBER:

This setting determinates the number of openings and closings used for computing the average values for statistical purpose.

The COIL A/B/C MAX CLOSE and COIL A/B/C MAX OPEN CURRENT are also updated with the maximum value of current flowing throughout the coil during the selected period.

The values are stored in a non-volatile memory.

MEAN OPEN/CLOSE STATISTICS		**Units**
MEAN OPENING TIME PHA	0.000	s
MEAN OPENING TIME PHB	0.000	s
MEAN OPENING TIME PHC	0.000	s
COIL A MAX OPEN CURRENT	0.00	A
COIL B MAX OPEN CURRENT	0.00	A
COIL C MAX OPEN CURRENT	0.00	A
MEAN CLOSING TIME PHA	0.000	s
MEAN CLOSING TIME PHB	0.000	s
MEAN CLOSING TIME PHC	0.000	s
COIL A MAX CLOSE CURRENT	0.00	A
COIL B MAX CLOSE CURRENT	0.00	A
COIL C MAX CLOSE CURRENT	0.00	A

SNAPSHOT EVENTS: This setting enables or disables the snapshot event generation for reclose/recloser signals.

Table 5-17: Reclose/Recloser states

Reclose/Recloser State	Description
RCL WEAR PH A ALARM	Alarm indicating the maximum Recloser wear has been reached on phase A.
RCL WEAR PH B ALARM	Alarm indicating the maximum Recloser wear has been reached on phase B.
RCL WEAR PH C ALARM	Alarm indicating the maximum Recloser wear has been reached on phase C.
RCL WEAR 3P ALARM	Alarm indicating the maximum Recloser wear has been reached, three-phase.
RCL PH A 1 HOUR ALARM	Alarm signaling the maximum allowed number of operations has been reached for the recloser of phase A.
RCL PH B 1 HOUR ALARM	Alarm signaling the maximum allowed number of operations has been reached for the recloser of phase B.
RCL PH C 1 HOUR ALARM	Alarm signaling the maximum allowed number of operations has been reached for the recloser of phase C.
RCL 3P 1 HOUR ALARM	Alarm signaling the maximum allowed number of operations has been reached for the recloser, three-phase.
RCLS PHA/B/C/3P WEAR MON	Recloser phase A/B/C wear monitor. These registers store the accumulated values of the wear duty cycle per phase in percentage of the total wear capacity. The accumulated wear values are stored in a non-volatile memory. These values will be reset after receiving a RCL WEAR PHA/B/C/3P RESET

The signals associated with the Recloser can be monitored at **Actual > Status > Recloser > Recloser States**, and they are as follows:

Table 5-18: Reclose/Recloser status

Recloser Status	Description
RCL PH A OPEN	Phase A Reclose/Recloser in open position
RCL PH A CLOSED	Phase A Reclose/Recloser in close position
RCL PH A UNDEFINED	Phase A Reclose undefined
RCL FAIL TO CLOSE PH A	Reclose/Recloser phase A in fail to close condition
RCL FAIL TO OPEN PH A	Reclose/Recloser phase A in fail to open condition
RCL PH A NOT CONFIGURED	Reclose/Recloser Phase A no configured
RCL PH B OPEN	Phase B Reclose/Recloser in open position
RCL PH B CLOSED	Phase B Reclose/Recloser in close position
RCL PH B UNDEFINED	Phase B Reclose undefined
RCL FAIL TO CLOSE PH B	Reclose/Recloser phase B in fail to close condition
RCL FAIL TO OPEN PH B	Reclose/Recloser phase B in fail to open condition
RCL PH B NOT CONFIGURED	Reclose/Recloser Phase B no configured
RCL PH C OPEN	Phase C Reclose/Recloser in open position
RCL PH C CLOSED	Phase C Reclose/Recloser in close position
RCL PH C UNDEFINED	Phase C Reclose undefined
RCL FAIL TO CLOSE PH C	Reclose/Recloser phase C in fail to close condition
RCL FAIL TO OPEN PH C	Reclose/Recloser phase C in fail to open condition
RCL PH C NOT CONFIGURED	Reclose/Recloser Phase C no configured
RCL 3P OPEN	Three-Phase Reclose/Recloser in open position
RCL 3P CLOSED	Three-Phase Reclose/Recloser in close position
RCL 3P UNDEFINED	Three-Phase Reclose/Recloser undefined
RCL FAIL TO CLOSE 3P	Three-Phase Reclose/Recloser in fail to close condition
RCL FAIL TO OPEN 3P	Three-Phase Reclose/Recloser in fail to open condition
RCL 3P NOT CONFIGURED	Three-Phase Reclose/Recloser no configured
RCL WEAR PH A ALARM	This signal is asserted when the set value for phase A is exceeded
RCL WEAR PH B ALARM	This signal is asserted when the set value for phase B is exceeded
RCL WEAR PH C ALARM	This signal is asserted when the set value for phase C is exceeded

Recloser Status	Description
RCL PH A OPEN 1 HOUR ALARM	Alarm maximum number of phase A openings reached in one hour
RCL PH B OPEN 1 HOUR ALARM	Alarm maximum number of phase B openings reached in one hour
RCL PH C OPEN 1 HOUR ALARM	Alarm maximum number of phase C openings reached in one hour

5.3.5.2 Single-pole and three-pole settings

The R650 design supports both a three-pole recloser and three single-pole reclosers.

A single-pole recloser operates by opening or closing one phase of the distribution line. In the past, single-pole reclosers were used exclusively for transmission lines. Utilities avoided using single phase reclosing for distribution lines due to the difficulty of coordination among devices along the feeder and the protection of three-phase loads against unbalances. However, due to the use of modern IEDs in power distribution systems, single-phase reclosing in conjunction with coordination schemes now increases the reliability power system protection.

Statistically single line-to-ground faults are the most common type in distribution lines, accounting for about 90% of all faults. Some studies claim that at least 60% of line-to-ground faults can be cleared using single-pole tripping. Single phase tripping only opens the affected phase in the fault, so the outage for a single-phase fault can be reduced by two-thirds. For faults where two phases are affected, the reduction is one-third. All indices used by utilities to measure system reliability are based on the level of service provided to customers. By using single-pole tripping the reliability can increase dramatically, and depending on the application, different tripping and reclosing criteria can be used.

When single-pole reclosers are used with a single per phase pole, the main concerns are the voltage unbalance and current unbalance produced during the opening of one or two phases, and the effectiveness of ground fault protection under such conditions. For some applications, working in single-phase mode with each phase controlled separately is allowed and supported by the distribution system. Examples include a blown fuse, damaged switchgear, or a single-phase unsuccessful reclosing scheme. In other applications, leaving the system working with one phase opened can jeopardize the reliability of the system, losing coordination among upstream IED devices. In such cases, working with the opening of one phase is only permitted for a limited period of time, for example during the clearance and reclosing of a single phase fault.

The R650 uses a single/three pole open detection element that detects single and three pole openings. The states provided by this element are used in the internal states of the auto-reclosing scheme. In order to provide fully flexible configuration, these states are also accessible through theR650 logic for use in customized logic schemes.

Setpoint > System Setup > Recloser > Single - Three Pole			
Name	**Default Value**	**Step**	**Range**
TRIP MODE	THREE POLE	N/A	[ONE POLE ; THREE POLE]
TRIP MIN SEAL TIME	0.02	0.01 s	[0.02 ; 60.00]
YELLOW HANDLE TRIP	ENABLED	N/A	[ENABLED ; DISABLED]
YELLOW HANDLE TIMER	0	0.01 s	[0 ; 60.00]
MIN CURRENT SUPV	0.05	0.01 x CT	[0.05 : 1.00]
SNAPSHOT EVENTS	DISABLED	N/A	[ENABLED ; DISABLED]

TRIP MODE: This setpoint determines whether single phase-trips are allowed, regardless of the type of recloser being controlled by the R650.

When ONE POLE is chosen, the states 1P PHASE A TRIP, 1P PHASE B TRIP and 1P PHASE C TRIP are generated, allowing the logic to manage individual phase trips. This is useful for SINGLE-PHASE reclosers operating in single-phase auto-reclosing mode.

For THREE-PHASE reclosers the selection of 3 POLE TRIP can be used instead. See the logic of this recloser function for further information.

TRIP MIN. SEAL IN: This setting establishes the minimum time the operand 1 POLE TRIP or 3 POLE TRIP is kept after a trip condition is asserted.

YELLOW HANDLE TRIP This setting allows the R650 to trip all phases when one yellow handle input is activated.

YELLOW HANDLE TIMER: Reclosers are provided with a yellow handle mechanism used to lock the recloser manually. Lowering the yellow manual operating handle locks all three phases of the recloser until the yellow handle is raised to the unlocked position.

The yellow handle condition comes to the R650 through an external input designated as the YELLOW HANDLE INPUT. The Yellow handle condition is asserted when the yellow handle timer times out. For reclosers equipped with independent yellow handles per phase, an external wiring connexion should be used to provide the assertion of the yellow handle input when any one of the yellow handles is manually lowered.

The yellow handle operation is not supervised by any blocking open or trip input, and triggers the recloser to trip as soon as this signal is received and the timer has elapsed; the R650 trips all three phases to avoid an unbalanced trip condition. The next figure depicts a G&W Electric VIPER-S recloser, with the yellow handle clearly visible.

Figure 5-4: G&W Electric Viper-S recloser

MIN. CURRENT SUPERV: This setting defines the maximum current permitted to detect that a phase of the line has been de-energized. The proof of current supervision per phase accomplished with the recloser open condition provides the phase open supervision operand.

SNAPSHOT EVENTS: This setting enables or disables the snapshot event generation.

5.3.5.3 Single-pole and three-pole operands

SP PHASE A/B/C OPEN This operand is asserted when reclose has been set to control the three single-phase reclosers, and the pole of the phase A/B/C of the recloser has been opened (RCL PHASE A/B/C OPEN) whilst the flowing current of the phase A/B/C is below the minimum current supervision.

This state is used in the internal logic of the reclose controller.

SINGLE POLE OPEN This operand is asserted when working with single-phase reclosers, where one or two poles have been opened.

This element should be used to provide blocking or inhibit input to the unbalance and neutral current and voltage protection functions during the transition of the reclosing process. For applications where the system is allowed to work with one phase opened, the blocking should be continuous.

This flag is not asserted when the three-pole phases are opened.

3 POLE OPEN This operand is asserted when the three phases are opened and the current flowing though phases are below the minimum current supervision set in the MIN CURR SUPERV setpoint.

This state is provided for single-phase and three-phase recloser configurations.

5.3.5.4 Trip operands

TRIP PHASE A | B | C INPUT This input operand provides, by means of the PLC logic, a way to trip a single phase of the recloser. The one-pole / three-pole logic checks whether the trip mode has been set to ONE POLE or THREE POLE MODE. If ONE POLE is chosen, assertion of the TRIP PHASE INPUT activates the 1 POLE PH A|B|C TRIP operand. The assertion of this state should be used as the final state to activate the phase coil recloser. It is qualified by the BLK OPEN/TRIP PH A|B|C input, it should be asserted in order to allow the phase trip condition.

This input is applicable only for single-phase reclosers.

OPEN PHASE A | B | C INPUT This input operand provides, by means of the PLC logic, the way to trip a single phase of the recloser. Unlike the trip phase input, the OPEN PHASE INPUT operand doesn't consider the state of the TRIP MODE settings. The assertion of this state triggers the 1 POLE PH A|B|C TRIP flexlogic operand. This state is also qualified by the BLK OPEN/TRIP PH A|B|C input, it should be asserted in order to allow the phase trip condition.

This input is applicable only for single-phase reclosers.

TRIP 3 PHASE INPUT This input operand provides, by means of the logic of PLC, the way to trip the three phases of the recloser. The trip 3 phase input state is qualified by the BLK OPEN/TRIP 3P input, it should be asserted in order to allow the 3 pole trip condition evolves.

BLK TRIP PHASE A | B | C This input operand provides a way to block single phase tripping. When this input is asserted, the single-phase trip of the affected phase is blocked. This input can be used as a way to qualify the Trip Phase input.

BLK 3P TRIP This input operand provides a way to block three-phase tripping. When this input is asserted, three-phase trips are blocked.

5.3.5.5 Close operands

HOT LINE TAG: The R650 provides a way to interlock all closing commands and automatic reclosing., called the HOT LINE TAG feature. The logic linked to the hot line tag is described below and it is used to block the automatic recloser logic and closing commands of the controller. The name Hot Line Tag is taken from the manual process of disabling and tagging reclosers and reclosers when de-energizing an electrical line for maintenance.

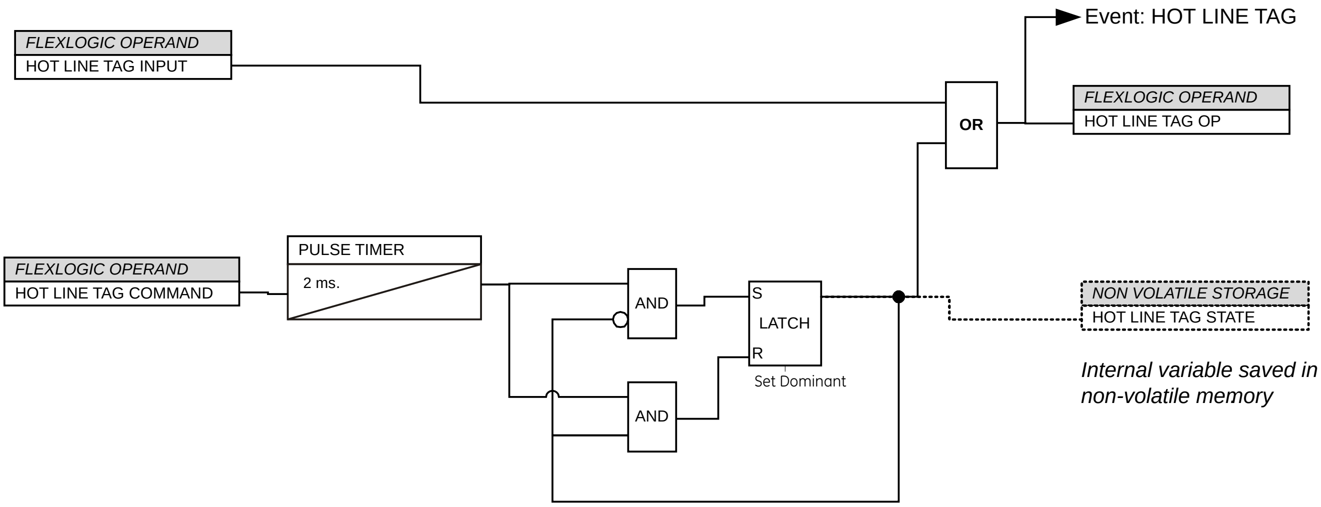


Figure 5-5: Hot line tag logic diagram

⚠CAUTION **When conducting local maintenance use the "Local" setting "OFF" along with the HOT line tag feature as a secondary means of protection and isolation. This recommendation is in addition to local safety requirements such as LOTO.**

The Hot line tag operation, HOT LINE TAG OP, can be performed in two ways: from the HOT LINE TAG COMMAND or the HOT LINE TAG INPUT. The assertion of the HOT LINE TAG OP is prioritized. In order to provide a safer working mode, the status of the HOT LINE TAG is stored in non-volatile memory, to avoid loss of information during shutdown events. When the R650 boots-up, the status of the HOT LINE TAG is reestablished, blocking any attempt to close the recloser until a new HOT LINE TAG COMMAND is issued to remove the HLT condition.

For increased reliability during line maintenance, the inverse state of the HOT LINE TAG OP can be assigned to an external contact located in series with the power supply of coils. In this way, the coils cannot be activated until the R650 device is energized and the HLT condition removed. The next picture illustrates this possibility:

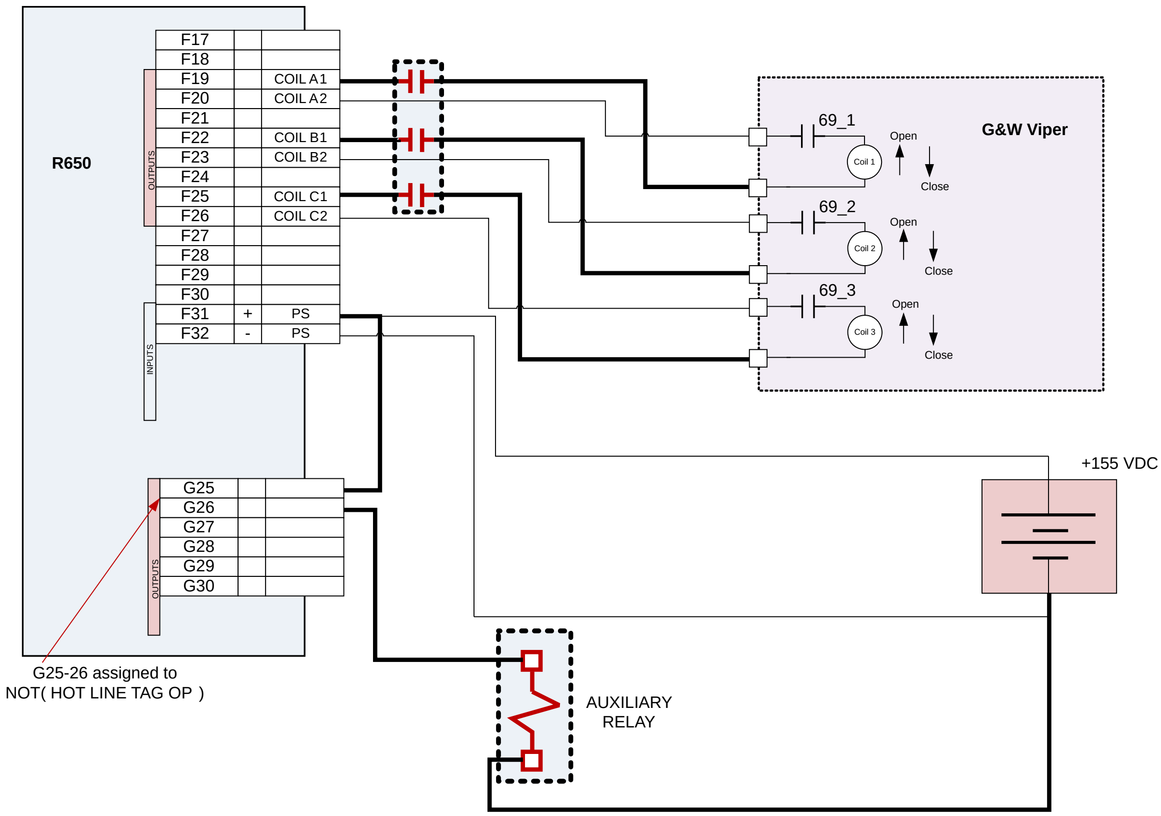


Figure 5-6: Hot Line Tag inverse state wiring example

Instead of using a direct connection to the R650 contact output, an auxiliary contact with higher current flowing capacity on its contacts has been used.

CLOSE 3P: The CLOSE 3P logic operand is the state that is used to close the three-pole recloser. The logic associated with the CLOSE 3P operand is shown in the figure below.

The Close operand is asserted after the following conditions are fulfilled:

1-The Autoreclose triggers AR CLOSE 3P, or after the assertion of CLOSE 3P INPUT by logic.

2-There are no blocking conditions such as HOT LINE TAG, YELLOW HANDLE INPUT or BLOCK CLOSE 3P configured in the PLC.

CLOSE PHA|B|C: The state CLOSE PHA|B|C operand is asserted after the next conditions are satisfied:

1-After the assertion of AR CLOSE PHA|B|C by the Autoreclose element or after the assertion of the CLOSE PHA|B|C INPUT by the logic configuration.

2-There is no blocking conditions such as HOT LINE TAG, YELLOW HANDLE INPUT or BLOCK CLOSE PHA|B|C asserted.

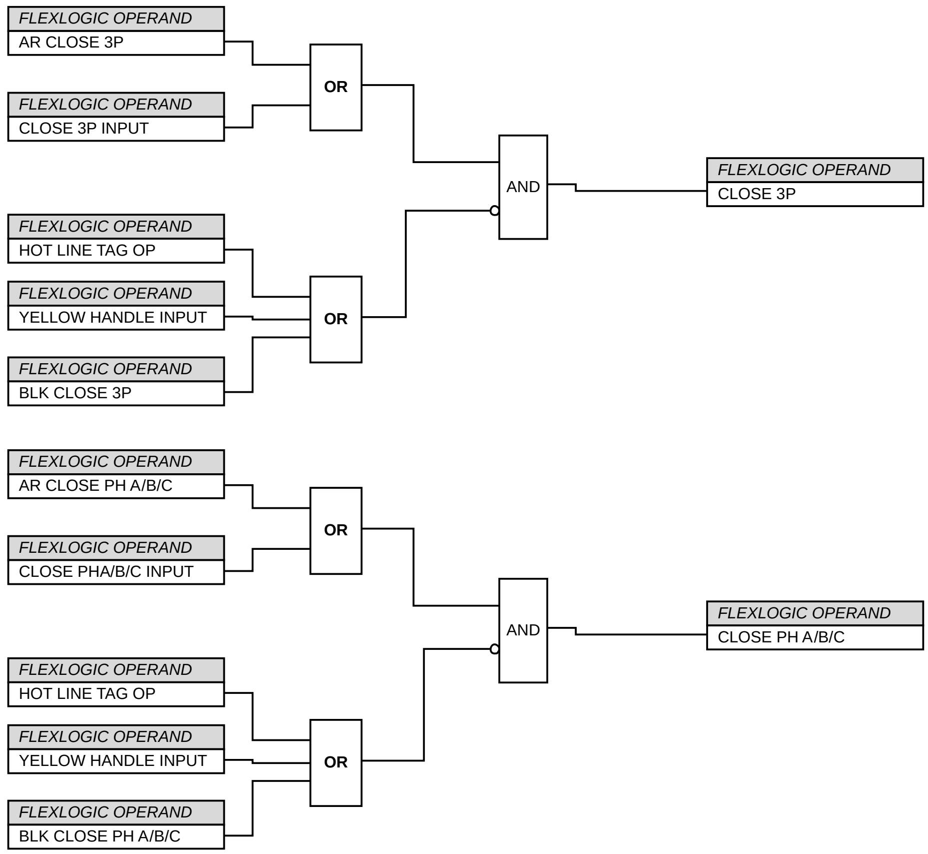


Figure 5-7: CLOSE 3P / PHA|B|C logic diagram

The states 'CLOSE PHA', 'CLOSE PHB', and 'CLOSE PHC', are used to produce straight closing commands for the poles of the recloser. These states are useful for the single-pole recloser by configuring the contact output state that operates directly over each phase of the recloser.

CLOSE 3P / PHA|B|C INPUT: These inputs provide a separate condition to close the recloser, apart from the AR close operand produced by the Autorecloser logic. The close state produced by any manual or automatic commands should be configured under the CLOSE 3P/PHA|PHB|PHC operands, using the provided close logic of the R650.

BKL CLOSE 3P / PHA|B|C: These logic inputs provide a way to block any close operation of the recloser. Any logic to block the operation of the closing coil should be configured under these operands.

The BLK CLOSE 3P is for three-pole recloser whereas the BLK CLOSE PHA, BLK CLOSE PHB, BLK CLOSE PHC provides a way to manage separate blocking conditions for single-pole reclosers.

5.3.5.6 Trip states

STATUS	DESCRIPTION
SP PHASE A OPEN	Phase A Reclose/Recloser opened
SP PHASE B OPEN	Phase B Reclose/Recloser opened
SP PHASE C OPEN	Phase C Reclose/Recloser opened
SINGLE POLE OPEN	One phase or two phases are opened
3 POLE OPEN	All three phases are opened
ANY PHASE OPEN	Any phase is kept opened
1 POLE PHASE A TRIP	Trip operand to open phase A for single-phase reclosers
1 POLE PHASE B TRIP	Trip operand to open phase B for single-phase reclosers
1 POLE PHASE C TRIP	Trip operand to open phase C, for single-phase reclosers
3 POLE TRIP	Trip operand to open the recloser for three-phase reclosers
OPEN PHASE A	Open/Trip Operand used by logic to open the phase A.
OPEN PHASE B	Open/Trip Operand used by logic to open the phase B.
OPEN PHASE C	Open/Trip Operand used by logic to open the phase C.
3 POLE OPEN	Open/Trip Operand used by logic to open the three-phase reclosers

5.3.5.7 Close states

STATUS	DESCRIPTION
YELLOW HANDLE INPUT	Input operand to provide the status of the YELLOW HANDLE from recloser
HOT LINE TAG INPUT	Configurable input to provide the HOT LINE TAG condition
HOT LINE TAG OP	Output from the HOT LINE TAG logic that blocks any closing command to the recloser
CLOSE 3P INPUT	Input operand used to send the closing command to the recloser.
CLOSE PHA|B|C INPUT	Input operand used to send the closing command to each pole of the recloser separately.
BLK CLOSE 3P INPUT	When asserted this state blocks any attempt to close the recloser
BLK CLOSE PHA|B|C INPUT	When asserted this state blocks any attempt to close the affected pole of the recloser.
CLOSE 3P	Close operand for three-pole reclosers. This operand should assert the contact output that close the recloser.
CLOSE PHA|B|C	Close operand for single-pole reclosers. This operand should assert the contact output that close each pole of the recloser.

5.3.6 Switchgear settings

Internal signal generation for the different elements (protection, control, inputs and outputs, switchgear) can be enabled/ disabled in the R650.

Setpoint > System Setup > Switchgear				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Snapshot Event generation for switchgear #1..12	Snapshot Events SWGR 1..12	DISABLED	N/A	[DISABLED – ENABLED]

The following three logic diagrams show switchgear # configured for PHASE A of the recloser. The same criteria can be applied for the remaining phases and for a three-phase type recloser.

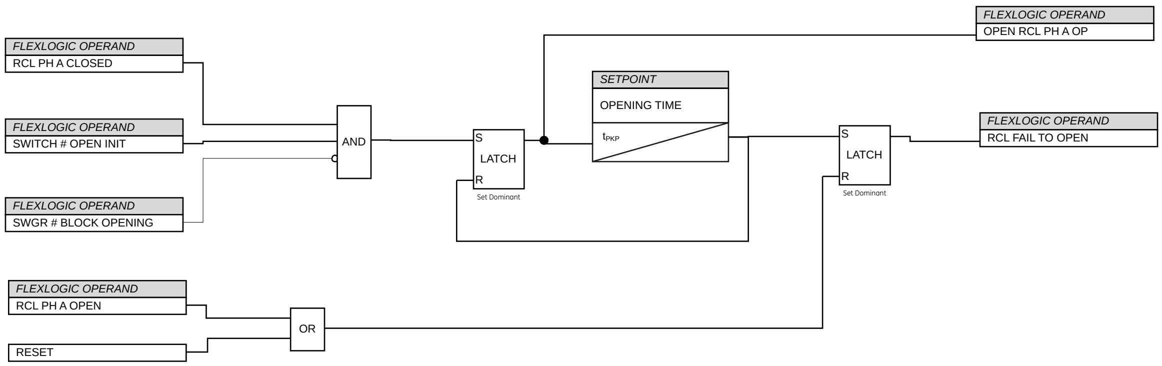


Figure 5-8: Switchgear phase A opening logic diagram

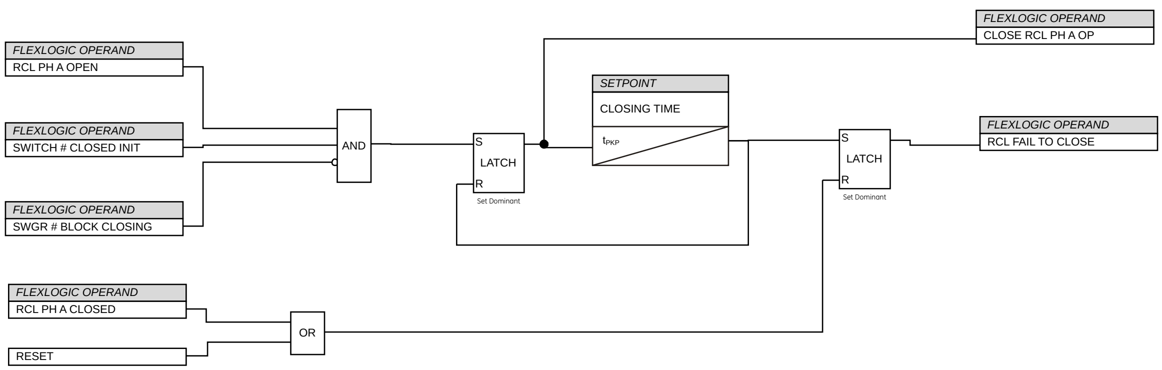


Figure 5-9: Switchgear phase A closing logic diagram

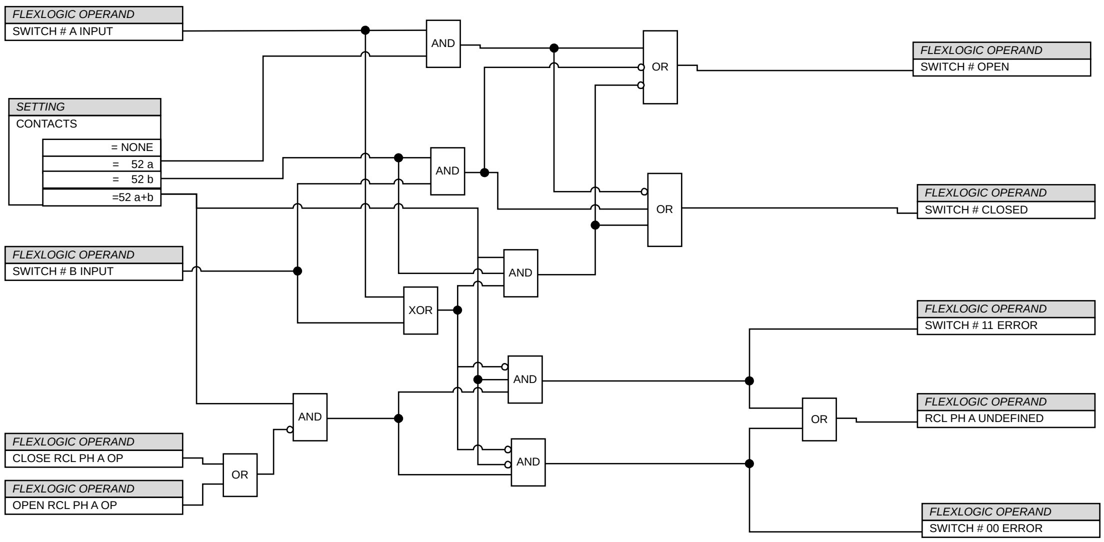


Figure 5-10: Switchgear linked to phase A logic diagram

The signals associated with the switchgear can be monitored at **Actual > Status > Switchgear Status > Switchgear #**, and they are as follows:

Table 5-19: Switchgear status

Switchgear Status	Description
SWITCH # A INPUT	
SWITCH # B INPUT	
SWITCH # A STATUS	
SWITCH # B STATUS	
SWITCH # OPEN	Switchgear # in open position
SWITCH # CLOSED	Switchgear # in closed position
SWITCH # 00 ERROR	Switchgear # in error 00 state.
SWITCH # 11 ERROR	Switchgear # in error 11 state.
SWITCH # OPEN INIT	
SWITCH # CLOSE INIT	
SWGR # FAIL TO CLOSE	Switchgear # in fail to close condition
SWGR # FAIL TO OPEN	Switchgear # in fail to open condition
SWITCH # NOT DEFINED	Switchgear # not defined

5.3.7 Miscellaneous settings

This section determines the relays status configuration regarding the service and local or remote modes.

Setpoint > System Setup > Miscellaneous Settings				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Relay Out of Service	Relay Out of Service	ENABLED	N/A	[DISABLED – ENABLED]
Local/Remote Blocked	Local/Remote Blocked	OFF	N/A	[ON -OFF]

5.3.7.1 Out of service setting

The unit Relay Out of Service setting is configured in **Setpoint > System Setup > Miscellaneous**. When this setting is set to DISABLE, internal logic monitors different internal status/errors and also the **Out of Service** status. The **Out of Service** status can be configured in **Relay Configuration > Protection Elements**, where any digital signal available in the drop-box list can be configured as the input.

When internal logic is running, the relay goes into **OUT OF SERVICE** under the following circumstances:

- If any of following internal errors reports status indicated below:
  - **Self-Test Memory OK**: Status set to 0 which means internal memory is faulty
  - **Self-Test DSP Fault**: Status set to 1 which means that there is a communication error between DSP and the main processor. After this error occurs, measurements are frozen for 10 seconds and then they drop to zero.
  - **Magnetics Fault**: Status set to 1 which indicates a communication error between DSP and the magnetic module. After this error occurs, measurements are frozen for 10 seconds and then they drop to zero.
  - **Logic Fault**: Status set to 1 which indicates PLC equations sent to the relay have an error or are incorrect.
  - **Order Code Fault**: Status set to 1 which means the order code and hardware configuration do not match
  - **Calibration Error**: Status set to 1 which means there is a problem in the calibration settings (wrong values).
  - **Board Status**: Status set to 0 indicates that an I/O board is faulty or it does not correspond to the type configured. When this error occurs due to faulty board, status of inputs/outputs remain as they were just before it went to the faulty state.
- Or if Out of Service status (Signal configured in **Relay Configuration > Protection Elements**) is set to 1.

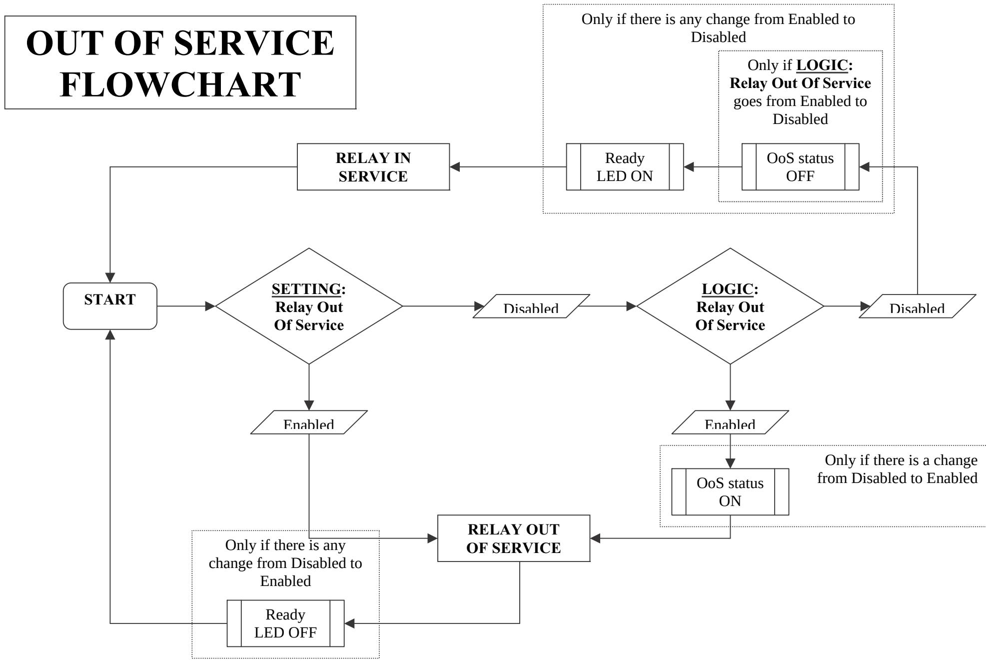
When the **Out of Service** status goes to ON, or the setting has been changed to Enabled, the ready LED changes to red. Be careful if the ready LED is linked to an output, because the output will not change its state.

When relay is OUT OF SERVICE, the following services stop working as expected:

- Protection functions will stop working.
- Output will not operate. For example, if an output is closed and the unit goes to the Out of Service state, the output is kept closed even if the state that closed it changes and would otherwise open the output. When the unit goes out of the Out of Service state, the output is then opened.
- Measurements will continue to be displayed unless the cause of the OUT OF SERVICE is a Self-Test DSP Fault or Magnetics Fault.
- PLC will continue running.
- Communications will continue working.

Please, note that if the cause for OUT OF SERVICE is Self-Test Memory OK, this could affect the services listed above.

The following figure shows the flow chart of these states:



5.3.7.2 Local - remote block setting

In the enhanced HMI with USB port new setting has been released in order to be able to lock the Local/Remote front key. This setting is available via COMS or frontal HMI menu. The settings can be locked by password, so the operator wouldn't be able to change the local-remote without inserting the password.

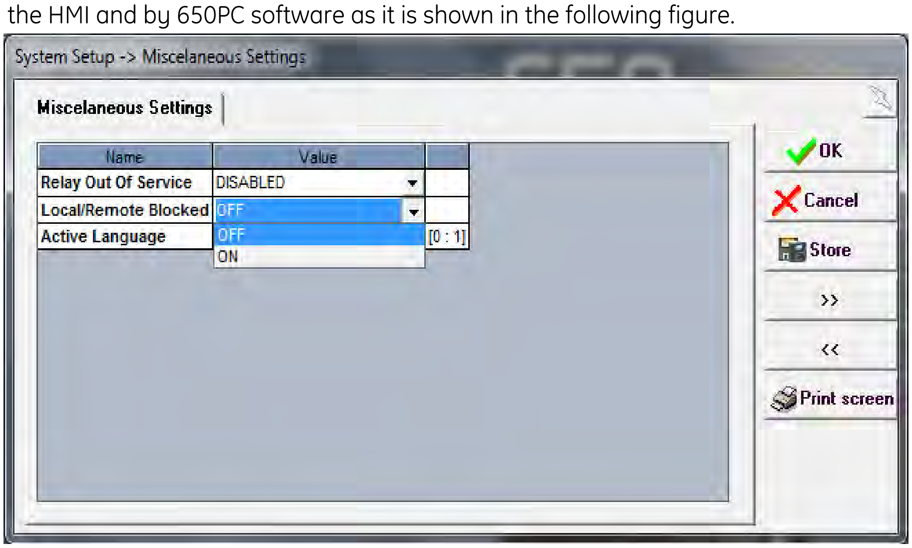
Definitions

The value is defined as:

- OFF: The operator is able to change the operations from local to remote or OFF.
- ON: The operator is not able to change the operations from local to remote or OFF.

Settings

The unit is set by the HMI and by 650PC software as it is shown in the following figure.



5.4 Protection elements

5.4.1 Setting Groups

All R650 functions that are affected by setting groups are located in Enervista 650 Setup under **Protection (Setpoints > Protection Elements > Setting Group X**). All these functions are grouped into every different setting group available (up to 6)**.**

CURRENT ELEMENTS

Instantaneous overcurrent:

3 x PHASE IOC HIGH (50PH)

3 x PHASE IOC LOW (50PL)

3 x NEUTRAL IOC (50N)

3 x GROUND IOC (50G)

3 x SENSITIVE GROUND IOC (50SG)

3 x ISOLATED GROUND IOC (50IG)

Time delayed overcurrent:

3 x PHASE TOC HIGH (51PH)

3 x PHASE TOC LOW (51PL)

3 x NEUTRAL TOC (51N)

3 x GROUND TOC (51G)

3 x SENSITIVE GROUND TOC (51SG)

Negative sequence overcurrent:

3 x NEGATIVE SEQUENCE TOC (46P)

Thermal image:

3 x THERMAL MODEL (49P)

DIRECTIONAL ELEMENTS

3 x PHASE DIR (67P)

3 x NEUTRAL DIR (67N)

3 x GROUND DIR (67G)

3 x SENSITIVE GROUND DIR (67SG)

SOURCE VOLTAGE ELEMENTS

Phase under/overvoltage

3 x PHASE UV (27P)

3 x PHASE OV (59P)

Zero sequence overvoltage

3 x NEUTRAL OV (59N)

Negative sequence overvoltage:

3 x NEGATIVE SEQUENCE OV (47P)

LOAD VOLTAGE ELEMENTS

Phase under/overvoltage

3 x PHASE UV (27P)

3 x PHASE OV (59P)

Zero sequence overvoltage

3 x NEUTRAL OV (59N)

Negative sequence overvoltage:

3 x NEGATIVE SEQUENCE OV (47P)

POWER

3 x FORWARD POWER (32FP)

3 x DIRECTIONAL POWER (32)

3 x WATT GND FLT (32N)

FREQUENCY ELEMENTS

3 x OVERFREQUENCY (81O)

3 x UNDERFREQUENCY (81U)

MISCELLANEOUS:

3 x BROKEN CONDUCTOR

The R650 elements incorporate also the following **control elements**. These control elements are not affected by setting groups and they are available in Enervista 650 Setup at Setpoints>Control Elements

1 x SETTINGS GROUP

1 x SYNCHROCHECK(25)

1 x AUTORECLOSE (79)

1 x recloser FAILURE (50BF)

1 x VT FUSE FAILURE (VTFF)

8 x PULSE COUNTERS

8 x DIGITAL COUNTERS

20 x ANALOG COMPARATORS

1 x COLD LOAD PICKUP

16 x PLC TIMER MASK

1x 60 CTS FAILURE

1x 2ND HRMC INHIBIT

1x COIL CIRCUIT SUPERVISION

R650 elements incorporate a flexible grouping capability for elements grouped in **protection elements** section. This means that protection elements can be used in either one of the following modes:

5.4.1.1 Single setting group

In this operation mode, all protection elements under one particular Setting Group can be activated and operated simultaneously. When the Setting Group Function is disabled at **Setpoint > Control Elements > Setting Group**, protection elements of the group selected as the Active Group become available.

5.4.1.2 Multiple setting groups

In this mode, all protection elements are available in each individual setting group (up to maximum of 6). Only one configured setting groups is active at a given time. A logic signal, e.g. a digital input, selects which table is active at each time, providing adaptive protection to each network condition.

The distribution of protection elements in groups is described in Table 5–33:

Table 5-20: DISTRIBUTION OF PROTECTION ELEMENTS

SETTING GROUP 1	SETTING GROUP 2	SETTING GROUP 3	SETTING GROUP 4	SETTING GROUP 5	SETTING GROUP 6
3x50PH	3x50PH	3x50PH	3x50PH	3x50PH	3x50PH
3x50PL	3x50PL	3x50PL	3x50PL	3x50PL	3x50PL
3x50N	3x50N	3x50N	3x50N	3x50N	3x50N
3x50G	3x50G	3x50G	3x50G	3x50G	3x50G
3x50SG	3x50SG	3x50SG	3x50SG	3x50SG	3x50SG
3x50IG	3x50IG	3x50IG	3x50IG	3x50IG	3x50IG
3x51PH	3x51PH	3x51PH	3x51PH	3x51PH	3x51PH
3x51PL	3x51PL	3x51PL	3x51PL	3x51PL	3x51PL
3x51N	3x51N	3x51N	3x51N	3x51N	3x51N
3x51G	3x51G	3x51G	3x51G	3x51G	3x51G
3x51SG	3x51SG	3x51SG	3x51SG	3x51SG	3x51SG
3x46P	3x46P	3x46P	3x46P	3x46P	3x46P
3x49P	3x49P	3x49P	3x49P	3x49P	3x49P
3x67P	3x67P	3x67P	3x67P	3x67P	3x67P
3x67N	3x67N	3x67N	3x67N	3x67N	3x67N
3x67G	3x67G	3x67G	3x67G	3x67G	3x67G
3x67SG	3x67SG	3x67SG	3x67SG	3x67SG	3x67SG
3x27P	3x27P	3x27P	3x27P	3x27P	3x27P
3x59P	3x59P	3x59P	3x59P	3x59P	3x59P
3x47P	3x47P	3x47P	3x47P	3x47P	3x47P
3x59N	3x59N	3x59N	3x59N	3x59N	3x59N
3x32FP	3x32FP	3x32FP	3x32FP	3x32FP	3x32FP
3x32	3x32	3x32	3x32	3x32	3x32
3x32N	3x32N	3x32N	3x32N	3x32N	3x32N
3x81U	3x81U	3x81U	3x81U	3x81U	3x81U
3x81O	3x81O	3x81O	3x81O	3x81O	3x81O
3 x Broken conductor	3 x Broken conductor	3 x Broken conductor	3 x Broken conductor	3 x Broken conductor	3 x Broken conductor

The settings used for setting group management are located in **Setpoint >Control Elements > Setting Group**

Table 5-21: Setting group settings

Setpoint > Control Elements > Setting Group				
Setting Description	Name	Default Value	Step	Range
Setting Grouping Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Active Group	Active Group	GROUP 1	N/A	[GROUP 1 – GROUP 2 – GROUP 3- GROUP 4-GROUP 5-GROUP 6]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Setting Group settings are as follows:

Function: Possible values are: [DISABLED – ENABLED]

When this setting is DISABLED, the relay is working in single setting group mode. All protection elements that belong to the group selected in the active groups setting are available and working at the same time if required.

If this setting is ENABLED, the relay is working in multiple setting groups mode. In this mode, all protection elements of different setting groups are available to be activated. However, only protection elements of the Active Group selected are real active ones. In this case, selection of active setting group can be modified through logic signals.

l**Active group:** Possible values are 1, 2, 3, 4, 5 or 6.

This setting indicates which setting group is active by default. Default configuration value is 1.

- When this function is disabled, the Active Group value indicates which setting group of protection elements is available, e.g if Active Group is GROUP 1, all protection elements under setting group 1 in **SetPoint > Protection Elements** are available.
- When this function is enabled, the Active Group value indicates the active setting group when no group is selected as the active one.

Snapshot events: Possible values are: [DISABLED – ENABLED]

If this setting is ENABLED, Snapshot events related to change of setting groups are reported.

Regarding changing between setting groups when working in multiple setting groups mode, the Relay incorporates several signals associated with the Protection elements grouping in tables.

First, signals that indicate the group activation:

GROUP 1 ACT ON: This signal produces the activation of setting group 1

GROUP 2 ACT ON: This signal produces the activation of setting group 2

GROUP 3 ACT ON: This signal produces the activation of setting group 3

GROUP 4 ACT ON: This signal produces the activation of setting group 4

GROUP 5 ACT ON: This signal produces the activation of setting group 5

GROUP 6 ACT ON: This signal produces the activation of setting group 6

Priority of activation signals is indicated as follow:

GROUP 6 > GROUP 5 > GROUP 4 > GROUP 3 > GROUP 2 > GROUP 1

E.g: If group 4 and group 1 are selected at the same time, setting group 4 is the active one due to the higher priority level.

As previously mentioned, when no activation signal is selected, the default group set in Enervista 650 Setup under **Setpoint > Control Elements > Setting Group > Active group** is the active group.

These activation signals for the different setting groups can be configured using EnerVista 650 Setup at **Setpoint > Relay Configuration > Control Elements** as shown. Different inputs can be linked to different activation signals.

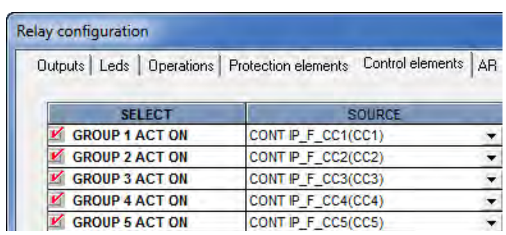


Figure 5-11: Table change signals configuration example

The example above uses six digital inputs to perform the table selection, but it is possible to use any other logic signal in the relay.

In case of using digital inputs, the user can select the setting table activating these digital inputs (which can come from the PLC, or from a different relay, or from an auxiliary switch, for adaptive protection). This selection of the active group has priority over default setting.

The time used in the table change is one PLC logic scan cycle (5 ms typical), allowing a fast adaptation to system changes.

Another type of signal is PROT ACTIVE GROUP, which indicates the active setting group. Protection element settings in the active group are the values being used by different protection functions.

All actual values signals corresponding to setting groups are located in the ***Actual > Status > Control Elements > Setting Groups*** menu.

5.4.2 Inverse time curve characteristics

Inverse time curves available in time overcurrent elements are as follows:

IEEE extremely/very/moderately inverse

IEC Curve A/B/C/Long-Time Inverse/ Short-Time Inverse

IAC extremely/very/normally/moderately inverse

ANSI extremely/very/normally/moderately inverse

I2t

Definite time curves

Rectifier time curves

User Curve - FlexCurve A/B/C/D

Recloser Curves

The saturation level for the user curve is 20 times the pickup value, for the rest of time overcurrent elements the saturation level is 48 times the pickup.

All these curves follow the standards defined for each of them, allowing an efficient coordination with other devices located downstream. A dial or curve setting allows selection of a tripping time X times the set time in the selected curve. Fixing this value to 0 would produce an instantaneous response for any selected curve.

Tripping time calculations are performed on the base of an internal variable called “energy”. This energy represents the system dissipation capability, that is, when 100% of energy is reached, this means that the tripping time associated with the curve for a certain current value has expired.

Therefore, once the current value has exceeded the pickup value, the relay starts increasing the energy variable value. If it reaches 100%, a trip is produced. When the current value falls below 97% of the pickup value, the element is reset. There are two reset types: Instantaneous and Timed (IEEE) or Linear.

The instantaneous mode provides that, when the current value falls below the reset level, energy is immediately reset to 0. This mode is used for coordinating with static devices, which behave in a similar way. In the Linear mode, energy is reduced at a speed associated with the reset times curve (showed in the curve tables), trying to simulate the behavior of electromechanical relays.

5.4.2.1 IEEE curves

This family of curves follows the standard IEEE C37.112-1996 for extremely inverse, very inverse, and inverse curves. The following formulas define this type of curve:

$$t = dial * \left[\frac{A}{\left(\frac{I}{Itap}\right)^p - 1} + B \right] \qquad T_{RESET} = dial * \left[\frac{t_r}{\left(\frac{I}{Itap}\right)^2 - 1} \right]$$

Where:

t = Operation time in seconds

Dial = multiplier setting

I = Input current

Itap = Current pickup value

A, B, p = constants defined by the standard

T_{RESET} = reset time in seconds

t_r = characteristic constant.

Table 5-22: Constants for IEEE curves

IEEE Curve Shape	Name	A	B	p	tr
IEEE Extremely Inverse	IEEE Ext Inv	28.2	0.1217	2.0000	29.1
IEEE Very Inverse	IEEE Very Inv	19.61	0.491	2.0000	21.6
IEEE Inverse	IEEE Mod Inv	0.0515	0.1140	0.0200	4.85

Table 5-23: Tripping time in seconds for IEEE curves

Dial	Current (I/Itap)									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
IEEE Extremely Inverse										
0.5	11.341	4.761	1.823	1.001	0.648	0.464	0.355	0.285	0.237	0.203
1.0	22.682	9.522	3.647	2.002	1.297	0.927	0.709	0.569	0.474	0.407
2.0	45.363	19.043	7.293	4.003	2.593	1.855	1.418	1.139	0.948	0.813
4.0	90.727	38.087	14.587	8.007	5.187	3.710	2.837	2.277	1.897	1.626
6.0	136.090	57.130	21.880	12.010	7.780	5.564	4.255	3.416	2.845	2.439
8.0	181.454	76.174	29.174	16.014	10.374	7.419	5.674	4.555	3.794	3.252
10.0	226.817	95.217	36.467	20.017	12.967	9.274	7.092	5.693	4.742	4.065
IEEE Very Inverse										
0.5	8.090	3.514	1.471	0.899	0.654	0.526	0.450	0.401	0.368	0.345
1.0	16.179	7.028	2.942	1.798	1.308	1.051	0.900	0.802	0.736	0.689
2.0	32.358	14.055	5.885	3.597	2.616	2.103	1.799	1.605	1.472	1.378
4.0	64.716	28.111	11.769	7.193	5.232	4.205	3.598	3.209	2.945	2.756
6.0	97.074	42.166	17.654	10.790	7.849	6.308	5.397	4.814	4.417	4.134
8.0	129.432	56.221	23.538	14.387	10.465	8.410	7.196	6.418	5.889	5.513
10.0	161.790	70.277	29.423	17.983	13.081	10.513	8.995	8.023	7.361	6.891
IEEE Inverse										
0.5	3.220	1.902	1.216	0.973	0.844	0.763	0.706	0.663	0.630	0.603
1.0	6.439	3.803	2.432	1.946	1.688	1.526	1.412	1.327	1.260	1.207
2.0	12.878	7.606	4.864	3.892	3.377	3.051	2.823	2.653	2.521	2.414
4.0	25.756	15.213	9.729	7.783	6.753	6.102	5.647	5.307	5.041	4.827
6.0	38.634	22.819	14.593	11.675	10.130	9.153	8.470	7.960	7.562	7.241
8.0	51.512	30.426	19.458	15.567	13.507	12.204	11.294	10.614	10.083	9.654
10.0	64.390	38.032	24.322	19.458	16.883	15.255	14.117	13.267	12.604	12.068

5.4.2.2 IEC curves

This family of curves follows the European standard IEC 255-4, and the British standard BF142 for IEC Curves A, B and C, IEC Long-Time Inverse and IEC Short-Time Inverse. The formulas that define these curves are as follows:

$$t = dial * \left[\frac{K}{\left(\frac{I}{Itap}\right)^{E} - 1} \right] \qquad T_{RESET} = dial * \left[\frac{t_r}{\left(\frac{I}{Itap}\right)^{2} - 1} \right]$$

Where:

t = Operation time in seconds

Dial = multiplying factor

I = Input current

Itap = Current pickup value

K, E = constants defined by the standard

T_{RESET} = reset time in seconds (assuming 100% of power capacity and that the reset is activated)

t_r = characteristic constant.

Table 5-24: Constants for IEC curves

IEC Curve Shape	Name	K	E	tr
IEC Curve A	IEC Curve A	0.140	0.020	9.7
IEC Curve B	IEC Curve B	13.500	1.000	43.2
IEC Curve C	IEC Curve C	80.000	2.000	58.2
IEC Long-Time Inverse	IEC Long-Time Inv	120.000	1.000	120.0
IEC Short-Time Inverse	IEC Short-Time Inv	0.050	0.040	0.5

Table 5-25: Tripping time in seconds for IEC curves

Dial	Current (I/Itap)									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
IEC Curve A										
0.05	0.860	0.501	0.315	0.249	0.214	0.192	0.176	0.165	0.156	0.149
0.10	1.719	1.003	0.630	0.498	0.428	0.384	0.353	0.330	0.312	0.297
0.20	3.439	2.006	1.260	0.996	0.856	0.767	0.706	0.659	0.623	0.594
0.40	6.878	4.012	2.521	1.992	1.712	1.535	1.411	1.319	1.247	1.188
0.60	10.317	6.017	3.781	2.988	2.568	2.302	2.117	1.978	1.870	1.782
0.80	13.755	8.023	5.042	3.984	3.424	3.070	2.822	2.637	2.493	2.376
1.00	17.194	10.029	6.302	4.980	4.280	3.837	3.528	3.297	3.116	2.971
IEC Curve B										
0.05	1.350	0.675	0.338	0.225	0.169	0.135	0.113	0.096	0.084	0.075
0.10	2.700	1.350	0.675	0.450	0.338	0.270	0.225	0.193	0.169	0.150
0.20	5.400	2.700	1.350	0.900	0.675	0.540	0.450	0.386	0.338	0.300
0.40	10.800	5.400	2.700	1.800	1.350	1.080	0.900	0.771	0.675	0.600
0.60	16.200	8.100	4.050	2.700	2.025	1.620	1.350	1.157	1.013	0.900
0.80	21.600	10.800	5.400	3.600	2.700	2.160	1.800	1.543	1.350	1.200

1.00	27.000	13.500	6.750	4.500	3.375	2.700	2.250	1.929	1.688	1.500
IEC Curve C										
0.05	3.200	1.333	0.500	0.267	0.167	0.114	0.083	0.063	0.050	0.040
0.10	6.400	2.667	1.000	0.533	0.333	0.229	0.167	0.127	0.100	0.081
0.20	12.800	5.333	2.000	1.067	0.667	0.457	0.333	0.254	0.200	0.162
0.40	25.600	10.667	4.000	2.133	1.333	0.914	0.667	0.508	0.400	0.323
0.60	38.400	16.000	6.000	3.200	2.000	1.371	1.000	0.762	0.600	0.485
0.80	51.200	21.333	8.000	4.267	2.667	1.829	1.333	1.016	0.800	0.646
1.00	64.000	26.667	10.000	5.333	3.333	2.286	1.667	1.270	1.000	0.808
IEC Long-Time Inverse										
0.05	12.000	6.000	3.000	2.000	1.500	1.200	1.000	0.857	0.750	0.667
0.10	24.000	12.000	6.000	4.000	3.000	2.400	2.000	1.714	1.500	1.333
0.20	48.000	24.000	12.000	8.000	6.000	4.800	4.000	3.429	3.000	2.667
0.40	96.000	48.000	24.000	16.000	12.000	9.600	8.000	6.857	6.000	5.333
0.60	144.000	72.000	36.000	24.000	18.000	14.400	12.000	10.286	9.000	8.000
0.80	192.000	96.000	48.000	32.000	24.000	19.200	16.000	13.714	12.000	10.667
1.00	240.000	120.000	60.000	40.000	30.000	24.000	20.000	17.143	15.000	13.333
IEC Short-Time Inverse										
0.05	0.153	0.089	0.056	0.044	0.038	0.034	0.031	0.029	0.027	0.026
0.10	0.306	0.178	0.111	0.088	0.075	0.067	0.062	0.058	0.054	0.052
0.20	0.612	0.356	0.223	0.175	0.150	0.135	0.124	0.115	0.109	0.104
0.40	1.223	0.711	0.445	0.351	0.301	0.269	0.247	0.231	0.218	0.207
0.60	1.835	1.067	0.668	0.526	0.451	0.404	0.371	0.346	0.327	0.311
0.80	2.446	1.423	0.890	0.702	0.602	0.538	0.494	0.461	0.435	0.415
1.00	3.058	1.778	1.113	0.877	0.752	0.673	0.618	0.576	0.544	0.518

5.4.2.3 IAC curves

This family of curves follows the time response of the General Electric IAC electromechanical relays. The following formulas define these curves:

$$t = dial * \left[A + \frac{B}{\left(\frac{I}{Itap} - C\right)} + \frac{D}{\left(\frac{I}{Itap} - C\right)^2} + \frac{E}{\left(\frac{I}{Itap} - C\right)^3} \right] \qquad T_{RESET} = dial * \left[\frac{t_r}{\left(\frac{I}{Itap}\right)^2 - 1} \right]$$

Where:

t = Operation time in seconds

Dial = multiplier setting

I = Input current

Itap = Current pickup value

A, B, C, D, E = predefined constants

T_{RESET} = reset time in seconds

t_r = characteristic constant.

Table 5-26: Constants for IAC curves

IAC Curve Shape	Name	A	B	C	D	E	tr
IAC Extremely Inverse	IAC Ext Inv	0.0040	0.6379	0.6200	1.7872	0.2461	6.008
IAC Very Inverse	IAC Very Inv	0.0900	0.7955	0.1000	-1.2885	7.9586	4.678
IAC Inverse	IAC Mod Inv	0.2078	0.8630	0.8000	-0.4180	0.1947	0.990

Table 5-27: Tripping time in seconds for IAC curves

Dial	Current (I/Itap)									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
IAC Extremely Inverse										
0.5	1.699	0.749	0.303	0.178	0.123	0.093	0.074	0.062	0.053	0.046
1.0	3.398	1.498	0.606	0.356	0.246	0.186	0.149	0.124	0.106	0.093
2.0	6.796	2.997	1.212	0.711	0.491	0.372	0.298	0.248	0.212	0.185
4.0	13.591	5.993	2.423	1.422	0.983	0.744	0.595	0.495	0.424	0.370
6.0	20.387	8.990	3.635	2.133	1.474	1.115	0.893	0.743	0.636	0.556
8.0	27.183	11.987	4.846	2.844	1.966	1.487	1.191	0.991	0.848	0.741
10.0	33.979	14.983	6.058	3.555	2.457	1.859	1.488	1.239	1.060	0.926
IAC Very Inverse										
0.5	1.451	0.656	0.269	0.172	0.133	0.113	0.101	0.093	0.087	0.083
1.0	2.901	1.312	0.537	0.343	0.266	0.227	0.202	0.186	0.174	0.165
2.0	5.802	2.624	1.075	0.687	0.533	0.453	0.405	0.372	0.349	0.331
4.0	11.605	5.248	2.150	1.374	1.065	0.906	0.810	0.745	0.698	0.662
6.0	17.407	7.872	3.225	2.061	1.598	1.359	1.215	1.117	1.046	0.992
8.0	23.209	10.497	4.299	2.747	2.131	1.813	1.620	1.490	1.395	1.323
10.0	29.012	13.121	5.374	3.434	2.663	2.266	2.025	1.862	1.744	1.654
IAC Inverse										
0.5	0.578	0.375	0.266	0.221	0.196	0.180	0.168	0.160	0.154	0.148
1.0	1.155	0.749	0.532	0.443	0.392	0.360	0.337	0.320	0.307	0.297
2.0	2.310	1.499	1.064	0.885	0.784	0.719	0.674	0.640	0.614	0.594
4.0	4.621	2.997	2.128	1.770	1.569	1.439	1.348	1.280	1.229	1.188
6.0	6.931	4.496	3.192	2.656	2.353	2.158	2.022	1.921	1.843	1.781
8.0	9.242	5.995	4.256	3.541	3.138	2.878	2.695	2.561	2.457	2.375
10.0	11.552	7.494	5.320	4.426	3.922	3.597	3.369	3.201	3.072	2.969

5.4.2.4 ANSI curves

This family of curves complies with the American Standard ANSI C37.90 for Extremely inverse, Very inverse, Normally inverse and Moderately inverse curves. The formulas that define these curves are as follows:

$$T = Dial\left[A + \frac{B}{\left(\frac{I}{Ipickup} - C\right)} + \frac{D}{\left(\frac{I}{Ipickup} - C\right)^2} + \frac{E}{\left(\frac{I}{Ipickup} - C\right)^3}\right] \qquad T_{reset} = TDM \times \left[\frac{T_r}{\left(\frac{I}{I_{pickup}}\right)^2 - 1}\right]$$

where:

T = Operation time (in seconds).

Dial = Multiplying factor

I = Input current

I_{pickup} = Current pickup setting

A, B, C, D, E = Constants

T_{reset} = Reset time (in seconds) assuming a 100% of power capacity and that the reset is activated

T_r = Characteristic constant

The different constants that define the above-mentioned curves are:

Table 5-28: Constants for ANSI curves

ANSI Curve Shape	A	B	C	D	E	Tr
ANSI Extremely Inverse	0.0399	0.2294	0.5	3.0094	0.7222	5.67
ANSI Very Inverse	0.0615	0.7989	0.34	-0.284	4.0505	3.88
ANSI Normally Inverse	0.0274	2.2614	0.3	-4.1899	9.1272	5.95
ANSI Moderately Inverse	0.1735	0.6791	0.8	-0.08	0.1271	1.08

Table 5-29: Tripping time in seconds for ANSI curves

Dial	Current (I/Itap)									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
ANSI Extremely inverse										
0.50	2.000	0.872	0.330	0.184	0.124	0.093	0.075	0.063	0.055	0.049
1.00	4.001	1.744	0.659	0.368	0.247	0.185	0.149	0.126	0.110	0.098
2.00	8.002	3.489	1.319	0.736	0.495	0.371	0.298	0.251	0.219	0.196
4.00	16.004	6.977	2.638	1.472	0.990	0.742	0.596	0.503	0.439	0.393
6.00	24.005	10.466	3.956	2.208	1.484	1.113	0.894	0.754	0.658	0.589
8.00	32.007	13.955	5.275	2.944	1.979	1.483	1.192	1.006	0.878	0.786
10.00	40.009	17.443	6.594	3.680	2.474	1.854	1.491	1.257	1.097	0.982
ANSI Very Inverse										
0.50	1.567	0.663	0.268	0.171	0.130	0.108	0.094	0.085	0.078	0.073
1.00	3.134	1.325	0.537	0.341	0.260	0.216	0.189	0.170	0.156	0.146
2.00	6.268	2.650	1.074	0.682	0.520	0.432	0.378	0.340	0.312	0.291
4.00	12.537	5.301	2.148	1.365	1.040	0.864	0.755	0.680	0.625	0.583
6.00	18.805	7.951	3.221	2.047	1.559	1.297	1.133	1.020	0.937	0.874
8.00	25.073	10.602	4.295	2.730	2.079	1.729	1.510	1.360	1.250	1.165
10.00	31.341	13.252	5.369	3.412	2.599	2.161	1.888	1.700	1.562	1.457
ANSI Normally inverse										
0.50	2.142	0.883	0.377	0.256	0.203	0.172	0.151	0.135	0.123	0.113
1.00	4.284	1.766	0.754	0.513	0.407	0.344	0.302	0.270	0.246	0.226
2.00	8.568	3.531	1.508	1.025	0.814	0.689	0.604	0.541	0.492	0.452
4.00	17.137	7.062	3.016	2.051	1.627	1.378	1.208	1.082	0.983	0.904
6.00	25.705	10.594	4.524	3.076	2.441	2.067	1.812	1.622	1.475	1.356
8.00	34.274	14.125	6.031	4.102	3.254	2.756	2.415	2.163	1.967	1.808
10.00	42.842	17.656	7.539	5.127	4.068	3.445	3.019	2.704	2.458	2.260
ANSI Moderately inverse										
0.50	0.675	0.379	0.239	0.191	0.166	0.151	0.141	0.133	0.128	0.123
1.00	1.351	0.757	0.478	0.382	0.332	0.302	0.281	0.267	0.255	0.247
2.00	2.702	1.515	0.955	0.764	0.665	0.604	0.563	0.533	0.511	0.493
4.00	5.404	3.030	1.910	1.527	1.329	1.208	1.126	1.066	1.021	0.986
6.00	8.106	4.544	2.866	2.291	1.994	1.812	1.689	1.600	1.532	1.479
8.00	10.807	6.059	3.821	3.054	2.659	2.416	2.252	2.133	2.043	1.972
10.00	13.509	7.574	4.776	3.818	3.324	3.020	2.815	2.666	2.554	2.465

5.4.2.5 I2t curves

The following formulas define this type of curves:

$$t = dial * \left[\frac{100}{\left(\frac{I}{Itap} \right)^{2}} \right] \qquad T_{RESET} = dial * \left[\frac{100}{\left(\frac{I}{Itap} \right)^{-2}} \right]$$

where:

t = Operation time in seconds

Dial = multiplier setting

I = Input current

Itap = Current pickup value

T_{RESET} = reset time in seconds

Table 5-30: Tripping time in seconds for I2t curves

Dial	Current (I/Itap)									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
0.01	0.444	0.250	0.111	0.063	0.040	0.028	0.020	0.016	0.012	0.010
0.10	4.444	2.500	1.111	0.625	0.400	0.278	0.204	0.156	0.123	0.100
1.00	44.444	25.000	11.111	6.250	4.000	2.778	2.041	1.563	1.235	1.000
10.00	444.444	250.000	111.111	62.500	40.000	27.778	20.408	15.625	12.346	10.000
100.00	4444.444	2500.000	1111.111	625.000	400.000	277.778	204.082	156.250	123.457	100.000
600.00	26666.667	15000.000	6666.667	3750.000	2400.000	1666.667	1224.490	937.500	740.741	600.000

5.4.2.6 Definite time curves

The definite time makes the element trip when the current value is maintained beyond the pickup value during a longer time period than the set value. The Dial setting allows modifying this time frame from instantaneous to 900 seconds in steps of 10 ms.

5.4.2.7 Rectifier time curves

Rectifier curves are generated from the following formulas:

$$T = TDM \times \left(\frac{45900}{\left(\frac{I}{I_{pickup}} \right)^{5{,}6} - 1} \right) \qquad T_{reset} = TDM \times \left(\frac{45900}{\left(\frac{I}{I_{pickup}} \right)^{2} - 1} \right)$$

where:

T = Operation time (in seconds).

TDM = Multiplying factor

I = Input current

I_{pickup} = Pickup current

T_{reset} = Reset time (in seconds) assuming a 100% of power capacity and that the reset is activated

5.4.2.8 User curves - FlexCurves A/B/C/D

The relay incorporates 4 user curves called User Curve A, B, C and D. The points for these curves are defined by the user. Each of the four curves has an operation characteristic (operate), defined by 80 points, and a reset characteristic, defined by 40 points. Each point is defined as a time value for each I/I_{pickup} value (number of times the pickup current) given on the table. The user can assign values between 0 and 65.535 seconds in steps of 1 ms.

The following table details the 120 points as well as the characteristic for each of them, and a blank cell where the user can write the time value when the operation (for $I > I_{pickup}$) or the reset (for $I < I_{pickup}$) is required,

Table 5-31: User curve characteristics

RESET (xPKP)	Time (s)	RESET (xPKP)	Time (s)	OPERATE (xPKP)	Time (s)	OPERATE (xPKP)	Time (s)	OPERATE (xPKP)	Time (s)	OPERATE (xPKP)	Time (s)
0.00		0.68		1.03		2.9		4.9		10.5	
0.05		0.70		1.05		3.0		5.0		11.0	
0.10		0.72		1.1		3.1		5.1		11.5	
0.15		0.74		1.2		3.2		5.2		12.0	
0.20		0.76		1.3		3.3		5.3		12.5	
0.25		0.78		1.4		3.4		5.4		13.0	
0.30		0.80		1.5		3.5		5.5		13.5	
0.35		0.82		1.6		3.6		5.6		14.0	
0.40		0.84		1.7		3.7		5.7		14.5	
0.45		0.86		1.8		3.8		5.8		15.0	
0.48		0.88		1.9		3.9		5.9		15.5	
0.50		0.90		2.0		4.0		6.0		16.0	
0.52		0.91		2.1		4.1		6.5		16.5	
0.54		0.92		2.2		4.2		7.0		17.0	
0.56		0.93		2.3		4.3		7.5		17.5	
0.58		0.94		2.4		4.4		8.0		18.0	
0.60		0.95		2.5		4.5		8.5		18.5	
0.62		0.96		2.6		4.6		9.0		19.0	
0.64		0.97		2.7		4.7		9.5		19.5	
0.66		0.98		2.8		4.8		10.0		20.0	

The two first columns (40 points) correspond to the RESET curve. The other 4 columns, with 80 points in total, correspond to the OPERATE curve. The reset characteristic values are between 0 and 0.98, and the operation values are between 1.03 and 20.

The final curve is created by means of a linear interpolation from the points defined by the user. This is a separate process for the RESET and the OPERATE curve.

The definition of these points is performed in a separate module from the relay, using a configuration program included in the EnerVista 650 Setup, which incorporates a graphical environment for viewing the curve, thus making it easy for the user to create it. This module can be accessed from the “Edit Curve” option in the FlexCurve menu, at ***Setpoint > System Setup > Flex Curves***.

5.4.3 Phase current

The R650 Phase current menu incorporates the following overcurrent elements:

Phase time overcurrent (51PH/51PL)

Phase instantaneous overcurrent (50PH/50PL)

Phase directional overcurrent (67P)

Thermal Model (49)

5.4.3.1 Phase time delayed overcurrent elements – phase high/low (51PH/51PL)

The phase overcurrent element (51P) can be configured in Enervista 650 Setup at **Setpoint > Protection Element > Setting Group X > Phase Current**.

Table 5-32: Phase time overcurrent settings

SETPOINT> PROTECTION ELEMENT> SETTING GROUP X > Phase Current > > Phase TOC High > Phase TOC High 1> Phase TOC High 2 > Phase TOC High 3 > Phase TOC Low > Phase TOC Low 1 > Phase TOC Low 2 > Phase TOC Low 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]
Pickup level	Pickup Level	1.00	0.01 x CT	[0.5 : 20.00]
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]
Voltage Restraint	Voltage Restraint	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The phase overcurrent element (51P) operates in a time period that depends on the applied current and on the set curve. Possible outputs for the protection element logic are the pickup and tripping signals independent for each phase, and the general element pickup and tripping signals.

Function: This setting allows enabling or disabling the corresponding directional element.

Input: The phase current input may be selected as fundamental phasor magnitude or total waveform RMS magnitude as required by the application.

Pickup Level: This setting allows selecting the current level for the Phase Time Overcurrent element to operate. The PICKUP setting of the element can be dynamically reduced by a VOLTAGE RESTRAINT feature

Curve: This setting allows to select the curve that want to be use to operate this element. If the element Curve is set as Definite Time, then the TD Multiplier setting is used to define both the Operation time and, in case of selecting Linear reset, the Reset time of the element.

TD Multiplier: This setting allows the curve to be shifted up or down on the time-current characteristic curve. This allows configuration of the relay depending on network selectivity

Reset: The element reset can be selected between Instantaneous and Linear (timed according to the corresponding equation).

Voltage Restraint: As mention above, the pickup current magnitude can be dynamically reduced depending on the existing voltage value. This is done using the Voltage Restraint setting. The pickup current level is proportional to the phase-to-phase voltage measured according to a coefficient shown on Figure 5–5:.This is accomplished via the multipliers (Mvr) corresponding to the phase-phase voltages of the voltage restraint characteristic curve; the pickup level is calculated as 'Mvr' times the 'Pickup' setting. In the figure, Vpp is the phase-to-phase voltage, and VT Nominal is the rated voltage set under General settings (refer to section 5.3.1)

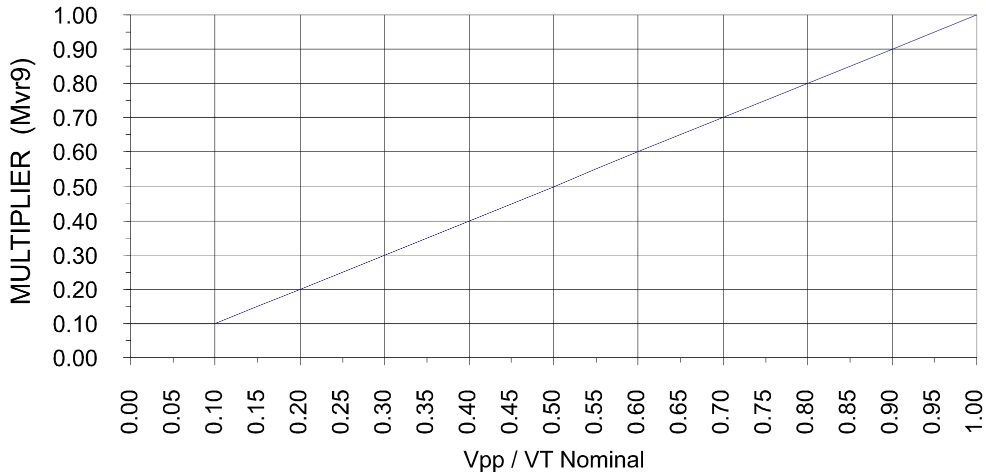


Figure 5-12: Voltage restraint characteristics

If the voltage restraint feature is disabled, the pickup level always remains at the value set in the Pickup Level setting.

Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for the phase directional elements.

Phase time delayed overcurrent element is an independent Protection element that provides block and Operation signals for each phase. Block signal status can be monitored through the relay HMI or using EnerVista 650 Setup at ***Actual > Status > Protection > Protection*** Block and Operation Signal status at ***Actual > Status > Protection > Phase Current***

The element incorporates independent block inputs for each phase. Block signals indicate blocked elements by an external block input. When a particular signal is activated, the element is blocked. These inputs can be configured using Enervista 650 setup at Setpoint>Relay Configuration>Protection elements

Table 5-33: Block signal for the phase time delayed overcurrent element

BLOCK SIGNALS FOR 51P
PH TOC1 HIGH A BLK
PH TOC1 HIGH B BLK
PH TOC1 HIGH C BLK
PH TOC2 HIGH A BLK
PH TOC2 HIGH B BLK
PH TOC2 HIGH C BLK
PH TOC3 HIGH A BLK
PH TOC3 HIGH B BLK
PH TOC3 HIGH C BLK

When the element is blocked, the tripping time counter is reset to 0. This feature allows the use of this input to instantaneously reset the protection element timing

The following diagram shows the logic scheme followed by high range and low range time overcurrent elements (51PH and 51PL.

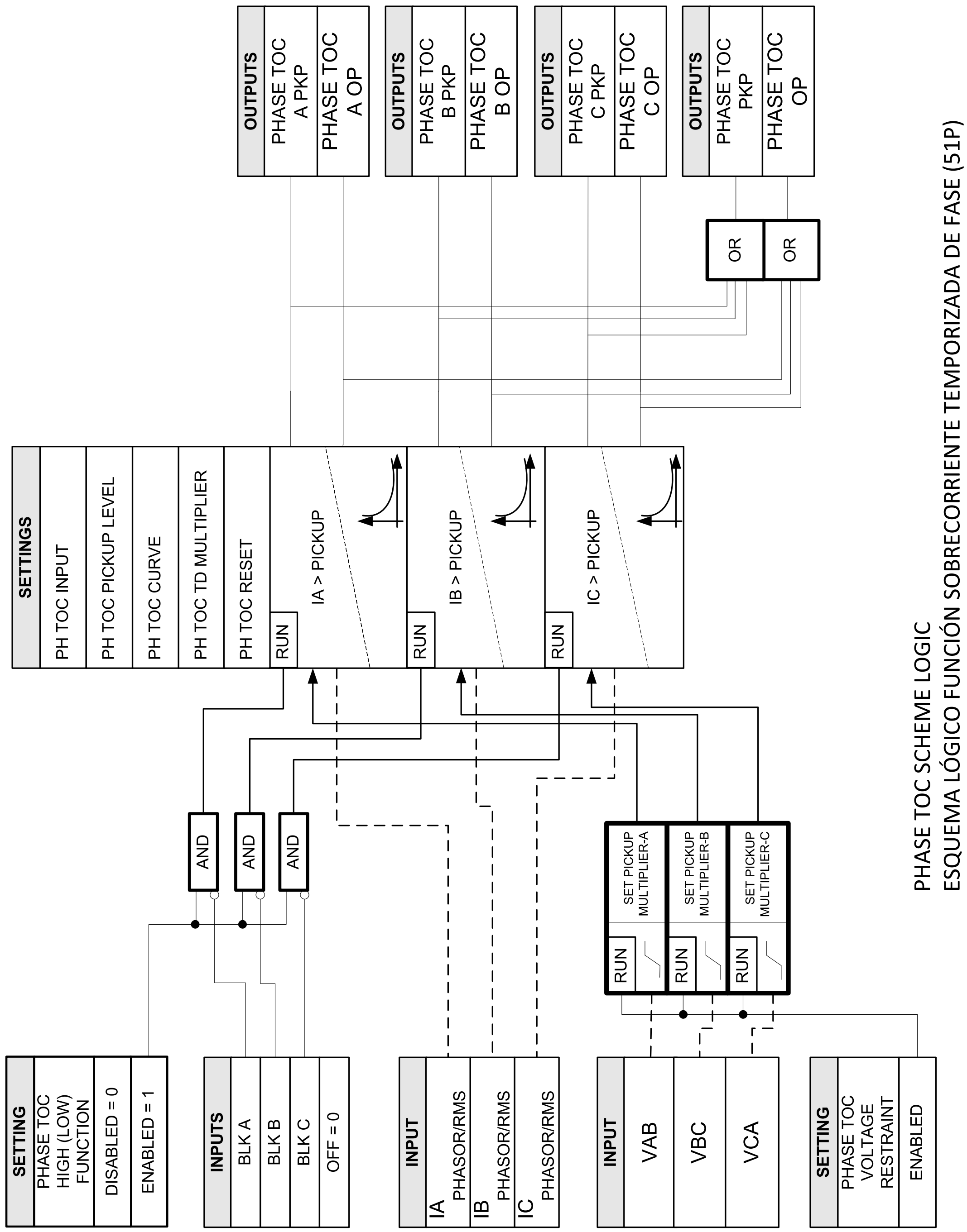


Figure 5-13: TOC element logic scheme (A6632F2)

5.4.3.2 Phase instantaneous overcurrent element- phase high/low (50PH/ 50PL)

The Phase instantaneous overcurrent element has a setting range from 0.05 x CT to 20.00 x CT. It can be set as instantaneous or timed, with the timer selectable between 0.00 and 900 seconds. The input quantities may be chosen as Fundamental phasor magnitude or RMS magnitude as required by the application. The element incorporates a reset time selectable between 0 and 900 seconds.

This element also incorporates a block input for disabling the pickup and trip signals. The logic outputs for the element are the pickup and trip flags, independent for each phase, and general pickup and trip flags.

SETPOINT> PROTECTION ELEMENTS> SETPOINT GROUP X> Phase Current > > Phase IOC High > Phase IOC High 1> Phase IOC High 2 > Phase IOC High 3 > Phase IOC Low > Phase IOC Low 1 > Phase IOC Low 2 > Phase IOC Low 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]
Pickup level	Pickup Level	1.00	0.01 x CT	[0.05 : 20.00]
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for these elements.

The following figure shows the logic scheme diagram for high range and low range Instantaneous overcurrent elements (50PH, 50PL).

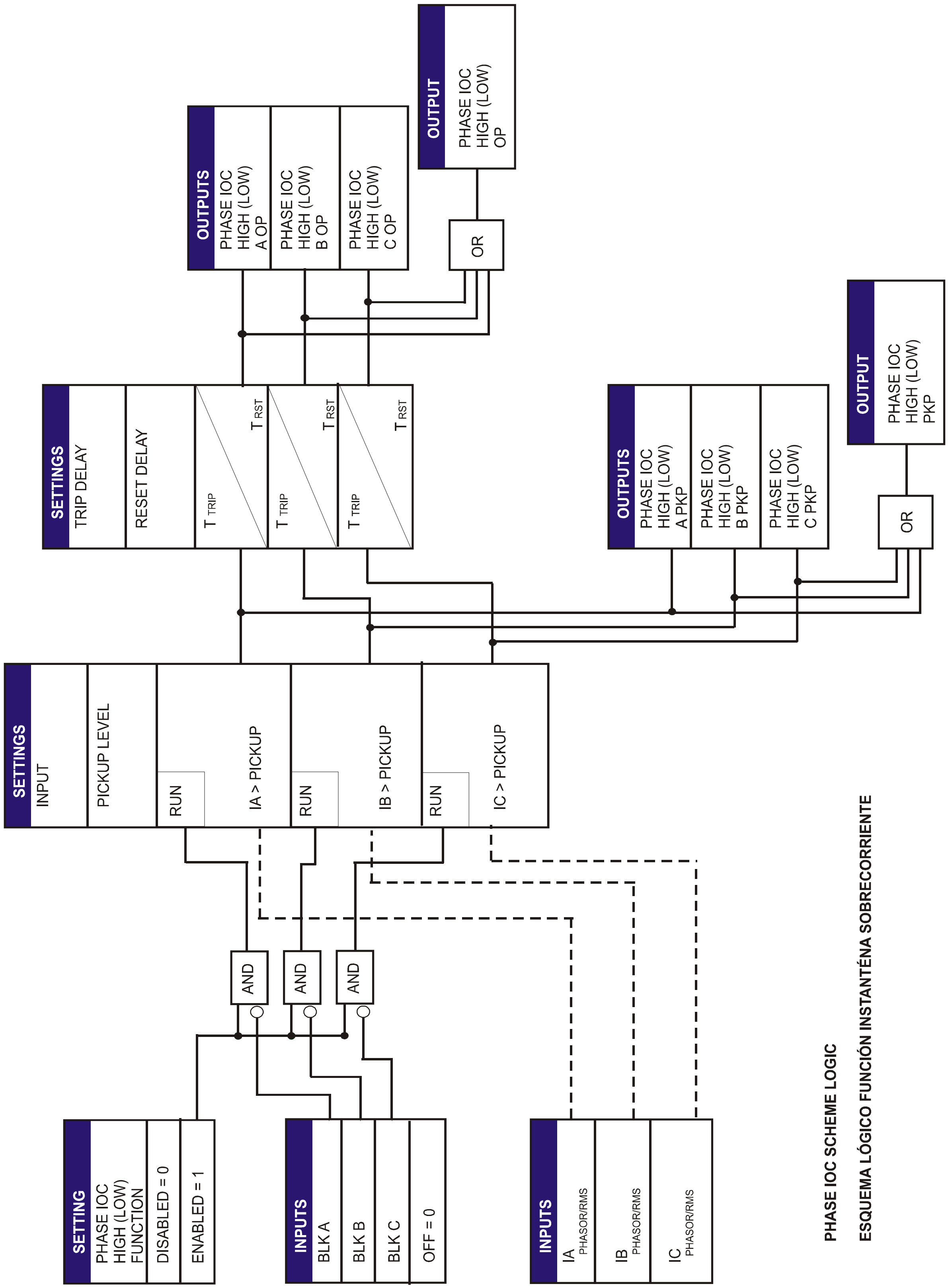


Figure 5-14: Phase IOC elements logic scheme (A6632F1)

5.4.3.3 Phase directional element (67P)

The Phase directional element (67P) provides independent elements for each phase, and determines the direction of the current both in permanence and in fault condition.

Its main function is to apply a blocking signal to the overcurrent elements to prevent their operation when the current is flowing in a certain direction. In order to determine the direction of the current, the element uses phase current values as operation magnitude, and phase-to-phase voltage values as polarization magnitude. This means that in order to polarize a phase, we use the phase-to-phase voltage of the other two phases, known as crossed polarization. To increase security for three phase faults very close to the VTs used to measure the polarizing voltage, a voltage memory feature is incorporated. This feature remembers the measurement of the polarizing voltage 3 cycles back from the moment when the voltage has collapsed below the “polarizing voltage threshold”, and uses it to determine direction. The voltage memory remains valid for a maximum of 3 seconds after the voltage has collapsed. This time is configurable.

The following table describes the phase directional element settings.

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > SETPOINT GROUP X > Phase Current > Phase Directional > Phase Directional 1> Phase Directional 2 > Phase Directional 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Maximum Torque Angle	MTA	45°	1 Deg	[-90 : +90]
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]
Block logic	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]
Polarization voltage threshold	Pol V Threshold	0.10	0.01 x VT	[0 : 1.25]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]
Voltage Memory Time	Voltage Memory time	0,00	s	[0,00: 3,00]

Function: This setting allows enabling or disabling the corresponding directional element.

MTA: The MTA setting corresponds to the Torque angle, which is the rotation applied to phase-to-phase crossed voltage.

Direction: This setting allows selecting the area for the directional element to operate, either forward or reverse.

Block Logic: This setting allows selecting either permission or block, depending on the logic to be applied upon expiration of voltage memory.

Polarization Voltage Threshold: This is the minimum voltage considered for the direction calculation. Under this setting, memory voltage is used.

Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for the phase directional elements.

Voltage Memory Time: This is the time voltage memory is considered as valid and used for direction calculation when polarization voltage collapses.

Phase directional element is an independent Protection element that provides block and Operation signals for each phase. These signals can be monitored both through the relay HMI or using EnerVista 650 Setup at “***Actual > Status > Protection > Phase Current***”

Table 5-34: Block and operation signals for the phase directional element

BLOCK AND OPERATION FOR 67P
PHASE DIR1 BLOCK A
PHASE DIR1 A OP
PHASE DIR1 BLOCK B
PHASE DIR1 B OP
PHASE DIR1 BLOCK C
PHASE DIR1 C OP
PHASE DIR2 BLOCK A
PHASE DIR2 A OP
PHASE DIR2 BLOCK B
PHASE DIR2 B OP
PHASE DIR2 BLOCK C
PHASE DIR2 C OP
PHASE DIR3 BLOCK A
PHASE DIR3 A OP
PHASE DIR3 BLOCK B
PHASE DIR3 B OP
PHASE DIR3 BLOCK C
PHASE DIR3 C OP

Signals provided by the directional element are, block and operation signals. Signals used to block overcurrent elements are configured at ***Setpoint > Relay Configuration > Protection Elements.***

Operation signals are active when operation and polarization magnitudes meet conditions given by the settings.

Block signals indicate blocked elements by an external block input or by polarization voltage loss after voltage memorize time elapses. Using the "Block logic" setting, the user can select how the directional element responds in case of a block. When the "Block" option is selected, the operational signal is not activated in a block condition. When the "Permission" option is selected, the operation signal is activated in a block condition.

Figure 5-15: Overcurrent elements block configuration by the directional element shows the default configuration for the phase overcurrent block input. When the "Block logic" setting is set as "Block", this input is active in case of a block in the directional element, avoiding any phase overcurrent trip.

When the "Block logic" setting is set as "Permission", the phase overcurrent element is enabled to trip as the block input is not active in case of polarization voltage memory expiration.

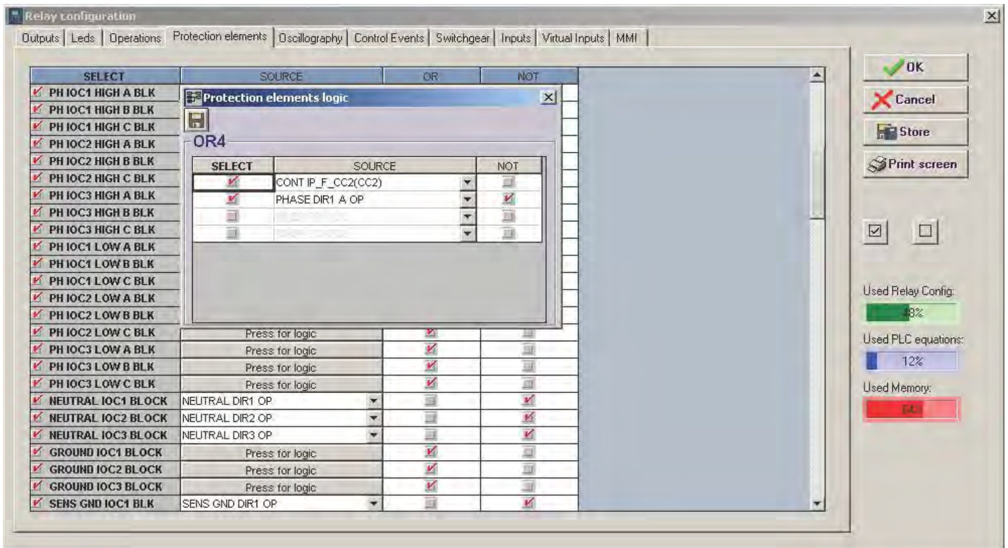


Figure 5-15: Overcurrent elements block configuration by the directional element

Directional elements can also be blocked with signals coming from other relays, PLCs, or through signals configured in the relay PLC Editor (Logic configuration tool). The signal used in that case is PHASE DIR BLK INP. Figure 5-16: Directional element block configuration by input shows an example of the default block configuration of directional elements by digital input. There is one block signal per input for each setting group.

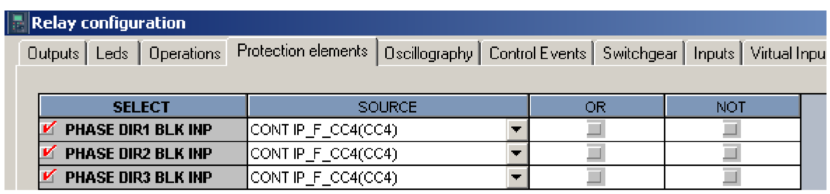


Figure 5-16: Directional element block configuration by input

The main component of the phase directional element is the angle comparator with two inputs: the operation magnitude (phase current) and the polarization magnitude (phase-to-phase voltage rotated the angle set in MTA setting), which is the torque angle.

The Polarization type used in the directional element is crossed, this means that in case of a fault in phase A, the Operation magnitude is Ia, and the polarization magnitude is Vbc, rotated by the torque angle. In case of a fault in phase B, the operation magnitude is Ib, and the polarization magnitude is Vca rotated by the torque angle. Finally, in case of a fault in phase C, the operation magnitudes is Ic, and Vab.

Table 5-35: Operation and polarization magnitudes for directional units

		POLARIZING SIGNAL VPOL	
PHASE	OPERATING SIGNAL	ABC PHASE SEQUENCE	ACB PHASE SEQUENCE
A	IA angle	VBC angle x 1 MTA	VCB angle x 1 MTA
B	IB angle	VCA angle x 1 MTA	VAC angle x 1 MTA
C	IC angle	VAB angle x 1 MTA	VBA angle x 1 MTA

The polarization diagram is as follows:

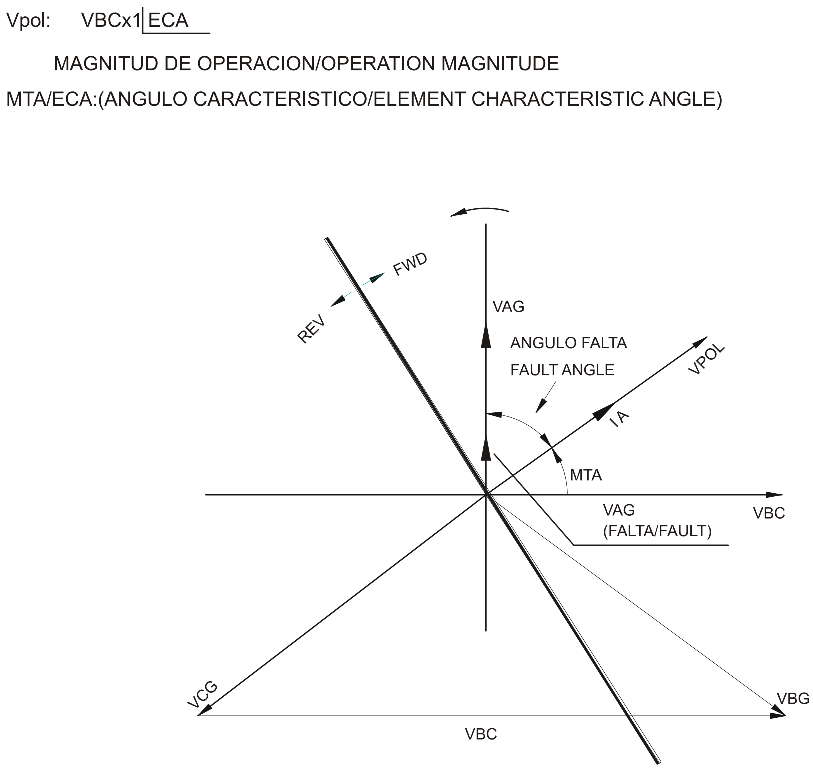
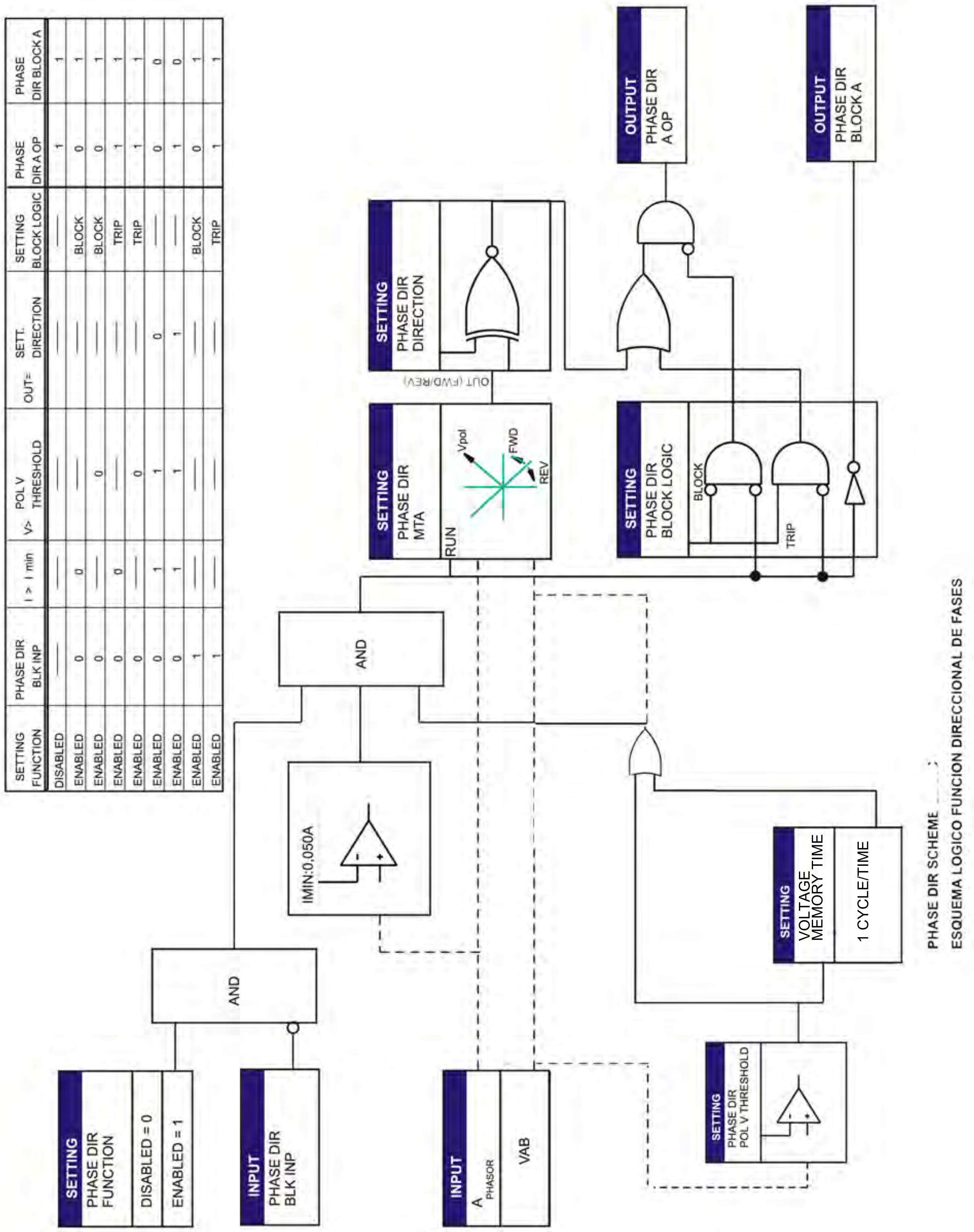


Figure 5-17: Polarization diagram

The diagram shows a fault in phase A, therefore the Operation magnitude is IA, the polarization magnitude is VBC, which has been rotated the torque angle set as ***MTA***. Positive angles are considered as counter clockwise rotations, and negative angles clockwise rotations. Direction is considered to be forward when the fault current is inside an arc of ±90° to both sides of the polarization voltage. In the directional element settings there is a ***Direction*** setting that allows to select in which area the element operation is allowed, either forward or reverse. Operation areas include a safety zone of 5° to each side of the cone. This safety cone is applied when the operation direction calculation is performed from initial block conditions. When we go from a non-trip area to a trip area, the safety cone is considered.When going from a trip area to a non-trip area, this cone is not considered, and the whole area is operative. This safety cone is always located in the operation area, both in forward and reverse cases.

NOTE: In situations where a current inversion is produced during a fault, the phase directional element requires a period of time to establish the blocking signal. This time is approximately 20 ms. Certain instantaneous overcurrent elements can be activated before receiving the blocking signal from the directional element. In cases where these situations can be expected, we recommend to add a 50ms delay to IOC elements.

The following figure shows the logic scheme for the phase directional element.



SETTING FUNCTION	PHASE DIR BLK INP	I > I min	V> POL V THRESHOLD	OUT= SETT. DIRECTION	SETTING BLOCK LOGIC	PHASE DIR A OP	PHASE DIR BLOCK A
DISABLED	—	—	—	—	—	1	1
ENABLED	0	0	—	—	BLOCK	0	1
ENABLED	0	—	0	—	BLOCK	0	1
ENABLED	0	0	—	—	TRIP	1	1
ENABLED	0	—	0	—	TRIP	1	1
ENABLED	0	1	1	0	—	0	0
ENABLED	0	1	1	1	—	1	0
ENABLED	1	—	—	—	BLOCK	0	1
ENABLED	1	—	—	—	TRIP	1	1

Figure 5-18: Directional element logic scheme (A6632F3)

5.4.3.4 Thermal model element (49)

Thermal model is a protection element that calculates the thermal heating generated as a result of the flowing current, and prevents this heating from causing damage to the protected equipment. In order to calculate the tripping time, the following equation is used:

$$t = \tau * Ln \frac{I'^2}{I'^2 - 1}$$

Where,

t is the heating/cooling time constant.

I' is the ratio current/pickup

Table 5-36: Thermal model element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X Phase Current > Thermal Model > Thermal Model 1> Thermal Model 2 > Thermal Model 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Heating time constant	Heat Time Constant	6.0	0.1 min	[3.0 : 600.0]
Cooling time constant	Cool Time Constant	2.00	0.01 times Heat Time	[1.00 : 6.00]
Pickup level	Pickup Level	1.00	0.01 x CT	[0.05 : 20.00]
Alarm level	Alarm Level	80.0	0.1 %	[1.0 : 110.0]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The cooling constant is given in times the heating constant.

The snapshot event setting enables or disables the snapshot event generation for the thermal model elements.

5.4.4 Neutral current

The Neutral Current menu incorporates the following overcurrent elements:

- Neutral time overcurrent (51N)
- Neutral instantaneous overcurrent (50N)
- Neutral directional element (67N)

5.4.4.1 Neutral time-delayed overcurrent element (51N)

Neutral TOC is a neutral time delayed overcurrent protection element. This element uses as the input quantity the **neutral current, calculated from the phase currents**. The trip can be timed by a curve selectable by setting. The reset can be instantaneous or linear.

Table 5-37: Neutral TOC element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Neutral Current > Neutral TOC Neutral TOC 1> Neutral TOC 2 > Neutral TOC 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup level	Pickup Level	1.00	0.01 x CT	[0.05 : 20.00]
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.4.2 Neutral instantaneous overcurrent element (50N)

This function can be used as an instantaneous element or as a definite time element. The element responds to the neutral current, calculated from phase currents.

Table 5-38: Neutral IOC element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Neutral Current > Neutral IOC Neutral IOC 1> Neutral IOC 2 > Neutral IOC 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup level	Pickup Level	1.00	0.01 x CT	[0.05 : 20.00]
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

The following figure shows the logic scheme for the neutral Instantaneous overcurrent element.

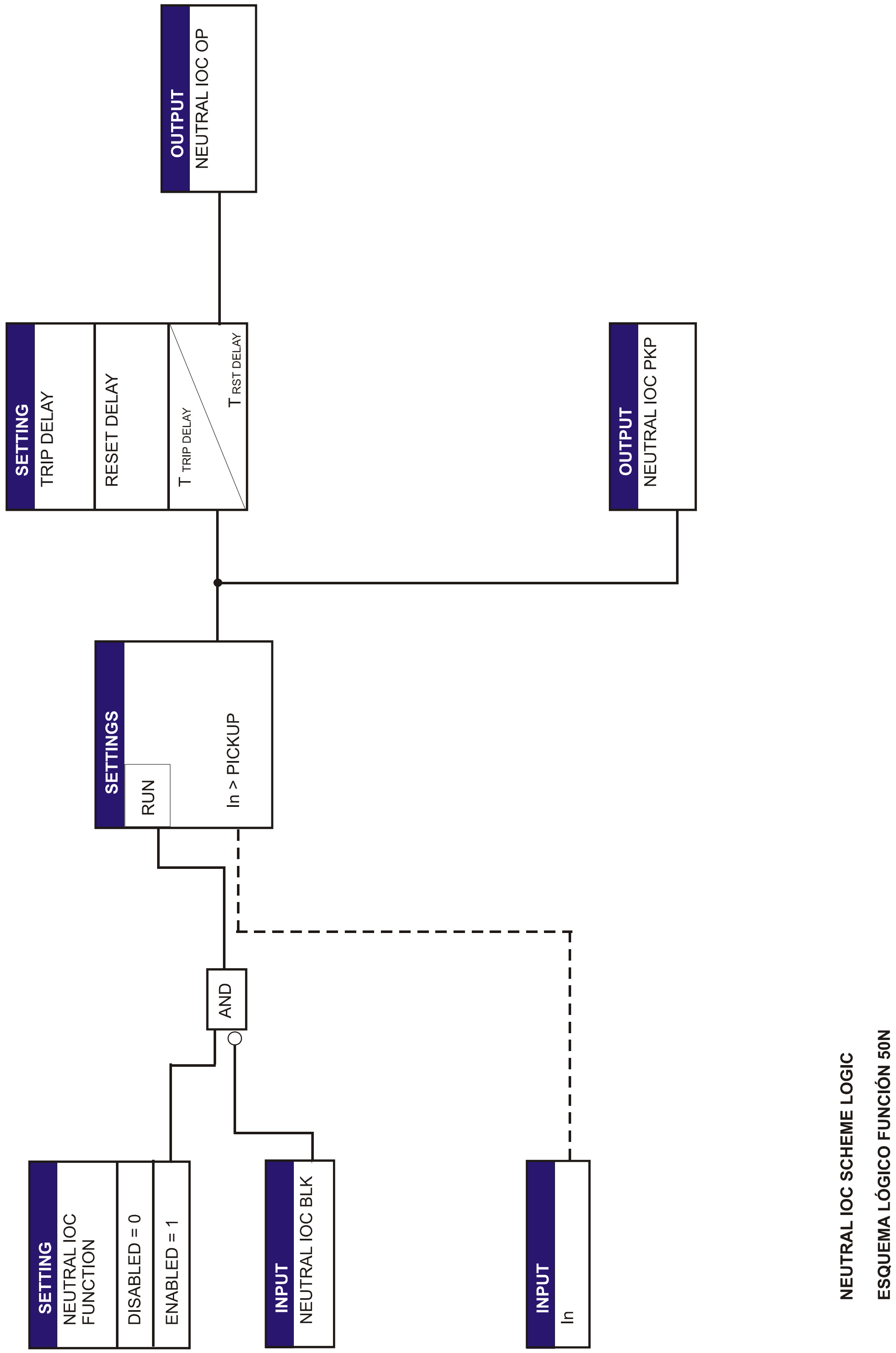


Figure 5-19: LOGIC SCHEME FOR NEUTRAL IOC element

5.4.4.3 Neutral directional element (67N)

The Neutral directional element is used for supervising the neutral (3I0) overcurrent elements. This element can be set to use either the neutral voltage, or the polarization current measured by the 5th current input (Ip), or both as polarization magnitude.

Table 5-39: 67N element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Neutral Current > Neutral Directional > Neutral Directional 1> Neutral Directional 2 > Neutral Directional 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]
Polarization type	Polarization	VO	N/A	[V_0 – I_P – V_0+I_P – V_0*I_P]
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]
Polarization voltage threshold	Pol V Threshold	0.10	0.01 x VT	[0.00 : 1.25]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Settings for this element are:

Maximum Torque Angle (MTA): Angle used to rotate the polarization voltage. Positive angles are counter clockwise rotations, and negative angles are clockwise rotations. The polarization magnitude, once rotated, defines the MTA line. Vn rotated by this angle points to the semi plane that corresponds to a Reverse fault. -Vn rotated this angle points to the semi plane that corresponds to a Forward fault. A typical setting can be –45°.

Directional element direction (Direction): This setting indicates the Direction for which the element allows a trip. Depending on this setting, the element is activated for faults in the forward direction, or ion the reverse direction, allowing its use in tripping or blocking schemes. Possible options for this setting are FORWARD and REVERSE.

Polarization type (Polarization): This setting indicates the type of Polarization to be used. The relay can use voltage polarization (V0), and/or current polarization (Ip). Possible setting values are:

- **V0** Voltage polarization
- **Ip** Current polarization
- **V0 + Ip** Voltage or current polarization. This allows the element to operate when any of the polarization magnitudes allow operation.
- **V0 * Ip** Voltage and current polarization. This allows the element to operate when both polarization magnitudes allow operation.

If the selected polarization type is V0+Ip, then the relay operates when any of the polarization magnitudes indicate the selected direction in the Direction setting.

If the selected polarization type is V0*Ip, then the relay only operates when both polarization magnitudes indicate the selected direction in the Direction setting.

Polarization Voltage Threshold This is the minimum voltage considered for the direction calculation. Under this setting, the element is blocked.

Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for this elements.

The Neutral directional element is an independent Protection element that provides Block and Operation signals. These signals can be monitored both through the relay HMI or using EnerVista 650 Setup at "***Actual > Status > Protection > Neutral Current***"

67N Block (NEUTRAL DIR BLOCK): It indicates that the element is blocked by digital input or because the Operation magnitude (In current), or the Polarization magnitude (Vn voltage and/or Ip current) level is too low.

67N Operation (NEUTRAL DIR OP): It indicates that the directional element is giving permission, that the angle relations between the operation magnitude and the polarization magnitude are met, according to the set conditions, or in case of having selected Permission in the Block Logic setting, it indicates that the element allows operation under block conditions.

Table 5-40: Signals for the neutral directional element

NEUTRAL DIRECTIONAL
NEUTRAL DIR1 BLOCK
NEUTRAL DIR1 OP
NEUTRAL DIR2 BLOCK
NEUTRAL DIR2 OP
NEUTRAL DIR3 BLOCK
NEUTRAL DIR3 OP

5.4.4.4 Voltage polarization operation principles

Operation Magnitude: In = 3·Io, calculated from the phase currents.

Polarization Magnitude: $-3V_0$. Calculated from the phase voltages or measured at the input terminals (A11, A12).The relay measures $3V_0$ and rotates 180º internally to obtain $-3V_0$.

shows the operation of the zero sequence polarization, $3V_0$, in case of an AG fault. In this case, the polarization magnitude $3V_0$ can be calculated from the three phase voltage values, or measured through the fourth voltage input (Vx). In this last case, the voltage transformer must be wye connected, and the ***Auxiliary Voltage*** setting in ***General settings*** must be configured as VX. The operation magnitude I_n, is calculated from the phase currents.

When Ip Polarization is selected, the Polarization magnitude is Ip, this current value measured at the fifth current input (terminals B11-B12). This polarization current usually comes from a CT measuring the current flow from the ground to the neutral of the neutral fault current source, which is usually a transformer. The direction is considered to be ***Forward*** when the neutral current I_n is inside a ±90º arc at both sides of the polarization current. In any other case, the direction is ***Reverse***. If the polarization current is lower than 5 mA, the element output takes the value of the ***Block Logic*** setting. See Figure 5-20: Voltage polarization.

Figure 5-20: Voltage polarization shows the Operation of the directional element for a Phase A to Ground fault, where the Phase A current grows in magnitude and is delayed with respect to its voltage by an angle similar to the protected line. Va voltage decreases or can even disappear if the fault is close and the fault resistance is very low.

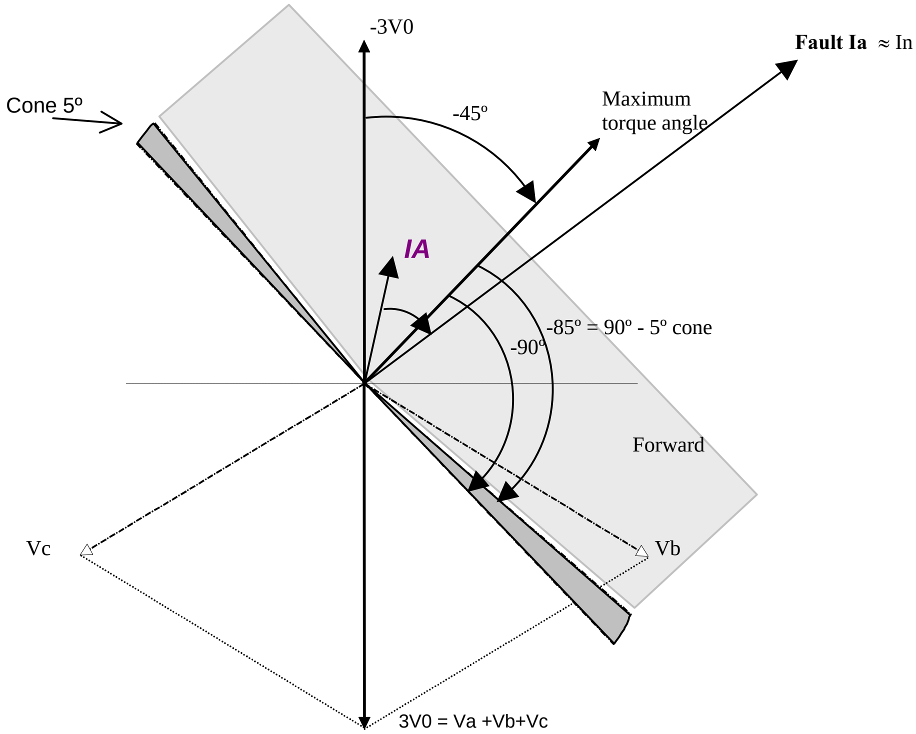


Figure 5-20: Voltage polarization

The voltage polarization algorithm uses –Vn, -(Va+Vb+Vc) = -3·V_0, as a substitute for the faulted phase voltage. This magnitude can be rotated by the desired angle to fix the MTA line and to define the operative semi plane of the relay, following the rule that positive angles are in counter clockwise direction. A typical setting is –45°, as shown on the figure. The operative semi plane is delimited to ± 85° of the MTA line. Every time the operation magnitude, In, is inside this semi plane, the element considers the direction to be forward. If the ***Direction*** setting is set as ***Forward***, the operation signal of the neutral directional element (NEUTRAL DIR OP) is activated.

Minimum acceptable values, both for the polarization magnitude and the operation magnitude are as follows: minimum In current for the element to operate is 50 mA. Minimum polarization voltage for the element to operate is set in the ***Polarization Voltage Threshold*** setting. Minimum polarization current (Ip) is 5 mA.

The voltage polarized directional element needs a typical time of 1 cycle (20ms @ 50Hz) to polarize. This time must be considered when setting the overcurrent elements with the ***Block Logic*** setting as ***Permission***. This may cause, especially in testing processes, the relay to trip with counter direction faults when voltage and current are applied at the same time starting from zero. As there is no previous polarization voltage, the overcurrent element is ready to trip under any overcurrent (as set in the ***Block Logic*** setting), while the directional element needs a complete cycle to polarize and give the correct direction. If the current is high enough to pickup the overcurrent element and there is no set time delay, the element trips before the directional element blocks the trip. In cases where this situation is foreseen, it is recommended to program the ***Block Logic*** setting as ***Block***, or else to add a small time delay to the overcurrent element to allow the directional element to polarize and block the trip.

5.4.4.5 Current polarization operation principles:

Operation Magnitude: In = calculated from phase currents.

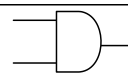
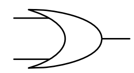
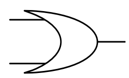
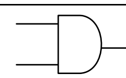
Polarization Magnitude: Ip, measured at input terminals B11-B12.

To perform a directional comparison by current, the polarization magnitude used is the current measured at the relay Ip input, terminals B11-B12, with input or "positive" in B11. This current is taken from the source (transformer or generator) neutral grounding.

Direction is considered to be forward when the phase shift between both magnitudes is lower than 85º. If the angle is higher than 85º, the fault is considered to be reverse.

The following table shows the element's output signals management (block and permission) depending on the polarization type setting.

Table 5-41: Output signals management according to polarization type setting

POLARIZATION setting	NEUTRAL DIR BLOCK SIGNAL	NEUTRAL DIR OP SIGNAL
Vo	Vo < POL V THRESHOLD setting	Permission Vo
Ip	Ip < 5 mA	Permission Ip
Vo + Ip	Vo < POL V THRESHOLD Ip < 5 mA 	Permission Vo Permission Ip 
Vo * Ip	Vo < POL V THRESHOLD Ip < 5 mA 	Permission Vo Permission Ip 

Configuration of the required signals for blocking the neutral overcurrent elements from the signals provided by the neutral directional elements is performed at ***Setpoint > Relay Configuration > Protection Elements*** using the inverted operation signals to block the trip, as shown in the following example:

How to block neutral time overcurrent elements with neutral directional functions:

NEUTRAL TOC1 BLOCK = NOT (NEUTRAL DIR1 OP)

NEUTRAL TOC2 BLOCK = NOT (NEUTRAL DIR2 OP)

NEUTRAL TOC3 BLOCK = NOT (NEUTRAL DIR3 OP)

To block neutral instantaneous elements:

NEUTRAL IOC1 BLOCK = NOT (NEUTRAL DIR1 OP)

NEUTRAL IOC2 BLOCK = NOT (NEUTRAL DIR2 OP)

NEUTRAL IOC3 BLOCK = NOT (NEUTRAL DIR3 OP)

Table 5-42: Quantities

POLARIZING MODE	DIRECTION	COMPARED PHASORS	
VOLTAGE (Vo)	FORWARD	-Vo	Io x 1 MTA
	REVERSE	-Vo	-Io x 1 MTA
CURRENT (Ip)	FORWARD	Isg	Io
	REVERSE	Isg	-Io
Vo + Ip	FORWARD	- Vo	Io
		or	
		Isg	Io
	REVERSE	- Vo	-Io
		or	
		Isg	-Io
Vo * Ip	FORWARD	- Vo	Io
		and	
		Isg	Io
	REVERSE	- Vo	-Io
		and	
		Isg	-Io

5.4.5 Ground current

The Ground Current menu incorporates the following overcurrent elements:

Ground time overcurrent (51G)

Ground instantaneous overcurrent (50G)

Ground directional element (67G)

5.4.5.1 Ground time-delayed overcurrent element (51G)

Ground TOC is a ground time delayed overcurrent protection element. The ground current is measured from the ground input, terminals B9-B10, and it may be programmed as Fundamental phasor magnitude or RMS magnitude as required by the application. The element trip can be time delayed using a selectable curve. It incorporates a reset time that is selectable between instantaneous or linear.

Table 5-43: 51G element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Ground Current > Ground TOC Ground TOC 1> Ground TOC 2 > Ground TOC 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]
Pickup level	Pickup Level	1.00	0.01 x CTg	[0.05 : 20.00]
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.5.2 Ground instantaneous overcurrent element (50G)

Ground IOC is a ground instantaneous overcurrent protection element, with a setting range from 0.05 x CTg to 20.00 x CTg, which can also be time delayed. The delay is selectable between 0.00 and 900 seconds. The ground current input quantity is measured from the ground input, and it may be programmed as Fundamental phasor magnitude or RMS magnitude as required by the application. The element incorporates a reset time selectable between 0 and 900 seconds, and a block input that resets the pickup and trip signals to 0. The element outputs are the general pickup and trip signals of the element.

Table 5-44: 50G element settingS

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Ground Current > Ground IOC Ground IOC 1> Ground IOC 2 > Ground IOC 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]
Pickup level	Pickup Level	1.00	0.01 x CTg	[0.05 : 20.00]
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.5.3 Ground directional element (67G)

Ground directional is a directional protection element, used for monitoring the ground overcurrent elements. The operation magnitude is the ground current measured directly from the corresponding input (B9-B10), while the polarization magnitude is the neutral voltage (V_n). The neutral voltage is calculated from the three phase voltages or measured from the dedicated voltage input (A11-A12).

In case of using the voltage measured from the dedicated voltage input terminals, the ***Auxiliary Voltage*** setting in ***General settings*** must be ***V_N***.

If the R650 is set to have synchronism check protection, then this input is adjusted as busbar voltage and it will not be the 3V0 voltage* (AUXILIARY VOLTAGE *setting as VX)

If the R650 does not have a synchronism check element, then this input can be set as I_n neutral voltage, and it can be used as polarization magnitude for the 67G element* (AUXILIARY VOLTAGE *setting as VN).

As in the case of a phase directional element, this element incorporates a voltage loss logic that allows blocking or permitting the trip by means of a setting.

Table 5-45: 67G element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Ground Current > Ground Directional > Ground Directional 1> Ground Directional 2 > Ground Directional 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]
Polarization type	Polarization	VO	N/A	[V_0 – I_P – V_0+I_P – V_0*I_P]
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]
Polarization voltage threshold	Pol V Threshold	10	1 V	[0 : 300]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Operation of the Ground directional element 67G is similar to the operation of the neutral directional element 67N (refer to section 5.4.4.3 Neutral directional element (67N)), with the exception that the operation magnitude here is the ground current Ig (67G), measured from the input terminals B9-B10 instead of the Neutral current, In (67N), calculated from the phase currents.

Polarization magnitudes can be, as in the case of 67N, Polarization voltage (3Vo), either calculated from the phase voltages or measured from terminals A11-A12, or polarization current (Ip), measured from the fifth input transformer terminals, Isg, terminals B11-B12.

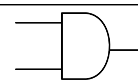
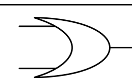
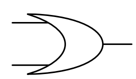
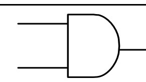
The following table shows the used magnitudes in each of the Polarization possibilities:

Table 5-46: Magnitudes according to polarization setting

POLARIZATION setting	OPERATION MAG.	POLARIZATION MAG.
Vo	Ig	3V0
Ip	Ig	Isg
Vo + Ip	Ig	3V0 or Isg
Vo * Ip	Ig	3V0 and Isg

The following table shows the management of the element output signals (block and permission) depending on the **Polarization Type** setting.

Table 5-47: Output signal management according to polarization type setting

POLARIZATION setting	GROUND DIR BLOCK SIGNAL	GROUND DIR OP SIGNAL
Vo	V_0 < Ajs. POL V THRESHOLD	Permission V_0
Ip	I_P < 5 mA	Permission I_P
Vo + Ip	V_0 < POL V THRESHOLD I_P < 5 mA 	Permission V_0 Permission I_P 
Vo * Ip	V_0 < POL V THRESHOLD I_P < 5 mA 	Permission V_0 Permission I_P 

The configuration of the signals required for blocking the Ground overcurrent elements from the signals provided by the Ground directional element is made at ***Setpoint > Relay Configuration > Protection Elements*** using inverted operation signals to block the trip.

For example, to block the ground time delayed elements:

GROUND TOC1 BLOCK = NOT (GROUND DIR1 OP)

GROUND TOC2 BLOCK = NOT (GROUND DIR2 OP)

GROUND TOC3 BLOCK = NOT (GROUND DIR3 OP)

To block the Ground Instantaneous elements:

GROUND IOC1 BLOCK = NOT (GROUND DIR1 OP)

GROUND IOC2 BLOCK = NOT (GROUND DIR2 OP)

GROUND IOC3 BLOCK = NOT (GROUND DIR3 OP)

Table 5-48: Quantities

POLARIZING MODE	DIRECTION	COMPARED PHASORS	
VOLTAGE (Vo)	FORWARD	-Vo	Io x 1 MTA
	REVERSE	-Vo	-Io x 1 MTA
CURRENT (Ip)	FORWARD	Isg	Io
	REVERSE	Isg	-Io
Vo + Ip	FORWARD	- Vo	Io
		or	
		Isg	Io
	REVERSE	- Vo	-Io
		or	
		Isg	-Io
Vo * Ip	FORWARD	- Vo	Io
		and	
		Isg	Io
	REVERSE	- Vo	-Io
		and	
		Isg	-Io

5.4.6 Sensitive ground current

The R650 Sensitive ground Current menu incorporates the following overcurrent elements:

- Sensitive ground time overcurrent (51SG)
- Sensitive ground instantaneous overcurrent (50SG)
- Isolated ground overcurrent (50IG)
- Sensitive ground directional overcurrent (67SG)

5.4.6.1 Sensitive ground time-delayed overcurrent element (51SG)

Sensitive Ground TOC is a sensitive ground time delayed overcurrent protection element with a setting range 0.005A to 16A. The sensitive ground current input quantity is measured from the sensitive ground input, terminals B11-B12, and it may be programmed as fundamental phasor magnitude or RMS magnitude as required by the application. The element trip can be time delayed using a selectable curve. And it incorporates a reset time selectable between instantaneous or linear.

Table 5-49: 51SG element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Sensitive Ground Current > Sensitive Ground TOC Sensitive Ground TOC 1> Sensitive Ground TOC 2 > Sensitive Ground TOC 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]
Pickup level	Pickup Level	1.00	0.001 x CTsg	[0.025 : 20.000]
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.6.2 Sensitive ground instantaneous overcurrent element (50SG)

50SG is a sensitive ground instantaneous overcurrent protection element, with a setting range from 0.005 A to 16.00 A, which can also be time delayed, with a delay selectable between 0 and 900 seconds. The ground current input quantity is measured from the sensitive ground input, and it may be programmed as fundamental phasor magnitude or RMS magnitude as required by the application. The element incorporates a reset time selectable between 0 and 900 seconds, and a block input that resets the pickup and trip signals to 0. The element outputs are the general pickup and trip signals of the element.

Table 5-50: 50SG element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Sensitive Ground Current > Sensitive Ground IOC Sensitive Ground IOC 1> Sensitive Ground IOC 2 > Sensitive Ground IOC 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]
Pickup level	Pickup Level	1.000	0.001 x CTsg	[0.025 : 20.000]
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.6.3 Instantaneous overcurrent element for ungrounded systems (50IG)

The operation of this element is similar to sensitive ground overcurrent elements; the difference is that in this case, 3I0 current is capacitive, and uses very reduced magnitudes (0.5-10.0 A primary values).

The operation characteristic is shown on figure Figure 5-21: Operations characteristics, element 50IG, where Vh, Vl, Ih and Il are element settings.

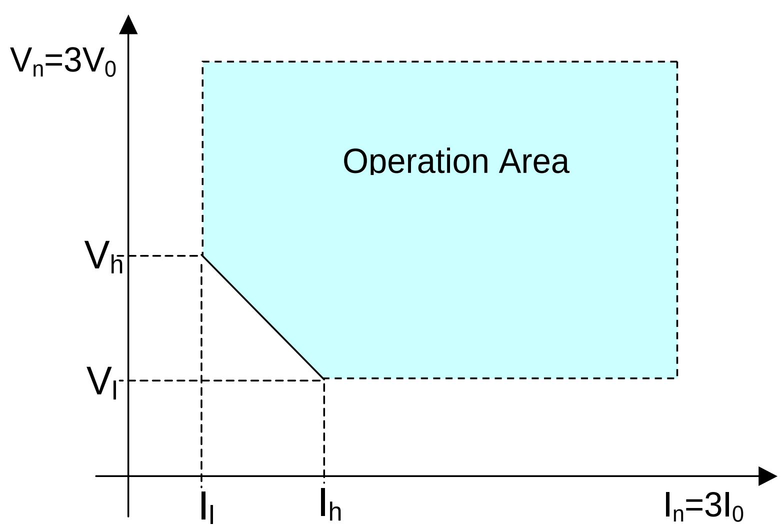


Figure 5-21: Operations characteristics, element 50IG

Table 5-51: Isolated ground IOC element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Sensitive Ground Current > Isolated Ground IOC Isolated Ground IOC 1> Isolated Ground IOC 2 > Isolated Ground IOC 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]

High Voltage	Vh Level	0.20	0.001 x VT	[0.02 : 4.00]
Low Current	Il LEVEL	0.025	0.001 x CTsg	[0.025 : 2.00]
Low Voltage	Vl LEVEL	0.02	0.001 x VT	[0.02 : 4.00]
High Current	Ih LEVEL	0.025	0.001 x CTsg	[0.025 : 2.00]
Operation time	Delay	0.00	0.01 s	[0.00 : 900.00]
Deviation time to instantaneous	Time to inst	0.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The relay settings for the Isolated Ground IOC elements are as follows:

Function: This setting determines whether the element is operative and can generate pickup and trip events, which can be configured to close outputs, light up LEDs or trigger oscillography.

Vh, VL, Ih, IL: Vn and In values that define the points in the operative area.

Operation time (Delay): This is the selectable period between the element pickup and trip, with a range from 0 to 900 seconds in steps of 0,01 seconds.

Deviation time to Instantaneous (Time to inst): Time after the trip during which the elements become instantaneous. It must be set to zero if the functionality is not required.

Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for this element.

OPERATION PRINCIPLES:

Operation of the isolated Ground element is based on the detection of a current that exceeds the setting, with neutral voltage supervision (3V0). This allows very sensitive setting of the element, with a very low current level, ensuring that small angle or ratio errors in the current transformers do not cause the relay to operate, as the neutral voltage verified is higher than the one set.

Values for Ih, IL, Vh and VL, which define the relay operation area, are configurable. H magnitudes must be higher than L magnitudes. The 50IG element can be supervised by directional element 67SG.

Using the relay input magnitudes In and Vn, if the point defined by (In, Vn) is inside the operation area and if the directional element (if directional supervision is set) allows it, the element picks up and the set delay time starts counting down. If a directional block appears during the countdown, the element is reset. After the set time the element trips. Once tripped, the relay cannot be blocked by the directional element, and the trip remains while the fault exists.

After the trip, the deviation time to instantaneous starts to run, so that all pickups produced during this time produce an Instantaneous trip. This means that, if after a trip the recloser is reclosed and the fault persists or reappears, the trip is instantaneous. If the user doesn't want to use this function, then the ***Deviation Time to Instantaneous (Time to inst)*** setting must be set to zero seconds. Once the time has expired, the element returns to its normal operation.

5.4.6.4 Sensitive ground directional element (67SG)

Sensitive Ground directional is a directional element used for supervising sensitive ground overcurrent functions. The operation magnitude is the ground current measured directly from the corresponding input (terminals B11-B12), while the polarization magnitude is the neutral voltage (3Vo). The neutral voltage is either calculated from three phase voltages or measured from the dedicated voltage input (A11-A12)

In case of using the voltage measured at the dedicated voltage input terminals, the ***Auxiliary Voltage*** setting in ***Setpoint > System Setup > General settings*** must be VN.

If the R650 is set to have synchronism check protection, then this input is adjusted as busbar voltage and it will not be the 3V0 voltage (AUXILIARY VOLTAGE *setting as VX)*

If the R650 does not have a synchronism check element, then this input can be set as 3V0 neutral voltage, and it can be used as polarization magnitude for the 67SG element (AUXILIARY VOLTAGE *setting as VN).*

The same way as the directional element for phases, it has a polarization voltage loss logic that allows blocking or producing trip depending on the setting.

Table 5-52: Sensitive ground directional element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Sensitive Ground Current > Sensitive Ground Directional > Sensitive Ground Directional 1> Sensitive Ground Directional 2 > Sensitive Ground Directional 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]
Polarization voltage threshold	Pol V Threshold	0.10	0.01 x VT	[0.00 : 1.25]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Available settings are:

Function permission (Function): This setting determines whether the sensitive Ground directional element is enabled or Disabled.

Maximum Torque Angle (MTA): This angle is used to rotate the Polarization voltage. Positive angles mean counter clockwise rotation, and negative angles mean clockwise. The polarization magnitude, once rotated, defines the MTA line. Vn rotated by this angle points to the semi plane that corresponds to a Reverse fault. (-Vn) rotated this angle points to the semi plane that corresponds to a Forward fault.

Operation Direction (Direction): This setting indicates the Direction for which the element allows a trip. Depending on this setting, the element is activated for faults in a direction or in the opposite direction. Possible setting values are FORWARD or REVERSE.

Polarization Voltage Threshold (Pol. V Threshold):This is the minimum polarization voltage threshold. For a voltage value lower than this setting the directional element is blocked.

Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for this element.

Sensitive ground directional element is an independent Protection element that provides block and Operation signals. These signals can be monitored both through the relay HMI or using EnerVista 650 Setup at **Actual > Status > Protection > Sensitive Ground Current**

67SG Block (SENS GND DIR1 BLOCK): It indicates that the element is blocked by digital input or because the Operation magnitude (In current), or the Polarization magnitude (Vn voltage and/or Ip current) level is too low.

67SG Operation (SENS GND DIR1 OP): It indicates that the directional element is giving permission, the operation magnitude and the polarization magnitude conditions are met, or in case of having selected Permission in the Block Logic setting, it indicates that the element allows operation under block conditions.

Table 5-53: Sensitive ground directional signals

SENS GND DIRECTIONAL
SENS GND DIR1 BLOCK
SENS GND DIR1 OP
SENS GND DIR2 BLOCK
SENS GND DIR2 OP
SENS GND DIR3 BLOCK
SENS GND DIR3 OP

Configuration of the required signals for blocking the sensitive ground overcurrent elements from the signals provided by the sensitive ground directional elements is performed at ***Setpoint > Relay Configuration > Protection Elements.*** This is done using the inverted operation signals to block the trip, as shown in the following example:

For example, to block sensitive Ground time overcurrent elements, use the following signals:

SENS GND TOC1 BLOCK = NOT (SENS GND DIR1 OP)

SENS GND TOC2 BLOCK = NOT (SENS GND DIR2 OP)

SENS GND TOC3 BLOCK = NOT (SENS GND DIR3 OP)

To block Ground instantaneous elements:

SENS GND IOC1 BLOCK = NOT (SENS GND DIR1 OP)

SENS GND IOC2 BLOCK = NOT (SENS GND DIR2 OP)

SENS GND IOC3 BLOCK = NOT (SENS GND DIR3 OP)

To block isolated Ground elements:

ISOLATED GND1 BLK = NOT (SENS GND DIR1 OP)

ISOLATED GND2 BLK = NOT (SENS GND DIR2 OP)

ISOLATED GND3 BLK = NOT (SENS GND DIR3 OP)

5.4.7 Negative sequence current

The Negative sequence menu incorporates the Negative sequence time overcurrent (46P) element:

5.4.7.1 Negative sequence overcurrent element (46P)

Negative Sequence TOC is an overcurrent protection element that uses the fundamental phasor of the negative sequence current as input magnitude, calculated from the phase currents. This element can be used for detecting load unbalance in the system, and for open phase conditions (fallen or broken conductor). The trip can be time delayed by a curve selectable by setting. The reset can be instantaneous or linear.

Table 5-54: Negative sequence TOC element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Negative Sequence Current > Negative Sequence TOC > Negative Sequence TOC 1> Negative Sequence TOC 2 > Negative Sequence TOC 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup level	Pickup Level	1.00	0.01 x CT	[0.05 : 20.00]
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.8 Voltage elements

The R650 incorporates the following voltage elements:

- Phase undervoltage (27P)
- Phase overvoltage (59P)
- Neutral overvoltage (59N)
- Negative sequence overvoltage (47)

These protection elements can be used in multiple applications, such as:

Undervoltage protection: for induction motor load types, where a voltage dip can cause an increase of the consumed current. Element 27P (phase undervoltage) can be used to issue a trip or an alarm.

Transfer Schemes: in the event of an undervoltage condition, we can use the 27P element (phase undervoltage) to send a signal that transfers load to another power source.

Undervoltage elements can be set to operate with definite time or with an inverse time curve. If the element is set as definite time, it operates when voltage remains under the set value during the set period of time. This period can be set from 0s to 900.00 s in steps of 10ms.

These elements can also be set as inverse time curves. This family of curves is defined by the following formula:

$$T = \frac{D}{1 - \frac{V}{Vpickup}}$$

Where:

T = operation time

D = operation time setting (delay)

V = voltage applied to the relay

Vpickup = pickup setting (Pickup level)

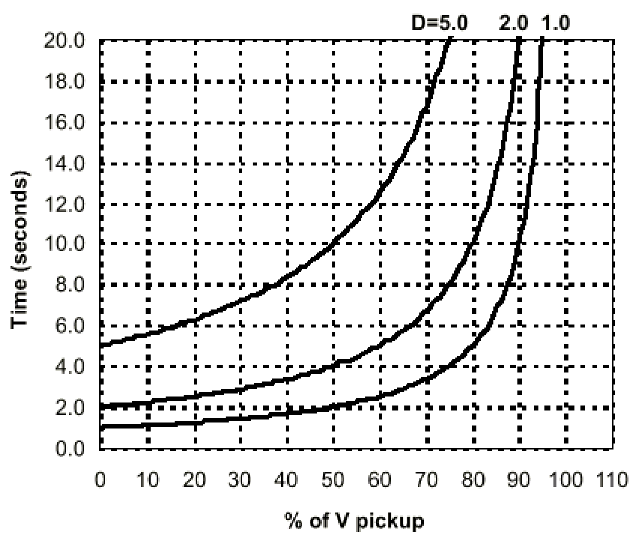


Figure 5-22: Inverse time undervoltage curves

5.4.8.1 Phase undervoltage element (27P)

This element may be used to give a desired time-delayed operating characteristic versus the applied fundamental voltage (phase-to-ground or phase-to-phase for wye VT connection, or phase-to phase- for Delta VT connection) or as a Definite time element. The element resets instantaneously if the applied voltage exceeds the dropout voltage.

The delay setting selects the minimum operating time of the phase undervoltage. The minimum voltage setting selects the operating voltage below which the element is blocked (a setting of "0" allows a dead source to be considered a fault condition.

This element generates independent pickup and trip signals per phase, and general pickup and trip signals for the element. These last signals can be selected, by means of the operation logic setting, to be an OR (any phase signal) or an AND (all phase signals).

Table 5-55: 27P element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Voltage Elements > Phase UV > Phase UV 1> Phase UV 2 > Phase UV 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input mode	Mode	PHASE-PHASE	N/A	[PHASE-PHASE, PHASE-GROUND]
Pickup Level	Pickup Level	0.10	0.01 x VT	[0.02 : 1.25]
Curve shape	Curve	DEFINITE TIME	N/A	[DEFINITE TIME – INVERSE TIME]
Time Dial	Delay	10.00	0.01 s	[0.00 : 900.00]
Minimum Voltage Threshold	Minimum Voltage	0	0.01 x VT	[0 : 1.25]
Operation logic	Logic	ANY PHASE	N/A	[ANY PHASE – TWO PHASES – ALL PHASES]
Supervision by recloser status	Supervised by 52	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Phase undervoltage element settings are:

Function Permission (Function): This setting indicates whether the phase undervoltage element is enabled or disabled.

Input mode (Mode): This setting allows selecting operation for phase-to-phase or phase-to-ground voltage, depending on the selected setting.

Pickup Level: This is the voltage threshold below which the undervoltage element operates.

Curve Shape (Curve): Undervoltage elements can be set to operate with definite time or with an inverse time curve. Elements set as definite time operate when the voltage value remains under the pickup setting during the set time. If inverse time is selected, the element operates according to the previously described inverse time curve.

Time Dial (Delay): Setting of the Protection element operation time.

Minimum voltage Threshold (Minimum Voltage): Voltage setting under which the undervoltage element is inhibited, in order not to operate in dead line cases.

Operation logic (Logic): This setting allows the element operation logic selection:

ANY PHASE The element operates under an undervoltage condition in any of the three phases.

TWO PHASES The element operates under an undervoltage condition in at least two phases.

ALL PHASES The element operates under an undervoltage condition in three phases.

Supervision by recloser status (Supervised by 52): This setting allows inhibiting the undervoltage element if the recloser is open recloser. In case this setting is enabled, the undervoltage element is supervised by the recloser status. Otherwise, the element operates independently of the recloser status.

Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.8.2 Phase overvoltage element (59P)

The Phase overvoltage element may be used as an instantaneous element with no intentional time delay or as a Definite Time element. The input voltage is the phase-to-phase voltage, either measured directly from Delta-connected VTs or as calculated from phase-to-ground (wye) connected VTs. The time delay can be set from instantaneous to 900 seconds. The element reset can be delayed up to 900 seconds.

As in the case of the undervoltage element, this element generates independent pickup and trip signals for each phase. The general signal is selectable by setting to be an OR or an AND of the phase signals.

Table 5-56: 59P element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Voltage Elements > Phase OV > Phase OV 1> Phase OV 2 > Phase OV 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup Level	Pickup Level	1.25	0.01 x VT	[0.02 : 1.25]
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Operation logic	Logic	ANY PHASE	N/A	[ANY PHASE – TWO PHASES – ALL PHASES]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Phase overvoltage element settings are:

Function Permission (Function): This setting indicates whether the phase overvoltage element is enabled or disabled.

Pickup Level: This is the voltage threshold over which the overvoltage element operates.

Trip time (Trip Delay): setting of the Protection element operation time.

Reset time (Reset Delay): Reset time of the Protection element.

Operation logic (Logic): This setting allows the element operation logic selection:

- ANY PHASE — The element operates under an overvoltage condition in any of the three phases.
- TWO PHASES — The element operates under an overvoltage condition in at least two phases.
- ALL PHASES — The element operates under an overvoltage condition in three phases.

Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.8.3 Neutral overvoltage element (59N)

The Neutral Overvoltage element can be used to detect an asymmetrical system voltage condition due to a ground fault or to the loss of one or two phases of the source.

The element responds to the system neutral voltage (3V0), calculated from the phase voltages or measured by the 4th voltage transformer.

VT errors and normal voltage unbalance must be considered when setting this element.

The element time delay is selectable between 0 and 900 seconds and incorporates a reset with a selectable delay between 0 and 900 seconds.

Notice that the neutral overvoltage element is not be available if a ***DELTA*** Connection is set in the ***Phase VT Connection*** setting in General settings, and the fourth voltage transformer input is set to the busbar voltage for the synchronism element (Vx in ***Auxiliary Voltage*** setting). This is because with this combination of settings it is not possible to calculate the zero sequence component from the phase-to-phase voltage magnitudes.

Table 5-57: 59N element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Voltage Elements > >Neutral OV > Neutral OV 1> Neutral OV 2 > Neutral OV 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup Level	Pickup Level	1.25	0.01 x VT	[0.02 : 1.25]
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.8.4 Negative sequence overvoltage element (47)

The Negative sequence phase overvoltage element uses as its input magnitude the negative sequence component calculated from the phase voltage values. This element can be used to detect the loss of one or two phases, unbalance voltage conditions, etc.

Table 5-58: 47 element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > VOLTAGE ELEMENTS > Negative Sequence OV > Negative Sequence OV 1> Negative Sequence OV 2 > Negative Sequence OV 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup Level	Pickup Level	1.25	0.01 x VT	[0.02 : 1.25]
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.9 Power elements

5.4.9.1 Forward power element (32FP)

The 32FP element produces a trip when exported power exceeds the setting value. Monitored power is active power, calculated by the three phase voltages and currents, and it is considered to be exported, positive active power, the one given in the direction of the line protected by the relay; in this situation, the angle between secondary voltage and current is lower than 90º, according to the relay wiring diagram.

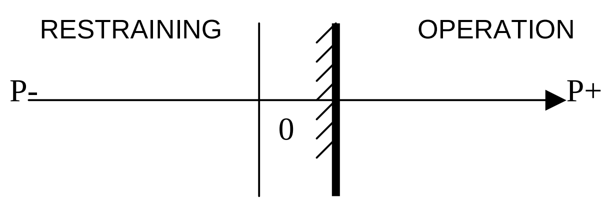


Figure 5-23: Forward power characteristics

Table 5-59: 2FP element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Power > Forward Power Forward Power 1> Forward Power 2 > Forward Power 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Block from offline	Blk Time After Close	0.00	0.01 s	[0.00 : 900.00]
Pickup level for stage 1	Stage 1 Tap	10.00	0.01MW	[0.00 : 10000.00]
Trip time for stage 1	Stage 1 Time	60.00	0.01 s	[0.00 : 900.00]
Pickup level for stage 2	Stage 2 Tap	20.00	0.01MW	[0.00 : 10000.00]
Trip time for stage 2	Stage 2 Time	60.00	0.01 s	[0.00 : 900.00]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

The R650 includes three 32FP elements. Each elements incorporates two stages, the first stage, less critical, is intended to produce an alarm, the second stage is used for trip. Both **levels are set in primary values**, for instance: if in general settings we set CT_RATIO to a value of 100, and the same value for PT_RATIO, the base power is: 100 x 100 = 10000 W

The block time allows blocking the element operation during a set time after the coupling recloser closure. For this purpose it is necessary to connect the recloser bay using a 52B type contact. The purpose of this setting is to avoid spurious trips caused by overloads after the recloser closure.

Power calculations depending on the VT connection:

1- **WYE** VT connection, or only one transformer in phase-to-ground connection:

$$P = V_a * I_a * \cos\varphi_a + V_b * I_b * \cos\varphi_b + V_c * I_c * \cos\varphi_c$$

2- **DELTA** VT connection, or only one voltage transformer in phase-to-ground connection:

$$P = \frac{V_{ab}}{\sqrt{3}} * I_a * \cos(\varphi_a - 30) + \frac{V_{bc}}{\sqrt{3}} * I_b * \cos(\varphi_b - 30) + \frac{V_{ca}}{\sqrt{3}} * I_c * \cos(\varphi_c - 30)$$

5.4.9.2 Directional power element (32)

Element description

The Directional Power element responds to three-phase active power measured from the feeder associated with the R650. This element can be selected to operate according to the power threshold adjusted in the corresponding setting. This element is ideal for reverse power applications (F32 REV) or forward power (F32 FWD), depending on the selected setting. The relay measures the three-phase power for wye or delta connections.

The element has an adjustable characteristic angle and minimum operating power as shown in the Directional Power Characteristic diagram. The element responds to the following condition:

P cos(j) + Q sin (j) > SMIN

where: P and Q are active and reactive powers as measured per the R650 convention, j is the angle set at the 32 setting (DIR POWER ANGLE) in degrees in steps of 0.01°, and SMIN is the minimum operating power.

The element has two independent (as to the pickup and delay settings) elements. Both elements can be used for alarm and trip, and they can be set separately to provide a mixed power protection.

The Directional Power Characteristic is shown in the following diagram.

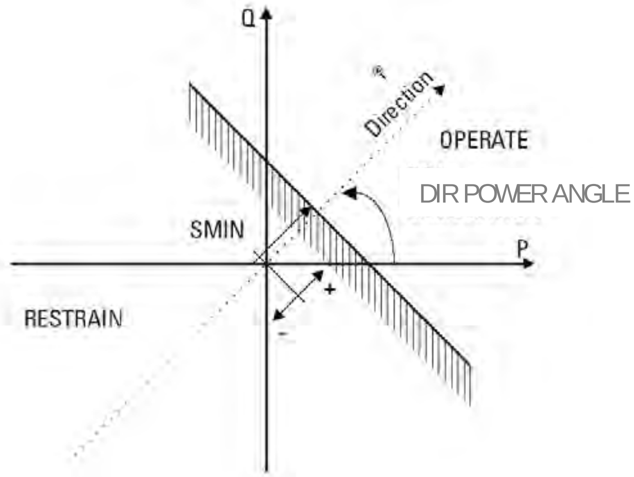


Figure 5-24: Power directional characteristics

By making the characteristic angle adjustable from 0° to 360° in steps of 0.01°, a variety of operating characteristics can be achieved as presented in the figures below. For example, for an angle of 0°, the element would operate as a 32 Forward Power element, while if setting an RCA angle of 180°, the element would operate as a 32 Reverse Power element. For angles of 90° and 270°, the case would be similar but with reactive power.

Figures (a, b, c, d, e, f) below shows settings for different power applications.

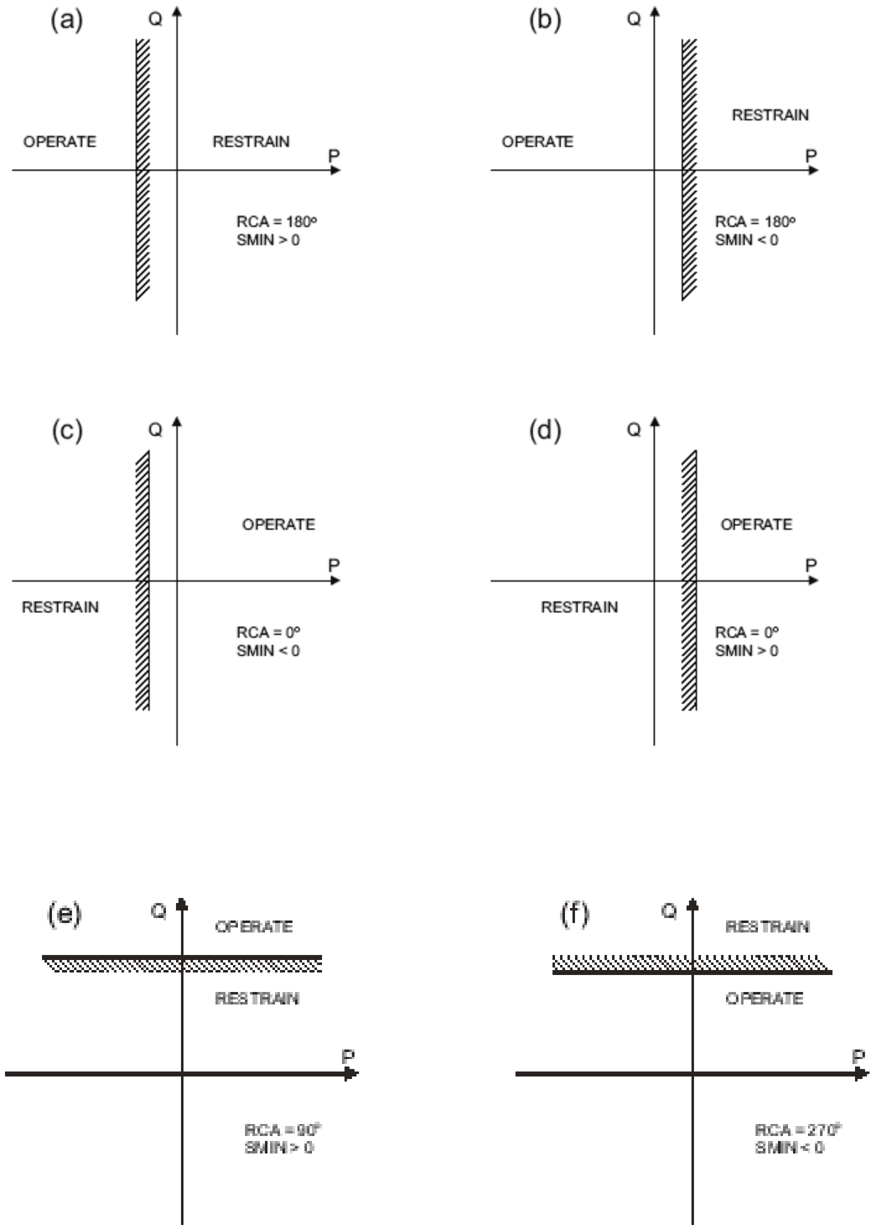


Figure 5-25: Directional power element sample applications

The following table shows the SMIN and angle values that must be used for some typical applications:

Table 5-60: Directional power element

SMIN (Stage Tap)	ANGLE (RCA)	ELEMENT
>0	0º	Forward Active Power
<0	0º	Reverse Low Forward Active Power
>0	180º	Reverse Forward Active Power
<0	180º	Low Forward Active Power

By adding 90º to the angles shown on figures a, b, c and d, the represented elements would be similar but with ***Reactive Power*** instead of Active Power.

Any other angle would provide a mixed Protection Between Active and Reactive power.

A different angle selection for Stage 1 and Stage 2 can provide in a single element, a Reactive and Active power limitation. For example, using the following values:

Dir Power Angle 1(RCA)	0º
Stage 1 Tap	0
Dir Power Angle 2(RCA)	90º
Stage 2 Tap	0

We would obtain a mixed Protection Between figure (d) and figure (e).

Settings

Table 5-61: 32 element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Power > Directional Power> Directional Power 1> Directional Power 2 > Directional Power 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Block from offline	Blk Time After Close	0.00	0.01 s	[0.00 : 900.00]
Directional Angle for stage 1 (RCA1)	Dir Power Angle 1	0.00	1 Deg	[0.00 : 359.99]
Pickup level for stage 1	Stage 1 Tap	10.00	0.01MW	[-10000.00 : 10000.00]
Trip time for stage 1	Stage 1 Time	60.00	0.01 s	[0.00 : 900.00]
Directional Angle for stage 2 (RCA2)	Dir Power Angle 2	0.00	1 Deg	[0.00 : 359.99]
Pickup level for stage 2	Stage 2 Tap	20.00	0.01MW	[-10000.00 : 10000.00]
Trip time for stage 2	Stage 2 Time	60.00	0.01 s	[0.00 : 900.00]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

Function: Enables or disables the directional element.

Blk Time After Close: In seconds. This settings allow to block the element 32 during the time specified in the setting after the recloser switches from OPEN to CLOSED.

Dir Power Angle (1-2) (RCA): This setting specifies the relay characteristic angle (RCA) for the directional power element. This setting provides ability to respond to the function in any direction defined (active forward power, active low forward power, etc.)

The following figure illustrates the conventions established:

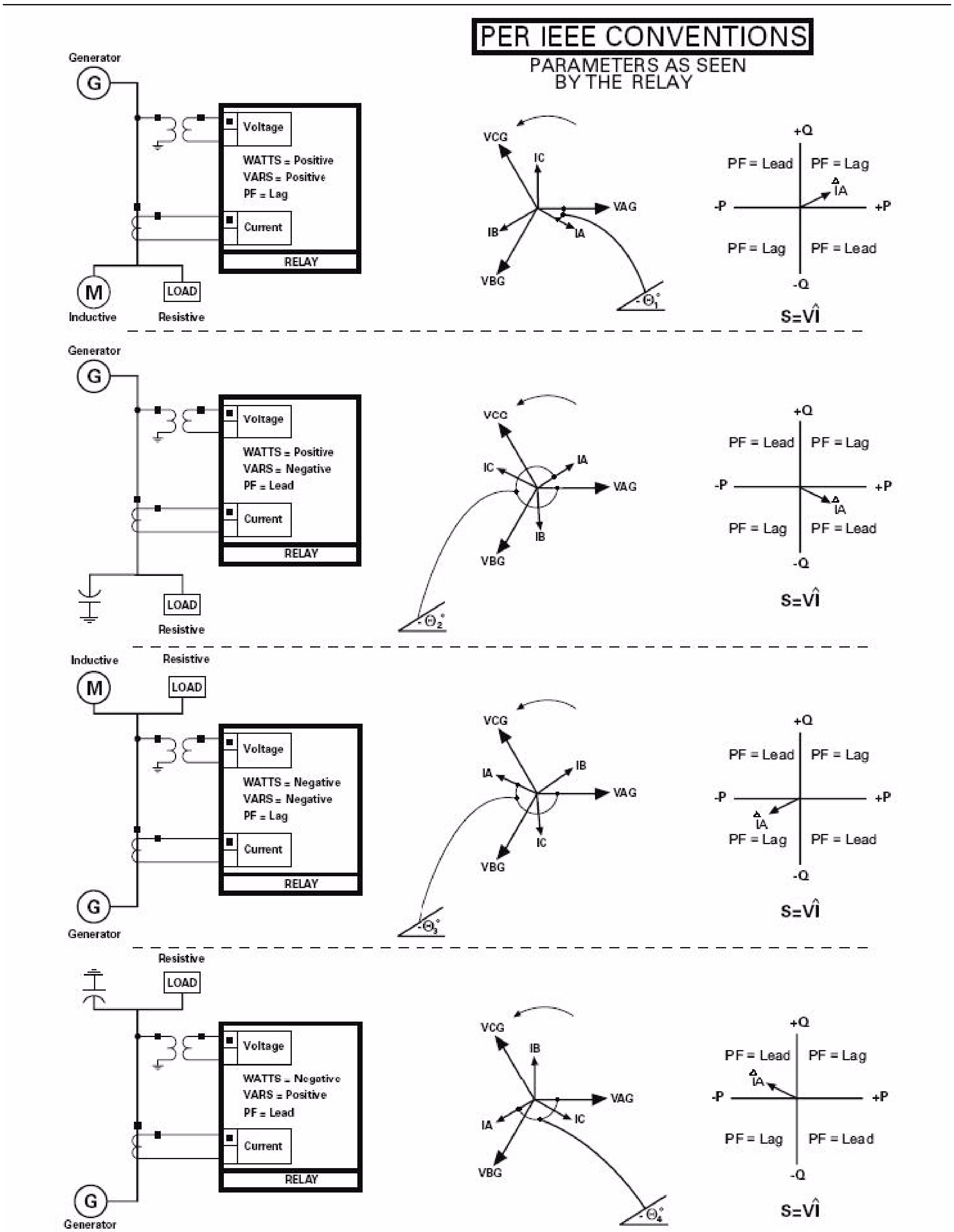


Figure 5-26: Angles

Stage (1 - 2) Tap: This setting specifies the minimum Operation three-phase power for the Stage 1 (2) element. The power value defined in this setting is the minimum distance between the source and the directional power characteristic. This value can be positive or negative. The value of this setting is defined in total MW (primary) – the CT and VT value is considered in the calculations.

> **NOTE**:
>
> Even if the element defined in this setting is MW, this does not necessarily mean that the resulting value and the RCA setting are in MW. For example:
>
> ***RCA**: 30 º* ***SMIN**: 100 MW.*
>
> If we assume that there is only active power. The element operation would be produced for a value of:
>
> P = 100 / cos (30) = 115,7 MW.
>
> If there was only reactive power:
>
> Q = 100/sin (30) = 200,0 MVar.
>
> (In this case the real Operation elements are Mvar, even if SMIN is expressed in MW.)

Stage 1 (2)Time: This setting specifies the delay for Stage 1 of the element. For reverse power or direct power applications, usually Stage 1 is used for alarm functions, while Stage 2 is used for tripping functions.

Snapshot Events: This setting enables or disables the generation of events. All states in this function are affected by this setting.

Status

Statuses defined for this Function are as follows:

DIR PWR1 (2, 3) BLOCK: Writing status, operates by level. When this status is activated externally (via PLC), the directional power element is blocked. This status affects both elements in the protection element (stage 1 and 2).

Activation of this status produces the event: **DIR PWR1 (2, 3) BLK ON.**

Deactivation produces the event : **DIR PWR1 (2, 3) BLK OFF.**

DIR PWR1 (2, 3) STG1 (2) OP: This is activated when the element that corresponds to stage 1/2 is activated. Events generated by this element are:

DIR PWR1 (2, 3) STG1 (2) OP ON

DIR PWR1 (2, 3) STG1 (2) OP OFF

DIR PWR1 (2, 3) STG1 (2) PKP: Activation of this status indicates that the power value has exceeded the threshold indicated by the Stage 1/2 element. Events generated by this element are:

DIR PWR1 (2, 3) STG1 (2) PKP ON

DIR PWR1 (2, 3) STG1 (2) PKP OFF

DIR PWR1 (2, 3) STG PKP: This status is a logic OR between the DIR PWR STG1 PKP and DIR PWR STG2 PKP statuses. Activation of this status indicates that the power value has exceeded the threshold indicated by any of the Stage 1/2 elements. Events generated by this element are:

DIR PWR1 (2, 3) STG PKP ON

DIR PWR1 (2, 3) STG PKP OFF

DIR PWR1 (2, 3) STG OP: This status is a logic OR between the DIR PWR STG1 OP and DIR PWR STG2 OP statuses. This is activated when the element that corresponds to stage 1/2 is activated. Events generated by this element are:

DIR PWR1 (2, 3) STG OP ON

DIR PWR1 (2, 3) STG OP OFF

5.4.9.3 Wattmetric ground fault (32N)

This document specifies wattmetric zero-sequence directional function, which can be used on solidly grounded, low-resistance grounded, isolated or resonant (Petersen coil) grounded systems. The function determines presence and direction of ground faults by measuring value and direction of zero-sequence power.

The element responds to power derived from zero-sequence voltage and current in a direction specified by the element characteristic angle. The angle can be set within all four quadrants, the power can be selected to be either active or reactive. Therefore, the element may be used to sense either forward or reverse ground faults in either inductive, capacitive or resistive networks. Inverse time characteristic allows time coordination of the elements across the network.

Typical applications include ground fault protection in solidly grounded transmission networks, grounded/ungrounded/resistor-grounded/resonant-grounded distribution networks, or for directionalizing other non-directional ground elements.

Element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > POWER > WATT GND FLT 1> WATT GND FLT 2 > WATT GND FLT 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
Function permission	Function	DISABLED	N/A	[DISABLED-ENABLED]
Supervision minimum voltage	Voltage Pickup Level	0.02	0.01 x VT	[0.02 : 1.00]
Source of operating current.	Current selection	IN	N/A	[IN-IG]
Pickup Level for Overcurrent	OC Pickup Level	0.050	0.001 x CT	[0.002 : 0.400]
Pickup Delay for Overcurrent	OC Pickup Delay	0.20	0.01 s	[0.00 : 600.00]
Pickup Level for operating Power	Power Pickup	0.10	0.001 x CTVT	[0.001 : 1.200]
Max torque angle	MTA	0	1 Deg	[0 : 360]
Pickup Delay for Operating Power	Power Pickup Delay	0.20	0.01 s	[0.00 : 600.00]
Curve shape	Curve	DEFINITE TIME	N/A	[DEFINITE TIME - INVERSE TIME - USER CURVE A - USER CURVE B - USER CURVE C - USER CURVE D]
Multiplier	Multiplier	1.00	0.01 s	[0.02 : 2.00]
Snapshot event generation	Snapshot Event	DISABLED	N/A	[DISABLED-ENABLED]

Function: Enables or disables the directional element.

Voltage Pickup Level: The element uses neutral, i.e. 3 times zero-sequence, voltage. This setting specifies the minimum neutral voltage supervising the directional power measurement. This threshold should be higher than possible unbalance during normal operation of the system.

Current selection: The element responds to the neutral (3 times zero-sequence) current, either calculated internally (IN) from the phase currents, or supplied externally (IG) via the ground CT input. This setting allows selecting the source of the operating current.

OC Pickup Level: This setting specifies the current supervision level for the measurement of the zero-sequence power.

OC Pickup Delay: This setting specifies delay for the overcurrent portion of this element. The delay applies to the 32N1(2 3) OC PKP operand driven from the overcurrent condition.

Power Pickup: This setting specifies the operating point of the element.

MTA: This setting adjusts the maximum torque angle of the element.

Power Pickup Delay: This setting defines a definite time delay before the inverse time characteristic is activated. If the curve selection is set as “Definite Time”, the element would operate after this security time delay plus the Time Delay Multiplier (m) applied to a flat curve of 1s.

t = Power Delay Pickup + m

Curve: This setting allows choosing one of three methods to delay operate signal once all conditions are met to discriminate fault direction:

Definite time: Fixed time delay defined by the POWER PICKUP DELAY setting

Inverse time: Inverse time characteristics delay defined by**:**

$$t = m \bullet \frac{S_{PKP}}{S_{OP}}$$

where m is a multiplier defined by the MULTIPLIER setting, S_{PKP} is the pickup setting and S_{OP} is the operating power at the time.

FlexCurve A,B,C,D: any time characteristics programmed by the user with FlexCurves.

Multiplier: Time dial multiplier

Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for the wattmetric ground fault elements.

Element description

The operating power is calculated as:

S_op= real(Vn(In 1ÐMTA))*

where: * stands for complex conjugate. By varying the MTA angle one can make the element to respond to forward or reverse direction in inductive, resistive, or capacitive networks as shown in the figure below.

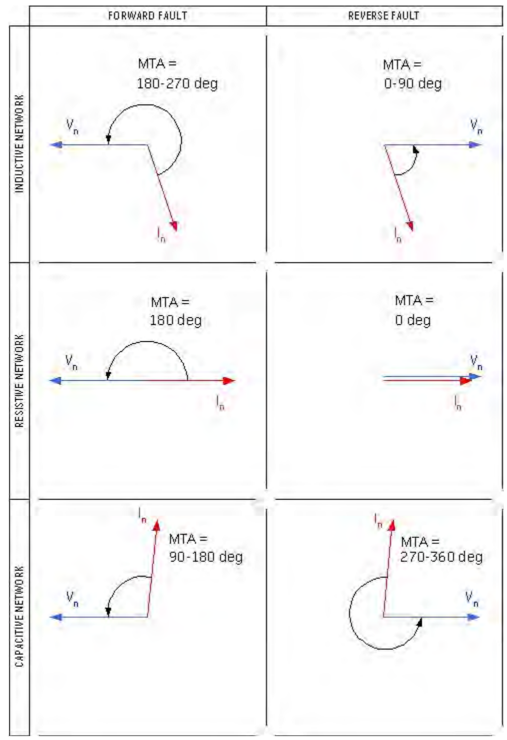


Figure 5-27: Angles

Operating power

V_n – neutral voltage (3 times V_0): either calculated (VX as auxiliary voltage setting) or supplied from the Auxiliary voltage channel (VN as auxiliary voltage setting)

I_n – neutral current (3 times I_0): either calculated (IN as current selection setting) or supplied from the ground current channel (IG as current selection setting)

The following figure shows the logic scheme diagram for high range and low range wattmetric ground fault elements (32N).

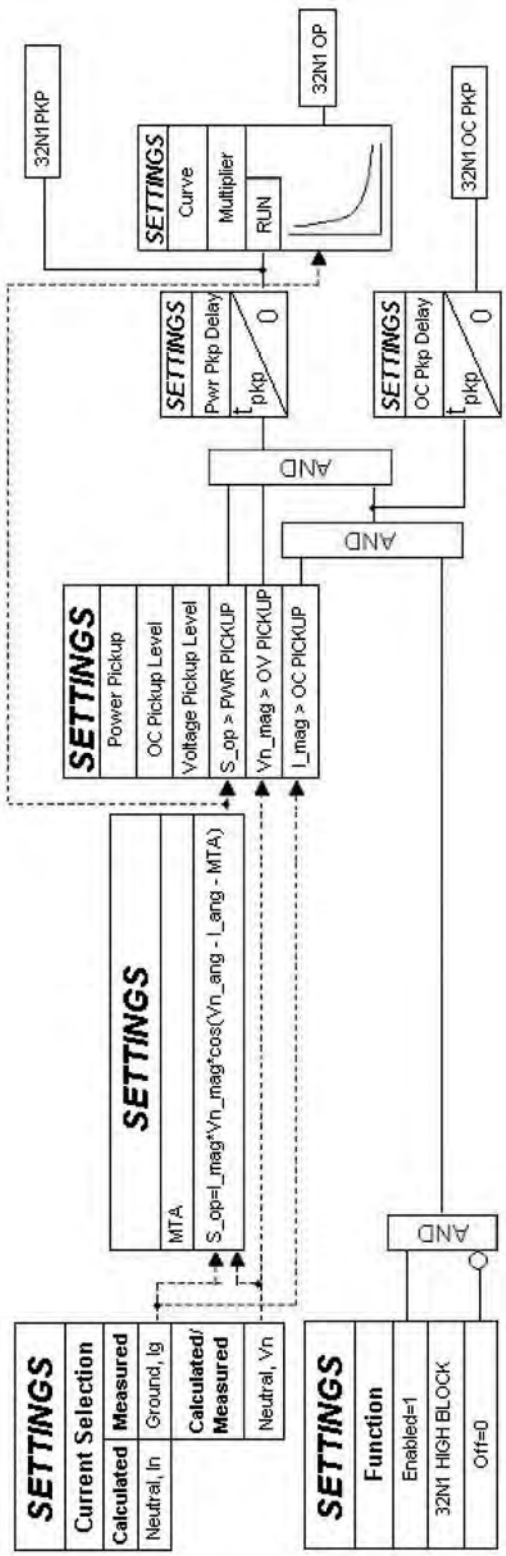


Figure 5-28: Wattmetric ground fault elements logic scheme

Status

Statuses defined for this Function are as follows:

32N1 (2, 3) BLOCK :Writing status, operates by level. When this status is activated externally (via PLC), the wattmetric ground fault element is blocked.

The activation produces the event: **32N1 (2, 3) BLOCK ON**.

Deactivation produces the event: **32N1 (2, 3) BLOCK OFF**.

32N1 (2, 3) OC PKP: The activation of this status indicates that the current value has exceeded the threshold indicated and pickup delay has expired. Events generated by this element are:

32N1 (2, 3) OC PKP ON

32N1 (2, 3) OC PKP OFF

32N1 (2, 3) PKP: Activation of this status indicates that the current, voltage and power value has exceeded the threshold indicated and power pickup delay has expired.

Events generated by this element are:

32N1 (2, 3) PKP ON

32N1 (2, 3) PKP OFF

32N1 (2, 3) HIGH (LOW) OP: This is activated when the element is activated. Events generated by this element are:

32N1 (2, 3) OP ON

32N1 (2, 3) OP OFF

5.4.10 Frequency elements

5.4.10.1 Underfrequency element (81U)

The steady-state frequency of a power system is a certain indicator of the existing balance between the generated power and the load. Whenever this balance is disrupted through the loss of an important generating unit, the effect is a reduction in frequency. A reliable method to quickly restore the balance between load and generation is to automatically disconnect the selected loads, based on the actual system frequency. This technique called "load-shedding" maintains system integrity and minimizes widespread outages.

The 81U element is an underfrequency control element. The pickup setting can be selected from 20.00 to 65.00 Hz. The element reset time delayed is selectable between 0.00 and 900 seconds, and for the element to operate it is necessary that the voltage value is over the value set for minimum voltage threshold. This way undesired trips are prevented when the signal for metering the frequency is not available or has a very low value.

Underfrequency elements (81U) can be configured by using Enervista 650 Setup at **Setpoint > Protection Elements > Setting Group X**

Table 5-62: 81U element settings

Setpoint > Protection Elements > Setting Group X > Frequency > Underfrequency UNDERFREQUENCY 1 > UNDERFREQUENCY 2 > UNDERFREQUENCY 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup level	Pickup Level	49.50	0.01 Hz	[20.00 : 65.00]
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Minimum voltage threshold	Minimum Voltage	0.10	0.01 x VT	[0.05 : 1.25]

Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]
Frequency Source	Frequency Source	LINE FRQ	N/A	[LINE FRQ - BUS FRQ]

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The snapshot event setting enables or disables the snapshot event generation for this element.

Frequency elements operate with the system frequency; this frequency is measured in the voltage channel set for the frequency reference, in the **Frequency Reference** setting inside **Setpoint > System Setup >General Settings.**

5.4.10.2 Overfrequency element (81O)

81O is an overfrequency protection element. The pickup setting can be selected from 20.00 to 65.00 Hz, with a time delay selectable between 0 and 900 seconds. The element-reset delay is from 0.00 to 900.00 seconds.

Underfrequency elements (81U) can be configured by using Enervista 650 Setup at **Setpoint > Protection Elements > Setting Group X**

Table 5-63: 81O element settings

Setpoint > Protection Elements > Setting Group X > Frequency > Overfrequency OVERFREQUENCY 1 > OVERFREQUENCY 2 > OVERFREQUENCY 3				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup level	Pickup Level	50.50	0.01 Hz	[20.00 : 65.00]
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Minimum voltage threshold	Minimum Voltage	0.10	0.01 x VT	[0.05 : 1.25]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]
Frequency Source	Frequency Source	LINE FRQ	N/A	[LINE FRQ - BUS FRQ]

The snapshot event setting enables or disables the snapshot event generation for this element.

Frequency elements operate with the system frequency; this frequency is measured in the voltage channel set for the frequency reference, in the **Frequency Reference** setting inside **Setpoint > System Setup > General Settings**.

5.4.11 Miscellaneous elements

5.4.11.1 Broken conductor

R650 incorporates a broken or fallen conductor detection function. The relay uses the ratio between the negative sequence current, I_2, and the positive sequence current I_1. In normal and balanced load situations, this ratio is zero, while in severe load fault conditions, an unbalance is produced and this ratio increases.

SETPOINT > PROTECTION ELEMENTS >SETTING GROUP X > MISCELLANEOUS > BROKEN CONDUCTOR				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Tap Level in percentage of I2/I1	Tap	20.0	0.1%	[20.0 : 100.0]
Trip Time	Trip Delay	60.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]
Current Inhibition Level setting	Operation Threshold	0.05	0.01 x CT	[0 : 1.00]

This way, when the function is enabled and the unbalance is produced over the set percentage, the element picks up. If unbalance conditions are maintained during a period longer than the set time delay, the element trips.

In order to avoid trips or pickups with very weak loads there is a **current level threshold to inhibit the operation of the element** when the three phase currents are below a fixed level.

Note: The I2/I1 current inhibition level for the different firmware versions is as follows:

Firmware Version	Current Inhibition Level
1.50 or Lower	10 mA
1.60 or Higher	50 mA
1.80 or Higher	Selectable by setting from 0.000 to 1.000 in steps of 0.001 A

The Operation Threshold level has been included to allow the user selecting the current inhibition level suitable for a particular application, in order to avoid operation of the element when the relay is not connected to the line or in case the relay has previously operated correctly and has been disconnected from the line, as in this case the operation condition is met but the relay should not trip.

The operation threshold operation is as follows:

The Broken conductor element is fully operational if at least one of the phase currents is higher than the setting. This condition assumes that the relay is connected to the line.

If the element is on trip or pickup condition, the element is reset if the three phase currents are below the operation threshold level. This condition assumes that the relay is not connected to the line and therefore the relay should not trip.

Due to the response time of this function, if the set time delay is 0s, a trip can occur in situations where, for example, one of the currents is stopped before the rest, as these currents would produce a negative sequence current calculation. Therefore, to avoid this kind of undesired trips, it is strongly recommended to establish a minimum time delay setting, such as 100 ms, or higher depending on the expected normal unbalances in the network. This is to differentiate these situations from broken conductor situations.

5.5 Control elements

The R650 incorporates the following control elements:

- Setting Group
- Synchrocheck (25)
- Autoreclose (79)
- Recloser Failure (50BF)
- VT Fuse Failure
- Pulse Counters
- Digital Counters
- Analog Comparators
- Cold Load Pickup
- PLC Timer mask
- 60 CTS Failure
- 2nd Harmonic Inhibit

Note: for all control elements related to the recloser, it must be considered that all operations are performed considering the status of the switchgear configured as recloser. In ***Setpoint > Relay Configuration > Switchgear*** up to 16 switchgear elements can be configured to operate and be monitored, but only one of them can be configured as a recloser, for monitoring, number of openings and closings counters, $(KI)^2t$.

5.5.1 Setting group

The settings used for setting table management are located in ***Setpoint > Control Elements > Setting Group***:

Table 5-64: Setting group settings

Setpoint > Control Elements > Setting Group				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Setting Grouping Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Active Group	Active Group	GROUP 1	N/A	[GROUP 1 – GROUP 2 – GROUP 3 – GROUP 4 – GROUP 5 – GROUP 6]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

For more detailed information go to sections 5.4 Protection elements and 5.4.1 Setting Groups. All R650 functions that are affected by setting groups are located in EnerVista 650 Setup under Protection (**Setpoints > Protection Elements > Setting Group X**). All these functions are grouped into each available setting group (up to 6).

5.5.2 Synchronism check element - Synchrocheck (25)

WARNING

When testing this function do not forget that the relay must detect an open recloser to operate.

The synchronism element is used for monitoring the connection of two parts of the circuit by the close of a recloser. This element verifies that voltages (V1 and V2) at both sides of the recloser are within the magnitude, angle and frequency limits set by the user. V1 and V2 are the line and busbar voltage values measured by the relay.

Synchronism check (25) is defined as the comparison of the voltage difference of two circuits with different sources to be either linked through an impedance element (transmission line, feeder, etc.), or connected through parallel circuits of defined impedance (Figure 5-29: Synchromism check element) The voltage comparison between both sides of a recloser is performed before closing the recloser, in order to minimize internal damage that can occur due to the voltage difference, both in magnitude and angle. This is extremely important in steam generating plants, where reclosing output lines with angle differences can lead to severe damage to the turbine axis.

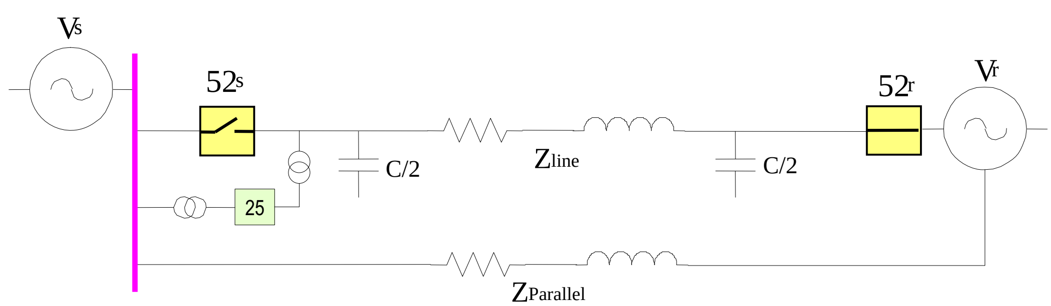


Figure 5-29: Synchromism check element

The difference in voltage level and phase angle in a given moment is the result of the existing load between remote sources connected through parallel circuits (load flux), as well as a consequence of the impedance of those elements connecting them (even if there is no load flux in parallel circuits, or because sources to be connected are completely independent and isolated from one another).

In interconnected systems, the angle difference between both ends of an open recloser is usually negligible, as its sources are remotely connected through other elements (equivalent or parallel circuits). However, in isolated circuits as in the case of an independent generator, the difference in angle, voltage levels and relative slip of voltage phasors can be very important. It may happen that the relative slip of voltage values is very low or null so that they are rarely in phase. Luckily, due to the changing conditions of a power system (connection-disconnection of loads, sources, and new inductive-capacitive elements) the relative slip between phasors is not null and they can be synchronized.

In the first case, even if we must take into consideration the length of the line whose ends (sources) are connected for determining the angle difference between them, this is not enough to fix the synchronism conditions before closing the recloser. Experience tells us that the window of angle difference between voltage phasors must be fixed to a value of 15°-20°.

5.5.2.1 Voltage inputs

In order to perform the synchronism check function, the R650 uses only one voltage from each end of the recloser. Voltage values to be compared must be on the same basis. Additional settings also have influence in the synchrocheck element.

Setpoint > System Setup > Source Volt. Sensing

Name	Default Value	Unit	Range
Source VT Ratio	1000		[1 : 1000]

Volt Rated Sec LEA	2.00	V	[0.50 : 10.00]
Phase VT Connection	WYE		[WYE – DELTA]

The voltage used as the reference is the selected channel on the frequency reference settings.

Setpoint > System Setup > Load Volt. Sensing

Name	Default Value	Unit	Range
Load VT Ratio	1000		[1 : 1000]
Volt Rated Sec LEA	2.00	V	[0.50 : 10.00]
Phase VT Connection	WYE		[WYE – DELTA]

The voltage used as the reference is the selected channel on the frequency reference settings.

The **Load and Source voltages** are taken as **phase-to-phase voltages** when both the load and source configuration settings allow it.

The following table shows all possibilities.

Load VT Connection	Source VT Connection	Frequency Reference	Voltage Reference
WYE/DELTA	WYE/DELTA	VI	VAB
WYE/DELTA	WYE/DELTA	VII	VBC
WYE/DELTA	WYE/DELTA	VIII	VCA

The Voltage reference is the base voltage for the synchronism settings. When the voltage reference is in the Invalid state, the synchronism element is automatically disabled.

The actual values of the Load Voltage and Source Voltage pane show the value of the selected voltage reference

5.5.2.2 Settings

There is only one synchrocheck element in the R650.

Setpoint > Control Elements > Synchrocheck				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Synchrocheck algorithm selection	Sync Type	TRADITIONAL	N/A	[TRADITIONAL – PREDICTIVE]
Dead Load – Dead Source Function permission	Dead Load - Dead Src	DISABLED	N/A	[DISABLED – ENABLED]
Live Load – Dead Source Function permission	Live Load - Dead Src	DISABLED	N/A	[DISABLED – ENABLED]
Dead Load – Live Source Function permission	Dead Load - Live Src	DISABLED	N/A	[DISABLED – ENABLED]
Dead source voltage level	Dead Src Level	0.10	0.01 x VT (S)	[0 : 1.25]
Live source voltage level	Live Src Level	0.150	0.01 x VT (S)	[0.03 : 1.25]
Dead load voltage level	Dead Load Level	0.10	0.01 x VT (L)	[0 : 1.25]
Live load voltage level	Live Load Level	0.50	0.01 x VT (L)	[0.03 : 1.25]
Voltage Difference	Max Volt Difference	1000.0	V	[0.0 : 30000.0]
Frequency Slip	Max Freq Difference	20	10 mHz	[10 : 5000]
Angle Difference	Max Angle Difference	10.0	0.1 Deg	[2.0 : 80.0]
Recloser Closing time	RCL Closing Time	0.10	0.01 s	[0.01 : 0.30]
Maximum allowed closing angle	Max Allowed CLS Angle	45.0	0.1 Deg	[0.0 : 179.0]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Settings description for element 25:

Function permission (Function): This setting allows enabling and disabling the synchrocheck element.

Sync Type: This setting allows the user to select between traditional synchrocheck algorithm and the predictive synchrocheck algorithm. Traditional does not have into account the recloser closing time.

Voltage Level determination settings for source and load:

This setting group allows determining the voltage levels considered as dead and live for source and load voltage.

Dead Source voltage level (Dead Source Level): Voltage level considered as dead source

Live Source voltage level (Live Source Level): Voltage level considered as live source

Dead Load voltage level (Dead Load Level): Voltage level considered as dead load

Live Load voltage level (Live Load Level): Voltage level considered as live load

Synchrocheck settings (live source, live load):

R650 relays verify synchronism by establishing and comparing three basic parameters: the difference in module and angle of voltage phasors, and the frequency slip of a phasor related to the other one. Synchrocheck settings include a fourth time setting, that allows using an anticipative algorithm to issue a closing signal.

Voltage Difference (Max Volt Difference): Maximum Difference in module between the load and source voltage to allow a closing in the synchrocheck element.

Angle Difference (Max Angle Difference): Maximum Difference in angle between the load and source voltage to allow a closing in the synchrocheck element.

Frequency Slip (Max Freq Difference): Maximum difference in frequency (slip) between both voltage values to be compared in the synchrocheck element.

Recloser Closing time (RCL Closing Time): Estimated recloser Closing time, used for establishing the Closing order in a moment that allows the source and load voltages to be in phase. For proper operation, the operation time (8-10ms) for standard outputs (i.e. output sfor I/O board type 1 and 2) should be taken into account when configuring this value

This time is considered if the relative slip is higher than 20 mHz; in this case, an anticipative algorithm is executed to calculate the closing signal with the necessary advance for the recloser effective Closing to be produced when voltages are in phase. The limit for the anticipative algorithm is two times the maximum angle difference. This means that if the product of the frequency slip multiplied by the recloser closing time covers an angle greater than two times the maximum angle, closing is not allowed. For further information see 5.5.4.5.

Closing permission logic settings:

In case that the voltage at one or both ends of the recloser is null, the synchronism element cannot establish the necessary parameters to give closing conditions, and therefore it does not issue synchronism permission. For those situations where the user wants to enable the closing permission in a condition of loss of one or both voltages at both ends of the recloser, R650 elements incorporate closing permission logics for the cases of: dead load-dead source, live load-dead source and dead load-live source.

Dead Load- Dead Source Function permission: Enabling this Function allows issuing a Closing permission signal in dead load and dead source Condition (without voltage at both sides of the recloser).

Live Load- Dead Source Function permission: Enabling this Function allows to issue a Closing permission signal in live load and dead source Condition (without voltage at the sides of the recloser that corresponds to the source voltage)

Dead Load- Live Source Function permission: Enabling this Function allows issuing a Closing permission signal in live load and dead source Condition (without voltage at the sides of the recloser that corresponds to the load voltage).

Snapshot event: The snapshot event setting enables or disables the snapshot event generation for this element.

5.5.2.3 Synchrocheck states

Internal signals provided by the R650 (***Actual> Status > Control Elements > Synchrocheck***) for the synchronism element are as follows:

Table 5-65: Synchrocheck internal states

SYNCHROCHECK ACTUAL VALUES
SYNCHROCHECK BLK INP
SYNCHROCHECK OP
SYNCHK CLOSE PERM
SYNCHROCHECK COND OP
DEAD LOAD - DEAD SRC
DEAD LOAD - LIVE SRC
LIVE LOAD - DEAD SRC
SLIP CONDITION
SEC FREQ > LOAD FREQ
SEC FREQ < LOAD FREQ
FORCE SYNC TRAD
MAX FREQ DIFFERENCE
VOLTAGE DIFFERENCE
FREQ DIFFERENCE
SYNCHK VOLT REFERENCE

SYNCHROCHECK BLK INP: Block signal for the synchrocheck unit, configurable at **Setpoint > Relay Configuration > Control Elements**

SYNCHROCHECK OP: Closing permission signal in live load – live source conditions with an open recloser.

SYNCHK CLOSE PERM: General Closing permission of the Synchronism unit. It contemplates all possible situations, live load – live source conditions, and the closing permission logics (dead load – dead source, live load – dead source, dead load – live source). **Note**: in case the Function is disabled, the Closing permission signal is activated in order not to interfere with possible logics where it is included. If the synchronism unit is enabled, this signal only activates under the closing conditions established by setting.

SYNCHROCHECK COND OP: Closing permission according to permission logics.

DEAD LOAD - DEAD SRC: Closing permission in dead load – dead source condition.

DEAD LOAD - LIVE SRC: Closing permission in dead load – live source condition.

LIVE LOAD - DEAD SRC: Closing permission in live load – dead source condition.

SLIP CONDITION: Internal signal indicating frequency slip between the load voltage and source voltage phasors.

SEC FREQ > LOAD FREQ: Source Frequency higher than load frequency

SEC FREQ < LOAD FREQ: Source Frequency lower than load frequency

FORCE SYNC TRAD: This signal indicates that the traditional type has been forced by means of the dedicated input.

MAX FREQ DIFFERENCE: This signal indicates that the difference in frequency between the source and the load voltages is greater than the setpoint for frequency difference.

VOLTAGE DIFFERENCE: Voltage difference between the load and the source in volts (secondary values), only available if the Synchrocheck element is enabled.

FREQ DIFFERENCE: Frequency difference between the load and the source in Hz, only available if the Synchrocheck element is enabled.

SYNCHK VOLT REFERENCE: Indicates the phase that is being used for calculating the differences in magnitude, phase and frequency.

Voltage and frequency values for the load and source can be obtained, both in primary and per unit values at:

Actual> Metering > Primary Values > Source / Load Voltage

Source Voltage (kV) Source voltage in primary values

Actual> Metering > Per Unit Values > Source / Load Voltage

Load Voltage (kV) Load voltage in primary values

Actual> Metering > Frequency

Load Frequency (Hz) Load frequency in Hz

Source Frequency (Hz) Source frequency in Hz

5.5.2.4 Algorithm

R650 elements perform the synchronism check by basically establishing and comparing three parameters:

Module difference of voltage phasors DV (V)

Phase angle of voltage phasors Dj (°)

Frequency slip between two phasors S (Hz)

These parameters are continuously determined and managed once that element 25 has been enabled by setting, and in open recloser conditions. It is necessary to consider that all calculations are made once the open recloser condition is detected; if the recloser is closed or undefined, the synchronism element does not issue a closing permission signal, even when closing conditions are met.

If voltage on one side of the recloser to be closed is null, the synchronism element cannot establish the synchronism check, and therefore it does not issue synchronism permission. For these cases, usual in recloser maintenance situations, or in new installations where voltage might not be present, but the recloser operation needs to be verified, R650 elements incorporate closing permission logics for situations of:

Dead Load – Dead Source

Live Load – Dead Source

Dead Load – Live Source

In order to establish the closing permission signal, the first parameter used by the algorithm is the difference in magnitude between load and surce voltages, and afterwards, the angle difference and frequency slip are verified.

Voltage Difference DV

Comparing the voltage values for load voltage (V1) and source voltage (V2) at both sides of the recloser, the relay can determine the synchronism situation of the element (see Table 5-66: Synchronism conditions).

Being:

V_1 load voltage

V_2 source voltage

V_L Minimum acceptable voltage by setting to establish synchronism conditions (dead load and source levels).

V_H Appropriate voltage to establish synchronism conditions, configured by setting (live load and source levels).

Table 5-66: Synchronism conditions

Synchronism Situation	Synchronism check	Closing logic	load voltage levels	Source voltage levels
(1) $V_L < (V_1 \& V_2) < V_H$	Not permitted	Not permitted	V1 > dead load level V1 < live load level	V2 > dead source level V2 < live source level
(2) $(V_1 \& V_2) > V_H$	Permitted	Live Load – Live Source	V1 > live load level	V2 > live source level
(3) $(V_1 \& V_2) < V_L$	Not permitted	Dead Load – Dead Source	V1 < dead load level	V2 < dead source level

(4) $(V_1 < V_L)$ & $(V_L < V_2 < V_H)$	Not permitted	Not permitted	V1 < dead load level	V2 > dead source level V2 < live source level
(5) $(V_2 < V_L)$ & $(V_L < V_1 < V_H)$	Not permitted	Not permitted	V1 > dead load level V1 < live load level	V2 < dead source level
(6) $(V_1 < V_L)$ & $(V_2 > V_H)$	Not permitted	Dead Load – Live Source	V1 < dead load level	V2 > live source level
(7) $(V_2 < V_L)$ & $(V_1 > V_H)$	Not permitted	Live Load – Dead Source	V1 > live load level	V2 < dead source level

Table 5-66: Synchronism conditions shows the different synchrocheck and closing logic situations, that can be produced depending on the load and source voltage levels.

Live Load – Live Source (Synchronism check): Only in case number (2), with live load and live source, the element starts evaluating the load and source voltage comparison with respect to the setting **DV**$_{set}$ established by setting (Max Volt Difference). In this case, if the voltage difference is lower than **DV**$_{set}$, the synchronism check element (25) verifies the angle difference **Dj** adjusted by setting (Max Angle Difference).

Dead Load – Dead Source: Case number (3) does not allow the synchronism function, but it does allow DL-DB operation logic, if this logic is enabled by setting (DL-DB Function).

Dead Load – Live Source: Case number (6) does not allow the synchronism function, but it does allow DL-LB Operation logic, if this logic is enabled by setting (DL-LB Function)

Live Load – Dead Source: Case number (7) does not allow the synchronism function, but it does allow LL-DB operation logic, if this logic is enabled by setting (LL-DB Function)

Case numbers (1), (4) and (5) are not considered neither for synchronism check purposes, nor for closing logic.

Phase Angle Difference Dj

In the live load-live source Condition, once the voltage difference has been successfully verified in magnitude, the system establishes the angle difference between both voltage phasors. If the angle difference is lower than the **Dj**$_{set}$ (Max Angle Difference) setting, then the system verifies the frequency slip **S** (Max Freq Difference).

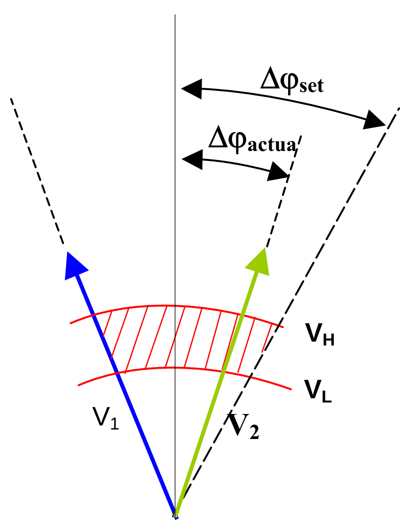


Figure 5-30: Voltage angle difference

In the live-live source condition, once the voltage difference has been successfully verified in magnitude, the relative frequency slip between phasors is calculated. From the information obtained from the relay, the algorithm knows the slip (mHz) of both phasors,and it takes as reference (VRef) the lowest frequency phasor. The behaviour of the algorithm depends on the slip frequency and the recloser close time as follows:

1. If the relative slip, Δf, is equal or lower than 20 mHz, the algorithm gives permission to close as soon as the angle difference is slower than the Δ?set (Max Angle Difference), because at such a low speed, the hold time for getting an "in-phase" closing permission would be too long.
2. If the relative slip is higher than 20 mHz, the element performs an anticipative algorithm, determining the right moment to give the closing command to the recloser, so that the recloser closes when the load and source voltages are in phase. When the difference between voltage values equals "two times" the set angle as maximum angle difference (ΔV = ΔVset), the anticipative algorithm starts running and uses the set recloser closing time to establish the initiation of permission, so that it is executed in the moment when both voltage phasors are completely in phase, thus minimizing the voltage difference in the recloser chamber to negligible values. The main benefit is that after a considerable number of recloser operations, damage to internal connection elements, as well as to the chamber isolating element is drastically reduced, ensuring a longer life for the recloser, and reducing costly maintenance operations.
3. If the product of frequency slip and recloser closing time is higher than Max Angle difference and lower than two times this setting, as an in phase close is not possible, the algorithm ensures that the difference between voltages in the real closing moment is not higher than the set value (Max Volt Difference).
4. If this product is beyond two times Max Angle difference, closing operation is not allowed.

The Closing process using anticipative algorithm is described on the following figure:

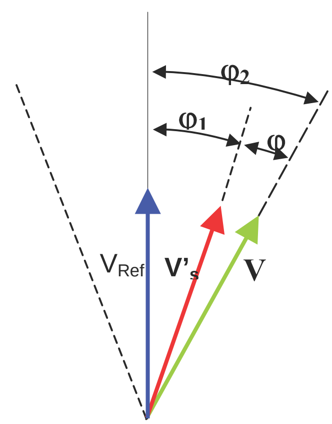


Figure 5-31: Anticipative algorithm

Where:

V_{ref} Referenced phasor (the one with lower frequency)

V_s Actual voltage phasor (the one with lower frequency)

V'_s Calculated voltage phasor, depending on the set recloser closing time (anticipative algorithm)

j 360º *TCB *Df = Calculated angle for phasor V'_s

TCB Recloser Closing time defined by setting

Df Frequency slip (mHz) between phasors

j_1 Angle difference set as maximum angle difference (**Dj_{set}** , Max Angle Difference)

j_2 = Angle difference between V_{ref} and V_s. The algorithm starts operating when **j_2** equals two times the angle set as maximum angle difference.

Closing permission is given when **V'_s** is over **V_{ref}**, which means that load and source voltages are in phase.

If the frequency slip is high, it is possible that as soon as the window defined by two times the maximum angle difference (**j**$_2$) is entered, the relay produces a closing permission output, if it is guaranteed that the projected phasor is within the limit marked by the setting, as shown in the following figure. Besides, when the product of frequency slip and recloser close time goes beyond this window, closing is not allowed.

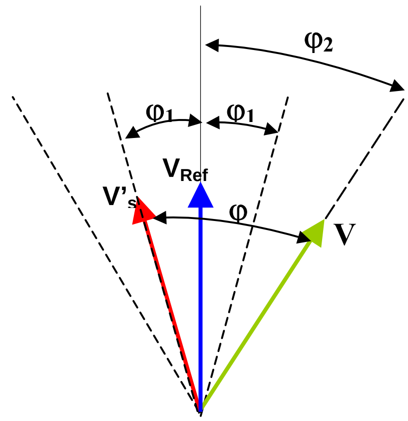


Figure 5-32: High slip closing permission signal

5.5.3 Autoreclose (79)

Note: Configuration of these Switchgear parameters is performed at **Setpoint > Relay Configuration > Recloser** using the EnerVista 650 Setup software.

The Autoreclose element of the R650 is a powerful feature that provides either one three-phase recloser or three single-phase reclosers. The autoreclose scheme, in addition to the powerful PLC, switchgear controls, and protection units, make the R650 one of the most complete autorecloser device available for majority distribution applications.

The R650 is intended for use on distribution lines with circuit reclosers operated in single pole and three pole modes. It offers up to 4 reclosing shots with separately programmable 'dead times' for each shot. The Autorecloser can be programmed to handle separate reclosers/reclosers per phase, with each phase working independently, or programmed as a three-phase Autorecloser controlling all three phases at the same time. The type of reclosing scheme used is not only accessible by settings; it can also be switched dynamically through the Autorecloser logic. Dynamic change is useful in seasons or periods of times when single-phase tripping and reclosing are not allowed by the electrical distribution system, mainly due to characteristics of the load.

The working mode of the Autorecloser depends on the RECLOSER TYPE selected under **Setpoint > System Setup > Recloser > Recloser Settings**. The recloser type allows to select between single-phase recloser or three-phase recloser:

- Single-phase recloser is a recloser with three separate poles. Each pole can be controlled separately.
- Three-phase recloser is a recloser with three poles. The poles cannot be operated independently.

The following sections provide a further description of the recloser functionality.

5.5.3.1 Autoreclose functional description

The Autorecloser (AR) is based on up to four independent State-Machines.

In single-phase mode, one state-machine operates on each phase. The states of each state-machine are:

1.AR PHA/B/C BLOCK

2.AR PHA/B/C READY

3.AR PHA/B/C IN PROGRESS

4.AR PHA/B/C LOCKOUT

For three-phase recloser types or single-phase reclosers working in 3-Pole mode, **TRIPMODE = 3 POLE** under **Setpoints > System Setup > Single/ Three Pole Trips** settings.

1.AR 3P BLOCK

2.AR 3P READY

3.AR 3P IN PROGRESS

4.AR 3P LOCKOUT

The next diagram shows how enabling the state-machines depends on the recloser type that is being controlled and on the selected trip mode programmed:

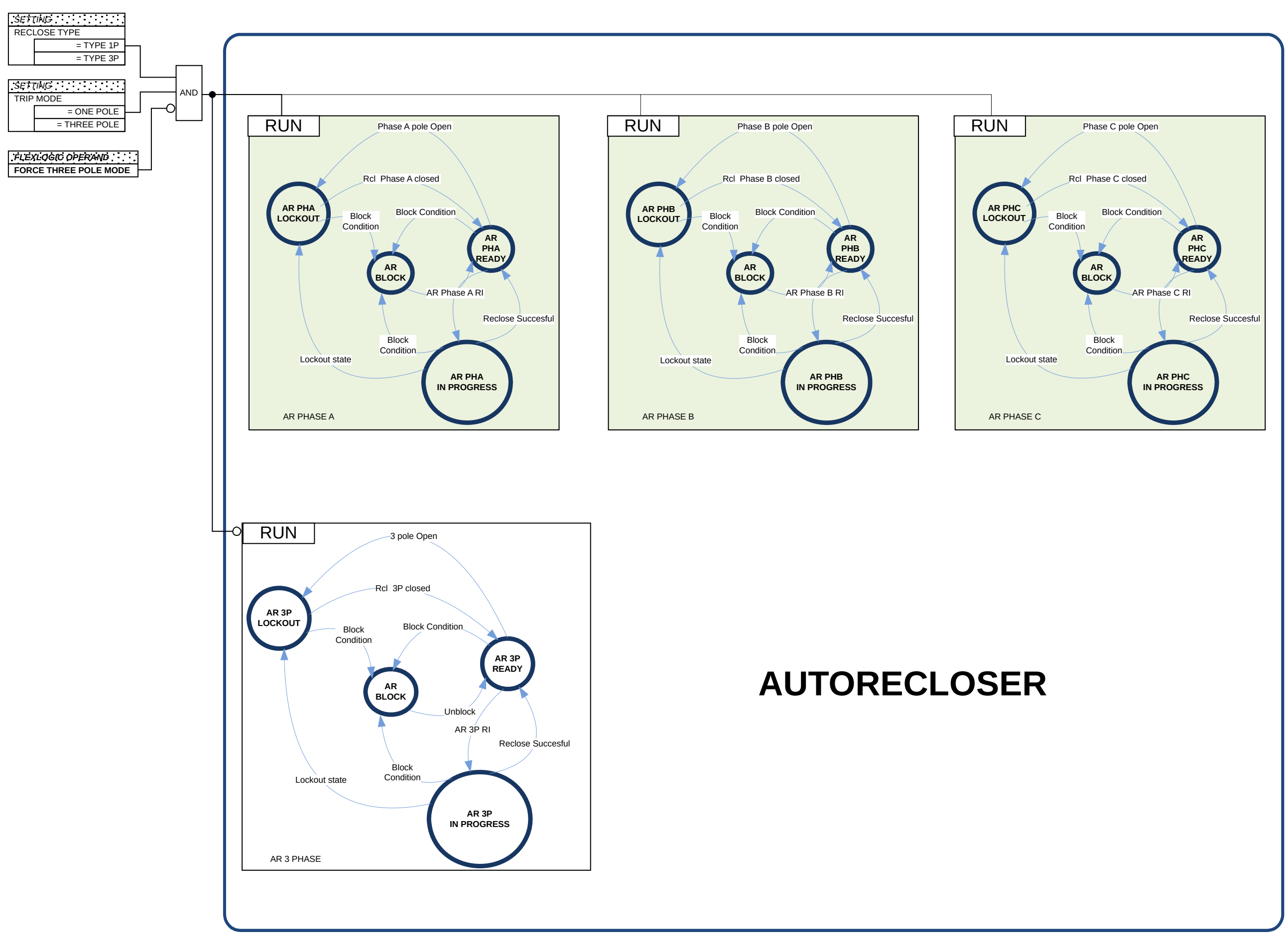


Figure 5-33: General autoreclose states

The logic diagram Figure 5-34: Autoreclose logic, phase A (/B/C) depicts the logic of the Autorecloser for the state-machine linked to phase A, with the same logic applied to the phase B and phase C. Logic diagram Figure 5-35: Autoreclose logic, 3 phase shows the 3 Phase Autorecloser scheme.

As has been explained earlier, the single-phase reclosing - the three state machines in green in Figure 5-33: General autoreclose states - is available only when single-phase reclosers are chosen and one-pole trip mode is allowed. The three-phases reclosing logic is available for single-pole reclosers if the three-phase trip mode is chosen by settings or when working in the single-pole scheme, the autorecloser is forced to work in three-phase mode by means of the FORCE THREE POLE MODE input. The state-machine in white is enabled for this case whereas the green state-machines are disabled.

Note: For three-phase reclosing scheme acting over single-pole recloser, the AR CLOSE 3P operand should be programmed to open each phase of the recloser. See how to configure the recloser settings in the Reclose/Recloser logic configuration.

The internal states of each AR state-machine are defined herein. The states are exclusive, with only one state active at a given time. The following logic diagrams show the selection between states. When the AR FUNCTION is disabled, all internal states are cleared. Once the AR FUNCTION is enabled, the AR goes by default directly to the Lockout state.

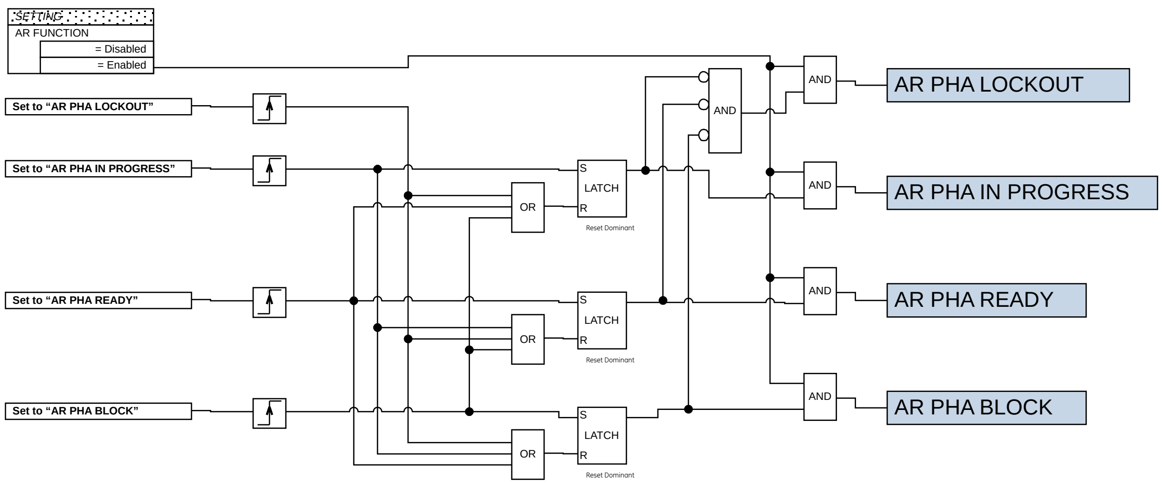


Figure 5-34: Autoreclose logic, phase A (/B/C)

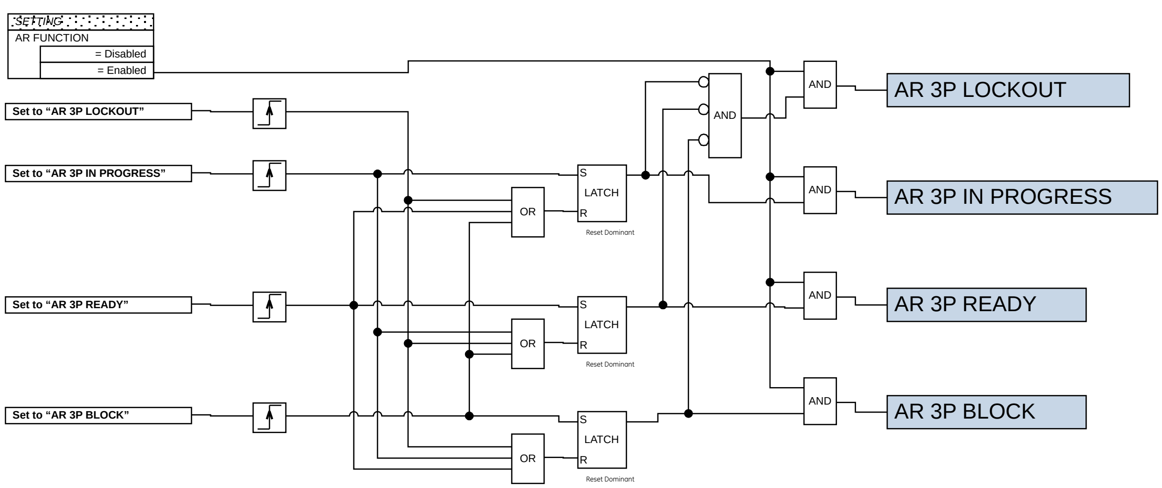


Figure 5-35: Autoreclose logic, 3 phase

AR 3P/PHA/PHB/PHC BLOCK

When the AR is in BLOCK state, the Autorecloser is out of service. There are two ways to send the autorecloser to the block state:

1. By raising the AR BLOCK INPUT. This input is configured in R**elay Configuration > Control Elements Pane**.
2. By temporarily activating the AR BLOCK PULSE input for more than 5 ms.

The AR will remain in the block state until the AR BLOCK INPUT deactivates. In cases when the blocking state was reached after receiving one AR BLOCK PULSE, an AR UNBLOCK PULSE command should be issued to unblock it.

After unblocking, the AR proceeds to the READY STATE without waiting the reclaim or reset time.

AR 3P/PHA/PHB/PHC READY

There are two ways to send the autorecloser to the READY state:

1. From the LOCKOUT state, the AR of one pole / three poles passes to the READY state if the single-pole / three-pole recloser of AR is closed for the reclaim time.
2. From the IN PROGRESS state, after a complete reclosing cycle, the AR moves to the READY state when the reset time expires.

The AR 3P/PHA/PHB/PHC remains in the READY state until the reclose initiation (AR RI 3P, AR PHA RI, AR PHB RI, AR PHC RI) input is raised. Then, the state changes to AR 3P/PHA/PHB/PHC IN PROGRESS.

If the single pole/three pole recloser is manually opened without receiving any AR RI input, the AR PHx/ AR 3P goes to the AR PHx / 3P LOCKOUT state.

AR 3P/PHA/PHB/PHC IN PROGRESS

The AR 3P/PHA/PHB/PHC will pass to 'AR 3P/PHA/PHB/PHC IN PROGRESS' state after staying in 'AR 3P/PHx READY' state and the reclose initiate input is raised.

In this state, the complete AR sequence passes through 4 stages:

1. AR WAIT TO OPEN: In this stage the AR checks the deactivation of the reclose initiation (RI) and the opening of the recloser for the 'Wait to open' time. If these conditions are not fulfilled in the expected time, the AR is sent to the 'AR Lockout State'.
2. AR TIME TO CLOSE: In this stage, the AR loads the internal reclosing timer with the "AR DEAD TIME #" that corresponds to the actual shot counter.

   After the Dead Time elapses, the SHOT COUNTER is increased and the AR advances to the third stage.

   If an AR SKIP SHOT input is raised before this time has elapsed, the AR SHOT COUNTER is incremented. The DEAD TIME timer is RESET and the 'DEAD TIME #' of the new shot counter is loaded.

   If the actual Shot Counter is higher than the maximum programmable counter, the AR is sent to the 'AR Lockout State' without completing the reclosing cycle.

   If a new Reclose initiate is raised during the counting period, the AR goes to the 'AR Lockout State'.
3. AR WAIT CLOSE CONDITIONS: In this stage the AR sends the close signal and waits for the recloser or the linked phase of the reclose to be closed. If the CLOSE CONDITIONS setting has been enabled, the AR waits to receive the 'AR CLS CONDITION' during the RCL CONDITION TIMER before sending the close signal. If the counter times out without closing conditions, the AR is sent to the 'AR Lockout State'.

   After the close signal is raised, the AR waits the closing time programmed in the control of the switchgear to detect the close of the recloser. If the recloser has not closed and the RCL FAIL TO CLOSE signal is received, then the AR is sent to the 'AR Lockout State'.

   If the recloser is opened, the AR passes to the AR TIME TO RESET stage.
4. AR TIME TO RESET: In this stage the AR waits the RESET TIME before passing to the 'AR 3P/PHA/PHB/PHC READY' state. When the counter times out, the SHOT COUNTER is cleared and all internal timers that belongs to the 'AR IN PROGRESS' state are reset, finalizing the reclosing cycle.

   If during the RESET TIME a new reclose initiation is received, the AR continues to the first stage: 'AR WAIT TO OPEN'.

AR 3P/PHA/PHB/PHC LOCKOUT STATE

The 'AR 3P/PHx LOCKOUT is the initial state after the auto-recloser is enabled. The AR remains in this state until these two conditions are satisfied:

1. There is not any Lockout input activated, that forces the AR to stay in Lockout.
2. The recloser has been closed and remained closed for the reclaim time.

After the two conditions are fulfilled, the 'AR 3P/PHx Lockout State' operand is set to 'None' and the AR passes to the 'AR 3P/PHx READY' state.

As described above, the Lockout state can be reached many different ways. The 'AR 3P/PHx Lockout State' operand records the cause of the lockout conditions. This is an enumerated operand with the next possible values:

AR LOCKOUT STATE	VALUE
NONE	0x00
RCLS OPEN MANUALLY	0x01
RCLS FAIL TO CLOSE	0x02
RCLS MAX NUMBER OF SHOTS	0x04
AR FAIL BY CONDITIONS	0x08
RCLS FAIL BY ANOMALY	0x10
RCLS FAIL TO OPEN	0x20
RCLS MAX HALT TIME	0x40
RCLS DIRECT TO LOCKOUT	0x80

The R650 has been designed with the flexibility to configure the controller for the majority of applications. Using available settings, the R650 can force the Autorecloser to pause, go directly to the lockout state, increase the shot number, and coordinate with a downstream recloser.

Examples of application modes that can be obtained with the R650:

- **Single-phase trip / Single-phase lockouts**. Single Pole tripping and reclosing are allowed. The lockout of a single phase is permitted regardless of the state of the remaining phases. In this case, the distribution system is allowed to work feeding energy with one phase or two phases opened.
- **Single-phase trip / Three-phase lockout**. This scheme can be achieved by adding some PLC equations. Single-phase trip and reclosing are allowed, but if one phase trips to lockout, the other poles are opened and forced to lockout.
- **Three-phase trip / Three-phase lockout**. Only three phase trips and reclosing are allowed.

Autorecloser HALT input

The AR Halt input pauses the timers of the AR state machine. This input affects to the timers located inside the 'AR 3P/PHx IN PROGRESS' state:

- AR WAIT TO OPEN
- AR DEAD TIMER
- RCL COND TIMER
- AR RESET TIMER

The remaining timers are not affected by this input. If the AR Halt Input remains asserted for longer than the RCL HALT TIMER, the AR goes to the 'AR LOCKOUT' state.

When this input is raised, the AR is frozen without evolving to any other state until the input is deactivated or the time has expired.

NOTICE The 'Fail to open', 'Fail to close' timers linked with the input reclosers are not affected by the status of this input.

Autoreclose SKIP SHOT input

The AR 3P/PHx SKIP SHOT input is evaluated when the AR is executing the reclose cycle (AR 3P/PHx IN PROGRESS). It remains in the second stage, AR TIME TO CLOSE, of the 'AR 3P/PHx IN PROGRESS' state where the AR 3P/PHx SKIP SHOT input is evaluated approximately every 5 ms. When the input is raised, the AR DEAD TIME is reset and the AR 3P/PHx SHOT COUNTER is incremented.

If the AR 3P/PHx SHOT COUNTER reaches the maximum number of shots, the AR 3P/PHx LAST SHOT operand is raised. If the AR 3P/PHx SHOT COUNTER exceeds the number of available shots, the AR is sent to 'AR 3P/PHx LOCKOUT' state by 'RCLS MAX NUMBER OF SHOTS'.

Autoreclose Zone Coordination

The Autoreclose scheme can be programmed to maintain the coordination of Overcurrent elements in the R650 with downstream reclosers. Zone coordination avoids having the R650 overreach for faults beyond the downstream reclosers. To manage this, the 'AR COORDINATION' state is used. Three conditions must be fulfilled:

1. The 'AR PH/3P COORDINATION' state is kept raised at least for the 'RCLS COORDINATION' time.
2. The Recloser is kept closed and without any trip conditions during the reclose coordination period.
3. The 'AR PH/3P COORDINATION' state operand deactivates.

The activation / deactivation of the Zone coordination input means that a downstream Autorecloser has operated to clear a fault. By incrementing the SHOT COUNTER of the recloser, coordination with the downstream recloser is achieved.

The AR SHOT COUNTER is clear after the AR remains in the 'AR READY' state for longer than the 'AR RESET SHOT TIMER'.

The Zone coordination state is assigned under **Relay Configuration > Control Element**.

The upstream recloser coordinates with the downstream recloser by means of the pickup of an enabled phase time-overcurrent function. The pickup state is used to assert the coordination input. In cases where the pickups of the phase-time overcurrent of downstream reclosers are set with lower current values than the upstream R650, another spare phase time-overcurrent can be used for coordination.

The R650 has up to 6 phase time-overcurrent elements per setting group that can help to achieve this.

Reclosing scheme based on load

Supposing a recloser is located downstream, and working in one or two pole-open schemes such that the ground fault sensitivity is lost. The protection located at the start of the feeder can also be affected by the downstream reclosing scheme. In some applications, the limitation of the ground sensitivity can be affordable while in other applications, an excessive unbalance produced with one pole or two poles opened cannot be allowed.

In the first case, single-pole reclosing schemes may be allowed. However, for the second case only a three-phase reclosing scheme should be permitted. An algorithm can be configured in the R650 PLC to change between a single-pole and a three-pole reclosing scheme.

For instance, if opening one or two phases on the downstream recloser generates a current unbalance at the feeder relay exceeding 50% of the ground protection pickup, only three phase reclosing schemes will be permitted. A single-phase reclosing scheme will be allowed in other cases.

This working model can be managed as shown in the following logic diagram:

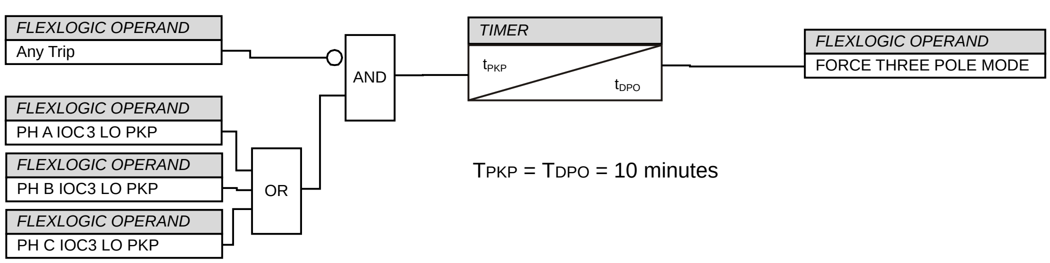


Figure 5-36: PLC Logic in R650: example forced three-pole mode based on load

One spare Phase instantaneous overcurrent element can be used for this logic, as a Load current detector. Once the Load current of one phase is higher than the selected pickup level for 10 minutes, the Force Three Pole mode is asserted. This operand forces the recloser to work in the three-phase reclosing scheme. If the Load lowers the pickup level for 10 minutes, the scheme switches back to the single-pole reclosing mode.

5.5.3.2 Main autoreclose settings

Autoreclose settings description:

Setpoint > Control Elements > Autoreclose			
Name	**Default Value**	**Step**	**Range**
Function	DISABLED	N/A	[DISABLED – ENABLED]
Max Number Shots	1	N/A	[1 : 4]
Dead Time 1	0.00	0.01 s	[0.00 : 900.00]
Dead Time 2	0.00	0.01 s	[0.00 : 900.00]
Dead Time 3	0.00	0.01 s	[0.00 : 900.00]
Dead Time 4	0.00	0.01 s	[0.00 : 900.00]
Reclaim Time	0.00	0.01 s	[0.00 : 900.00]
Reset Time	0.00	0.01 s	[0.00 : 900.00]
Halt Time	0.00	0.01 s	[0.00 : 900.00]
Cond. Permission	DISABLED	N/A	[DISABLED – ENABLED]
Cond. Time	0.0	0.01 s	[0.00 : 900.00]
Lockout Type	AUTOMATIC	N/A	[MANUAL – AUTOMATIC]
Coor. Time	0.0	0.01 s	[0.00 : 900.00]
Reset Shot Time	0.00	0.01 s	[0.00 : 900.00]
Sync Shots Counter	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

FUNCTION: This setting allows enabling or disabling the autoreclose operation. If this is set to DISABLED, the recloser is out of service and all AR states are cleared.

MAX NUMBER SHOTS: This setting specifies the number of autoreclose shots allowed in the element. If this number is exceeded, the autoreclose goes to LOCKOUT status, and the fault is considered to be permanent.

DEAD TIME 1 ... 4: This setting specifies the dead time delay before each reclosure. Up to 4 attempts occur in one complete reclose cycling. After the recloser is opened by the fault, the AR counts the dead time in a sequential order before sending the reclose command. The Dead Time 1 delay is applied on the initial reclose operation; dead Time 2 is applied after the first reclosure attempt and so on. The first dead time is often programmed to provide a fast reclose operation, however, it should be set longer than the estimated de-ionizing time following the opening.

RECLAIM TIME This setting specifies the minimum time delay needed to the Autoreclose to go to the ready state from the lockout state after the recloser has been manually close or a lockout reset is executed. Also known as **safety time** or **reset lockout delay**.

RESET TIME This is the time that the autoreclose takes to return to READY status after a successful reclose. Once this time has expired, the shot counter resets and the autoreclose goes to READY. If during the reset time another reclose is initiated, the autoreclose continues cycling until the extinction of the fault or until the maximum number of shots are reached.

HALT TIME The AR HALT INPUT operand allows freezing of the Autoreclose cycle until the halt signal deasserts. This input can be used in conjunction with the SKIP SHOT INPUT operand to temporarily stop the Autoreclose and change the SHOT COUNTERS.
One application for this setting is to synchronize the SHOT COUNTERS for single phase reclosers. When operating with three single-phase reclosers, the SHOT COUNTERS of each phase do not have to be synchronized. This can become an issue when working with a three-phase recloser device located upstream.
While the downstream recloser is provided with separate overcurrent element and independent autorecloser per phase, the upstream device can be using a three-phase overcurrent element. For multiphase or evolving faults, this situation can produce miscoordination between the upstream and the downstream recloser. This miscoordination can provoke several tripping and reclosing attempts of the upstream recloser until the maximum number of attempts or the lockout condition is reached. It this case, synchronization among SHOT COUNTERS per phases should be done downstream to avoid this issue.

COND. PERMISSION: This setting enables verification of the relay reclose conditions. If this setting is enabled, before the recloser closing command execution the system verifies the possible reclose conditions. If this setting is disabled, the closing command is executed after the reclose time without verifying these conditions. The reclose conditions input is configured as AR CONDS INPUT at ***Setpoint > Relay Configuration > Protection Elements***

COND. TIME: This setting indicates the maximum time the autoreclose checks for close conditions when in the reclosing cycle. Once the configured time has elampsed, the autoreclose goes directly to Lockout.

LOCKOUT TYPE: If set to AUTOMATIC, when in the autoreclose Lockout state, as soon as the recloser is closed the reclaim time starts to count. After the counter time out, the relay goes to READY state.
If set to MANUAL, the autoreclose remains in the Lockout state until the LOCKOUT RESET input is asserted.

COORD. TIME: This timer is used with the AR COORDINATION input. See 'Autoreclose Zone Coordination' for a description.

RESET SHOT TIME: Once the SHOT COUNTER has been incremented by AR COORDINATION input, this setting establishes witch is the maximum time the SHOT COUNTER is kept with this value before reset.
When autoreclose is in the READY state and after the SHOT COUNTER is increased, the reset shot counter time begins. Once the timeout is reached, the SHOT COUNTER is reset.

SYNC SHOT COUNTERS: Shot counters of phases are synchronized to the highest shot counter.
Once the SHOT COUNTER has been incremented by the AR COORDINATION input, this setting establishes the maximum time the SHOT COUNTER is kept with this value before reset.
When the autoreclose is in the READY state and after the SHOT COUNTER is increased, the reset shot counter begins. Once the timeout is reached the SHOT COUNTER is reset.

SNAPSHOT EVENTS: This setting enables or disables the snapshot event generation.

5.5.3.3 Autoreclose inputs

For the correct operation of the autoreclose element, it is required to configure several input signals in the Relay. These signals can be configured using the EnerVista 650 Setup software, at **Setpoint > Relay Configuration > Protection Elements**. The **Protection Elements** screen allows the selection of simple signals provided directly by the relay (***states***), or more complex logic using **virtual outputs**, configured at **Setpoint > Logic Configuration** using the PLC Editor tool inside EnerVista 650 Setup.

Table 5-67: Autoreclose (79) configurable inputs

AUTORECLOSE INPUTS
AR LEVEL BLOCK
AR PULSE BLOCK
AR PULSE UNBLOCK
AR INITIATE
AR CONDS INPUT

AR LEVEL BLOCK: This signal is configured to block the autoreclose by level; when the block signal disappears, the recloser goes to Lockout status before returning to either the READY status, or the corresponding status in the reclosing cycle.

AR PULSE BLOCK: This signal is configured to block the autoreclose by pulse; a pulse moves the autoreclose to BLOCK status. The autoreclose block is active until an unblock signal is received.

AR PULSE UNBLOCK: This signal is configured as autoreclose unblock by pulse; this pulse is required to bring the recloser out of the block status. The autoreclose goes to Lockout after a block situation.

AR INITIATE: This signal indicates the autoreclose initiation. Usually, the factory default configuration sets this signal as a combination of the general trip signal (Virtual Output 83), and an external input configured as AR Initiate.

AR CONDS INPUT: This signal configures the conditions that are to be met before executing a recloser close command. These conditions are verified once the configured ***Dead Time*** has expired, and they are only considered if the ***Cond. Permission*** setting is enabled. Otherwise, these conditions wouldn't have any effect. In the default factory configuration, the conditions input is associated with the synchronism check element close permission.

5.5.3.4 Autoreclose internal status

Actual> Status > Control Elements > Autoreclose. These signals can be used as conditions for executing logics in the relay; they also help explain the autoreclose behavior.

Table 5-68: Autoreclose (79) internal status

AUTORECLOSER STATUS	DESCRIPTION
LOCKOUT PHA/B/C RESET LOCKOUT 3P RESET	If Manual Reset has been chosen as Lockout type, the assertion of this input reset the Lockout state after the recloser is closed and reclaim time fulfilled.
AR BLOCK INPUT	During the assertion of this input, the Autorecloser stays in the AR BLOCK state.
AR BLOCK PULSE	A pulse on this state operand sends the Autorecloser to the AR BLOCK state. The AR will remain in this state until an AR UNBLOCK pulse is received.
AR UNBLOCK PULSE	A pulse on this state unblocks the recloser.
AR HALT INPUT	Once activated, the timers of the AR are freeze. This input affects to all timers in the 'AR IN PROGRESS' state.
AR FORCE 3P MODE	
AR PHASE A/B/C RI AR 3P RI	Reclose initiation of the reclosing cycle on phase A/B/C or 3-phase.
AR DTL PHA/B/C AR DTL 3P	Autorecloser of the phase A/B/C or 3-phase is sent to LOCKOUT state.
AR PHA/B/C COORD AR 3P COORD	The assertion of this input provides a way to increase the SHOT COUNTER PHA of the AR.
AR PHA/B/C CLS COORD AR 3P CLS COORD	
AR PHA/B/C SKIP SHOT AR 3P SKIP SHOT	The activation of this input when AR is in 'AR PROGRESS' state increases the SHOT COUNTER PHA/B/C or 3P.
AR CLOSE PHA/B/C AR CLOSE 3P	This operand is sent to close phase A/B/C/3P of the recloser.
AR PHA/B/C LOCKOUT AR 3P LOCKOUT	Autoreclose in Lockout state
AR PHA/B/C IN PROGRESS AR 3P IN PROGRESS	Autoreclose is in the progress state, leading into a reclosing cycle
AR PHA/B/C READY AR 3P READY	Autoreclose is ready waiting for a reclose initiate event.
AR PHA/B/C BLOCK AR 3P B BLOCK	Autoreclose Blocked
AR PHA/B/C SHOT 0 / 1 / 2 / 3 / 4 AR 3P SHOT 0 / 1 / 2 / 3 / 4	Up to five separate shot counter operands are available. This state activates when the shot counter equals the actual number of shot.
AR PHA/B/C LAST SHOT AR 3P LAST SHOT	This state is raised when the last shot is reached.
AR DEAD TIME PHA/B/C AR DEAD TIME 3P	
AR RECLAIM TIME PHA/B/C AR RECLAIM TIME 3P	
AR RESET TIME PHA/B/C AR RESET TIME 3P	

AR PH A/B/C LCK AR 3P B LCK	This state keeps the cause that forces the Lockout State. NONE - Any Lockout cause. RCLS OPEN MANUALLY- A manually open of the phase A of the recloser has been produced during the reclosing cycle. RCLS FAIL TO CLOSE- The Phase A of the recloser has not closed as expected during the reclosing cycle. RCLS MAX NUMBER OF SHOTS- The maximum number of Shots has been reached. AR FAIL BY CONDITIONS- The Conditions before sending the CLOSE command are not fulfilled. RCLS FAIL BY ANOMALY- A Reclose initiate has been received during the reclose in progress cycle with the recloser open. RCLS FAIL TO OPEN- The Phase A of the Recloser has not been opened after reclose initiation input. RCLS MAX HALT TIME- The Autorecloser has been halted for more than the expected time.
AR PHA/B/C IN PRG AR 3P IN PRG	This operant keeps the internal state of the AR when the relay is into a reclosing cycle of the phase A. AR WAIT TO OPEN- The AR waits the recloser of phase A to be opened AR TIME TO CLOSE- The AR waits the braker of the phase A to be closed. AR WAIT CLOSE COND- The AR Waits the close conditions before sending the AR CLOSE PHASE A signal AR TIME TO RESET - The AR is waiting the reset timeout AR HALTED- The AR is in HALTED state
AR PHA/B/C STATE AR 3P STATE	
AR SHOT COUNTER PHA/B/C AR SHOT COUNTER 3P	
AutoRecSt 61850 PHA/B/C AutoRecSt 61850 3P	

5.5.3.5 General autoreclose status

Description of the general autoreclose status:

OUT OF SERVICE / AR DISABLE

In this status, the autoreclose is disabled. From any state, if the *Function* setting is set as DISABLED, the autoreclose moves to OUT OF SERVICE status, where it is not operative.

AR READY

This is the initiation and normality situation status: closed recloser. There are neither faults producing a autoreclose initiation nor Block signal.

If the autoreclose was in LOCKOUT, if the recloser is closed and the time set in *Reclaim Time* setting expires, the autoreclose goes to the initial status of READY.

From RECLOSE IN PROGRESS, the recloser moves to READY, if the *Reset Time* setting expires without any autoreclose initiation condition.

AR RECLOSE IN PROGRESS

From READY status, a reclose initiation sets the cycle counter to 1 and a reclosing sequence is initiated which sproduce recloser close commands, unless any abnormality is produced that makes the autoreclose go to LOCKOUT status.

The reclosing sequence consists on the following steps:

Wait until the recloser is open, if the waiting exceeds the ***Fail to Open Time*** setting, the autoreclose goes to LOCKOUT by failure of opening status (AR LCK BY FAIL OPEN).

Once the recloser is open, it waits for the time set in the ***Dead Time N*** setting, *N* being the number of the cycles in progress. If during this waiting the recloser is closed or reclose initiation conditions are given, the recloser goes to LOCKOUT status by anomaly (AR LCK BY ANOMALY).

Once the Dead Time has expired, in case the ***Conditions Permission*** setting is disabled, a closing command would be produced. If the conditions permission setting is enabled, the system waits for the conditions fixed in the conditions input (AR CONDS INPUT) configured at ***Setpoint > Relay Configuration > Protection Elements***; if the waiting period for the reclosing conditions signal activation exceeds the ***Hold Time***, the autoreclose goes to Lockout status by conditions (AR LCK BY CONDS).

The autoreclose gives a Closing command and waits for the recloser to close. If the ***Fail to Close Time*** setting is exceeded, the autoreclose goes to lockout by failure to close (AR LCK BY FAIL CLOSE).

At this point, the diagram indicates that a reclosing cycle has been reached, and so the cycle counter is increased. In this time, the period set in ***Reset Time*** starts to count. If during the set element reset time there is no autoreclose initiation, the cycle counter resets to its initial value (1), and the autoreclose returns to the standby status (READY). If during the ***Reset Time*** setting period, there is a new autoreclose initiation, the ***Reclose In Progress*** sequence starts again. If this reclose is produced after the last configured cycle in the ***Maximum Number of Shots*** setting, the autorecloser goes to Lockout by maximum number of shots (AR LCK BY SHOTS).

AR LOCKOUT

This is a safety status, scheme lockout blocks all phases of the reclosing cycle, preventing automatic reclosure.

From the out of service (AR DISABLE) and BLOCK statuses, the autoreclose stays in LOCKOUT prior to going to READY.

From the RECLOSE IN PROGRESS status, the recloser goes to LOCKOUT status if any of the anomalies described above occur.

To go from the LOCKOUT status to READY it is necessary that the recloser is closed and stays closed for preset time in ***Reclaim Time*** setting.

AR BLOCK

The BLOCK status is similar to the LOCKOUT status, as it guarantees that if the autoreclose is in Block, no recloser close command is produced, but the difference between them is that this Block status is reached by an external action. The autoreclose block can be configured by pulse or level signals. This configuration must be selected at ***Setpoint > Relay Configuration > Protection Elements***

When the autoreclose block signal is deactivated, either by a level change in the set signal (in case of block by level) or by an Unblock pulse (in case of block by pulse), the block status is abandoned and the autoreclose returns to the Lockout status.

Configurable signals to block the autorecloser are described in section 5.5.3.3 Autoreclose inputs.

5.5.3.6 Logic for blocking protection functions during reclose cycle

The R650 autoreclose generates a series of internal signals that allow performing block logics for Protection elements during the reclosing cycle. These signals are blocks after autoreclose shots (***BLK AFTER SHOT***). For example, if the user wants to block a protection element during the complete reclosing cycle, it is necessary to configure a signal as an OR of the four blocking signals provided after each reclosing cycle in the logic configuration tool ***Setpoint > Logic Configuration***, and then use it to block the desired protection elements at ***Setpoint > Relay Configuration > Protection Elements***.

Figure 5-37: clock signal suring reclose cycleshows an example of the logic configuration for the block signal during the reclosing cycle.

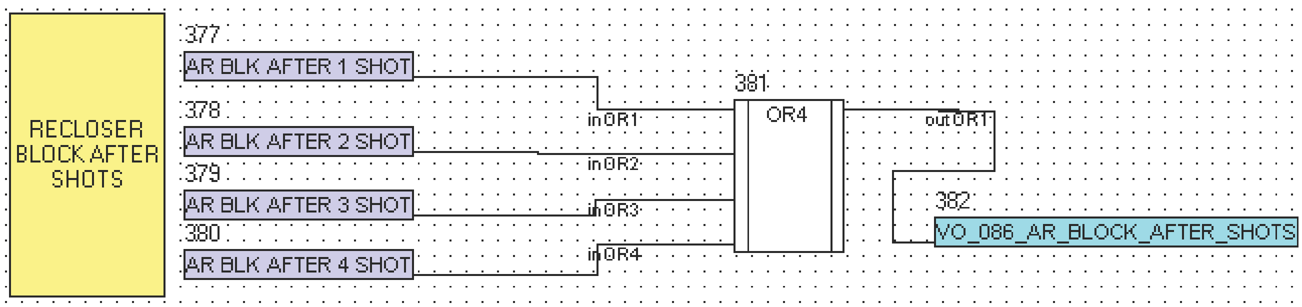


Figure 5-37: clock signal suring reclose cycle

Figure 5-38: Reclose initiation and block signals configuration example shows an example of the autoreclose initiation and protection element block signals after the different trips. The autoreclose initiate signal is configured to the relay general trip that corresponds to virtual output 83 configured in the logic configuration tool, and a physical contact to generate an external autoreclose initiation.

In the example shown on the figure, the 50PH element block signal is configured as a combination of block by digital input, block by non-trip permission of the directional element, and finally the element remains blocked during the reclosing cycle. This means that only the first trip can be executed by the phase instantaneous overcurrent element; after the first reclose trip, the element remains blocked until the end of the cycle.

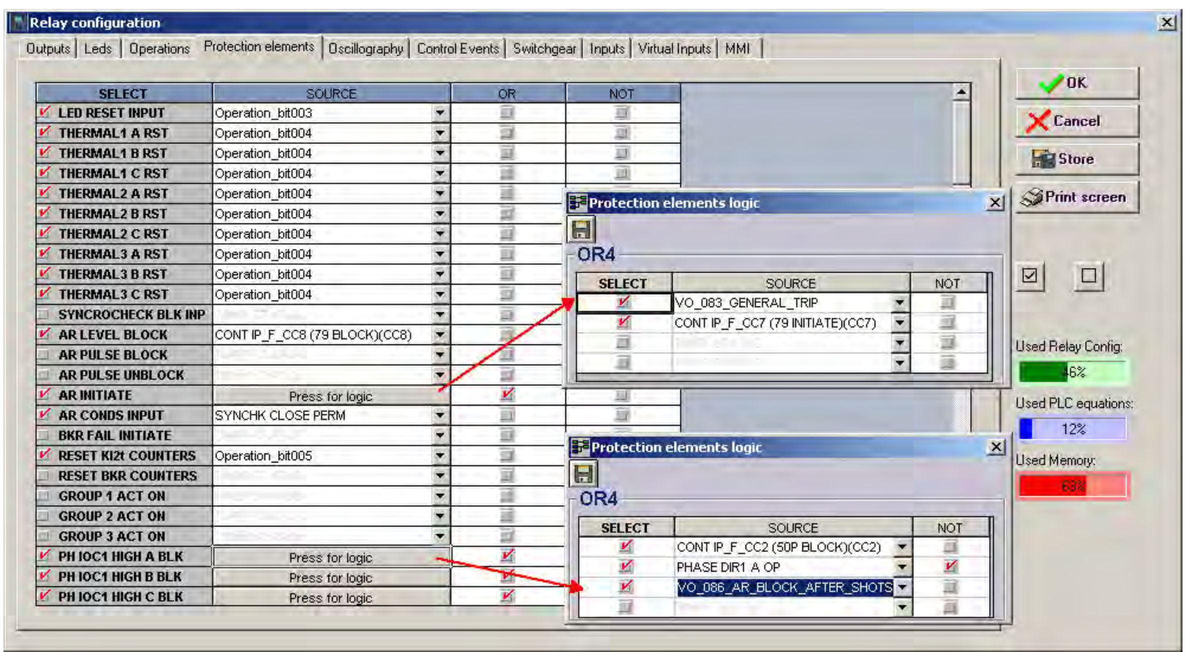


Figure 5-38: Reclose initiation and block signals configuration example

5.5.4 Breaker failure element (50BF)

The R650 provides one breaker/recloser failure element used as a backup protection system. The primary protection clears faults by sending open commands to the local recloser/recloser. However, if the recloser fails to open, the relay should provide an alternative method to isolate the fault. The recloser failure (BF) element provides such protection. The BF function detects the trip commands sent to the recloser by the assertion of the BF initiation inputs. If the fault is not cleared within a finite time, the recloser failure element trips all adjacent reclosers that can supply current to the faulty zone. The operation of this element clears a large section of the power system. Opening a large number of reclosers can affect system safety and stability, therefore, a very high level of security is required for backup protection schemes.

Two schemes are provided, one for use with three-pole only tripping (BF 3 POLE TRIP) and one for use on three pole plus single-pole operation (BF ONE POLE TRIP).

The operation of a recloser failure includes three stages: initiation, determination of the recloser failure condition, and outputs.

5.5.4.1 Initiation stage

The initiation is made by the BF PHA/PHB/PHC/3P INITIATE inputs and are configured by the internal PLC of the R650. The protection elements used for tripping the recloser raise the initiation signal for the BF scheme. This signal should be kept raised during the complete sequence until the fault condition is cleared by opening the recloser.

When the BF scheme is initiated, the Retrip time delay is initiated. After the expiration of the delay time, the supervision element checks the value of the phase, ground and sensitive ground currents. If the value of the affected phase or ground is higher than the supervision current level a retrip operation signal is sent to the local recloser. The supervision current level can be bypassed by the CURRENT SUPV setting. It is particularly important in any application to decide if a current-supervised initiate is to be used. The use of a current-supervised initiation results in the recloser failure element not being initiated for a recloser that has very little or no current flowing through it. If current supervision is enabled, the current flowing during the fault condition must be higher than the supervision level to trigger the recloser failure condition.

Backup protection should operate independently of the primary protection system. This condition requires duplicating some components of the primary protection system. For instance, some reclosers are provided by dual coil trips with a complete separate circuit to open the recloser. In such cases, the Retrip signal should be sent to the dual coil trip to assure the opening of the recloser due to a fail of the primary coil trip.

The R650 also provides a Recloser Failure trip without checking the flowing current in phases and ground. This signal is asserted whether the initiation of one pole or three pole recloser failure is kept after the time RETRIP TIME DELAY + BF W/O CURRENT DELAY running out.

5.5.4.2 Determination of a recloser failure condition

The recloser failure condition provides two stages to clear the fault. The first stage is determined by two separate paths: High current level and Low current level.

After a recloser failure is initiated, the logic checks both conditions: the status of the recloser is kept closed and the value of the flowing current through phases and ground is higher than current supervision level. If these two conditions are given for the RETRIP TIME delay with the initiation input asserted, an internal recloser failure initiation is produced.

High current level path:

After the internal recloser failure initiation condition asserts, the high set pickup delay timer start its count. If the value of phase currents or ground current are still higher than the PH/GND/SGND HISET PICKUP level after the delay interval, a BF HISET is asserted.

The HISET current supervision is not checked during the timing interval to avoid the interference of possible dropouts and pickups of the timer during severe CT saturations. Thus this scheme is unaffected by the value of the flowing currents during the counting interval.

Two distinct timers are provided to differentiate between one pole trip initiations and three pole initiations.

It should be bear in mind that recloser failure tripping times can have a significant impact on system stability. A three-phase fault is considered the worst-case scenario. Holding the line energized after a three-phase fault can drive the instability of the system, producing additional outages due to the actuation of the nearby backup protections. For instance, some studies show that for three-phase faults, the system goes unstable when the fault duration is approximately higher than 300 ms. For phase-to-phase faults the instability of the system can be achieved if the fault is maintained for approximately in 800 ms.

However, for most single-phase to ground faults the stability of the system is not severely affected even when the fault is maintained for long time, more than 5 seconds.

The R650 has been designed to declare an internal three-pole recloser initiation when a three- pole initiate has been raised or when two or more phase initiations has been produced indicating a multiphase fault. Under one of these two conditions, the HISET 3 POLE DELAY is applied providing a BF HISET TRIP 3P. A short time should be set under this setting to provide a quick clearance of the fault.

If single-pole trips are supported, the Recloser Failure discriminates among phase initiations, providing separate BF tripping per phase. For these types of events, the HISET 1 POLE DELAY is used instead.

Low current path

The low current path after the internal recloser failure initiation condition is asserted. After the timeout of the counting time delay, LOSET 1 POLE DELAY or LOSET 3 POLE DELAY, the relay checks that the flowing phase and ground currents thorough the recloser is higher than the PH/GND/SGND LOSET PKP LEVEL. If these two conditions are true, the BF LOSET TRIP operand is asserted.

The low current path provides a mechanism to detect low values of flowing current due to the insertion of an opening resistor into the faulted circuit motivated by a faulty opening recloser. The tripping time of the LOSET detector should be programmed to allow the HISET detector to clear the fault at a first fence. The delay interval between HISET and LOSET should be the expected recloser opening time.

Second stage trip

Once a LOSET or HISET detector has been triggered, the second stage detector is started. If the fault is not cleared during the expected time, the BF 2ND STAGE TRIP is provided. This detector acts as a second line of defense if the first backup protection system has not cleared the fault within the expected clearance time.

Recloser Failure without current

The R650 also provides logic path to generate a trip signal without taking into account the value of the flowing currents. After the RETRIP signal is sent, the BF W/O CURRENT DELAY starts its count. Subsequently, the BF W/O CURRENT TRIP is asserted after the timeout of the BF W/O DELAY timer.

Internal Arc detection

The internal arc or flash-over detection is a dedicated scheme that detects possible leakage phase current when the recloser is open due to overall loss of dielectric strength. The function provides independent detectors, one per phase. The protection is continuously monitoring the status of the recloser; if the recloser is open and there is a flowing current through any phase higher than the INTERNAL ARC LEVEL threshold, the INTERNAL ARC DELAY begins counting. After the timeout, the INTERNAL ARC trip is asserted. Note that Breaker Fail due to Internal Arc detection will operate whether or not the Breaker Failure function is enabled.

The recloser failure Initiate signal is configured at **Setpoint > Relay Configuration > Protection Elements**. In the BRK FAILURE INITIATE input, the user must select the desired signal for the recloser failure initiation.

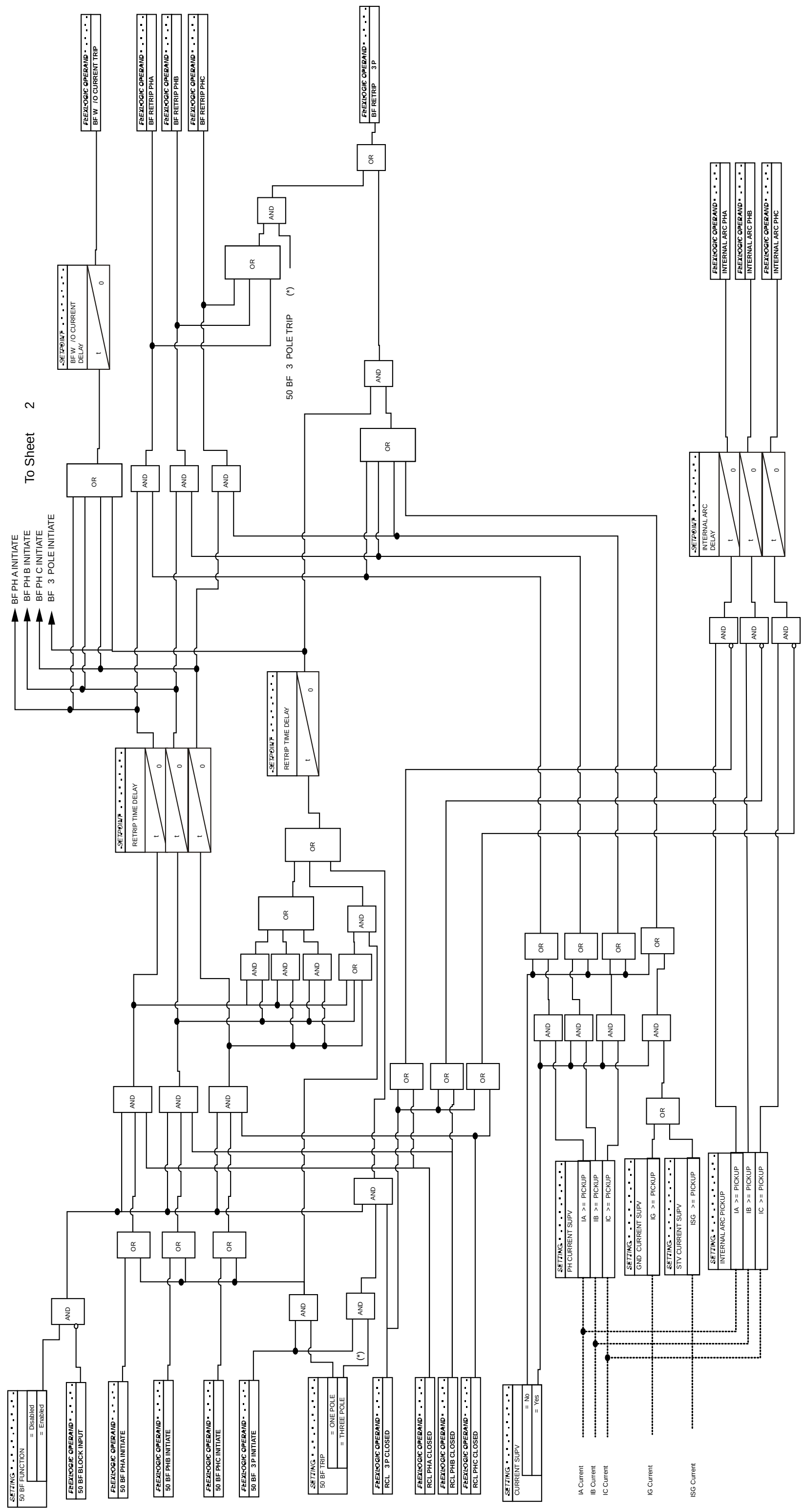


Figure 5-39: Breaker Failure logic sheet 1 of 2

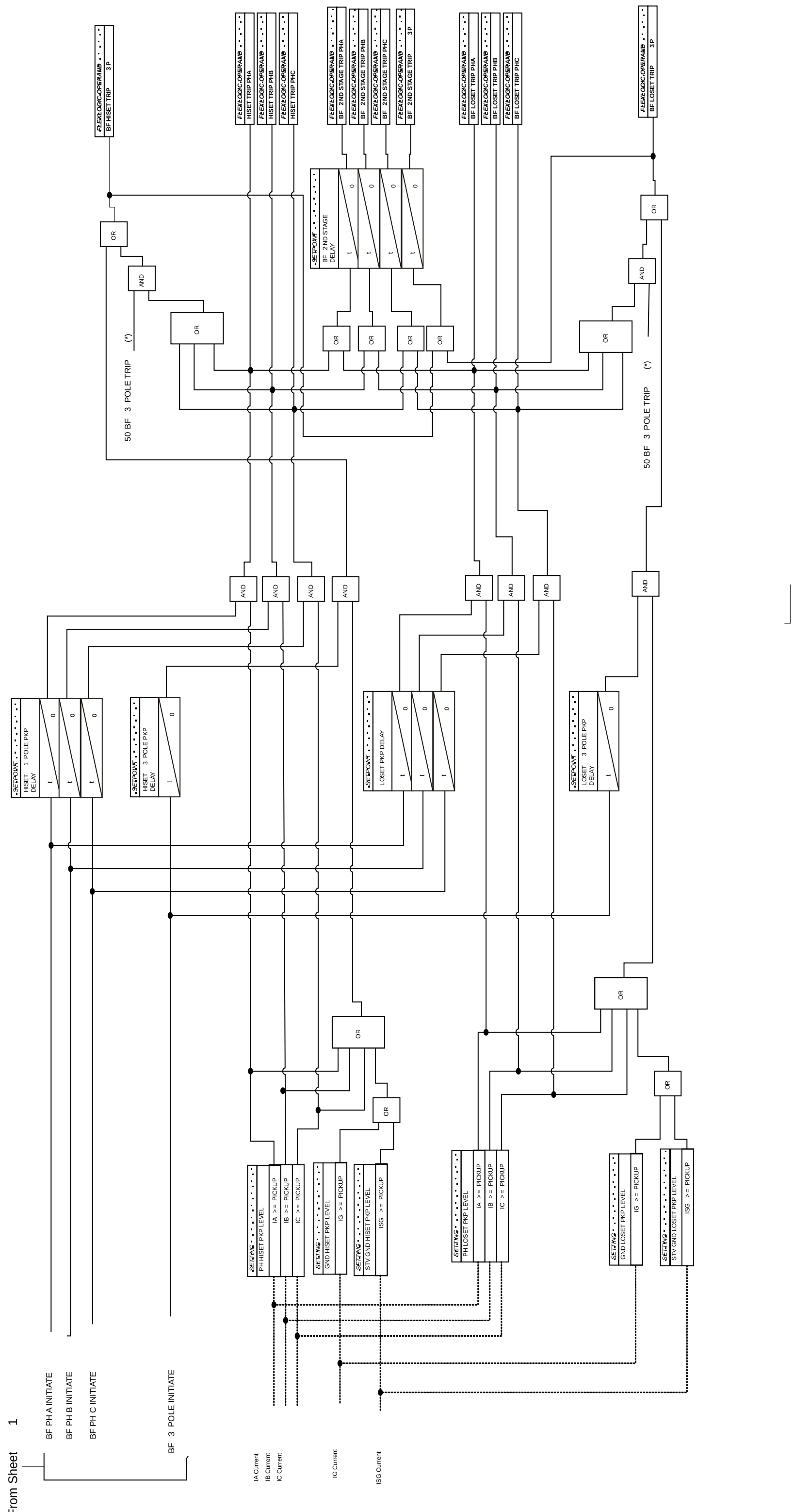


Figure 5-40: Breaker Failure logic sheet 2 of 2

The following table describes the recloser failure element settings: **Setpoint > Control Elements > Recloser Failure**

Table 5-69: 50BF element settings

Setpoint > Control Elements > Recloser Failure			
Name	**Default Value**	**Step**	**Range**
FUNCTION	DISABLED	N/A	[DISABLED – ENABLED]
TRIP MODE	ONE POLE	N/A	[ONE POLE – THREE POLE]
CURRENT SUPV	ENABLED	N/A	[DISABLED – ENABLED]
PH CURRENT SUPV	1.00	0.01 x CT	[0.05 : 20.00]
GND CURRENT SUPV	1.00	0.01 x CTg	[0.05 : 20.00]
SGND CURRENT SUPV	1.00	0.01 x CTg	[0.05 : 20.00]
RETRIP TIME DELAY	0.20	0.01 s	[0.00 : 999.99]
PH HISET PKP LEVEL	5.00	0.01 x CT	[0.05 : 20.00]
GND HISET PKP LEVEL	5.00	0.01 x CTg	[0.05 : 20.00]
SGND HISET PKP LEVEL	5.00	0.01 x CTg	[0.05 : 20.00]
HISET 1 POLE DELAY	2.00	0.01 s	[0.00 : 999.99]
HISET 3 POLE DELAY	0.50	0.01 s	[0.00 : 999.99]
PH LOSET PKP LEVEL	2.00	0.01 x CT	[0.05 : 20.00]
GND LOSET PKP LEVEL	2.00	0.01 x CTg	[0.05 : 20.00]
SGND LOSET PKP LEVEL	2.00	0.01 x CTg	[0.05 : 20.00]
LOSET 1 POLE DELAY	5.00	0.01 s	[0.00 : 999.99]
LOSET 3 POLE DELAY	1.00	0.01 s	[0.00 : 999.99]
2ND STAGE DELAY	5.00	0.01 s	[0.00 : 999.99]
INTERN ARC PKP LEVEL	0.10	0.01 x CT	[0.05 : 30.00]
INTERN ARC PKP DELAY	10.00	0.01 s	[0.00 : 999.99]
BF WO CURRENT DELAY	10.00	0.01 s	[0.00 : 999.99]
SNAPSHOT EVENTS	DISABLED	N/A	[DISABLED – ENABLED]

Settings description for recloser failure element:

FUNCTION: This setting allows enabling and disabling of the 50BF recloser failure element.

TRIP MODE: This setting determines the type of trips allowed for the 50BF element. If at least one of the backup protection reclosers is not working in single-pole mode, this should be set to three-pole. An analysis of the stability of the system should be completed to assure that the single-phase scheme is allowed without jeopardizing the stability of the system.

CURRENT SUPV: If set to disabled, the current supervision check is bypassed.

PH CURRENT SUPV / GND CURRENT SUPV / SGND CURRENT SUPV:

The phase current supervision setting is used to set the phase current supervision initiation. Generally this setting should detect the lowest expected fault current on the protected recloser. It can be set as low as necessary (lower than recloser resistor current or lower than load current).
The ground and sensitive ground current supervision are used in the three-phase scheme to provide increased sensitivity for faults with very low phase currents.

RETRIP TIME DELAY: This setting determines the time to assert a retrip signal after a recloser failure condition is declared.

PH HISET PKP LEVEL / PH HISET PKP LEVEL / PH HISET PKP LEVEL:

This setting is used to set the high current level supervision. Generally this setting should detect the lowest expected fault current on the protected recloser, before a recloser opening resistor is inserted.
The ground and sensitive ground settings are used in the three-phase scheme to provide increased sensitivity for faults with very low phase currents.

HISET 1 POLE DELAY: This setting determines the time to assert a high set recloser failure trip after the re-trip output has been asserted. This time delay is used for single-pole recloser failure initiations.

HISET 3 POLE DELAY: This setting determines the time to assert a high set recloser failure trip after the re-trip output has been asserted. This time delay is used for three-pole recloser failure initiations.

PH LOSET PKP LEVEL / GND LOSET PKP LEVEL/ SGND LOSET PKP LEVEL:
This setting is used to set the phase current output supervision level. Generally this setting should detect the lowest expected fault current on the protected recloser, after a recloser opening resistor is inserted across the circuit recloser contacts (approximately 90% of the resistor current).
The ground and sensitive settings are used in three phase scheme to provide increased sensitivity for faults with very low phase currents.

LOSET 1 POLE DELAY: This setting determines the time to assert a low set recloser failure trip after the re-trip output has been asserted. This time delay is used for single-pole recloser failure initiations.

LOSET 3 POLE DELAY: This setting determines the time to assert a low set recloser failure trip after the re-trip output has been asserted. This time delay is used for three-pole recloser failure initiations.

2ND STAGE DELAY: This setting established the interval time before a second stage trip is given.

BF W/O CURRENT DELAY: This setting is used to set the period of time for which a recloser failure without current condition is asserted. The timer starts counting following the retrip time delay.

SNAPSHOT EVENTS: This setting enables or disables the snapshot event generation for recloser failure protection.

Signals relative to recloser failure provided by the relay can be viewed at ***Actual> Status > Control Elements > Recloser Failure***, and they are as follows:

Table 5-70: Recloser failure status

recloser FAILURE STATUS
50BF BLOCK INPUT
50BF PHA/B/C INITIATE
50BF 3P INITIATE
50BF PH A/B/C RETRIP
50BF 3P RETRIP
50BF PHA/B/C INT ARC
50BF WO CURRENT
50BF PHA/B/C HISET TRIP
50BF 3P HISET TRIP
50BF PHA/B/C LOSET TRIP
50BF 3P LOSET TRIP
50BF PHA/B/C 2NDST TRIP
50BF 3P 2NDST TRIP

50BF PHA/B/C BLOCK INPUT:

50BF PHA/B/C INITIATE: External signal for recloser failure initiation on phase A. (Configurable at ***Settings> Relay Configuration > Protection Elements***.)

50BF 3P INITIATE: External signal for a three-phase recloser failure initiation. (Configurable at ***Settings> Relay Configuration > Protection Elements***.)

BF RETRIP PH A/B/C: Output to re-trip phase A of the recloser after an unsuccessful attempt to open it.

BF RETRIP 3P: Output to re-trip failure recloser after an unsuccessful attempt to open it.

INTERNAL ARC PH A/B/C: Output to indicate an internal arc condition on phase A of the recloser.

BF W/O CURRENT: Output to indicate a recloser failure condition without current.

BF PH A/B/C HISET TRIP: Output to indicate a High level recloser failure on phase A

BF PH A/B/C LOSET TRIP: Output to indicate a Low level recloser failure on phase A

BF 3P HISET TRIP: Output to indicate a three-phase High level recloser failure.

BF 3P LOSET TRIP: Output to indicate a three-phase Low level recloser failure.

BF PHA/B/C 2NDST TRIP: Output to indicate a second stage Trip condition on phase A.

BF 3P 2NDST TRIP: Output to indicate a three-phase second stage Trip condition.

5.5.5 VT fuse failure element (VTFF)

Note: The Switchgear element used in the **VT Fuse Failure** element is the one configured in the **Number of Switchgear** setting, inside **Recloser settings** at **Setpoint > Protection Element > Setting Group X > Recloser > Recloser Settings.** This switchgear must have previously been configured at **Setpoint > Relay Configuration > Switchgear**

The fuse failure detector is used to block protection elements that can operate incorrectly due to a partial or total voltage loss. This loss can be caused by the voltage transformers secondary circuit protection fuse failure.

Setpoint > Control Elements > VT Fuse Failure				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The fuse failure element has only two settings, one to enable or disable the element and the other to enable or disable the snapshot event generation.

The fuse failure signal provided by the element (VT FUSE FAILURE) can be monitored at **Actual> Status > Control Elements >VT Fuse Failure**

5.5.5.1 Fuse failure algorithm

To detect different types of fuses failures, it is necessary to use different detection methods. In example, a fuse failure indication with loss of one or two voltage phases provides a significant level of negative sequence voltage, instead of a loss of all voltage phases which causes a very low positive sequence voltage, but any negative sequence voltage.

R650 elements detect fuse failure under three possible situations:

(1)Recloser closed and positive sequence voltage (V1) under an established value (V1<0.5 p.u.).

(2)Positive sequence voltage lower than 0.5 p.u (V1<0.5 p.u.) and positive sequence current higher than 0.075 p.u. (I1>0.075 p.u.).

(3)Ratio between the negative and positive voltage components (V2/V1) higher than 0.25.

With the activation of any of the three previous signals during a period longer than 80 ms, the fuse failure signal (VT FUSE FAILURE) is activated. Once this signal is activated, it is latched until whatever caused it disappears; for this purpose the following condition must be met:

(4)Positive sequence voltage higher than 0.75 p.u and positive sequence current lower than 0.05 p.u.

The fuse failure signal can be used to issue an alarm and/or to block elements that may operate incorrectly due to a partial or total loss of voltage. Protection elements that are usually blocked by the fuse failure signal are voltage restraint overcurrent elements, and directional elements. To configure the block of these elements it is necessary to enter the ***Setpoint > Relay Configuration > Protection Elements***” menu and select as block input for protection elements, the fuse failure operation signal.

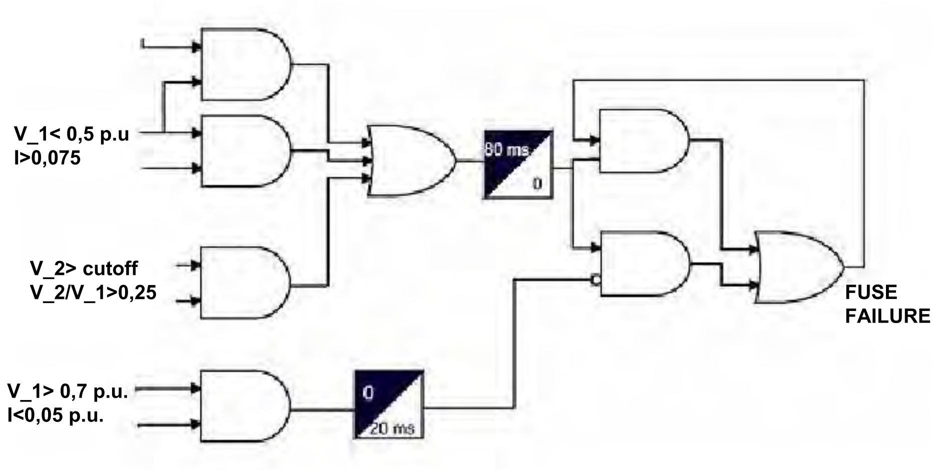


Figure 5-41: Fuse failure element block diagram

5.5.6 Pulse counters

The R650 includes eight pulse counters, each pulse counter stores the activation number to that pulse counter. This value can be multiplied for a factor selectable by setting.

The inputs used in this pulse counter function can be selected from all the available in the R650 device. Take into account that the input/output settings are both set for the generic input as well as for the pulse counter input, e.g. Debounce time.

SETPOINT > CONTROL ELEMENTS > PULSE COUNTERS				
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Pulse counter enabling setting	CntPulses Enabled X	DISABLED	N/A	[DISABLED – ENABLED]
Name of the pulse counter	CntPulses Name X	Pulse Counter X	N/A	N/A
Multiplier factor for the pulse counter	CntPulses Factor X	1.000	0.001	[0.000 : 65000.000]
Overflow value for the pulse counter	CntPulses Overflow X	65535	1	[0 : 1000000]
Board selection for the pulse counter	CntPulses Board Origin X	F	N/A	[F,G,H,I]
Input index inside the selected board	CntPulses Input Origin X	1	1	[1 : 32]
Note: X is the pulse counter index, up to 8.				

Pulse Counters settings are:

CntPulses Enabled: Enable/disable each pulse counter.

CntPulses Name: Each pulse counter can have a configurable user name.

CntPulses Factor: This is the factor multiplier applied to the input activations number stored in the pulse counter, providing possibilities to adjust the obtained value to any scale. It the "CntPulses Factor X" is set to zero it takes no effect.

CntPulses Overflow: It is the maximum value set as result of the CntPulses Factor plus the number of inputs activation. This means that after reaching that value, the pulse counter value starts counting from zero.

CntPulses Board Origin: Board selection for the pulse counter input.

CntPulses Input Origin: Index of the input select in the board origin.

The signals related to the 8 pulse counters can be viewed at **Actual> Status > Control Elements > Pulse Counters** and they are as follows:

Table 5-71: Pulse counters status

PULSE COUNTERS STATUS
CntPulses Value 1
CntPulses Value 2
CntPulses Value 3
CntPulses Value 4
CntPulses Value 5
CntPulses Value 6
CntPulses Value 7
CntPulses Value 8
CntPulses Freeze 1
CntPulses Freeze 2
CntPulses Freeze 3
CntPulses Freeze 4
CntPulses Freeze 5
CntPulses Freeze 6
CntPulses Freeze 7
CntPulses Freeze 8

The R650 includes eight different pulse counters in which the value shown is the result of the number of activation of the input configured for that counter multiplied plus the CntPulses Factor set for that pulse. For each pulse counter there are two magnitudes available, the actual value and the frozen value.

The freeze and unfreeze and reset operations are similar to the energy management, the signals used for that purpose are the same for both energy and pulse counters.

By default, all the counter pulses values are unfrozen, updating the values when they are activated, and all counter pulse freeze values are frozen. If a freeze operation is set, the actual value is copied to the frozen one, which remains frozen.

To unfreeze all the values it is necessary to perform an unfreeze operation.

If a reset operation is set, all the values, actual and frozen ones goes to zero.

All the operations (freeze, unfreeze and reset) are performed over all the energy counters (both energy and pulse counters). It is not possible to set them to a particular counter.

5.5.7 Analog comparators

The R650 provides 20 different analog comparators in an analog comparator module located in the control elements part of the device. Each analog comparator gives indication when the analog variable selected is inside or outside some minimum and maximum threshold values.

SETPOINT > CONTROL ELEMENTS > ANALOG COMPARATORS				
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Generic Analog Function Permission	Analog Function	DISABLED	N/A	[DISABLED – ENABLED]
Generic Snapshot Events Generation	Analog Snapshot Events	DISABLED	N/A	[DISABLED – ENABLED]
Analog Input Value Selection	Analog Input X	None	N/A	[All available analog values]
Analog Maximum Threshold Value	Analog Maximum X	1.000	0.001	[-100000.000 : 100000.000]
Analog Minimum Threshold Value	Analog Minimum X	1.000	0.001	[-100000.000 : 100000.000]
Analog Delay for Activation Signal	Analog Delay X	0.00	0.01 s	[0.00 : 900.00]
Analog Hysteresis for the Deadband	Analog Hysteresis X	1.0	0.1	[0.0 : 50.0]

Analog Direction for Activation Inside or Outside the Deadband	Analog Direction X	Out	N/A	[IN-OUT]
Note: X is the analog comparator index, up to 20				

The analog comparator settings includes two global settings such as

Analog Function: This setting allows enabling or disabling the analog comparators module. Each analog comparator can not be enabled/disabled individually.

Analog Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for this element.

Besides the main settings there are some settings for each analog comparator (up to 20) as follows:

Analog Input: Analog value selected by the user from the available analog variables in the device. This is used to make the comparison inside a set band for that magnitude.

Analog Maximum: Maximum threshold value for the comparison band.

Analog Minimum: Minimum threshold value for the comparison band.

Analog Delay: Time value for the analog signal to be active inside the comparison band before setting the Analog Level signal to 1.

Analog Hysteresis: It establishes the deadband at each extreme when going out of operation band.

Direction IN: min value = min - hysteresis (in %)
max value = max + hysteresis (in %)

Direction OUT: min value = min + hysteresis (in %)
max value = max - hysteresis (in %)

Analog Direction: Analog direction for the activation signal to be set Inside or Outside the Deadband.

OUT: The "Analog Level X" gives an activation signal when the analog value is located outside the comparison band.

IN: The "Analog Level X" gives an activation signal when the analog value is located inside the comparison band.

The R650 provides 20 different analog comparators. Their status values can be viewed at ***Actual> Status > Control Elements > Analog Comparators:***

Table 5-72: Analog comparator status

ANALOG COMPARATORS STATUS
Analog Level 01
Analog Level 02
Analog Level 03
Analog Level 04
Analog Level 05
Analog Level 06
Analog Level 07
Analog Level 08
Analog Level 09
Analog Level 10
Analog Level 11
Analog Level 12
Analog Level 13
Analog Level 14
Analog Level 15
Analog Level 16
Analog Level 17

Analog Level 18
Analog Level 19
Analog Level 20

The analog level value is by default in a reset state, when the value meets the comparison (inside or outside the comparison band) the "Analog Level X" signal is activated if the analog value remains active the time set in the analog delay setting. When the activation conditions are not met the "Analog Level X" value goes to the reset state.

An analog change must remain active at least 40 ms to be considered, plus the analog time setting. Besides the snapshot event data has a 20 ms accuracy.

5.5.8 Digital counters

Digital Counters are functions to count discrete bit logic value changes, for example, it is able to count the number of pickups of a protection element, the number of recloser openings or the contact inputs state changes.

There are 8 identical digital counters and they count the number of state transitions from Logic 0 to Logic 1, of the logic states configured by the user, that trigger the increment or decrement commands of the digital counter value.

Settings

SETPOINT> CONTROL ELEMENTS >DIGITAL COUNTERS				
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Digital counter enabling setting	DigCnt Function X	DISABLED	N/A	[DISABLED – ENABLED]
Name of the digital counter	DigCnt Name X	Digital Counter X	N/A	N/A
Initial Digital counter value	DigCnt Preset X	0.00	0	[-2,147,483,648 : 2,147,483,647]:
Compare Digital counter value	DigCnt Compare X	0.00	0	[-2,147,483,648 : 2,147,483,647]:
Note: X is the pulse counter index, up to 8.				

For each of the 8 digital counters, there exist independent and identical groups of settings:

DigCnt X Function: This setting allow to Enables or disables the specified counter. If a counter’s DigCnt X Function is set to Disabled, then the DIGCNT X HI, DIGCNT X EQ and DIGCNT X LO are set to OFF and the DIGCNT X VALUE, DIGCNT X FROZENVALUE and DIGCNT X FROZENDATE are set unaltered.

DigCnt X Name: Sets a name to identify the specified counter. Note that the name length is cut down to only 12 characters long.

DigCnt X Preset: Indicates the preset value that the specified counter can be set before counting operations begin or after a reset command is accomplished.

DigCnt X Compare: Indicates the comparison value that the specified counter current value is compared to and several logic bits (HI, EQ and LO) are updated accordingly.

Snapshot Events: This is a global setting that affects all of 8 digital counters. Enables or disables the snapshot events for this function. Note that all enabled digital counters are affected by this setting.

Relay configuration

To the correct operation of each counter, there are several PLC status variables in Enervista 650 Setup at **Setpoint> Relay Configuration>Control Elements** section that should be configured properly. Each one of the 8 digital counters has its own PLC statuses and they are identical:

SETPOINT> RELAY CONFIGURATION >CONTROL ELEMENTS	
SETTING DESCRIPTION	NAME
Digital counter block	DigCnt X Block
Digital counter UP	DigCnt X UP
Digital counter DOWN	DigCnt X DOWN
Digital counter SETPRESET	DigCnt X SetPreset
Digital counter RESET	DigCnt X Reset
Digital counter FREEZERESET	DigCnt X FreezeReset
Digital counter FREEZECOUNT	DigCnt X FreezeCount
Note: X is the pulse counter index, up to 8.	

DIGCNT X BLOCK: Blocks the functionality of the specified counter. If a counter's DIGCNT X BLOCK is set to 1, all the counter's values remain unaltered and no counter commands are processed. When the counter's DigCnt X Function is set to Enabled and the DIGCNT **X** BLOCK is set to 0, then the counter starts running and accepting counter commands.

DIGCNT X UP: Counter command. When this element changes from 0 to 1, the value of the specified counter is incremented by 1. If the current counter value is 2,147,483,647 and is incremented, the updated value is set to -2,147,483,648.

DIGCNT X DOWN: Counter command. When this element changes from 0 to 1, the value of the specified counter is decremented by 1. If the current counter value is -2,147,483,648 and is decremented, the updated value is set to 2,147,483,647.

DIGCNT X SETPRESET: Counter command. This element defines the behavior of the specified counter's Reset and the Freeze/Reset commands or when counter is set from Disabled to Enabled:

- If set to 0, all commands with a Reset involved or when counter is Enabled set the initial counter value to 0
- If set to 1, all commands with a Reset involved or when counter is Enabled set the initial counter value to the one specified in the setting DigCnt # Preset.

DIGCNT X RESET: Counter command. It sends a Reset command to the specified counter.

DIGCNT X FREEZERESET: Counter command. It copies the current counter value to the DIGCNT X FROZENVALUE actual value and the current date to the DIGCNT X FROZENDATE actual value. Then a Reset command is sent to the specified counter.

DIGCNT X FREEZECOUNT: Counter command. It copies the current counter value to the DIGCNT X FROZENVALUE actual value and the current date to the DIGCNT X FROZENDATE actual value. Then the specified counter value DIGCNT X VALUE is set to 0 or to the DigCnt X Preset setting value.

Periodically the counter current Value and Frozen Value and Date are saved to non-volatile memory to keep them safe from an unexpected energy loss.

Note: Digital Counters only appear in the Actual Values menu option in HMI, in the Control Elements level.

5.5.9 Cold load pickup

The R650 can be programmed to detect a Cold Load condition and generate a signal which can be configured to block protection elements.

Under normal operating conditions, the actual load on a feeder is less than the maximum connected load, since not all consumers require maximum load at the same time. A Cold Load condition can be caused by a prolonged outage of the load or by opening of the circuit recloser. Upon the return of the source, the circuit experiences inrush current into connected transformers, accelerating currents into motors, and simultaneous demand from many other loads because the normal load diversity has been lost.

The relay detects Cold Load condition (Cold Load Pickup OP) when the recloser remains opened for a period of time greater than the **Outage Time Before Cold Load** setting.

Once the recloser is closed, Cold Load Pickup OP is mantained asserted for the time programmed in **Cold Load Pickup Block.** This signal can be used as a source for blocking the protection elements to be inhibited during the Cold Load.

Specifications – Control

COLD LOAD PICKUP	
Operating Parameters:	Recloser opened (from AV)
Outage time before cold load:	1 -1000 in steps of 1min
Cold Load Blocking time:	1-1000 in steps of 1s

SETPOINT > CONTROL ELEMENTS > COLD LOAD PICKUP				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Outage Time before ColdLoad	Outage Time before ColdLoad	20 min	1 min	[1-1000]
ColdLoad Blocking Time	ColdLoad Blocking Time	5 s	1 s	[1-1000]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Setting description for Cold Load Pickup:

Function permission (Function): This setting allows enabling and disabling the Cold Load Pickup element.

Outage Time before ColdLoad: Time that the recloser must remain opened in order to detect Cold Load condition.

ColdLoad Blocking Time: Time that the Cold Load condition is maintained after the recloser has been closed.

Snapshot event generation: Enables or disables the snapshot event generation for this element.

5.5.10 60 CTS failure

The R650 incorporates, one CT failure element which can be used to detect if any of the current transformers experience abnormal conditions resulting in phase lost.

Phase lost, caused by a current transformer (CT) failure, or CT secondary wiring can lead to undesired operation by some of the enabled protection elements. The most affected protection would be the differential protection - main transformer percent differential, and the restricted ground fault, as well as some overcurrent protection such as the neutral and negative sequence instantaneous, and timed over-current elements.

SETPOINTS > CONTROL ELEMENTS > 60CTS FAILURE				
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function Permission	Function Permission	DISABLED	N/A	[DISABLED – ENABLED]
Neutral Current PKP	3I0 Current PKP	0.10	0.01 x CT	[0.05 : 2.00]
Neutral Voltage Inhibit	3V0 Voltage Inhibit	0.10	0.01 x VT	[0 : 1.25]
GND Current Inhibit	GND Current Inhibit	0.05	0.01 x CTg	[0.05 : 2.00]
SGND Current Inhibit	SGND Current Inhibit	0.005	0.001 x CTsg	[0.005-0.200]
Time Delay	Time Delay	0.00	0.01	[0.00 -600.00]
Snapshot events	Snapshot events	DISABLED	N/A	ENABLED/DISABLED

Function This setting allows enabling and disabling the CTS function.

3I0 Current PKP: This setting defines the level of neutral current, above which CT failure would pick up. Refer to the CT Failure logic diagram for more detail.

3V0 Voltage Inhibit This setting defines the level of neutral voltage (3V0) above which the CT failure detection is inhibited.

GND Current Inhibit *This* setting defines the level of ground current above which CT failure detection is inhibited.

SGND Current Inhibit This setting defines the level of sensitive ground current above which CT failure detection is inhibited.

TIME DELAY This setting defines the time for CT failure to operate.

Care must be taken when configuring the delay for an IOC or TOC element that is being supervised by CT Supervision Failure function. The delay time in the IOC function should be set to a value 10 ms greater than CT Supervision Failure delay timer

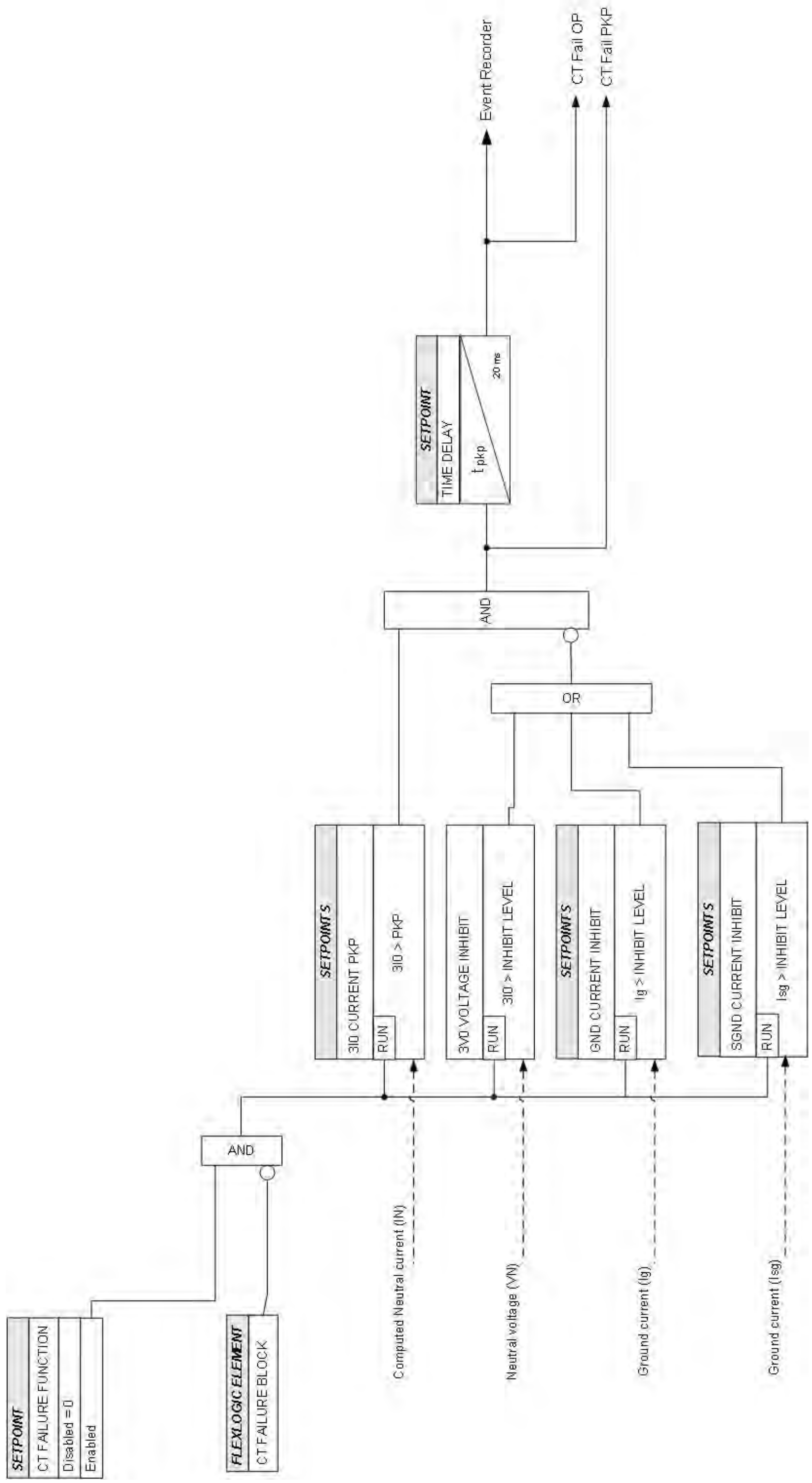


Figure 5-42: Logic scheme for 60 CTS failure function

5.5.11 Second harmonic inhibit

The R650 incorporates one Second Harmonic Inhibit element which can be used to block sensitive elements when particular level of inrush currents is detected in phase currents.

During transformer energization, the inrush current presenting in phase currents may impact some sensitive elements, such as neutral directional overcurrent. Therefore, the ratio of the second harmonic to the fundamental magnitude per phase is monitored, while exceeding the settable pickup level, an inhibit signal is asserted, which can be used to block such sensitive elements. In order to get proper functionality, 2nd Harmonic Inhibit delay must be minor than delay of IOC or TOC element that is being supervised by 2nd Harmonic inhibit function.

Second harmonic function settings are available at **Setpoint > Control Elements > 2ND HRMC Inhibit**

SETPOINTS ð CONTROL ELEMENTS ð 2nd HRMC Inhibit				
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function	Function	DISABLED	N/A	[DISABLED – ENABLED]
Second harmonic pickup	2ND HRMC PICKUP	1	1%	[1- 40.00]
Second harmonic delay	2ND HRMC DELAY	0.00	0.1s	[0.00-600.00]
Minimum secondary current to operate	MINIMUM. CURRENT	0.05	0.01 x CT	[0.05-2.00]
Phase affected to operate	PHASES FOR OPERATION	ANY ONE	N/A	[ANY ONE- ANY TWO- ALL THREE-AVERAGE]
Snapshot events	Snapshot events	DISABLED	N/A	[DISABLED – ENABLED]

Function This setting allows enabling and disabling the 2nd Harmonic Inhibit function.

2nd HRMC PICKUP This setting sets the Phase Current 2nd Harmonic value required to allow the Second Harmonic Inhibit element to pick up.

2nd HRMC DELAY This setting specifies the pickup time delay for this function to operate after pickup. Note that

MINIMUM CURRENT Sets the minimum value of fundamental secondary current required to allow the Second Harmonic Inhibit element to operate.
If Phase for Operation is set to AVERAGE, the average of three-phase currents is used for supervision. The similar adaptive average algorithm is applied to calculate the average of operation current magnitude. If second harmonic inhibit is being used to block instantaneous overcurrent elements when inrush current is present, the Min. Current setting should be configured within a maximum of 15% of pickup level of the function to be blocked.

PHASES FOR OPERATION This setting defines the phases required for operation, and the detail is explained below:
- ANY ONE: At least one phase picked up.
- ANY TWO: Two or more phases picked up.
- ALL THREE: All three phases picked up.
- AVERAGE: The average of three-phase harmonics picked up.

If set to AVERAGE, the relay calculates the average level of the second harmonic and compares this level against the pickup setting. Averaging of the selected harmonic follows an adaptive algorithm depending on the fundamental current magnitude per-phase. Only phases where the fundamental current exceeds the cut-off level are included in the average.

Second harmonic Inhibit actual values are available in Enervista 650 setup at Actual Values>Control Elements> 2nd HRMC Inhibit

Table 5-73: 2nd HRMC inhibit status

2nd HARMONIC STATUS	DESCRIPTION
2nd HARMONIC PKP	2nd Harmonic function has picked up
2nd HARMONIC OP	2nd Harmonic function has operated
2nd HARMONIC PHASE A	Shows % of 2nd harmonic in phase A
2nd HARMONIC PHASE B	Shows % of 2nd harmonic in phase B
2nd HARMONIC PHASE C	Shows % of 2nd harmonic in phase C

Blocks of 2nd harmonic inhibit can be configured in Enervista 650 Setup at Setpoint> Relay Configuration> Protection Elements. The status of this signal can be viewed at: ***Actual> Status > Protection > Protection Blocks***.

The following picture shows the logic scheme for the 2nd Harmonic Inhibit function:

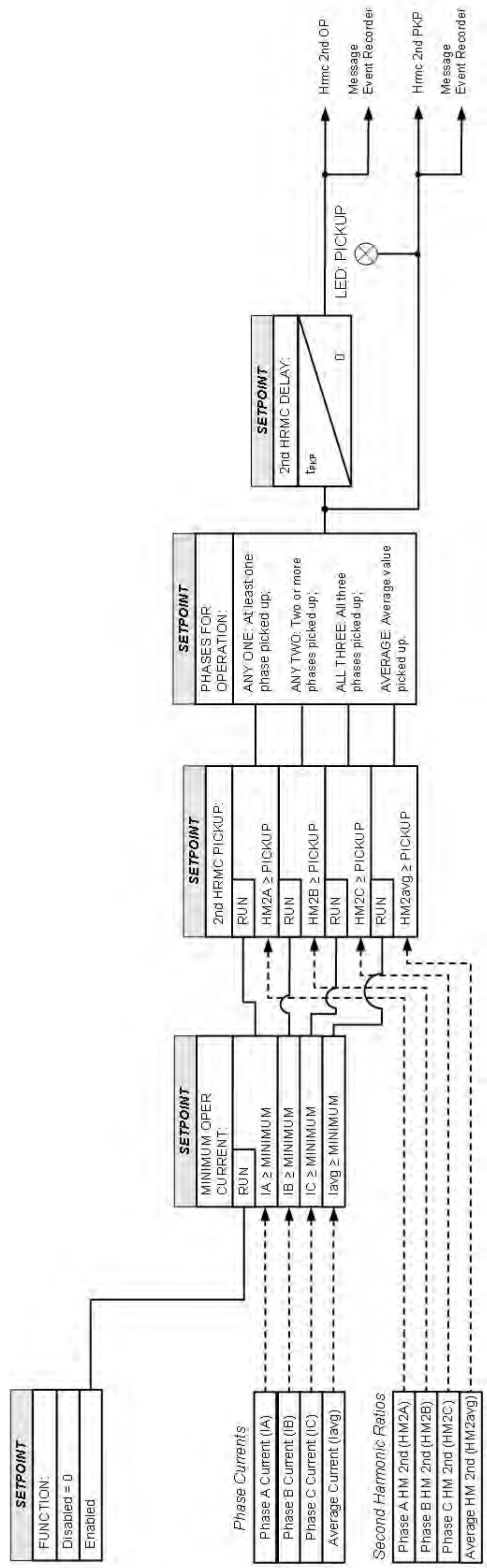


Figure 5-43: 2[nd] harmonic inhibit logic diagram

5.6 Inputs/outputs

5.6.1 Input/output placement

	MIXED	SUPERVISION	INPUTS	ANALOG
TERMINALS	1	2	4	5
1	CC1	COIL 1	CC1	CC1
2	CC2	52/a	CC2	CC2
3	CC3	COIL 1	CC3	CC3
4	CC4	52/b	CC4	CC4
5	CC5	CC1	CC5	CC5
6	CC6	CC2	CC6	CC6
7	CC7	CC3	CC7	CC7
8	CC8	CC4	CC8	CC8
9	COMMON 1/8	COMMON 1/4	COMMON 1/8	COMMON 1/8
10	COMMON 9/16	COMMON 5/8	COMMON 9/16	COMMON 9/16
11	CC9	CC5	CC9	CC9
12	CC10	CC6	CC10	CC10
13	CC11	CC7	CC11	CC11
14	CC12	CC8	CC12	CC12
15	CC13	COIL 2	CC13	CC13
16	CC14	52/a	CC14	CC14
17	CC15	COIL 2	CC15	CC15
18	CC16	52/b	CC16	CC16
19		O1	CC17	SHIELD 1/4
20	O1		CC18	AI 1
21		O2	CC19	
22			CC20	AI 2
23	O2	O3	CC21	
24			CC22	AI 3
25	O3	O4	CC23	
26			CC24	AI 4
27	O4	O5	COMMON 17/24	
28			COMMON 25/32	AI 5
29	O5	O6	CC25	
30			CC26	AI 6
31	O6	I SENS	CC27	
32		O7	CC28	AI 7
33	O7		CC29	
34		I SENS	CC30	AI 8
35	O8	O8	CC31	
36			CC32	SHIELD 5/8

Figure 5-44: Input/output location and type

5.6.2 Control settings for input/output

Configuration of settings relative to inputs and outputs can only be accessed through the EnerVista 650 Setup software, and not via the HMI. For this purpose, the user must access ***Setpoint > Inputs/Outputs > Contact I/O > Board X***, being X the corresponding I/O board.

Settings related to the Driving Electronics board F are described in Table 5-74: Driving electronics board F settings.

Settings related to I/O boards are described in Table 5-75: I/O board settings.

Table 5-74: Driving electronics board F settings

SETPOINT > INPUTS/OUTPUTS > CONTACT I/O > BOARD F			
NAME	DEFAULT VALUE	STEP	RANGE
Voltage Threshold A_F	80	1 V	V [10 : 230]
External Power Supply	155	1 V	V [60 : 165]
Debounce Time A_F	15	1 ms	ms [1 : 50]
Digital Input contact	Wet Type		[Wet Type; Dry Type]
Input Type_F_CC1	POSITIVE		[POSITIVE; POSITIVE-EDGE; NEGATIVE; NEGATIVE-EDGE]
Input Type_F_CC2	POSITIVE		[POSITIVE; POSITIVE-EDGE; NEGATIVE; NEGATIVE-EDGE]
Input Type_F_CC3	POSITIVE		[POSITIVE; POSITIVE-EDGE; NEGATIVE; NEGATIVE-EDGE]
Input Type_F_CC4	POSITIVE		[POSITIVE; POSITIVE-EDGE; NEGATIVE; NEGATIVE-EDGE]
Input Type_F_CC5	POSITIVE		[POSITIVE; POSITIVE-EDGE; NEGATIVE; NEGATIVE-EDGE]
Input Type_F_CC6	POSITIVE		[POSITIVE; POSITIVE-EDGE; NEGATIVE; NEGATIVE-EDGE]
Input Type_F_CC7	POSITIVE		[POSITIVE; POSITIVE-EDGE; NEGATIVE; NEGATIVE-EDGE]
Input Type_F_CC8	POSITIVE		[POSITIVE; POSITIVE-EDGE; NEGATIVE; NEGATIVE-EDGE]
Delay Input Time CC1	0	1 ms	ms [0 : 60000]
Delay Input Time CC2	0	1 ms	ms [0 : 60000]
Delay Input Time CC3	0	1 ms	ms [0 : 60000]
Delay Input Time CC4	0	1 ms	ms [0 : 60000]
Delay Input Time CC5	0	1 ms	ms [0 : 60000]
Delay Input Time CC6	0	1 ms	ms [0 : 60000]
Delay Input Time CC7	0	1 ms	ms [0 : 60000]
Delay Input Time CC8	0	1 ms	ms [0 : 60000]
Close Pulse Time	65	1 ms	ms [15 - 100]
Open Pulse Time	30	1 ms	ms [15 - 100]
Open Pulse Delay	0	1 ms	ms [0 - 50]
Open Max. Current	10	1 A	A [5 - 30]
Close Max. Current	15	1 A	A [5 - 30]
Snapshot Events	DISABLED		[ENABLED;DISABLED]

Voltage Threshold A_F: This setting choses the input activation voltage threshold. The available range is from 10 to 230 volts. This setting affects to all inputs of the same board that are sharing the same common. This setting is taking into account only for Wet type connections.

External Power Supply: This setting defines the nominal voltage of the external power supply that is connected to inputs F31-F32. This voltage is used to charge the external capacitors that are used to open and close the single-pole phases of the recloser. If the measured voltage of capacitors is less than 80% of the value set under this setting, the input state VOLTAGE CAP SUPERVISION is raised.
Note: The power supply voltage could be different from the voltage that feeds the contact inputs.

Debounce Time AF: Bouncing is the capability of a switch or contactor to generate multiples signals at the moment of opening and closing its contacts. The debouncing filter is a software filter used to remove these undesirable signals. The time of the debouncing filter is set by this setting and applies on all contact inputs. Thus, any change in the status of any digital contact input for a period less than the deboucing time is not detected.

Input Type F_CCX: This setting indicates the type of logic applied over the input, with one setting per contact input.

POSITIVE/NEGATIVE_EDGE: Under these two configurations the input works as a positive/negative pulse edge detector. POSITIVE EDGE detects transitions levels of the input from negative to positive values higher than the debounce time, while NEGATIVE EDGE detects state transitions levels of the contact input from positive to negative values higher than debounce time. The internal pulse duration of this event is one PLC scan cycle of the R650, or approximately 2.5 ms.

POSITIVE: The contact input is detected by the logic as activated for values of voltage higher than the threshold and after the delay time and debounce time has expired. The delay time is applied based on 'Delay Input Time F'. By default, this setting is zero. The delay time is not applied for positive to negative changes; only the debounce time is applied.

NEGATIVE: The contact input is detected by the logic as activated for voltages lower than the threshold and after the expiration time of the delay time plus the debounce time.

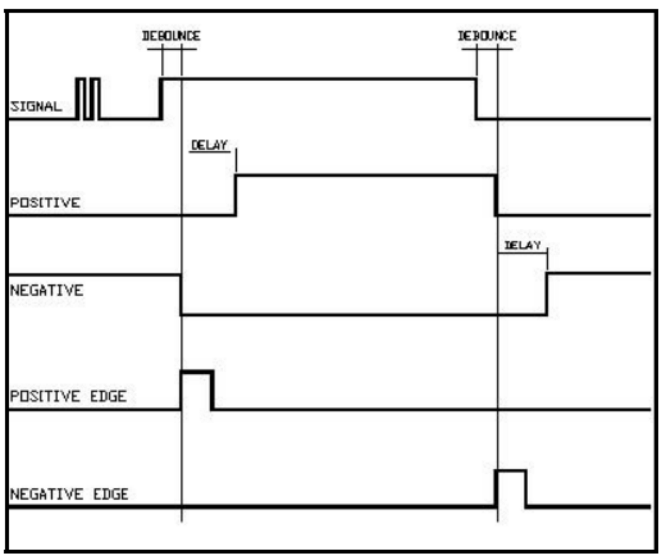


Figure 5-45: Input Logic Types

Delay Input Time_F_CCX: This setting establishes the delay time applied to detection of the input signal. This time is configured separately for each input and it is summed with the debouncing filtered time that is applied over all inputs.

Close Pulse Time: This setting indicates the maximum time the external close signal is energized after a close command is issued. This setting affects the COIL A1/2, COIL B1/2, COIL C1/2 contact outputs.
If the status of the recloser is linked to the contact inputs 52a, 52b, or 52a+b, then the minimum closing time is given by the detection of the recloser open condition. The same setting is used for all phases.

Open Pulse Time: This setting indicates the maximum time the external close signal is energized after an open command is issued. This setting affects to the COIL A1/2, COIL B1/2, COIL C1/2 contact outputs.
If the status of the recloser is linked to the contact inputs 52a, 52b, or 52a+b then the minimum opening time is given by the detection of the recloser close condition. The same setting is used for all phases.

Open Pulse Delay: This setting indicates the time an open command is delayed before being executed. Once one Open command is received, the driving electronics board delays the open pulse by the amount of time set under this setting. This setting is applied on the three COIL contact outputs.

Open Maximum Current: This setting specifies the maximum current allowed to flow through the external coil connected between COIL #1 and COIL #2 when an open command is being executed. The driving electronics board limits the flowing current during opening and closing operations.

Close Maximum Current: This setting specifies the maximum current allowed to flow through the external coil connected between COIL #1 and COIL #2 when a close command is being executed.

Table 5-75: I/O board settings

SETPOINT > INPUTS/OUTPUTS > CONTACT I/O >				
BOARD G > BOARD H > BOARD J				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
I/O board type (available only for CIO modules)	I/O Board Type_**X**	NONE	N/A	[NONE, 16 INP + 8OUT, 8 INP + 8OUT + SUPV, 32 INP 16 INP + 8 ANA]
Input activation voltage threshold Group A	Voltage Threshold A_**X**	80	1 V	[10 : 230]
Input activation voltage threshold Group B	Voltage Threshold B_**X**	80	1 V	[10 : 230]
Input activation voltage threshold Group C	Voltage Threshold C_**X**	80	1 V	[10 : 230]
Input activation voltage threshold Group D	Voltage Threshold D_**X**	80	1 V	[10 : 230]
Debounce time for Group A	Debounce Time A_**X**	15	1 ms	[1 : 50]
Debounce time for Group B	Debounce Time B_**X**	15	1 ms	[1 : 50]
Debounce time for Group C	Debounce Time C_**X**	15	1 ms	[1 : 50]
Debounce time for Group D	Debounce Time D_**X**	15	1 ms	[1 : 50]
Input type	Input Type_**X**_CC**Y** (CC**Y**)	POSITIVE	N/A	[POSITIVE-EDGE, NEGATIVE-EDGE, POSITIVE, NEGATIVE]
Input signal time delay	Delay Input Time_**X**_CC**Y** (CC**Y**)	0	1 ms	[0 : 60000]
Output logic type	Output Logic_**X**_0**Z**	POSITIVE	N/A	[POSITIVE, NEGATIVE]
Output type	Output Type_**X**_0**Z**	NORMAL	N/A	[NORMAL, PULSE, LATCH]
Output pulse length	Pulse Output Time_**X**_0**Z**	10000	1 ms	[0 : 60000]
Analog Inputs Range	Range_**X**_0**Z**	NONE	N/A	[NONE, -1 to 0mA, 0 to 1 mA, -1 to 1 mA, 0 to 5 mA, 0 to 10 mA]
Minimum Value	Min_Value_**X**_0**Z**	0.00	0.01	[-9999.99 : 9999.99]
Maximum Value	Max_Value_**X**_0**Z**	0.00	0.01	[-9999.99 : 9999.99]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Being:

X F, G, H or J, the I/O board name, depending on the Relay model.

F and G are internal Relay boards, and H and J are additional boards available in CIO modules (remote Bus CAN I/O module).

For the I/O board selection in the relay model, associated digits to each board type are as follows:

Table 5-76: I/O board type

ASSOCIATED DIGIT	ENERVISTA 650 Setup BOARD settingS	BOARD TYPE
0	NONE	None
1	16 INP+ 8OUT	Mixed
2	8 INP +8 OUT +SUPV	Supervision
4	32 INP	32 digital inputs
5	16 INP + 8 ANA	8 Analog Inputs + 16 digital inputs

CC**Y** Is the name used for inputs in I/O boards

0**Z** Is the name used for the different outputs in I/O boards

5.6.3 Inputs

Input settings description

Input Activation Voltage Threshold: The range of this value goes from 20 to 230 volts. There is a single setting for all inputs in the same group (inputs sharing the same common). In mixed and supervision boards there are two groups of inputs, called A and B., in 32DI board there are four groups of 8 inputs each.

Debounce Time: This is the debounce time set for inputs (1 to 50 ms). The debounce time is the time window for input filtering. If an input suffers a change of level that lasts less than this set time, the change is not considered. There is a single setting for all inputs in the same group.

Input Type: Type of logic associated with the physical input. Possible settings are, positive and negative.

Positive and Negative settings correspond to signals that are activated or deactivated with the input level, considering the delay setting. Positive-edge, and Negative-edge settings correspond to signals that are activated with the change of the input signal; in this case, the Delay Input Time is not considered, only the Debounce Time; this edge signals are deactivated automatically after one PLC scan cycle. Figure 5-46: INPUT LOGIC TYPES shows the types of signals associated with the different input configuration types.

Delay Input Time: This is the delay applied to the input signal; the default value is zero, meaning no delay; the setting range is 0 to 60000 milliseconds (1 minute). This setting is used in slow switchgear applications.

This is not a grouped setting; there is a different setting for each input. It is important to distinguish between this ***delay input time*** and the ***debounce time*** used for filtering undesired transients in the input signal. The Debounce time is always added to the delay input time.

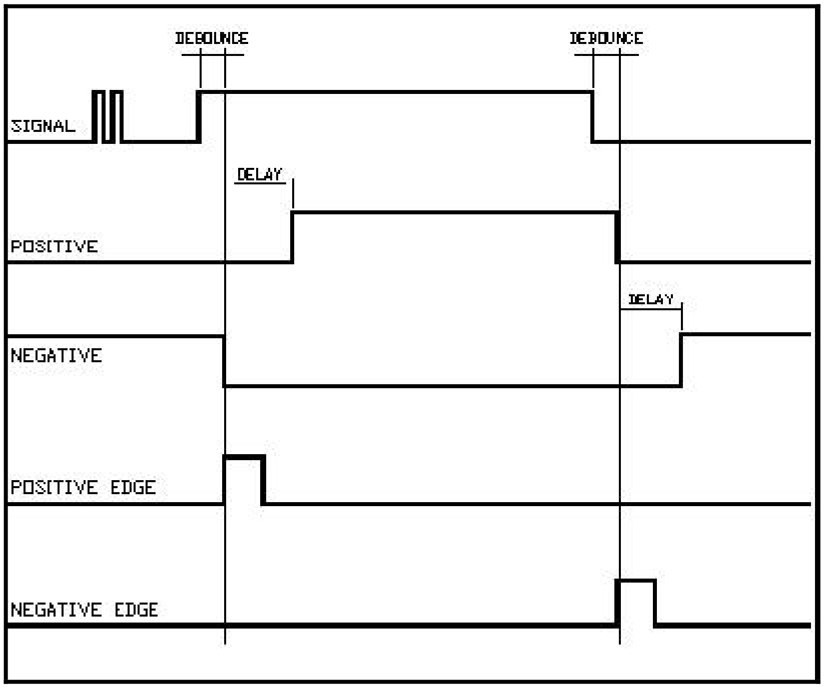


Figure 5-46: INPUT LOGIC TYPES

Input status signals

Actual > Inputs/Outputs > Contact inputs > Board X (being X the corresponding board in each case). Depending on the I/O board, inputs are represented as follows:

Table 5-77: Contact inputs status

INPUT STATUS (X: board F, G, H, J)	MIXED and analog BOARD (TYPEs 1 and 5)	SUPERVISION BOARD (TYPE 2)	32 di (type 4)	
CONT IP_X_CC1	CC1	CC1	CC1	CC17
CONT IP_X_CC2	CC2	CC2	CC2	CC18
CONT IP_X_CC3	CC3	CC3	CC3	CC19
CONT IP_X_CC4	CC4	CC4	CC4	CC20
CONT IP_X_CC5	CC5	CC5	CC5	CC21
CONT IP_X_CC6	CC6	CC6	CC6	CC22
CONT IP_X_CC7	CC7	CC7	CC7	CC23
CONT IP_X_CC8	CC8	CC8	CC8	CC24
CONT IP_X_CC9	CC9	Va_COIL1	CC9	CC25
CONT IP_X_CC10	CC10	Vb_COIL1	CC10	CC26
CONT IP_X_CC11	CC11	Va_COIL2	CC11	CC27
CONT IP_X_CC12	CC12	Vb_COIL2	CC12	CC28
CONT IP_X_CC13	CC13	O7_SEAL	CC13	CC29
CONT IP_X_CC14	CC14	O8_SEAL	CC14	CC30
CONT IP_X_CC15	CC15	SUP_COIL1	CC15	CC31
CONT IP_X_CC16	CC16	SUP_COIL2	CC16	CC32

The operation logic for supervision signals (board type 2) is detailed in section 5.6.5 Circuit supervision and contact seal-in circuits in this manual.

5.6.4 Outputs

Output settings description

Output Logic_0X _0Z: Type of logic applied to outputs. Possible values are ***positive*** and ***negative***. The default value is positive. Depending on the type of setting selected, the physical output is in the same direction (positive) or opposite (negative) the output activation command.

Output Type_0X _0Z: Type of output adjusted. Possible values are ***normal***, ***pulse*** *or* ***latched***, the default value is ***Normal***.

Normal: The contact output follows the activation command. Remains active while the operation signal is active.

Pulse: The contact output is active the pulse output time, according to the ***Pulse Output Time*** setting.

Latched: The output remains active after the operation signal has been cleared. The reset signal for the latched outputs is configured at ***Setpoint > Relay Configuration > Outputs > Contact Output Reset***".

Pulse Output Time_0X _0Z: This is the length of the output pulse in case the output type is selected as ***pulse***; the default value is 10000 ms.

Figure 5-47: Output logic typesshows the types of signals associated with the different output configuration types.

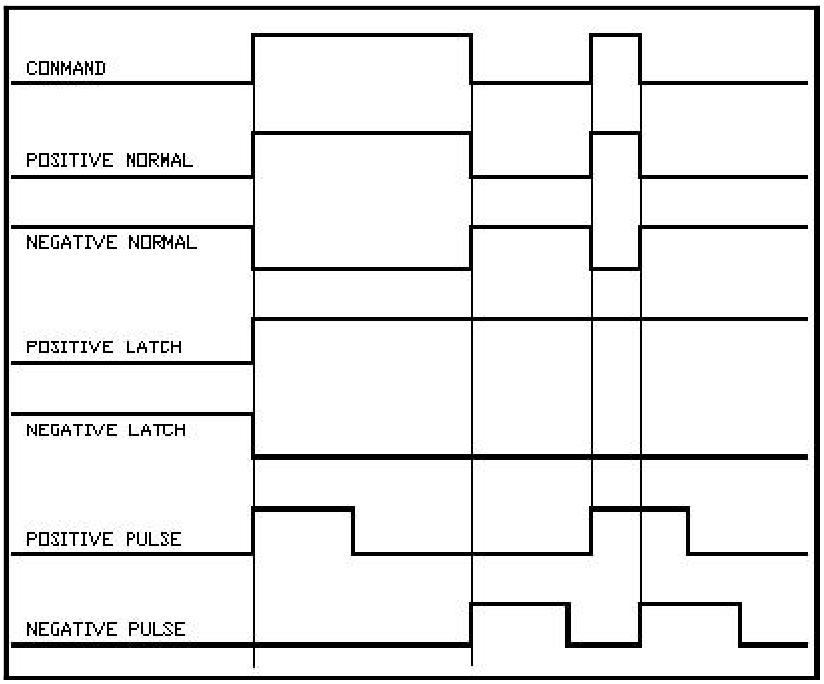


Figure 5-47: Output logic types

5.6.4.1 Output status signals

Boards types 1 and 2 have both 8 outputs, so the representation is the same for both types as shown in Table 5-78: Contact output signals

Actual > Inputs/Outputs >Contact Output Status

Real status of the contact output, which corresponds to the transformation of the output activation signal (Contact output operate), by the logic applied to this output in **Setpoint > Inputs/Outputs >Contact I/O > Board X**

Actual > Inputs/Outputs > Contact Output Operates

Activated or deactivated status of those variables used internally to operate a contact output.

Actual > Inputs/Outputs > Contact Output Resets

These are the logic signals associated with the contact output reset, which produce the reset of those signals previously configured as Latched. Configuration for the contact output reset signal is set at **Setpoint > Relay Configuration > Outputs > Contact Output Reset**.

Actual > Inputs/Outputs >I/O Board Status

These signals are associated with the different I/O boards. There are internal signals that provide information about the status of these boards, indicating whether there is any anomaly in the board, or whether the board is not available in the relay according to the relay model.

Table 5-78: Contact output signals

CONTACT OUTPUT STATUS	CONTACT OUTPUT OPERATES	CONTACT OUTPUT RESETS	IO BOARD STATUS
CONT OP_X_01	CONT OP OPER_X_01	CONT OP RESET_X_01	BOARD F STATUS
CONT OP_X_02	CONT OP OPER_X_02	CONT OP RESET_X_02	BOARD G STATUS
CONT OP_X_03	CONT OP OPER_X_03	CONT OP RESET_X_03	BOARD H STATUS
CONT OP_X_04	CONT OP OPER_X_04	CONT OP RESET_X_04	BOARD J STATUS
CONT OP_X_05	CONT OP OPER_X_05	CONT OP RESET_X_05	
CONT OP_X_06	CONT OP OPER_X_06	CONT OP RESET_X_06	
CONT OP_X_07	CONT OP OPER_X_07	CONT OP RESET_X_07	
CONT OP_X_08	CONT OP OPER_X_08	CONT OP RESET_X_08	

Being X the corresponding board in each case

5.6.5 Circuit supervision and contact seal-in circuits

Circuit Supervision:

R650 elements can include supervision boards (type 2), either in their internal slot F, or in an additional CIO module connected to the element via a CAN bus (slots H and J). This type of board includes 4 voltage detectors for implementing tripping or opening circuit supervision control logics.

Contact Seal-in:

The current seal-in circuit is used for verifying the current condition in a circuit during the time that the tripping contact remains closed. If the current in the tripping circuit is maintained over 500 mA, the function is sealed independently of the status of the function that caused the trip.

This current seal-in function in tripping circuits is mainly used in applications where auxiliary contacts 52/a (in charge of cutting the current in the tripping circuit) are very slow. This may cause that, once the function that produced the trip is reset, the relay contact opens before the recloser auxiliary 52/a, even if the time delay of the first has expired.

By using this function, we prevent the relay contact from cutting the current (basically inductive and high) from the tripping circuit, which can cause damage to the element, as these currents exceed the nominal breaking characteristics.

The circuit and the current threshold of the function are as follows:

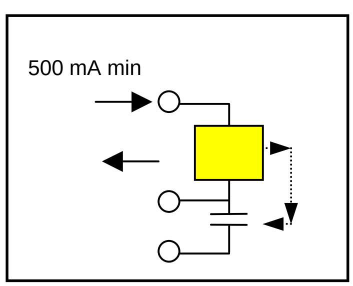


Figure 5-48: Current supervision

5.6.6 Digital inputs

5.6.6.1 With trip circuit supervision

The supervision board includes:

8 digital inputs in two groups of 4 inputs with one common, in terminals F9 to F10

8 auxiliary outputs: 6 normally open contacts in terminals F19 to F30 and two current sensing (latching) outputs (F31-F33 and F34-F36).

2 groups of inputs for trip circuit supervision with 4 voltage detectors. The first group includes two isolated digital inputs, terminals F1-F2 and F3-F4. The second group, symmetrical and identical to the first, is formed by isolated voltage inputs F15-F16 and F17-F18.

Using voltage detectors and current sensing, it is possible to implement several trip or close circuit supervision schemes, as well as protection of the element output contact.

In order to implement these schemes, it is not necessary to set any setting in the element. Internal functions are always operative and provide the following logic operands:

Table 5-79: Supervision logic operands

Actual > Inputs/Outputs > Contact inputs > Board X Being X the corresponding board in each case	
OPERAND	**DESCRIPTION**
CONT IP_X_CC9 (Va_COIL1)	Active when voltage is detected in terminals F1 - F2 (circuit 1)
CONT IP_X_CC10 (Vb_COIL1)	Active when voltage is detected in terminals F3 - F4 (circuit 1)
CONT IP_X_CC11 (Va_COIL2)	Active when voltage is detected in terminals F15 - F16 (circuit 2)
CONT IP_X_CC12 (Vb_COIL2)	Active when voltage is detected in terminals F17 - F18 (circuit 2)
CONT IP_X_CC13 (O7_SEAL)	Active if current is detected by sensor in output O7 (F31-F33)
CONT IP_X_CC14 (O8_SEAL)	Active if current is detected by sensor in output O8 (F34-F36)
CONT IP_X_CC15 (SUP_COIL1)	Active when continuity is detected in circuit 1
CONT IP_X_CC16 (SUP_COIL2)	Active when continuity is detected in circuit 2

A continuity failure is detected in a circuit when both voltage detectors (Va and Vb) detect lack of voltage during more than 500 ms. This function is not influenced by the recloser status.

These operands can be associated with internal signals (virtual outputs), LEDs or element outputs, to issue alarm signals or to block elements, for example for blocking the Recloser close if an anomaly is detected in the trip circuit.

Available schemes are as follows:

1. Without supervision
2. With current supervision (with seal-in)
3. With simple voltage supervision
4. With double voltage supervision
5. With current and simple voltage supervision (with seal-in)
6. With current and double voltage supervision (with seal-in)
7. With current and double voltage supervision (with seal-in) and serial resistor in voltage monitors.

The following subsections describe the different types of connection to create each supervision scheme in an easy way. As the supervision circuits are identical, only the first group connection examples are described, being also applicable to the second group.

In order to assure a high isolation level between groups, the digital inputs for supervision have been located in a symmetrical basis. That is to optimize the isolation between groups that can be connected to different batteries, and therefore requiring a greater distance between circuits.

5.6.6.2 Without supervision

This is a very frequent common case, and we must only wire the tripping circuit to terminals F35 and F36, leaving unused terminals F34, F15, F16, F17, F18.

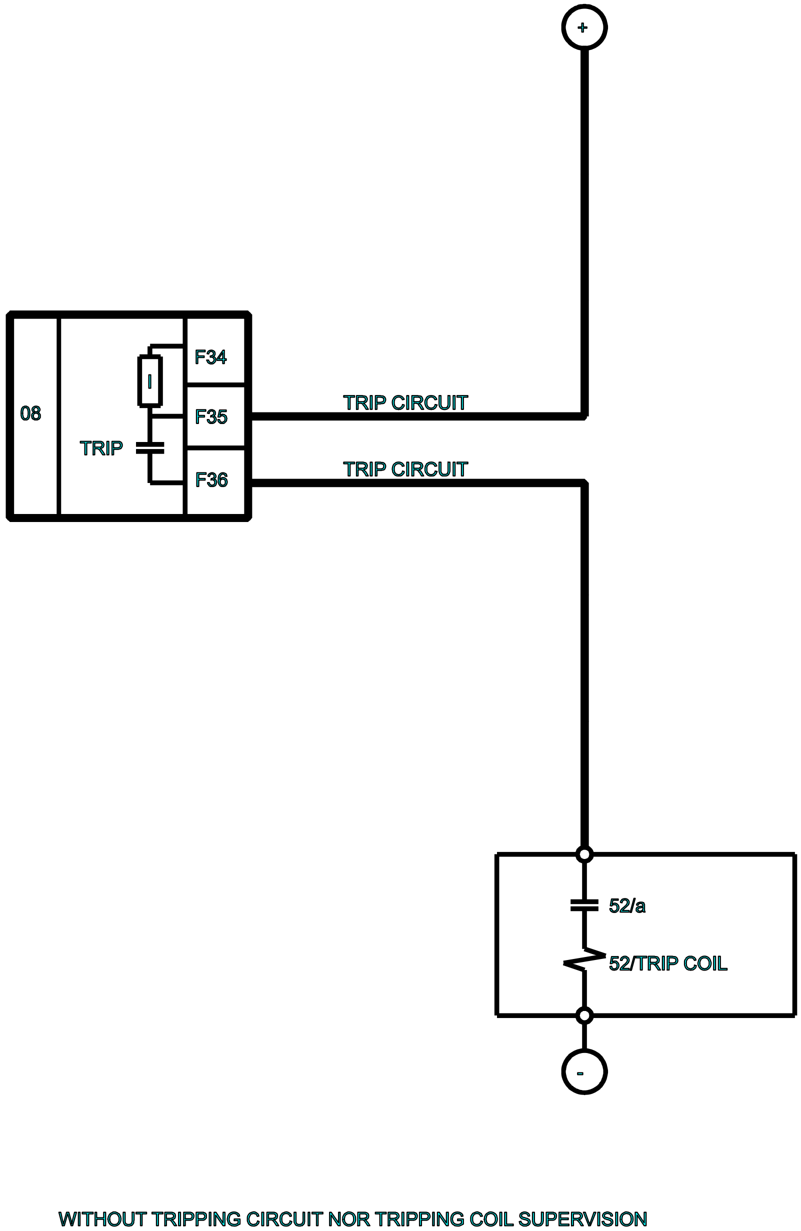


Figure 5-49: Circuit without tripping circuit supervision (A6631F1)

5.6.6.3 With current supervision (with SEAL-IN)

In this case, as shown in Figure 5-50: Current supervision of the tripping contact (A6631F2), the current supervision circuit consists of a circuit connected in series with the output contact, so that the external circuit is wired to terminals F34 and F36. This supervision circuit includes a low impedance reed relay that is activated when the current value exceeds 200 mA, and sends a signal to the main microprocessor. This latches the output relay in such a way that this indication can be used to produce a latching of the output relay, so that it remains closed while the circulating current is over 200 mA. To use the seal-in feature in the relay it is not necessary to configure any setting. It works, we only must program the corresponding Circuit latching setting wiring the external circuit to terminals F34 and F36.

With this scheme, in the case of a failure to open from the recloser auxiliary contact, the R650 output relay does not open the tripping coil current, as in this case the contact may be damaged, as it is prepared for opening currents around 0.35 A at 125 Vdc. This latching or memory function is only guaranteed while the element is powered.

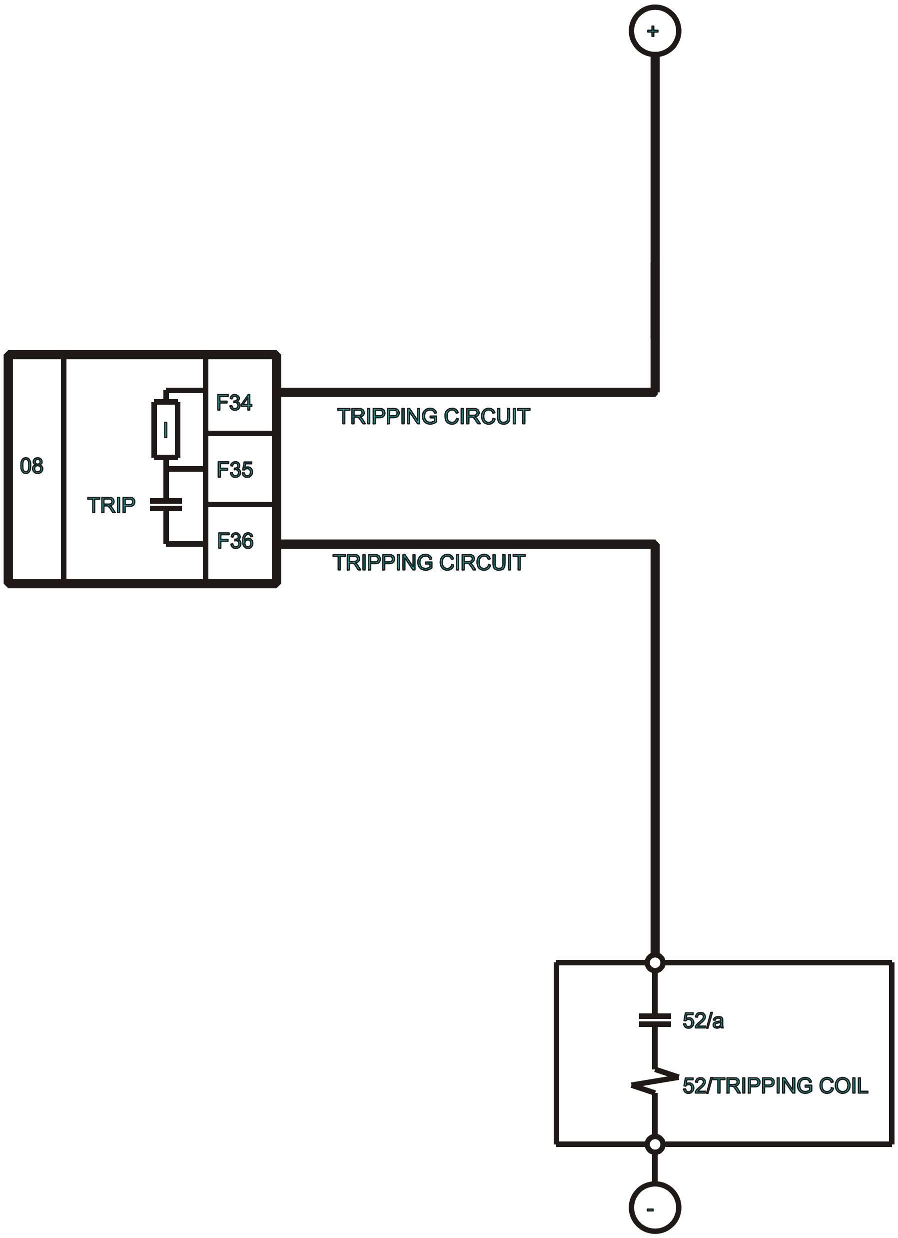


Figure 5-50: Current supervision of the tripping contact (A6631F2)

5.6.6.4 With simple voltage supervision

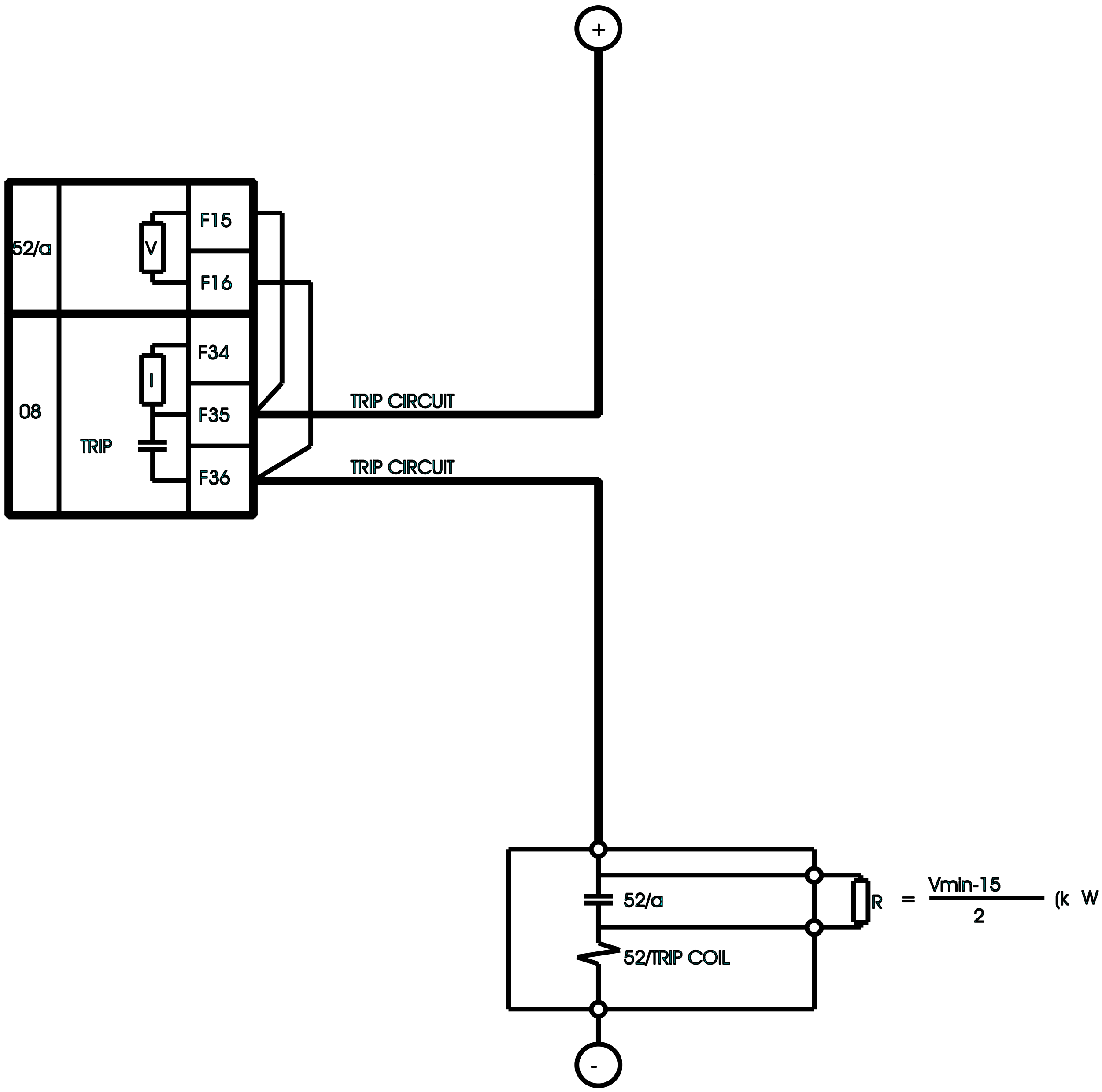


Figure 5-51: Supervision application with auxiliary contact 52a and a resistor (A6631F3)

Table 5-80: Supervision with 52/a

INTERNAL STATE	V 52/a	SUPERVISION
52 open	ON	OK
52 closed	ON	OK
TRIP	OFF	OK if t < 0.5 s
TRIP with 52 open	OFF	OK if t < 0.5 s

There is a possibility to monitor the trip circuit and trip coil continuity. This can be done by monitoring Vdc through the output contact when this is open.

Table 5-81: Supervision algorithm with simple voltage supervision scheme

Status of Involved Elements			Input to R650	Decision
CIRCUIT STATUS	OUTPUT STATUS (F35-F36)	recloser STATUS	OPERAND CONT IP_X_CC11 (Va_COIL2) V 52/a (F15-F16)	OPERAND CONT IP_X_CC16 (SUP_COIL2)
Healthy	Open	52 closed	ON	ON
Healthy	Open	52 open	ON	ON
Healthy	Closed	52 closed	OFF	ON (if t < 500 ms) OFF (if t > 500 ms)
Healthy	Closed	52 open	OFF	ON (if t < 500 ms) OFF (if t > 500 ms)
Faulty	Open	52 closed	OFF	OFF (500 ms delay)
Faulty	Open	52 open	OFF	OFF (500 ms delay)
Faulty	Closed	52 closed	OFF	OFF (500 ms delay)
Faulty	Closed	52 open	OFF	OFF (500 ms delay)

In this table, ON means that the voltage detector V52/a is active, detecting a voltage.

In the first case shown on the table, with closed recloser, voltage is detected by V 52/a sensor, and this means that there is continuity in the supervised circuit.

As shown on Figure 5-51: Supervision application with auxiliary contact 52a and a resistor (A6631F3), when the relay is not tripped, trip contact F35-F36 remains open. If the recloser is closed, its auxiliary contact 52a is closed. Therefore, a little current is flowing, about 2 mA, through terminals F15 and F16 through the voltage detector circuit, which flows through 52/a and the tripping coil 52TC (TC = tripping coil). Current only circulates when there is continuity in the whole circuit, so the complete circuit is monitored, and not only the trip coil. This circuit includes auxiliary 52/a as well as the whole wiring between the battery and the relay tripping terminals, and between these and the recloser tripping circuit.

For the second case shown on the table, open recloser, its auxiliary contact 52/a remains open, and current cannot flow through it for detecting continuity. In order to correctly monitor the circuit, a resistor must be used, not included in the protection, connected in parallel. The value of resistance is selected so that the V 52/a input circuit minimum detection current flows, but not as high as to activate the recloser-tripping coil. The figure shows the following equation:

Where:

$$R = \frac{V_{min} - 15}{2}$$

Vmin	Is the minimum voltage, in Volts, expected in the battery (e.g. 80% of Vn)
R	Resistance, in kilo ohms.
2	2 mA of approximate current flowing through input V 52/a

As shown in the second case in the table, with an open recloser, as current flows through R if there is continuity in the WHOLE tripping circuit, voltage is detected in input V 52/a.

This works correctly in steady state. However, if the recloser trips, while it is opening, the V 52/a input signal can be deactivated without this meaning that the circuit is not correct. This is due to the fact that the tripping relay, terminals F35-F36, short circuits input V 52/a temporarily.

Therefore, if there is a trip signal, it is permitted that no signal is detected during a period of 1s to allow the recloser to open, and reopen the tripping relay F35-F36.

Figure 5-52: Trip circuit and trip coil supervision, auxiliary contact 52/a (closed recloser only) (A6631F5) shows the possibility of monitoring the circuit only when the recloser is closed. In this case resistance R is not used, but it must be observed in the element logic that the corresponding signal CONT IP_F_CC16 (SUP_COIL2) is activated showing a failure when the recloser is open. Therefore it is required to supervise the continuity failure signaling by the recloser status information.

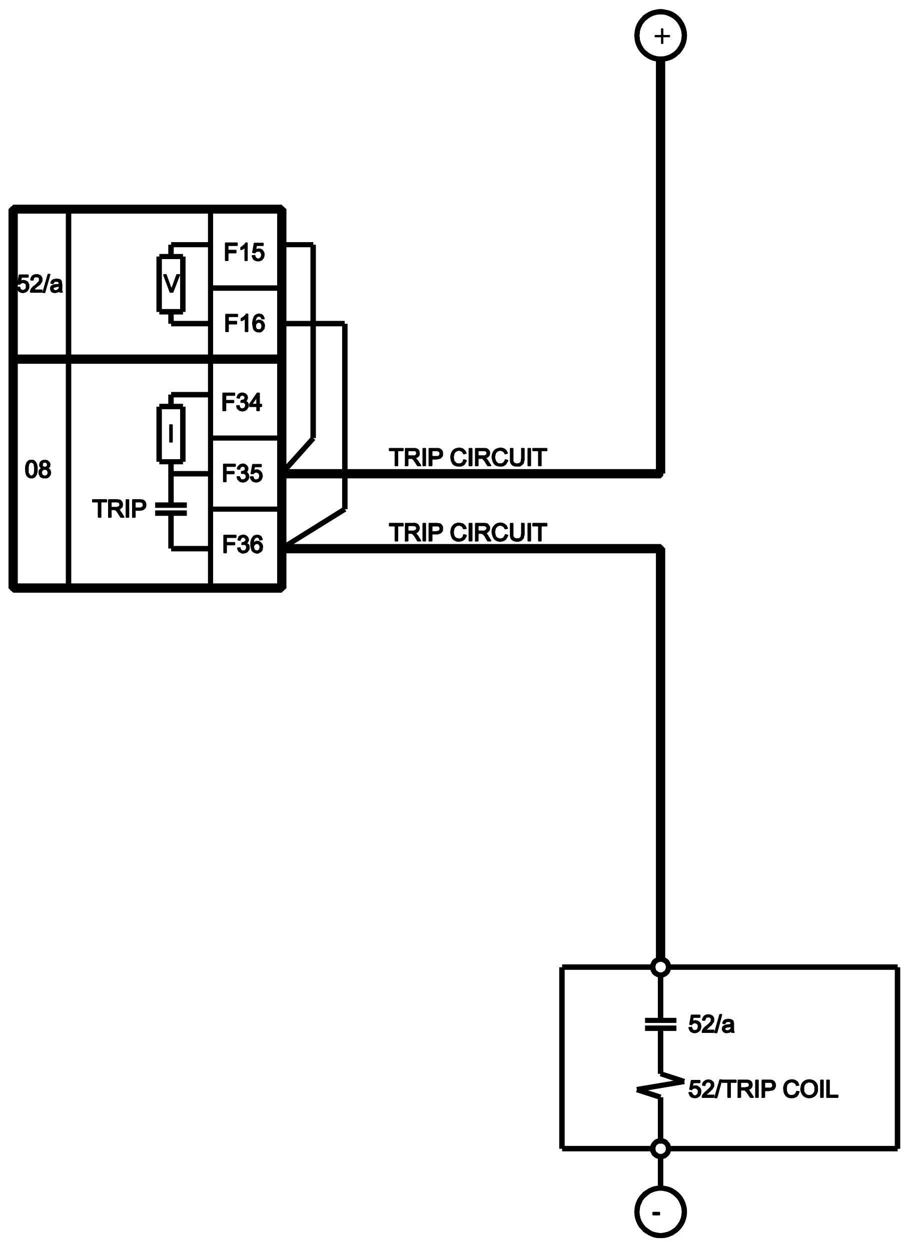


Figure 5-52: Trip circuit and trip coil supervision, auxiliary contact 52/a (closed recloser only) (A6631F5)

5.6.6.5 With double voltage supervision

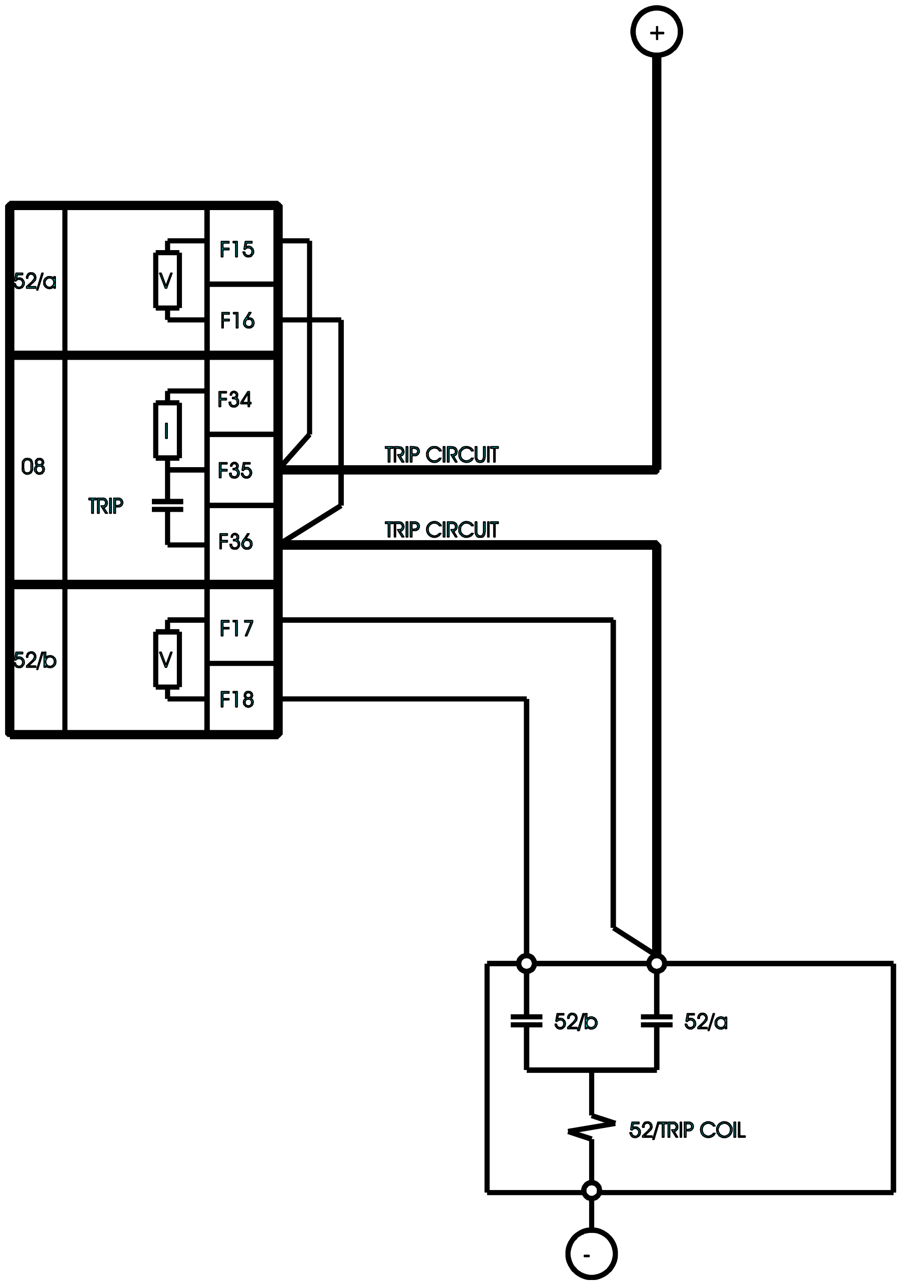


Figure 5-53: Supervision application with auxiliary contacts 52a and 52b (A6631F4)

Table 5-82: Supervision algorithm with double voltage supervision scheme

Status of Involved Elements			Inputs to 650		Decision
CIRCUIT STATUS	**OUTPUT STATUS (F35-F36)**	**recloser STATUS**	**OPERAND CONT IP_X_CC11 (Va_COIL2) V 52/a (F15-F16)**	**OPERAND CONT IP_X_CC12 (Vb_COIL2) V 52/b (F17-F18)**	**OPERAND CONT IP_X_CC16 (SUP_COIL2)**
Healthy	Open	52 closed	ON	OFF	ON
Healthy	Open	52 open	ON	ON	ON
Healthy	Closed	52 closed	OFF	OFF	ON (if t < 500 ms) OFF (if t > 500 ms)
Healthy	Closed	52 open	OFF	ON	ON (if t < 500 ms) OFF (if t > 500 ms)
Defective	Open	52 closed	OFF	OFF	OFF (500 ms delay)
Defective	Open	52 open	OFF	OFF	OFF (500 ms delay)
Defective	Closed	52 closed	OFF	OFF	OFF (500 ms delay)
Defective	Closed	52 open	OFF	OFF	OFF (500 ms delay)

There is a possibility to monitor the trip circuit continuity not only via its auxiliary contact 52/a, but also with auxiliary contact 52/b. This avoids the need to install a resistance in parallel with auxiliary 52/a. The correct connection is shown on Figure 5-53: Supervision application with auxiliary contacts 52a and 52b (A6631F4)

The circuit works in a similar way to the one described in the previous section, but it uses both supervision inputs F15-F16 and F17-F18.

The advantage in this case is that circuit supervision with 52 open is more complete, as input V 52/b is used through contact 52/b, (that is closed when the recloser is open).

We must point out that in this scheme, the tripping contact, shown in the example as the R650 trip relay, can be the one in the relay (terminals F35 and F36), or be provided by another protection or by the parallel of several protections. This provides high flexibility in the use of this circuit.

The battery voltage can also be monitored, by using one of the standard digital inputs.

5.6.6.6 With double voltage supervision and serial resistor in voltage monitors

Figure 5-54: Supervision application, auxiliary contacts 52a and 52b and series resistor in F15-F16shows the supervision scheme with an external resistor.

An external series resistor is used with the 52a voltage monitor to prevent CB tripping with a short-circuited voltage monitor. With CB open, 52/a is open and 52/b is closed. A shorted 52/a voltage monitor does not cause a trip because 52/b voltage monitor is current limited to 2mA. With a shorted 52/b voltage monitor, no false trip is performed because 52/a is in series limiting current to 2mA.

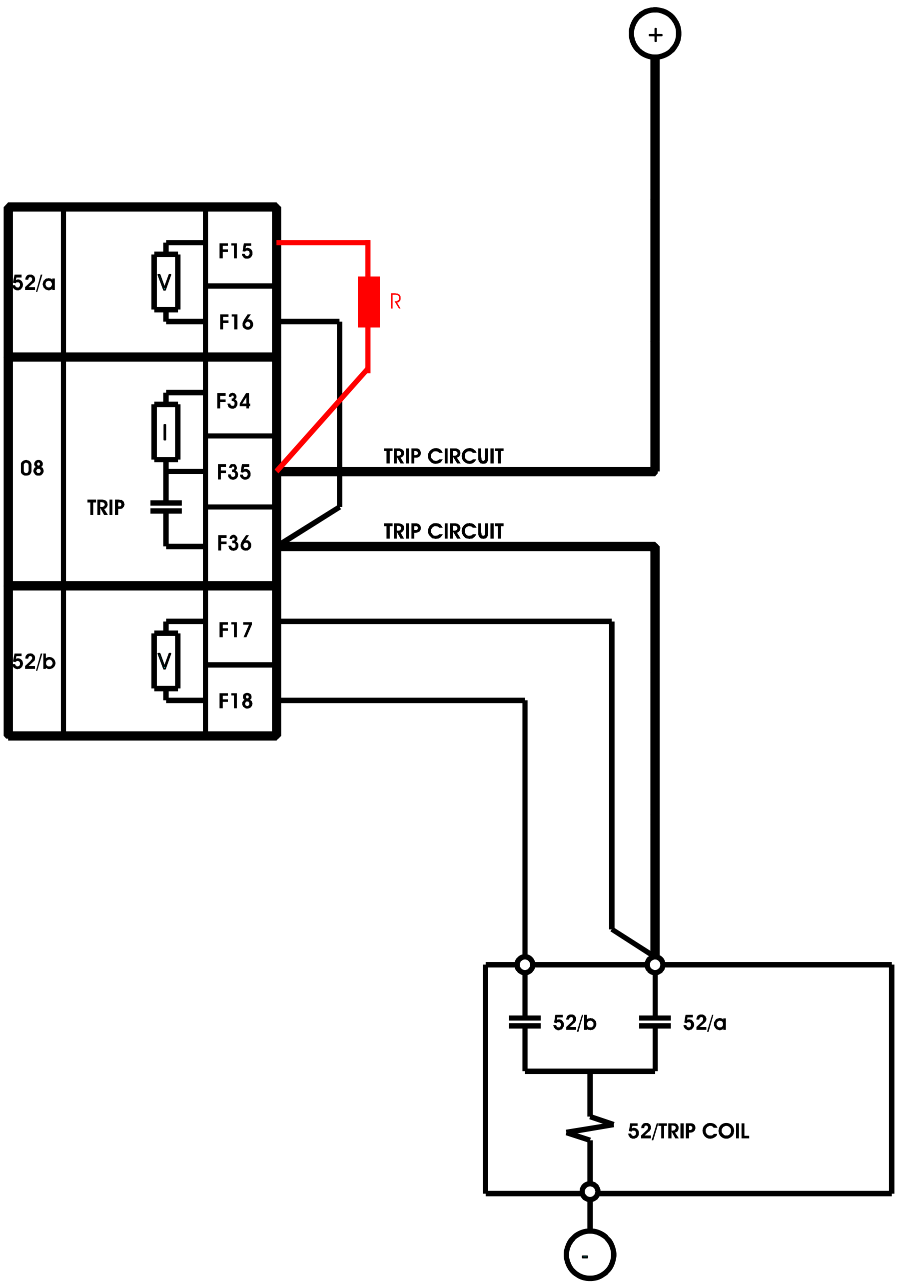


Figure 5-54: Supervision application, auxiliary contacts 52a and 52b and series resistor in F15-F16

5.6.7 Analog board specific settings

Hardware and software is provided to receive signals from external transducers and convert these signals into a digital format for use as required. The relay accepts inputs in the range of –1 to +20 mA DC, suitable for use with the most common transducer output ranges; all inputs are assumed to be linear over the complete range.

The Input Range setting specifies the mA DC range of the transducer connected to the input channel.

- Range: -1 to 0, 0 to 1, -1 to 1, 0 to 5, 0 to 10, 0 to 20, 4 to 20.

The Min and Max Value settings are used to program the span of the transducer in primary units.

- Min Value: -9999.99 to 9999.99
- Max Value: -9999.99 to 9999.99

5.6.8 Virtual inputs

Virtual inputs are signals that can be written directly via communications. Their status can be established as ON (1) and OFF (0), through writing by communications using EnerVista 650 Setup.

The change of state of virtual inputs is made according to their type. Latched virtual inputs remain at the set value until it is changed by communications. Self-reset virtual inputs are activated by writing, and they remain active during one cycle. There are 32 virtual inputs of each type.

5.6.8.1 Virtual inputs writing

Setpoint > Input/Outputs >Virtual Inputs for activating / deactivating signals

To write a virtual input, select the virtual input to activate by clicking on the virtual input checkbox, then click **Store** and the virtual input is written to the relay (see Figure 5-55: Virtual input writing through EnerVista 650 Setup).

For self-reset, the value remains active during one PLC cycle and after that the virtual input value is cleared.

For latched, the value remains active until it is cleared by the user, clicking again in the virtual input checkbox and clicking **Store** to clear the value.

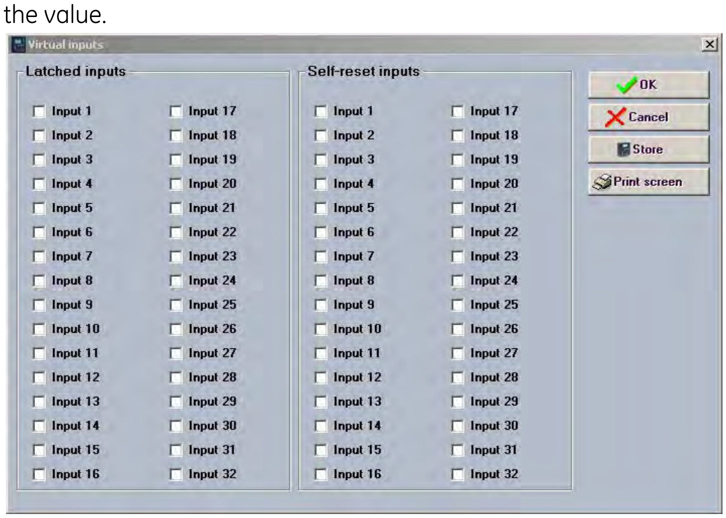


Figure 5-55: Virtual input writing through EnerVista 650 Setup

5.6.8.2 Virtual inputs status monitoring:

Actual > Inputs/Outputs > Virtual Inputs > Virtual Input Latched > Virtual Input Self-Reset

Table 5-83: Virtual input status

VIRTUAL INPUTS LATCHED	VIRTUAL INPUTS SELF-RESET
LATCHED VIRT IP 1	SELF-RST VIRT IP 1
LATCHED VIRT IP 2	SELF-RST VIRT IP 2
...	...
LATCHED VIRT IP 32	SELF-RST VIRT IP 32

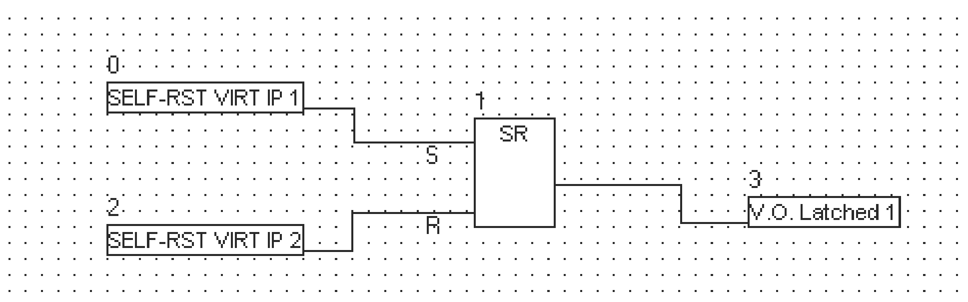
Text assignment for virtual input is made at ***Setpoint > Relay Configuration > Virtual Inputs***. It should be taken into account that the text assigned for virtual inputs in the relay configuration screen are only for file management, they are not sent to the relay.

5.6.9 Virtual outputs

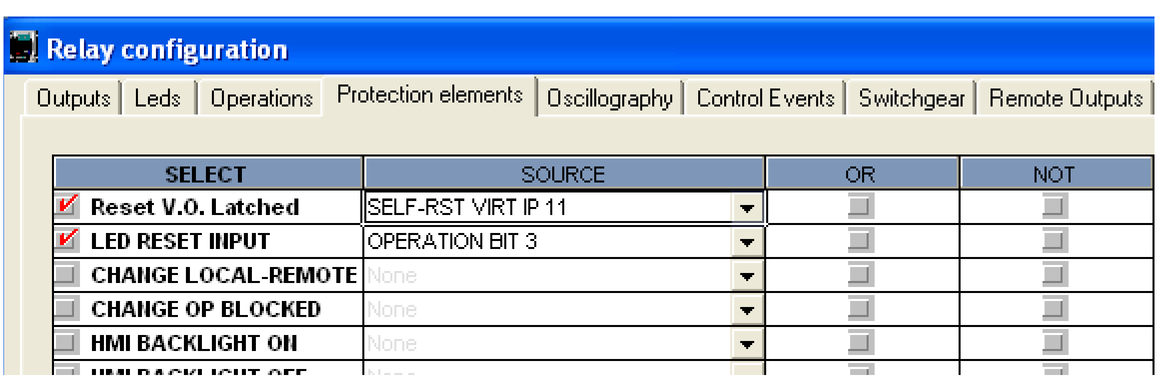
There are 512 virtual outputs that may be assigned via Logic configuration. If not assigned, the output is forced to OFF (Logic 0). An ID may be assigned to each virtual output. Virtual outputs are resolved in each pass through the evaluation of the logic equations. For more detailed information see chapters 5.9 Relay configuration and 5.10 Logic configuration (PLC editor) in this manual.

5.6.10 Virtual outputs latched

There are 16 virtual outputs latched that may be assigned via Logic configuration. If not assigned, the output is forced to OFF (Logic 0). Virtual outputs are resolved in each pass through the evaluation of the logic equations. These latched virtual outputs can only be assigned as an S/R output, they only are linked to a PLC's S/R output and their values remain after switching the unit off and then on.



These virtual output latched may be reset by a PLC setting as it is shown in the following figure



5.7 Remote comms

This settings allow configuring the remote comms settings for the IEC61850 protocol regarding GSSE. For more information see 7.3 IEC 61850 Edition 2 profile for R650.

SETPOINT > INPUTS/OUTPUTS > REMOTE COMMS				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
Remote comms selection	Remote Comms	NONE	N/A	[NONE – GSSE – GOOSE]
SETTING DESCRIPTION FOR GSSE				
Remote comms selection	Remote Comms	GSSE	N/A	[NONE – GSSE – GOOSE]
Device Identification	650 ID	R650	N/A	
Hold time signal send by the transmitting device	Hold Time	10000	1 ms	[1000 : 60000]
Snapshot Events Generation	Snapshot Events Remote Out	DISABLED	N/A	[DISABLED – ENABLED]
Remote Device Description	Remote Device X	Remote Device X	N/A	
Bit Pair Selection	Bit Pair X	None	N/A	[DNA-1 to DNA-32 – UserSt-1 to UserSt-64]
Default Value Selection	Default Value X	OFF	N/A	[OFF – ON – LATEST OFF – LATEST ON]
SETTING DESCRIPTION FOR GOOSE				
Remote comms selection	Remote Comms	GOOSE	N/A	[NONE – GSSE – GOOSE]
Default Value Selection	Default Value X	OFF	N/A	[OFF – ON – LATEST OFF – LATEST ON]
Note: X is the Remote Device index, up to 32				

5.8 Testing

5.8.1 Force IO–input testing

The input testing can only be performed in relay with graphical display, see the human interfaces section in this manual for more detailed information.

5.8.2 Force IO–output testing

Output testing can be performed via HMI in models with graphical display and via communications through EnerVista 650 Setup in all models.

Setpoint > Inputs/Outputs > Force Outputs

This menu allows activating each contact output in the relay, to facilitate maintenance testing. In the screen, the user can select the I/O board to be tested, and also select which output is to be forced (operated).

After selecting the desired output, clicking on the checkbox on the left, the user must click **Force Output** to activate the selected output.

In order to refresh the real status of outputs, according to the information received by the relay processor, click **Refresh**.

The following figure shows the output-testing screen:

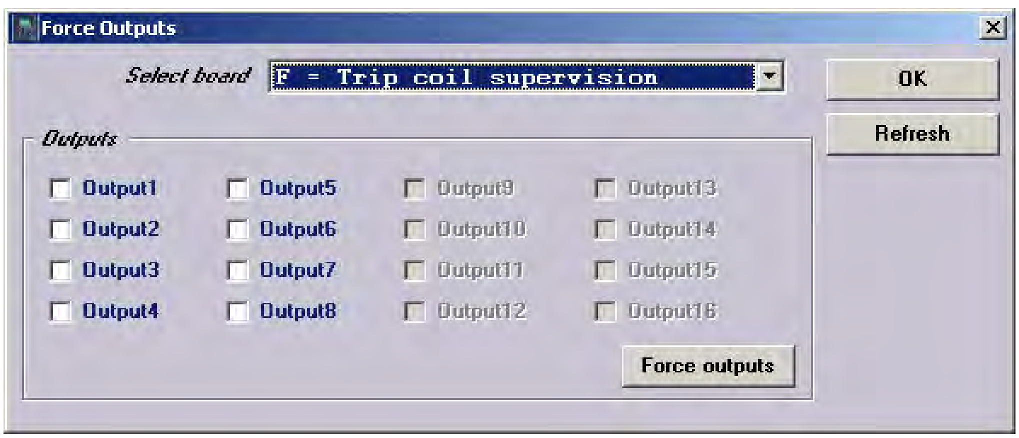


Figure 5-56: Force IO

5.9 Relay configuration

Setpoint > Relay Configuration

This is the relay configuration section in which the relay can be configured (all input/output and LEDs configuration, protection elements signals, graphic display configuration, etc.) using internal states or already compiled equation on PLC Editor (see section 5.10 Logic configuration (PLC editor)).

5.9.1 Outputs

Configuration of contact output operates and reset signals for all boards available in the device:

To configure any output it is necessary to select the output to be configured, clicking on the checkbox in the select column and choose the logic operand in the source column. Simple logics can be performed on this screen, using the “or” and “not” columns, for more complex logics go to the logic configuration tool to create the virtual outputs and afterwards select it in the source column.

The different options available in this screen are the following:

- ***Select*** checkbox enables each output. The output must be enabled before modifying any other setting on that output
- ***Name*** setting for defining identification for the output. Note: nor the Output name, nor the Input name, nor the Virtual Input name is recorded into the relay.
- ***Source*** setting for defining a function, logic, remote input, digital input, etc. that activates the contact.
- ***OR*** checkbox for configuring the output operation by activation of any of the indicated signals. The element performs an OR of the signals, and its output produces operation.
- ***NOT*** checkbox for inverting or not the configured logic.

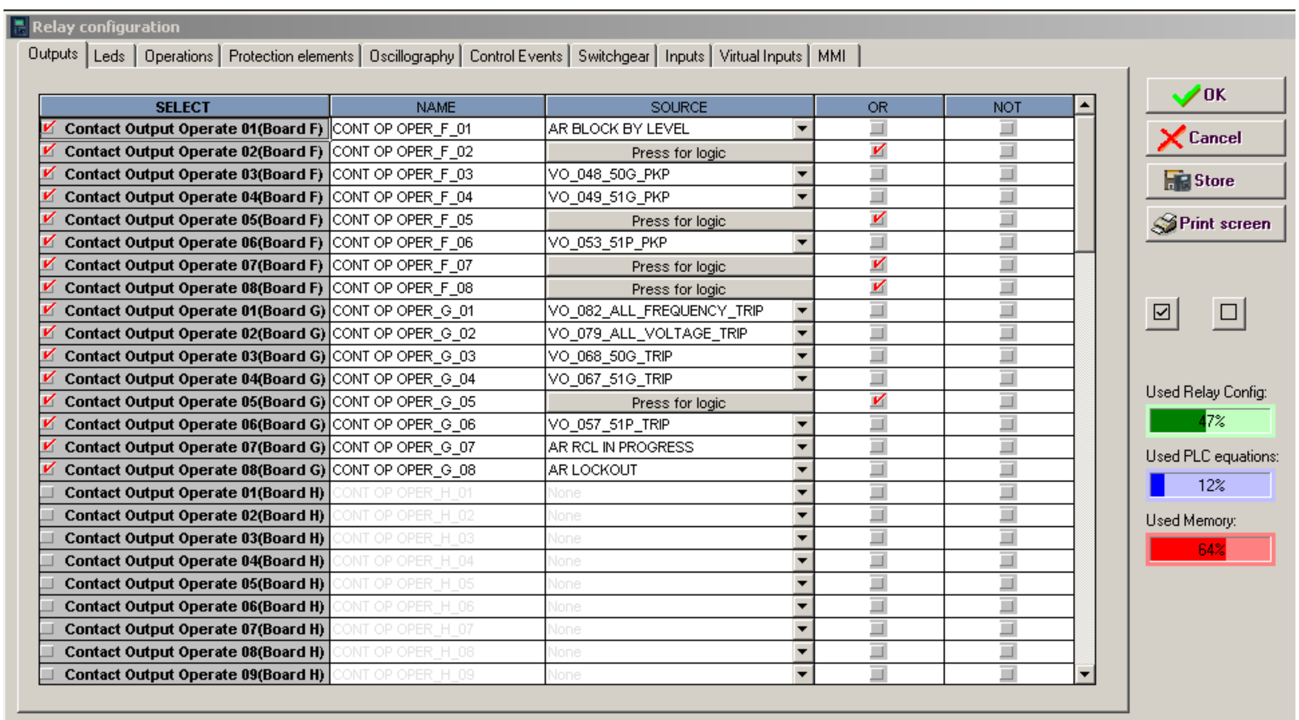


Figure 5-57: Output configuration

5.9.2 LEDs

R650 has 15 LEDs fully configurable from any logical variable, contact or virtual input. All these LEDs can be individually configured as latched or self-reset. This new setting is accessible from **Setpoint > Relay Configuration > LED.**

This window displays all relay LEDs with the following setting options for each one:

- **Select** checkbox enables each LED. The LED must be enabled before modifying any other setting on that LED
- **Name** setting for defining identification for the LED
- **Source** setting defines which function; logic, remote input, digital input, etc. activates the LED.
- **OR** checkbox for configuring the LED operation by activation of any of the indicated signals. The element performs an OR of the signals, and its output produces operation.
- **NOT** checkbox for inverting or not the configured logic.
- Latched checkboxes are available for configuring the LEDs. If it is selected, LED shall work as latched, if it is deselected, LED shall work as self-reset.

From the LED configuration screen, it is possible to print the vertical LED label for the relay. For this purpose, click the printer icon. The label obtained is similar to the default factory label, with black background and the LED texts in white. This label can replace the original one under the black plastic cover. The label is also provided in word format and can be modified by the user (e.g. different color marking)

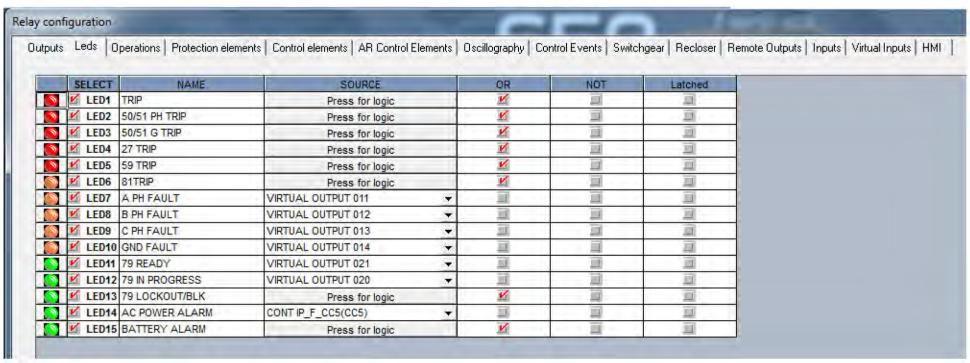


Figure 5-58: LED configuration

5.9.3 Operations

This menu option shows the settings for the 24 control operations that can be programmed, as follows:

- ***Select*** checkbox enables the desired operation.
- ***Command Text*** setting defines the command name.
- ***Interlocks Type*** setting defines the desired interlock type (An interlock is a condition that must be fulfilled for an operation to be performed). The possible options are ***Logic*** or ***None.*** If the **LOGIC** option is selected, the program enables a new window for creating the logic. If the **NONE** option is selected, then the following setting (***Interlocks***) is irrelevant.
- ***Interlocks*** setting define the desired interlocks. This setting is enabled selecting the "***logic***" option in "***Interlock type***". In the "***Interlock logic***" screen we can set the interlock logic, as shown on Figure 5-59: Operations and interlocks

  The settings on this screen allow creating a logic configuration with up to 3 AND gates and 1 OR gate for each of the 24 operations available in the relay. These settings are:

  Select – Enables/disables the selection for the interlock input

  Source – Selects a function, digital input, logic, etc. for defining each input of each AND gate.

  NOT – Logic inverter

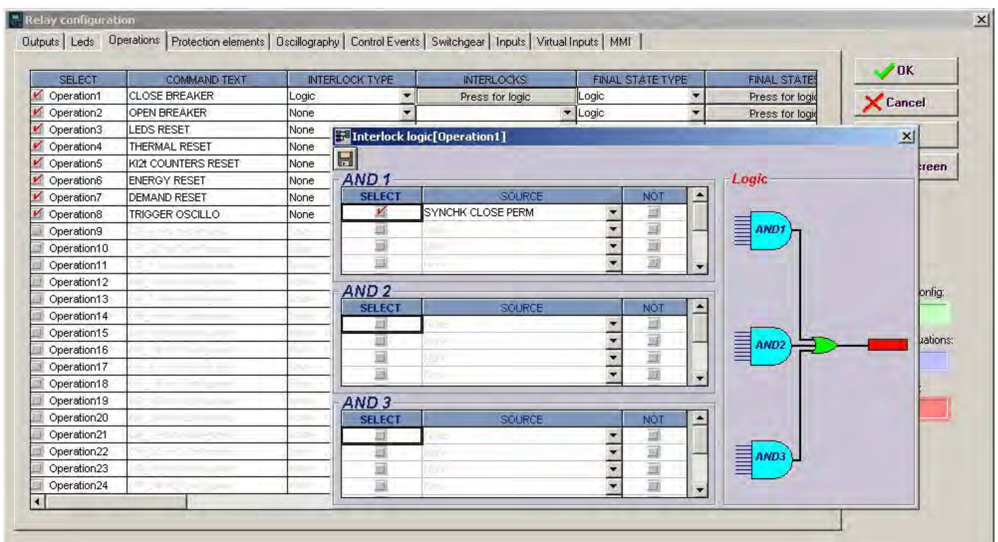


Figure 5-59: Operations and interlocks

- ***Final State Type*** setting: defines whether the operation requires (in addition to the interlock logic) any other conditions to determine a "success condition". If so, we must select LOGIC. Otherwise, we must select NONE.
- ***Final State*** setting: defines the success condition of a programmed operation, if the previous setting (***Final State type***) was set as LOGIC.
- ***Front Key*** setting: defines the front pushbutton from which the operation can be executed.
- ***Contact Input*** setting: defines whether the operation can be executed by digital input. It defines the digital input to be used for this purpose.
- ***Virtual Output*** setting: defines whether the operation can be executed from a virtual output previously defined at the logic configuration tool (PLC logic).
- ***Time Out*** setting: defines the period during which the operation command remains activated waiting for a success condition. If the success signal is received before this period expires, the command signal is removed and the timer reset. If the success condition is not received within this period of time, the operation is considered to be finished.
- **HMI setting:** defines whether the operation can be executed by HMI

- ***COM1 (REMOTE)*** setting: defines whether the operation can be executed by communications through the rear port COM1.
- ***COM2 (LOCAL)*** setting: defines whether the operation can be executed by communications through the rear port COM2. We must note that this local port is the same as the front port (DB-9 connector). We can establish simultaneous communication with the relay through ports COM1 and COM2. However, it is not possible to use rear COM2 and the front port simultaneously.
- ***ETHER-MASTER*** setting: defines whether the operation can be executed by communications through the ETHERNET.

It must be taken into account that besides the master selection in the operations screen inside relay configuration, there is a hardware selection (with the operation pushbutton in the front part of the relay) to switch between local (COM2 and HMI) and remote masters (COM1 and ETHERNET) for operations.The local-remote-off sequence can be also available through communications selecting the signal to switch in "***Setpoint>Relay Configuration>Protection Elements***".

The following diagram shows an example of the operations internal logic.

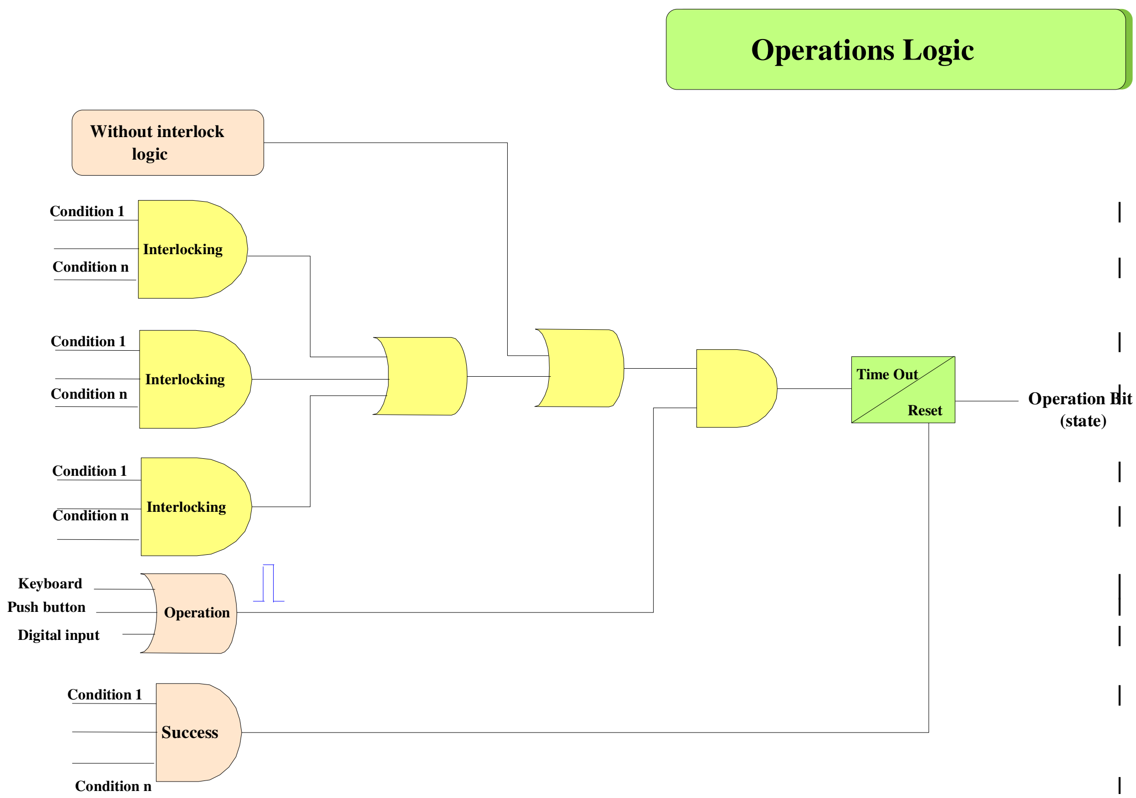


Figure 5-60: Operation logic diagram

5.9.3.1 Programming an operation

Example of how to program an operation to close a recloser with an operating time of 90 ms (closing), incorporating 52/b contacts to indicate the change of position, using an interlock logic to enable the operation if there is synchronism condition, and there is no autoreclose in progress. The operation must be commanded from the relay faceplate using one of the available operation push buttons.

To configure the related operation, go to ***Setpoint > Relay Configuration*** and select ***Operations*** tab.

This screen shows all the fields required for the operations configuration in the R650. In order to select an operation, click the operation name under the **Select** column, and all the related parameters are enabled. The chosen name for the operation is entered in **Command Text**. To configure an interlock logic, select the **Logic** option in **Interlocks Type**. Once this option has been selected, the interlock configuration screen is enabled. To display this screen, click **Press for Logic** for the desired operation on the **Interlocks** column. On this **Interlocks** screen, the two conditions that conform the Interlock that enables the operation have been selected. To save the interlock, click the disk icon on the toolbar. A **Logic Saved** displays.

Once the Interlocks have been defined, the user must define the success conditions for the operation, define **Final State Type** as LOGIC, and a PRESS FOR LOGIC message lights up below **Final States**. When clicking PRESS FOR LOGIC, the success condition screen is displayed, defining there as recloser CLOSED.

The front key to be used for executing the Operation can be selected on the Frontal Key column, in this example the **Key I** option is selected on **Frontal Key**. As none of the other contact input or virtual output options are going to be used they are set to **None**. The success condition time **Time out** is set to **500 ms**, and the operation is only enabled through the relay keypad, so only the **MMI** option is selected, thus disabling the rest of options (COM1, COM2, ETHERNET master are not selected).

All the selections previously related are summarized in the following table:

Table 5-84: Operation settingSs

OPERATION	COMMAND TEXT	settingS	VALUE/SOURCE
Operation1	CLOSE recloser	INTERLOCK (LOGIC)	SYNCHK CLOSE PERM
		FINAL STATES (LOGIC)	recloser CLOSED
		FRONT KEY	I Key
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	MMI

Finally, configure a contact output to be activated with the programmed Operation (Operation1).

This is done under **Setpoint > Relay Configuration > Output**, selecting an output and choosing the internal signal OPERATION BIT 1, which corresponds to the bit that is activated when the related operation is executed.

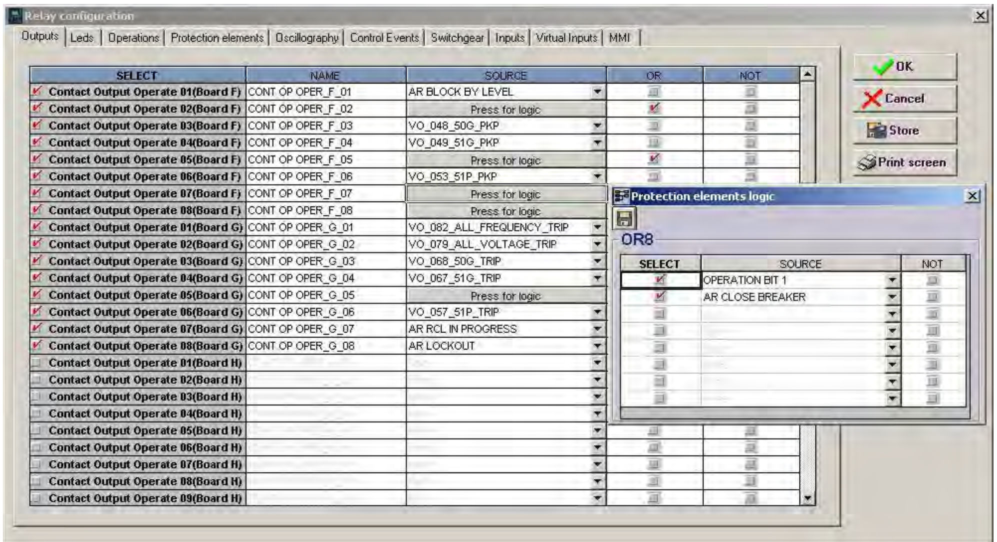


Figure 5-61: Contact output configuration

Note: Operations time out for confirmation

Configurable screen in graphical HMI: In the relay HMI the configurable objects wait one minute for confirmation after operation selection. The object is blinking for one minute. After that time, the object is deselected.

Front Keys: In operations performed by front keys, the time out for confirmation is 10 seconds.

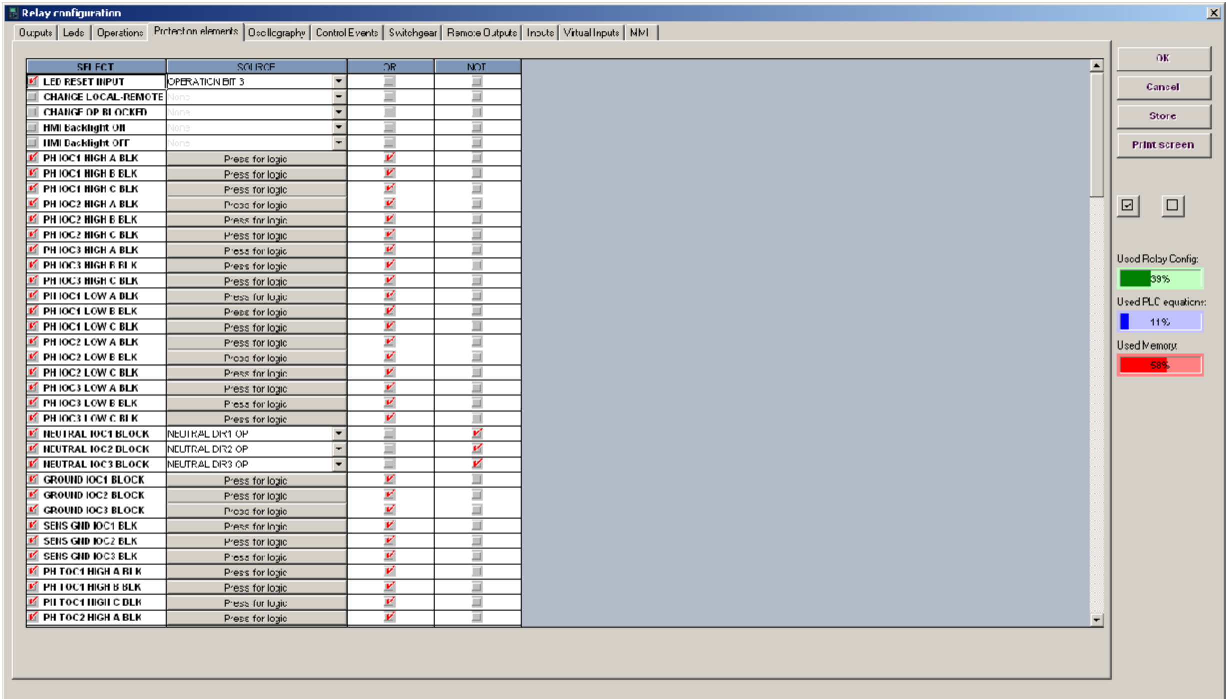
5.9.4 Protection elements

This tab allows assigning operands (logic signals) as inputs to different protection elements. This way, the user assigns which operands can reset the Thermal Image, etc. In this screen we can also configure a logic signal to perform the LED reset by communications.

The settings are as follows:

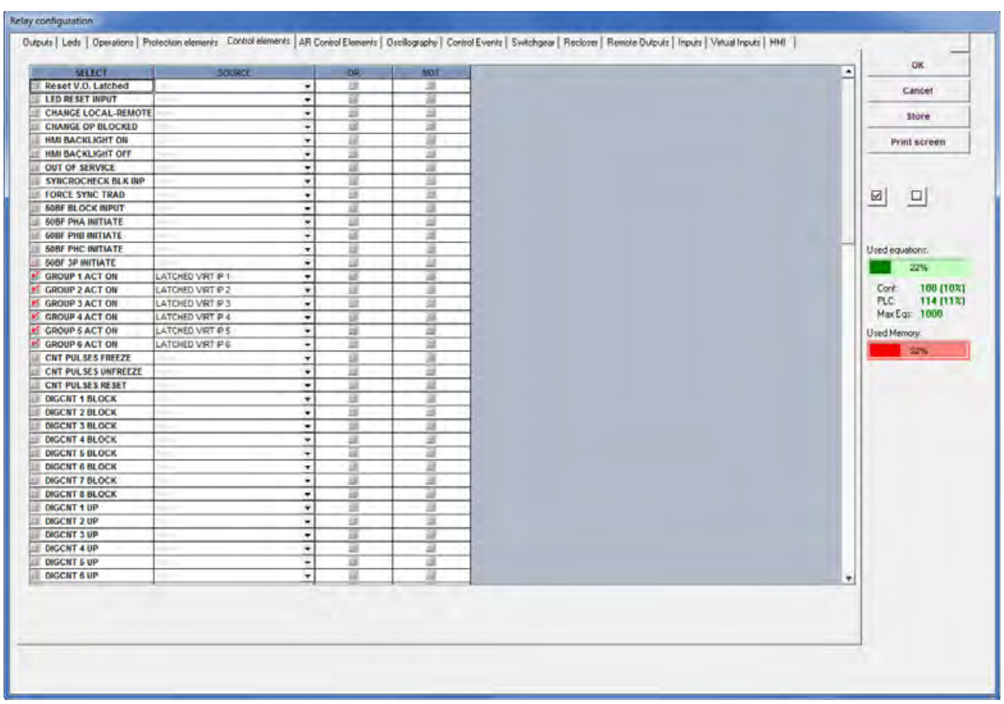
- ***Select*** checkbox enables/disables the selection.
- ***Source*** setting defines the operand that performs the function indicated in the SELECT column. ***NOT*** setting inverts the block signal.
- ***NOT*** setting for inverting the logic signal.
- ***OR*** checkbox to select a group of operands instead of a single one. The relay performs an OR of the signals, and its output produces the operation.

The following figure shows this screen:



5.9.5 Control elements tab

This tab allows assigning operands (logic signals) as inputs to different control elements. This way, the user assigns which operands configure digital counters, etc. In this screen we can also configure a logic signal to perform the LED reset by communications. The settings are the same as in *Protection Elements* tab.



5.9.6 Oscillography

This menu is used for selecting the digital channels to be included in oscillography records, and the oscillo trigger signal. As for the above-described settings, the trigger selection can be any of the signals provided by the relay or a logic combination of these.

settings are described below:

- ***Select*** checkbox enables or disables a digital channel and the oscillography trigger.
- ***Name*** setting defines the name of the digital channel to be included in oscillography records.
- ***Source*** setting defines the source or signal to be recorded in that specific channel, which can be selected among all the operands available in the signals menu.
- ***NOT*** checkbox inverts the enabled digital channel signal.
- ***OR*** checkbox to select a group of operands instead of a single one. The relay performs an OR of the signals, and its output produces operation.

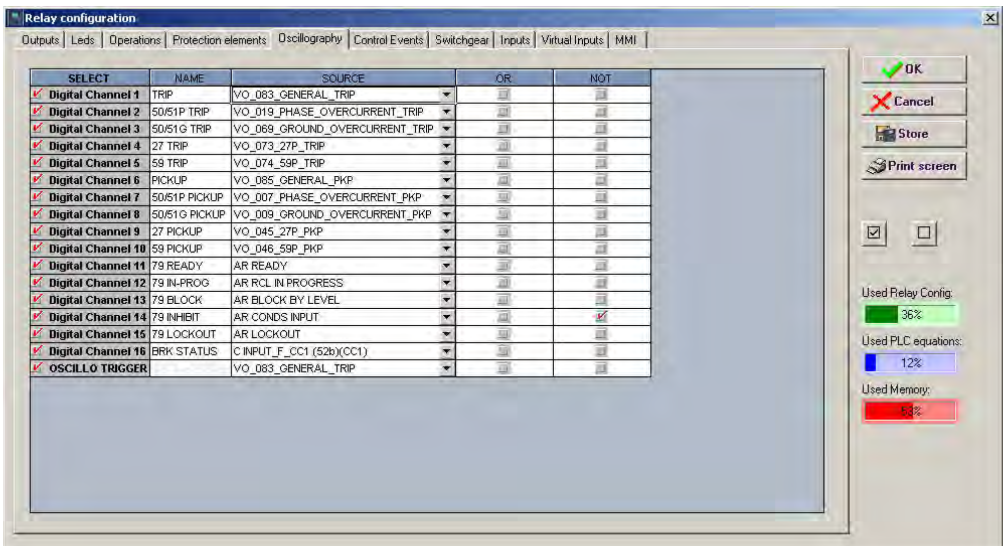


Figure 5-62: Oscillography configuration

NOTE This screen is used for the configuration of digital channels and oscillography trigger. The rest of parameters, such as function enabling/disabling, sampling rate, number of oscillography files, etc. must be set on the **Setpoint > Product Setup > Oscillography** menu.

5.9.7 Control events

This menu is used for defining the **CONTROL EVENTS**, up to 128 user programmable events.

A control event is a logic signal associated with an operand or combination of operands which monitories the change of status of the logic operand. The relay shows which events are active each time, as well as their date and time of activation.

There are 128 user programmable events and 64 pre-established events for switchgear, which correspond to opening, closing, Error00 and Error11 of the 16 programmable switchgear elements. (Refer to section 5.9.9 HMI (human-machine interface) for more detailed information).

As for the rest of previous settings, the source selection can be made between:

- An operand, selecting it directly on this screen.
- An **OR** of several operands, selecting directly the **OR** column in this same menu.
- A logic combination of operands, by selecting a VIRTUAL OUTPUT as trigger source, and using the logic configuration available in the relay, graphical PLC, that allows to design logic circuits and to assign their outputs to internal variables, called VIRTUAL OUTPUT.

Available settings are as follows:

- ***Select*** checkbox: enables or disables the generation of each event.
- ***Name*** setting: defines the text for each control event.
- ***Source*** setting defines the source that triggers the event. The source is chosen from the list that shows all the operands available in the element.
- ***NOT*** checkbox inverts the selected signal.
- ***OR*** checkbox to select a group of operands instead of a single one. The relay performs an OR of the signals, and its output produces operation.
- ***Alarm*** checkbox: allows treating the event as an alarm and making the event activation to be reported on the alarm panel.

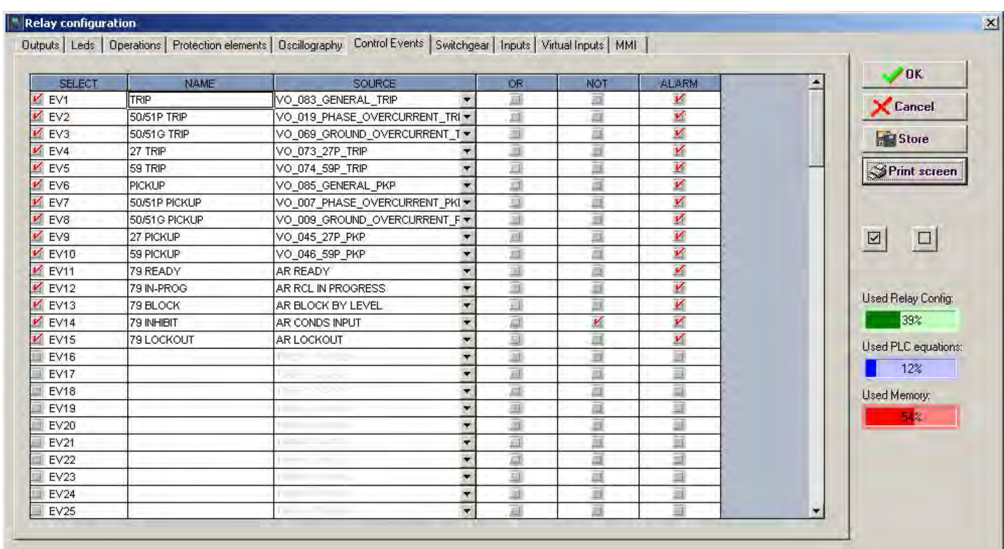


Figure 5-63: Control events configuration

The Alarm panel can be displayed in:

HMI screen for models with graphical display.

EnerVista 650 Setup: ***Actual>Event Recorder>Alarm Panel*** for all models.

Web Server application: ***http://xxx. xxx. xxx. xxx /Alarms.htm*** for all models.

If the event is not selected as an alarm, it can be viewed as an event at:

HMI screen for all models in snapshot event screen (with default text).

EnerVista 650 Setup: ***Actual>Event Recorder> Control Events*** for all models.

Web Server application: ***http://xxx.xxx.xxx.xxx/ControlEvents.htm*** for all models.

Alarm management in R650:

The relay can manage alarms in from three different masters, local, remote COM1, remote Ethernet. The alarms can be active or not active and can be acknowledged or not acknowledged. As shown in the following table:

Table 5-85: Alarm management

ALARM STATUS	MASTER MANAGEMENT		
ACTIVE - NOT ACTIVE	ALL MASTERS		
ACKNOWLEDGED - NOT ACKNOWLEDGED	LOCAL	REMOTE	
	COM2 & HMI	COM1	ETHERNET

ACTIVE status is shown on the display (relay HMI), showing an ON label on the right of the alarm. The PC shows the alarm text in red.

ACKNOWLEDGED: Operation acknowledgement can be performed from three independent channels: MMI-COM2 (local), COM1 (remote) and ETH_1/ETH2 or ETH_E/ETH_A/ETH_B (Ethernet). Inactive alarms disappear from the HMI when being acknowledged.

HMI: Acknowledged status is shown on the HMI with a selection mark on the right of the ON label.

EnerVista 650 Setup: the acknowledged status is shown by a check mark to the left of the Operation name.

5.9.8 Switchgear

This menu is used for defining the SWITCHGEAR elements to be controlled by the relay. A switchgear element can be a recloser, a line selector switch, a grounding selector switch, a busbar selector switch, etc. It is possible to define up to 12 switchgear elements. The settings are as follows:

- ***Select*** checkbox: enables or disables the control of a new switchgear element
- ***Contacts*** setting: allows selecting which type of contact is used for monitoring the status (open/closed) of the element. The selection can be: ***52a*** (contact type A, showing the same status as the represented element), ***52b*** (opposite status to the represented element), ***52a+52b*** (both types of contacts are used), ***NONE*** (no status monitoring).
- ***Opening Time*** setting: defines the maximum opening time of an element. It is used for issuing an opening time failure signal if the element opening is not produced within this time.
- ***Closing Time*** setting: defines the maximum closing time of an element. It is used for issuing a closing time failure signal if the element closing is not produced within this time.
- ***Contact A*** checkbox: allows selecting which operand or combination of operands activate the type A contact status. Usually it is an input contact wired to type A contact of the element (Recloser/selector switch). This column and the next two columns are only active if the selected contact type in the Contacts column is ***52a*** or ***52a+52b***.
- ***OR*** checkbox: selects a group of operands instead of a single one. The relay performs and OR of the signals, and its output produces operation.
- ***NOT*** checkbox inverts the status of the signal selected in column ***Contact A***.
- ***Contact B*** checkbox: allows selecting which operand or combination of operands activates the type B contact status. Usually it is an input contact wired to type B contact of the element (Recloser/selector switch). This column and the next two columns are only active if the selected contact type in the Contacts column is ***52b*** or ***52a+52b***.

  •***OR*** checkbox selects a group of operands instead of a single one. The relay performs OR of the signals, and its output produces operation.

  •***NOT*** checkbox inverts the status of the signal selected in column ***Contact B***.
- ***Open text*** setting: allows associating a text to the control event associated with the element opening.
- ***Close text*** setting: allows associating a text to the control event associated with the element closing.

- ***Error 00 text*** setting: in case of using double contact for the switchgear element status (***52a+52b***), this setting allows to associate a text to the Error00 internal status, this means, when both contacts are inactive during a period longer than the associated with the opening or closing Operation, depending on which Operation is being performed.
- ***Error 11 text*** setting: in case of using double contact for the switchgear element status (***52a+52b***), this setting allows to associate a text to the Error11 internal status, this means, when both contacts are active during a period longer than the associated with the opening or closing Operation, depending on which Operation is being performed.
- ***ALARM*** setting: enables the issue of an alarm in the event of a close, open, 00-type, 11-type error. If it is configured as an alarm.
- ***Opening init*** setting: this setting selects which operand or combination of operands indicate the initiation of an opening operation, in order to allow the follow up of the operation and generate the corresponding alarms if the operation is not successful. The operation bit signal used to launch the opening init must be configured in the operations tab inside relay configuration.
- ***Closing init*** setting: this setting selects which operand or combination of operands indicate the initiation of a closing operation, in order to allow the follow up of the operation and generate the corresponding alarms if the operation is not successful. The operation bit signal used to launch the closing init must be configured in the operations tab inside relay configuration.
- **Block Open** : allow selecting which operand or combination of operands activates the opening blocks for the switchgears (XSWISTBlkOpn and XSWISTBlkCls) for operating in 61850.
- **Block Close settings**: allow selecting which operand or combination of operands activates the closing blocks for the switchgears (XSWISTBlkOpn and XSWISTBlkCls) for operating in 61850.

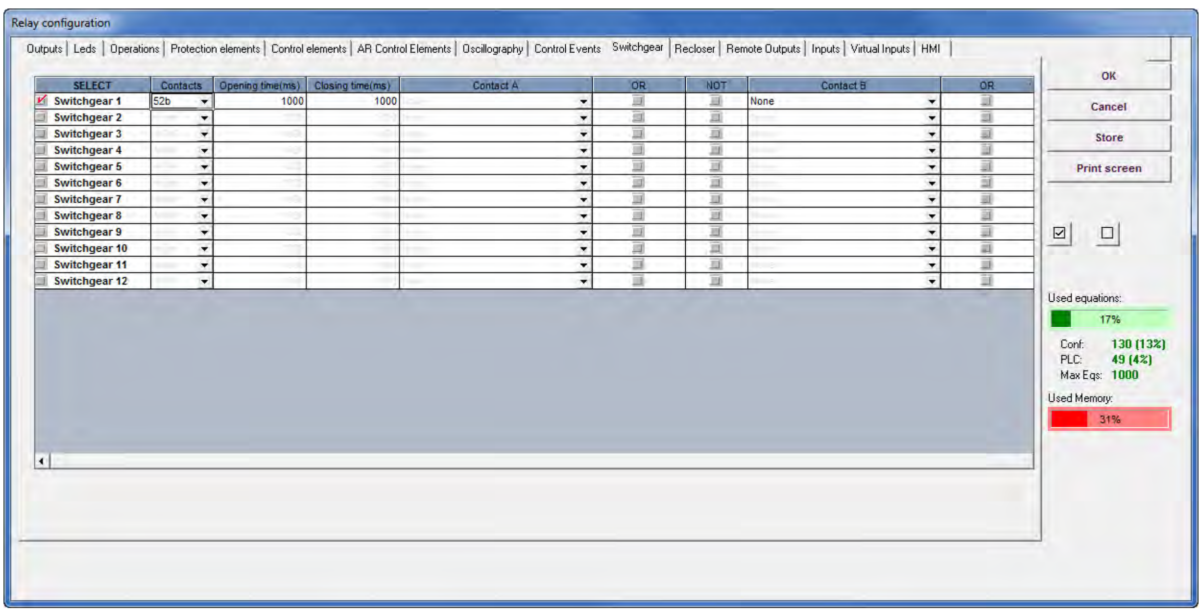


Figure 5-64: Switchgear configuration

Note: when a switchgear device is only monitored (open init and closing init signals are not used), it is not possible to distinguish between the fail to open or fail to close time, the time used to give an error 00 or 11 signal is the maximum of the opening and closing time configured for that switchgear.

5.9.9 HMI (human-machine interface)

This menu shows a scenario to draw a simplified one-line diagram of a bay in a feeder, line, transformer, etc. The menu includes a library for power elements, metering elements, text and drawings.

To use the drawing toolbar elements, select the desired element and then click the yellow area. The selected element is moved to the screen on the selected spot (see Figure 5-65: HMI configuration).

The graphic display can be used to configured switchgear elements, operations, metering values, date and time, etc. The configured values is always updated with the real status of the relay.

This functionality is only applicable to R650 elements with graphical display, and not for elements with alphanumerical display . Depending on the relay model, the graphical display can show IEC 1082-1 symbols (N option in order code).

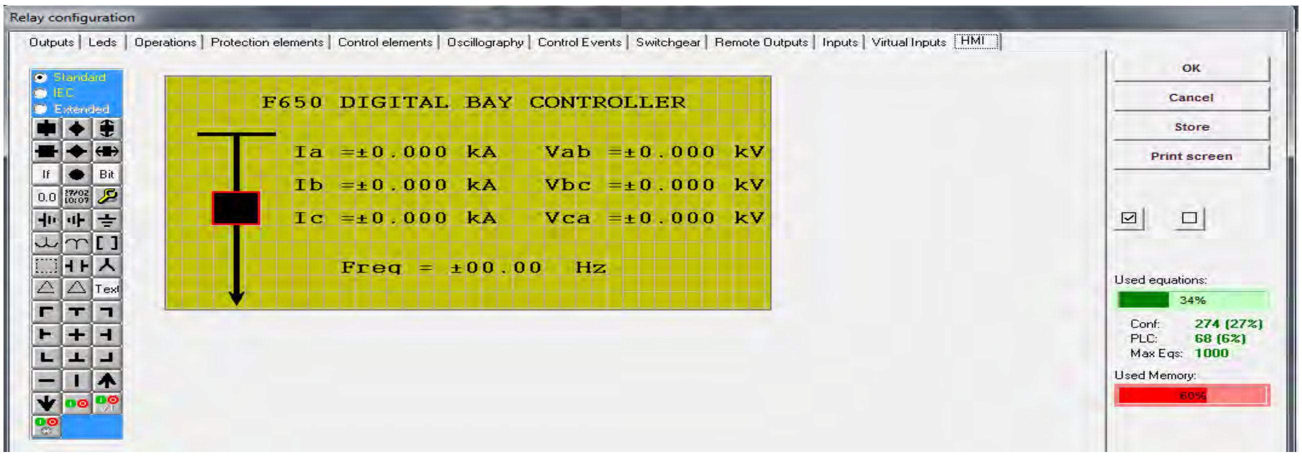
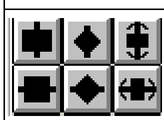
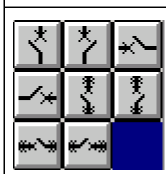
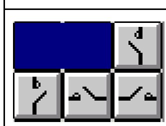
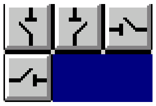
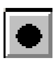
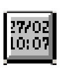
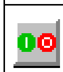


Figure 5-65: HMI configuration

On the left side of the window all the available elements to be programmed on the HMI are displayed. Their meaning is detailed on the right.

Table 5-86: Active configurable symbols in on-line diagram for graphical HMI

ACTIVE SYMBOLS	
ICONS IN SCREEN	**DESCRIPTION**
SWITCHGEAR SYMBOLS	STANDARD AND IEC 1082-1 SWITCHGEAR SYMBOLS
STANDARD SWITCHGEAR SYMBOLS	M selection for graphic display option in the order code
	Switchgear elements: recloser (square) and selector switch (rhombus),in vertical and horizontal positions. It is necessary to associate the figure to its corresponding switchgear number. The figure is shown filled if the element is closed, and blank if the element is open. The symbol on the right represents an unpluggable recloser. In this case it is necessary to indicate which operands show whether the element is plugged or unplugged. The figure shows also graphically these two statuses.
	Reclosers and recloser trucks in vertical and horizontal positions. The first fourth symbols are reclosers in vertical and horizontal positions for left and right options. The last fourth symbols are recloser trucks or unpluggable reclosers. When the device is connected two arrows can be seen, if the device is not connected only one arrow is displayed. When the device it is inserted the device can be seen and when it is not inserted only a blank space is displayed
	Contactors in vertical and horizontal positions

ACTIVE SYMBOLS	
ICONS IN SCREEN	**DESCRIPTION**
	Selector switches in vertical and horizontal positions.
OTHER CONFIGURABLE SYMBOLS	M selection for graphic display option in the order code
MULTISTATE VARIABLE SYMBOL	
	Displays a dialog box on screen that is one variable status function (like a switch case) for the following internal states AR STATUS, AR LOCKOUT MODE, AR BLOCK MODE and FAULT TYPE. This type of data allows to visualize the different states of one particular value, for example, AR STATUS has several states such as (0) OUT OF SERVICE, (1) READY, (2) LOCKOUT, (3) BLOCK, (4) RECLOSE IN PROGRESS. Significant texts can be associated with those states.
STATUS SYMBOLS	(TEXT AND GRAPHIC MODES):
	Bit: Represents the state of an operand by means of a configurable text. It allows associating a test to the active status and a different text to the inactive status.
	Led(O) Performs the same function in a graphical mode. This way, it works as a virtual LED. When showing a black circle, it means that the selected operand is active, and if the circle is blank, the operand is inactive
ANALOG MAGNITUDE SYMBOL	
	Used for displaying analog magnitudes (current, voltage, power, etc.) in floating point numbers, such as a current value (123.5 A). Both the number of decimals and the integer characters can be selected, in order to facilitate the reading. Any of the analog magnitudes available in the relay can be configured.
DATE AND TIME SYMBOL	
	Display the date and time provided by the device in the HMI.
OPERATIONS SYMBOL	
	Configure and execute operations on the graphic display. This symbol can only be selected once the operations have been configured in the **Operations** screen of the **Relay Configuration** menu. To select an Operation, click the element and then the display. A window opens to select the operation and the tab order. Once selected, a red border square is shown. Place this square on the object to operate. When the object is selected on the screen to execute this operation, the object on which it is located blinks. It is possible to place several operations on the same object, for example to open and close the recloser object.
	Configure and execute operations with the front keys "I" and "O" on the graphic display over an object selected. To select the object, click the element and then the display. A window opens to select the required operations "I" and "O" and the tab order. Once selected, a blue border square is shown. Place this square on the object to operate. When the object is selected on the screen to execute these operations, the object on which it is located blinks. Press key "I" or "O" to execute the configured operations.

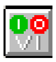
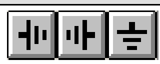
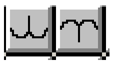
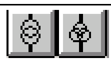
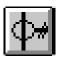
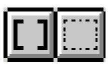
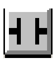
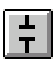
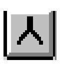
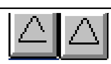
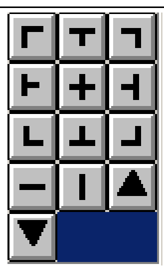
ACTIVE SYMBOLS	
ICONS IN SCREEN	**DESCRIPTION**
	Configure and execute operations with the front keys "I", "O" and "*" on the graphic display over an object selected. To select the object, click the element and then the display. A window opens to select the required operations "I", "O" and "*" and the tab order. Once selected, a green border square is shown. Place this square on the object to operate. When the object is selected on the screen to execute these operations, the object on which it is located blinks. Press key "I", "O" or "*" to execute the configured operations. After executing this kind of operation, information about the result of the operation is displayed on the HMI..
	Configure and execute virtual inputs with the frontal keys "I" and "O" on the graphic display over an object selected. To select the object, click the element and then the display. A window opens to select the required virtual operations "I" and "O" and the tab order. Once selected, a white border square is shown. Place this square on the object to operate. When the object is selected on the screen to execute this virtual inputs, the object on which it is located blinks. Press key "I" or "O" to set the configured virtual inputs.

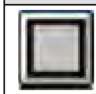
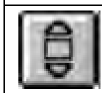
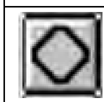
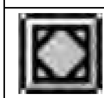
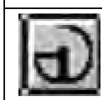
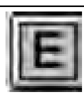
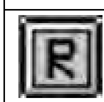
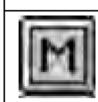
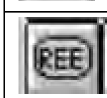
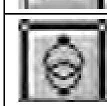
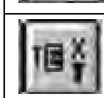
Table 5-87: GRAPHIC AND TEXT EDITION SYMBOLS

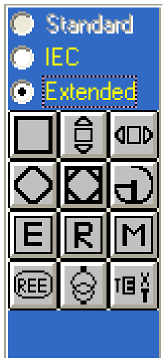
GRAPHIC AND TEXT EDITION SYMBOLS		
ICONS IN SCREEN	**DESCRIPTION**	**AVAILABILITY**
	Ground symbols in different positions.	The first two are not available in the N model (IEC selection).
	Voltage Transformers representation	Only for standard model M.
	Two and three winding voltage transformers representation.	Only for N model (IEC selection)
	Current transformer representation	Only for N model (IEC selection).
	Symbols reserved for future uses	Both M and N selection
	Symbol for capacitor banks.	Both M and N selection
	Symbol for vertical capacitor banks.	Only for N model (IEC selection).
	Symbol for wye connection	Both M and N selection
	Symbol for open delta and delta connection	Both M and N selection
	Display of a fix text up to 40 ASCII characters	Both M and N selection
	Auxiliary drawing lines	Both M and N selection

EXTENDED GRAPHIC SYMBOLS

For the extended graphic symbols, extraction device must be set to 52a+52b switchgear device.

Table 5-88: GRAPHIC AND TEXT EDITION SYMBOLS

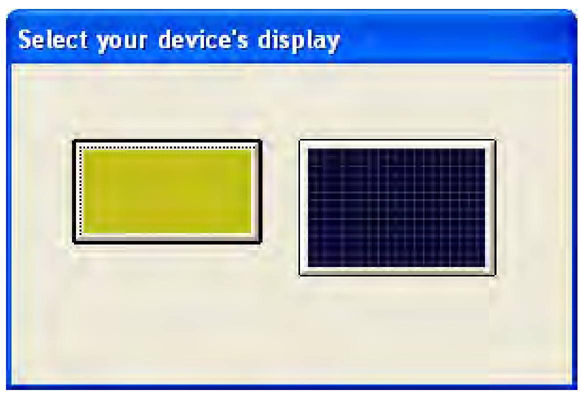
EXTENDED GRAPHIC AND TEXT EDITION SYMBOLS		
ICONS IN SCREEN	DESCRIPTION	AVAILABILITY
	Recloser	Only for N model (IEC selection)
	Recloser+Extraction device (Vertical)	Only for N model (IEC selection)
	Recloserrecloser+Extraction device (Horizontal)	Only for N model (IEC selection)
	Isolator	Only for N model (IEC selection)
	Isolator Remote controlled	Only for N model (IEC selection)
	Neutral Reactance	Only for N model (IEC selection)
	“Encravado” Interlocked	Only for N model (IEC selection)
	Autorecloser In Service/ Out of Service	Only for N model (IEC selection)
	“M”/”A” Symbol for Manual/Automatic	Only for N model (IEC selection)
	“Regime Especial Exploração”	Only for N model (IEC selection)
	Voltage transformer	Only for N model (IEC selection)
	Different Text properties (Bold/Vertical/Reverse Video)	Only for N model (IEC selection)



5.9.10 Device display selection

5.9.10.1 Type of graphical display

On offline mode, when creating a new setting file (*.650), when entering on SETPOINT > RELAY CONFIGURATION > HMI, it is possible to choose the display type that is wanted to configure from two types of graphical displays depending on the order code. Green one for standard models and the black one for "N" model IEC selection.



5.10 Logic configuration (PLC editor)

Setpoint > Logic Configuration

The logic configuration (or PLC Editor) tool is a graphical design tool that allows the R650 built complex logic diagram in an easy way using different logic functions.

The logical configuration is performed using graphical functions based on the IEC 61131-3 standard.

- **This standard defines five basic ways of programming:**
    - Sequential Function Chart (SFC).
    - Instruction List (IL).
    - Structured Text (ST).
    - Ladder Diagram (LD).
    - Function Block Diagram (FBD).

Out of these five methods, FBD has been chosen because it allows for graphical configurations that are more comprehensive. This method provides the possibility of grouping several basic functions inside a single function (hereon called libraries), achieving higher modularity and clarity in the design.

NOTICE The first equation entered in the PLC can never be a timer
Analog elements (analog comparators, etc,) are not implemented.

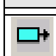
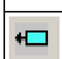
5.10.1 Theory of operation

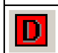
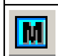
5.10.1.1 Description

As already mentioned in the introduction, this tool uses FBD mode of IEC 61131-3 standard. For this purpose we have defined a series of basic operations with illustrations below.

The basic operations available in the PLC Editor are located in the tool bar of the application and are as follows:

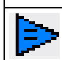
Table 5-89: PLC editor basic operation in R650

PLC EDITOR BASIC OPERATION	
ICONS IN SCREEN	DESCRIPTION
	INPUT TO LOGIC: Selection of the digital input to the logic. (All available internal status can be used as logic inputs **)
	OUTPUT FROM LOGIC: Virtual output built with internal logic. (Up to 512)
	LIBRARY: Possibility to build blocks of logic in a simple graphic object. OR and AND from 3 to 8 inputs are provided as libraries.
	AND of two digital inputs.
	OR of two digital inputs.
	NOT of a digital input.
	NAND of two digital inputs.
	XOR of two digital inputs.
	SR: Latch (set-reset): reset dominant.

PLC EDITOR BASIC OPERATION	
ICONS IN SCREEN	**DESCRIPTION**
	ONS: signal to pulse an logic input to a signal of one scan cycle length.
	TIMER: timer signal with set, reset and mask for timing.
	TEXT LABEL: text to customize the logic configuration file.
	Flip-Flop D: signal that maintains the actual value frozen during a PLC cycle
	MASK: Time mask to be used in timing operations.

Analog operands are available. It is possible to use these operands with analog or digital values.

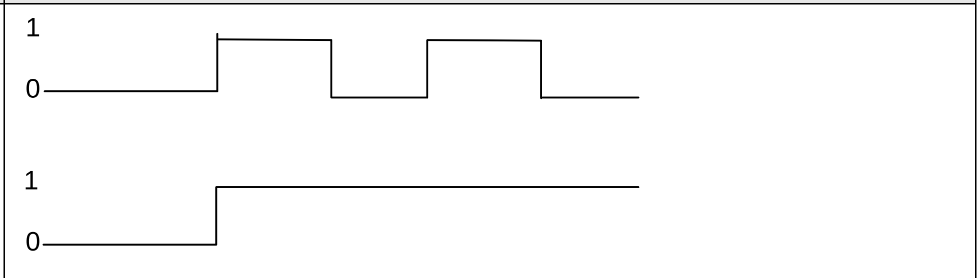
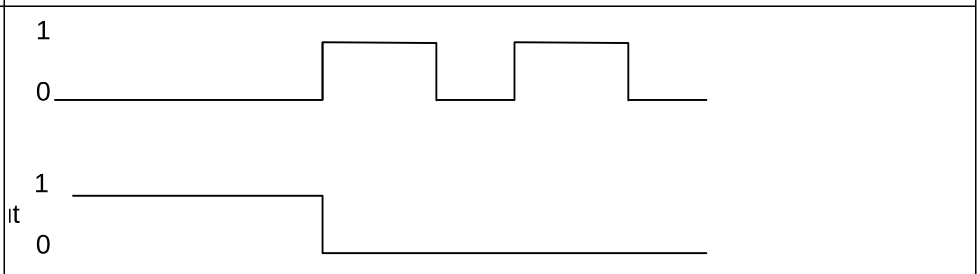
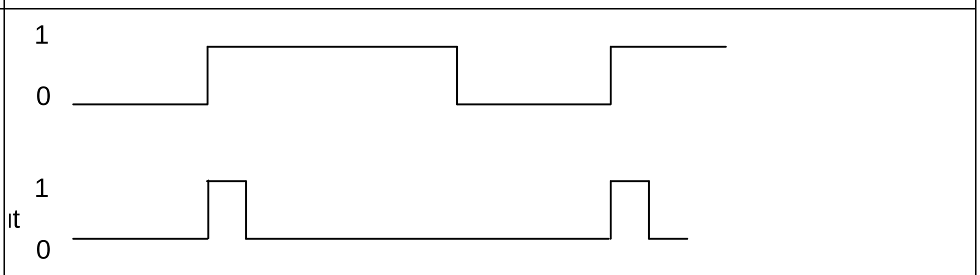
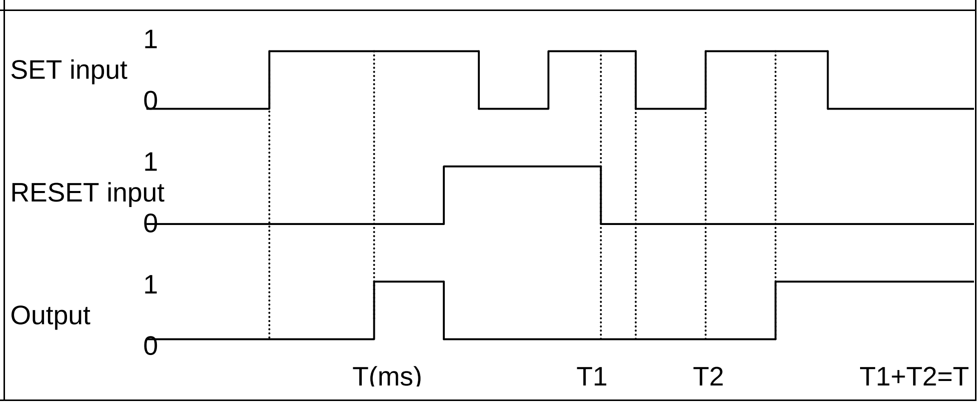
The basic operations available in PLC Editor are located in the tool bar of the application and are as follows:

PLC EDITOR ANALOG OPERATION	
ICONS IN SCREEN	**DESCRIPTION**
	GREATER THAN COMPARATOR of two digital or analog inputs.
	EQUAL TO COMPARATOR of two digital or analog inputs
	MULTIPLIER of two digital or analog inputs
	DIVIDER of two digital or analog inputs
	ADDER of two digital or analog inputs
	SUBTRACTOR of two digital or analog inputs

**NOTE1: Two new inputs have been added; PLC_BOOL_ON and PLC_BOOL_OFF. These two inputs are set always to PLC_BOOL_ON =1 and PLC_BOOL_OFF =0 and their values are not accessible via protocol and cannot be modified.

Example of logic signals in R650 logic configuration:

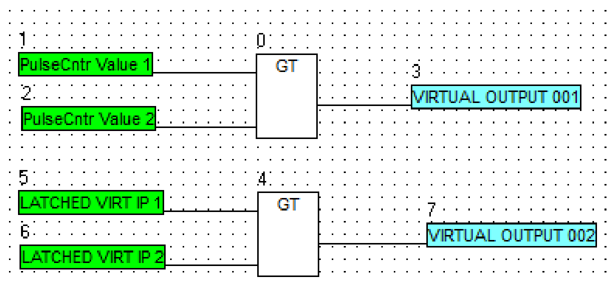
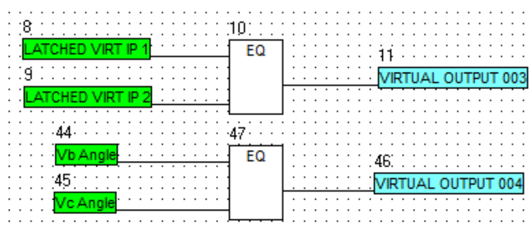
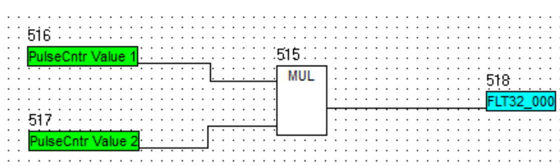
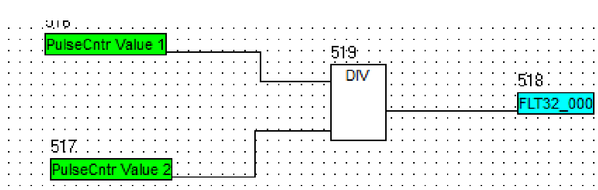
Table 5-90: Logic signals in R650

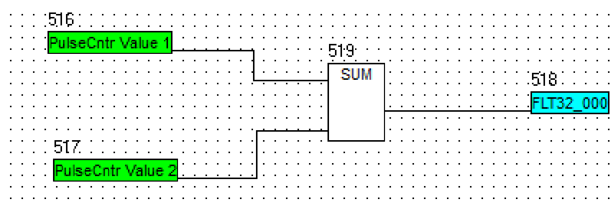
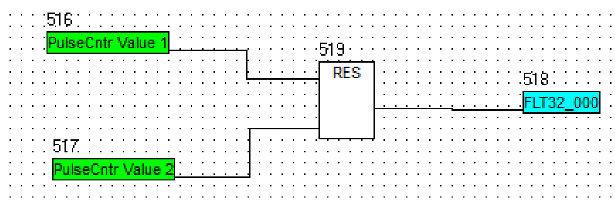
LOGIC SIGNALS EXAMPLES		
SIGNAL	**DESCRIPTION**	**TIME DIAGRAM**
SET	When the input signal is set to 1 the output signal remain fixed to 1 until a reset signal is received.	
RESET	When the input signal is reset to 1 the output signal remain fixed to 0.	
ONS	The input signal is pulsed. The width of the output pulse is the same as that of the PLC cycle	
TIMER	With selectable time (MASK), one SET input and one RESET input	

Example of analog operands in R650 logic configuration:

Table 5-91: Analog operands in R650

When this operand is used, Subtraction between two inputs is performed and result is stored into variable assigned to subtraction output.

ANALOG OPERANDS		
OPERANDS	example	Description
GREATER THAN		Analog Variables: 1. If Pulse Cntr value 1 > Pulse Cntr value 2 then Virtual output is set to 1 2. If Pulse Cntr value 1 = Pulse Cntr value 2 then Virtual output is set to 0 3. If Pulse Cntr value 1 < Pulse Cntr value 2 then Virtual output is set to 0 Digital Variables: 1. If Latched Virtual input 1 =0 & Latched Virtual input 2 =0 then Virtual output is set to 0 2. If Latched Virtual input 1 =1 & Latched Virtual input 2 =1 then Virtual output is set to 0 3. If Latched Virtual input 1 =1 & Latched Virtual input 2 =0 then Virtual output is set to 1 4 If Latched Virtual input 1 =0 & Latched Virtual input 2 =1 then Virtual output is set to 0
EQUAL TO		Analog Variables: 4. If Vb Angle > Vc Angle then Virtual output is set to 0 5. If Vb Angle = Vc Angle then Virtual output is set to 1 6. If Vb Angle < Vc Angle then Virtual output is set to 0 Digital Variables: 5. If Latched Virtual input 1 =0 & Latched Virtual input 2 =0 then Virtual output is set to 1 6. If Latched Virtual input 1 =1 & Latched Virtual input 2 =1 then Virtual output is set to 1 7. If Latched Virtual input 1 =1 & Latched Virtual input 2 =0 then Virtual output is set to 0 8. If Latched Virtual input 1 =0 & Latched Virtual input 2 =1 then Virtual output is set to 0
MULTIPLIER		Result of multiplication of both inputs is stored into variable assigned to Multiplier output
DIVISION		Result of division of both inputs is stored into variable assigned to Division output. If Input 2=0 Then result of division is stored as 0.

ADDITTION		Result of multiplication of both inputs is stored into variable assigned to addition output
SUBTRACTION		When this operand is used, Subtraction between two inputs is performed and result is stored into variable assigned to subtraction output.

5.10.1.2 Logic compilation

The R650 configuration is made using the basic operations related before and more complex operations can be developed inside libraries.

All the graphical configuration performed in the Logic configuration editor must be read and interpreted by the PLC as the R650 engine. The graphical equations must be translated into compiled equations to be understood by the relay. For this purpose the logic configuration editor provides a compilation option to compile the whole configuration, creating a series of equations that forms the logical configuration of the element.

The next diagram shows the way compiled logic equations are built.

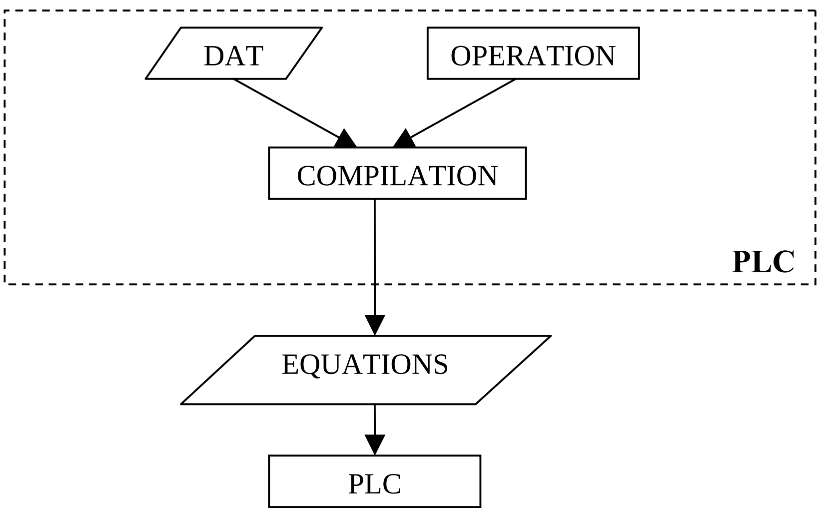


Figure 5-66: Compiled logic equations

A single equation is composed of one or more inputs, one or more operations, and one output. The order of equations is determined by the relative position of their outputs.

In the following example is shown the order of compilation for equations determined by their relative position in the configuration file:

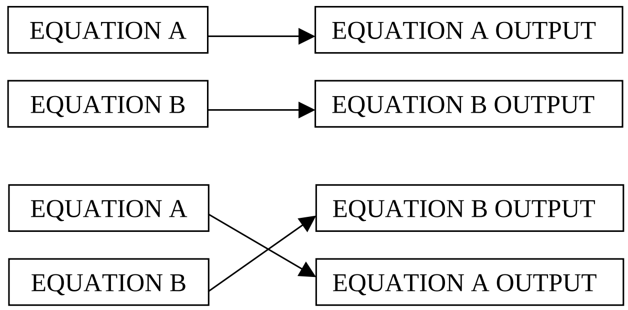


Figure 5-67: Order of equations

In this case, equation A is the first to be executed. However, in the second case, the first equation to be executed would be B, as its output is before the Equation A output.

5.10.2 Main menu

The PLC Editor tool (**Setpoint > Logic Configuration**) provides a main menu with different submenus (File, Project, Edit, Run, View, and Window) that allows the user to built customized logic for the R650 devices.

File menu

The FILE menu includes the following options:

New Project:	Create a new project that includes the logic configuration files.
Open Project:	Open an existing project.
Close Project:	Close the currently open project.
Get Project from Relay:	Retrieve a previously saved project from the relay.
Save Project and Save Project as:	Save the open project.
Save Automatic Function & Save Automatic Function As:	Save the file of the active project.
Library:	Give access to the library sub-menus, where new libraries can be created and existing libraries can be modified and saved.
Print:	Print the active configuration file.
Preview:	Preview of the document before printing.
Exit:	Close all open projects and exit the application.

Project menu

The Project menu includes the following options:

Project Explorer:	Display a tree structure showing all files contained in the project.
Insert library:	Insert a library in the active automatic function.

Edit menu

The Edit menu includes the following options:

Undo:	Undo the last modification in the active function.
Redo:	Repeat the last modification.

Cut:	Cut one or more logic operations.
Copy:	Copy one or more logic operations.
Paste:	Paste one or more logic operations.
Find:	Search for a logic operation in the project.
Copy as Bitmap:	Copy the active automatic function to the clipboard in picture format.
View Clipboard:	Launch the clipboard viewer application.

Run menu

The RUN menu includes the following options:

Configuration:	Not valid in the current application (for analog operations still not available).
Compile:	Compile the configuration functions to generate the equations that are interpreted by the 650 PLC.

Send Equations to Relay

View menu

The VIEW menu includes the following options:

Log:	Display the status name and time stamp of the digital statuses configured in the PLC logic (still not available).
Equations:	Display the equations resulting from the compilation.
Grid:	Show or hide the form grid where the configuration functions are developed. It also aligns the different objects to the grid.
Zoom:	Allow selection of the percentage of zoom in the application.
Rectangle Zoom (Zoom rectangular):	Allow zooming the selected rectangle.

5.10.3 Configuration generation

5.10.3.1 Create new project

Click **File > New Project** to open a new PLC project for programming the desired automation. An automation can be formed by one or more equations.

5.10.3.2 Create equation

A single equation can be formed by one or more inputs, one or more operations, and one output.

The order of equations is determined by the relative position of their respective outputs, this order being downward.

To link the output of an equation with the input of another equation, an internal variable (virtual output) must be used.

The virtual output is used as an input to the second equation.

5.10.3.3 Add input to automation

Click the button that represents the inputs in the toolbar at the top of the screen. A logic input can be any of the available digital internal status provided by the relay. Such as protection status, contact inputs, contact outputs, I/O status, other protection status, front keys, LEDs, operation bits, virtual inputs and virtual outputs.

5.10.3.4 Add output to automation

Click the button that represents the outputs in the toolbar at the top of the screen. The logic outputs are virtual outputs (up to 512 configurable signals), virtual metering (up to float 32 signals, up to 50 int 32 signals) or virtual output latched (up to 16 signals).

5.10.3.5 Add digital operation

Click any of the digital operations in the toolbar at the top of the screen, and then click the window background. A box with the selected digital operation is displayed and the inputs and outputs must be connected to the logic box as explained before.

5.10.3.6 Link inputs, outputs, and operations

The user can link the different graphic objects clicking on an object output and dragging to the input of another graphic object. Graphic objects available in the PLC configuration are digital objects.

There is a series of restrictions when performing connections:

It is not possible to auto-link an object; the output of a certain object cannot be linked to its input;

There can only be one input per object input;

RESET and SET outputs must be internal variables or outputs.

We must take into account that as the timer is a digital operation that operates as an analog, there must only be a single internal variable or digital input in the timer input.

5.10.3.7 Add library

Click **LIB** and select the corresponding file.

Users can build their own libraries and distribute them in their projects in an easy way.

The manufacturer provides default libraries such as ORs, ANDs of 3 up to 8 inputs, besides timers (pickup-dropout) and key examples.

5.10.4 Library generation

Libraries can contain a set of operations grouped in a single graphic object being formed by inputs, outputs and operations

Working with libraries follows the same procedure as working in the main project menu, the only difference is that the inputs and outputs to the library must be selected as external inputs and outputs. The rest of variables are internal variables used in the logic compilation.

The name assigned to the inputs and outputs of the library and to the library itself are used to represent the library as an object in the main project.

Internal variables inside the libraries are assigned randomly when compiling.

These libraries are saved in the LIB folder in order to be used in further projects

5.10.4.1 Library example

Go to the main menu **File >Library > Open Library > New Library**

Open a new library or modify an existing one, in this example a timer library is going to be displayed Timer (Pkp-Dpt).lib as shown on Figure 5-68: Timer (PKP-DPT).LIB configuratin example

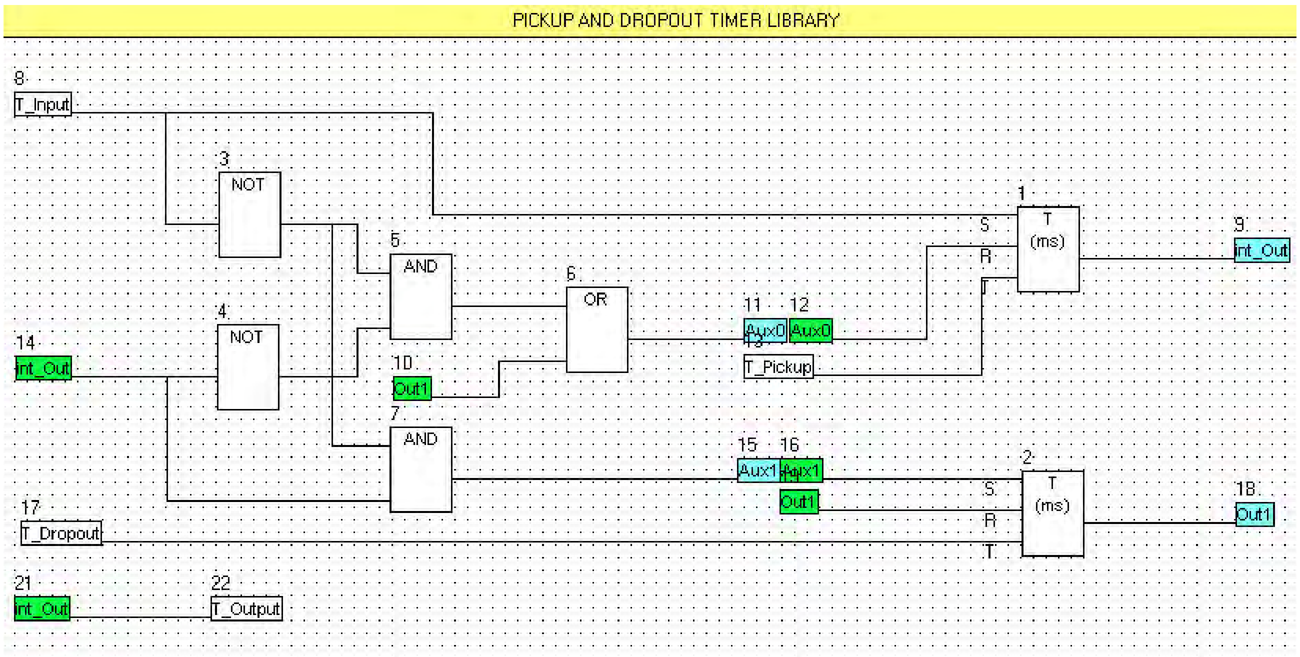


Figure 5-68: Timer (PKP-DPT).LIB configuratin example

Green and blue signals are internal inputs and outputs used in the library and are not going to be accessible to the user when working in the main menu outside the library environment. The white boxes (T_Input, T_Pickup, T_Dropout, T_output) are inputs and outputs to the library that are going to be accessible to the user to connect the library in the main application to create virtual outputs to be sent to the relay.

Once the library is created and saved it can be selected in the main application menu in ***Project > Insert Library.*** The library has the following object:

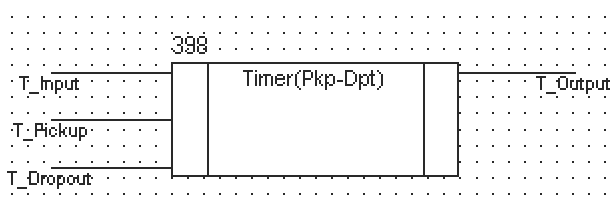


Figure 5-69: Library object

5.10.5 Application example

In this section a simple logic application is described step by step, a logic is such that keeping one digital input activated, several outputs are activated and deactivated in a time window (outputs remain activated for 200 ms and deactivated for 5 ms). See the following figure:

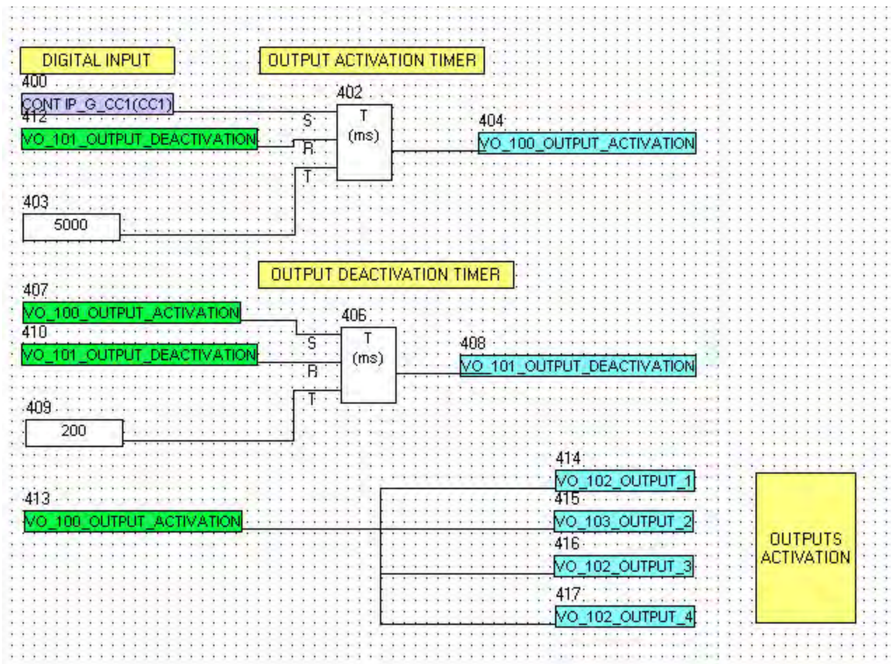


Figure 5-70: Logic example

Go to the main menu and select **File >New project,** create a new project and select an input in the icons toolbar on the top of the window. This input is selected as a digital input among the several options for inputs that can be selected. This input is the SET input for the first timer to launch the output activation signal. Click the icon related to the timer to insert the timer on the project. The timer has three inputs (S=set, R=reset and T=timing input)

The reset signal of the first timer is a virtual output called output_deactivation that has been created as an output of another second timer. This signal is selected as an output

The timing signal for the first timer is a mask provided by the application, in which the time in milliseconds must be entered in order to configure the timer time delay.

After creating the first timer, the second one for output deactivation is made. The set signal is the virtual output created as an output of the first timer (VO_100_OUTPUT_ACTIVATION), the reset signal is the output of the second timer (VO_100_OUTPUT_DEACTIVATION), the time delay is set as 200 ms.

Once the timing logic (timer 1 + timer 2) has been created, the activation signal (VO_100_OUTPUT_ACTIVATION) is linked to several virtual outputs. Therefore, virtual outputs (VO_102_OUTPUT_1, VO_103_OUTPUT_2, VO_104_OUTPUT_3, VO_105_OUTPUT_4) are activated if the CONT IP_G_CC1(CC1) variable is set to 1. Once the VO_100_OUTPUT_ACTIVATION is active, it is deactivated after 200 ms, and remains deactivated for 5 seconds. This process is repeated while the digital input is active.

To finish the process the logic must be compiled (***Run >Compile***) and the equations sent to the relay (***Run >Send Equations to relay***) to start working with the new logic.

5.11 IEC 60870-5-103 configuration

The IEC103 Configuration option is only be available if the R650 that supports this protocol (3 in the order code for protocol selection). The IEC103 protocol for the R650 can be configured using the EnerVista 650 Setup program in the menu **Setpoint > IEC103 Configuration**.

When opening the IEC103 configuration tool, either open a "r650iec103.cfg" configuration file or continue to the IEC103 configuration tool with no file selected. The IEC103 configuration can be retrieved from the relay by clicking **Retrieve Configuration**. Changes can be saved to the configuration file, and then sent to the relay by clicking **Send Configuration**. In order to start working with the new IEC103 configuration, the relay must be switched off and on.

The IEC103 slave can be identified (besides the slave number) with a long name (8 characters identifier) and with a short name (4 characters identifier for the manufacturer's internal software release) that can be set in the IEC103 configuration file.

Control data that can be configured includes: digital states, measurands and commands. Some IEC103 parameters can be set in the configuration file and then sent to the relay

Digital states:

All the digital states that R650 supports are available in order to be mapped using the EnerVista 650 Setup program. All the mapped information is sent as a response to a general interrogation.

In the interoperability table, the states that the standard propose have been selected with the suitable information number. Some of them must be generated in the firmware code as an OR operation. This information is mapped by default, but the user can delete them if desired. For the other states, you can assign the Information Number <1..255> and the Function Type <0..255>, but the Identification Type 1 (Time-tagged message) is fixed.

- To configure a new mapping of a digital state, set the Function Type and the Information number. Then select **Digital Status** from the first combo box in the **Status** frame for mapping a single digital state, and the digital state to be sent to the IEC103 master from the second combo box. You can configure a logic OR operation of digital states selecting **Logic** in the first combo box and clicking **Press for Logic**. In the next screen, choose the digital status combination to be sent to the IEC103 master and click **Save**.

  Finally click **Add** and the configured data is added to the Status List.
- To remove an existing signal from the status list, select the signal then click **Remove**. The signal is removed from the status list.
- In the same way, to change a configured signal from the status list, select the signal, make the changes, and then click **Update**. The signal is updated in the status list
- To save the data in the configuration file, click **Save** and all the data is stored in the corresponding "*.cfg" file.

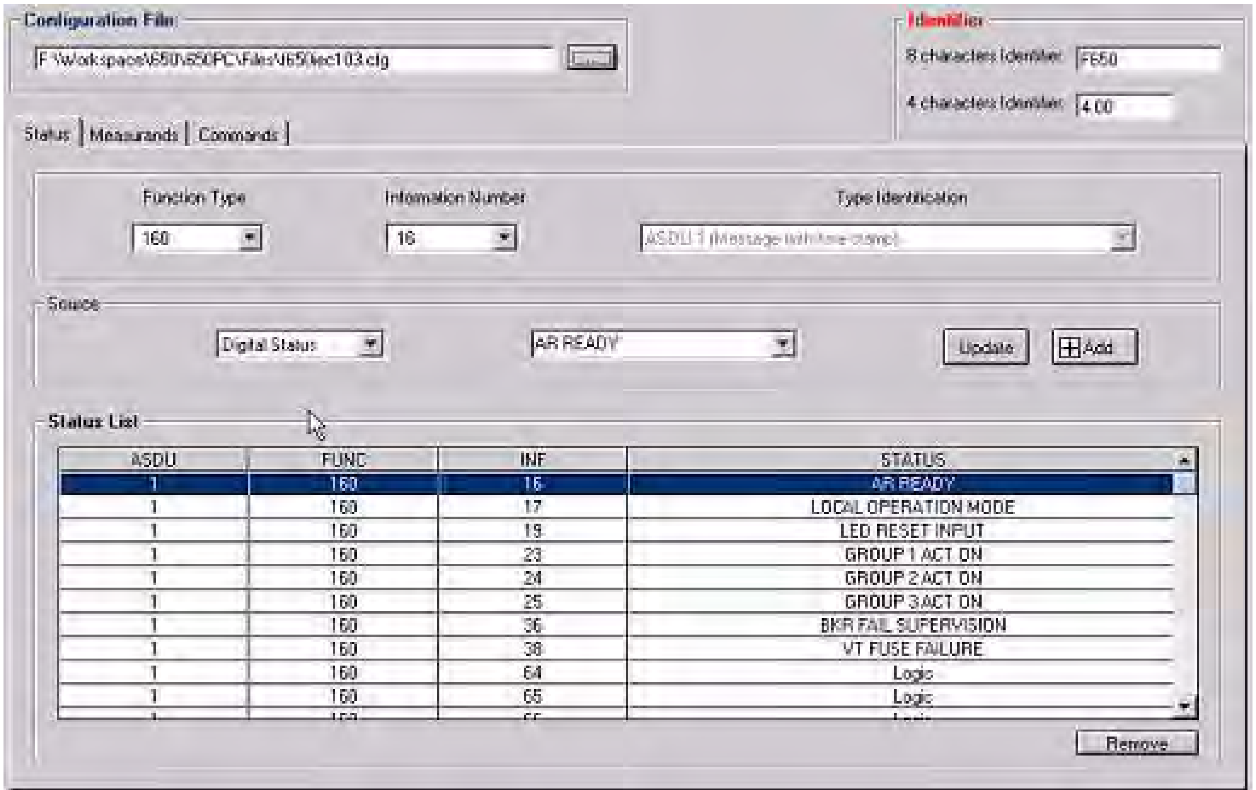


Figure 5-71: Digital signal configuration for IEC 60870-5-103 protocol

Measurands

The standard proposes some analog points supported by the R650 with compatible information number that has been included in the previous profile.

For the other measurands, it would be possible to use the 650 EnerVista Setup to select the desired point and assign the Identification Type (3 or 9), Function Type <0..255>, and Information Number <1..255>.

If the user selects Identification Type 3 (ASDU 3) only four measurands are available for the configuration, but if Identification Type 9 (ASDU 9) is selected, up to nine measurands can be sent in the IEC103 slave answer. For each measurand, all metering values that R650 supports, are available in order to be mapped.

In the measurands configuration screen, with each selected measurement, a Factor and an Offset must be configured. The Factor is a multiplier factor and the Offset is an offset factor to be applied to the relay measurement to make the final measurement calculation to be sent to the master The factor and offset parameters allow the user to perform different scaling in the relay measurements. The final measurement sent to the IEC103 master is: "a*x+b", where "x" is the relay measurement, "a" is the multiplier factor and "b" is the offset.

The measurands are sent to the primary station as a response to a class 2 request. There is a Timeout configurable with increments of 100 ms, between 0 and 60 min, in order to configure the interval desired.

Click **Add** and the configured data is added to the Measurands List. The processes of removing, updating and saving are done in the same way as for digital states.

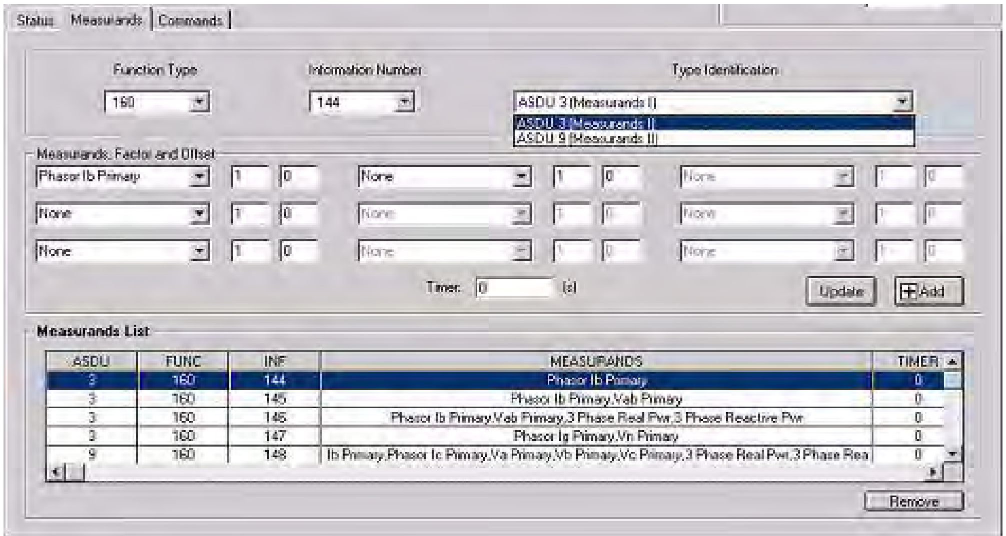


Figure 5-72: Measurand configuration for IEC 60870-5-103 protocol

Commands

All configurable commands and virtual inputs self-reset are available in order to be mapped using the EnerVista 650 Setup program. It would be possible to choose the desired command for the ON state and the same or different command for the OFF state.

You can select the Information Number <1..255> and the Function Type <0..255>, but the Identification Type 20 (General Commands) is fixed and it is used to send a command to the slave station.

Clicking the **Add** button the configured data is added to the Operations List. The processes of removing, updating and saving are done in the same way as for digital states and for measurands.

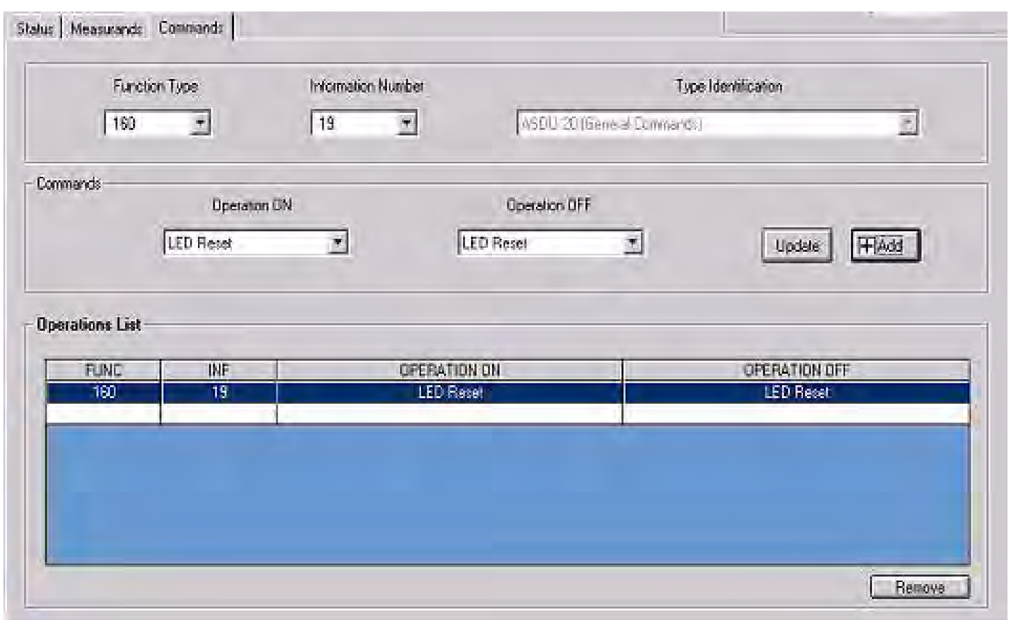


Figure 5-73: Command configuration for IEC 60870-5-103 protocol

R650 Recloser Controller

Chapter 6: Actual values

6.1 Front panel

The menu bar in the main screen of EnerVista 650 Setup software shows the ACTUAL menu option. This option concentrates and displays all status of protection, control elements, metering, counters information, oscillography, events, fault locator, etc. This menu is divided in several submenus that are detailed in the following sections.

6.1.1 LEDs

Operation of the relay front LEDs is shown on the following figure (***Actual > Front Panel > LEDs***) by the lighting of the associated LED in the appropriate color. The Ready LED is green when the relay is in service. LEDs 1 to 5 light up in red when active, LEDs 6 to 10 light up in orange, and the last 5 LEDs light up in green.

The first five LEDs are latched by hardware and can only be reset by a LEDs RESET Command, either pressing the “esc” key on the Front of the Relay, or by Communications using the appropriate signal. The rest of LEDs are not latched, but can be latched by logic.

Table 6-1: Front panel LEDs

LEDS	
READY LED	LED 10
LED 1	LED 11
LED 2	LED 12
LED 3	LED 13
LED 4	LED 14
LED 5	LED 15
LED 6	LOCAL OPERATION MODE
LED 7	OPERATIONS BLOCKED
LED 8	ST HMI BACKLIGHT
LED 9	

6.2 Status

6.2.1 Operation bits status

(***Actual > Status > Operation bits***)

OPERATION BIT 1...32 These 32 bits are the outputs of each possible Operation modules, programmed in menu **Setpoint > Relay Configuration > Operations**. The light up LED indicates their status 1 (activation)

OPERATION BITS
OPERATION BIT 1
OPERATION BIT 2
...
OPERATION BIT 32

6.2.2 Recloser

6.2.2.1 Recloser Status

The Signals associated with the opened or closed status of the recloser and the signals associated with its maintenenace can be monitored at **Actual > Status > Recloser > Recloser Status**.

RCL WEAR PHA ALARM	RCL PHA UNDEFINED	RCL PHA FAIL TOCLOSE
RCL WEAR PHB ALARM	RCL PHB UNDEFINED	RCL PHB FAIL TOCLOSE
RCL WEAR PHC ALARM	RCL PHC UNDEFINED	RCL PHC FAIL TOCLOSE
RCL WEAR 3P ALARM	RCL 3P UNDEFINED	RCL 3P FAIL TOCLOSE
RCL PHA 1HOUR ALARM	RESET CNT WEAR PHA	RCL PHA ERROR
RCL PHB 1HOUR ALARM	RESET CNT WEAR PHB	RCL PHB ERROR
RCL PHC 1HOUR ALARM	RESET CNT WEAR PHC	RCL PHC ERROR
RCL 3P 1HOUR ALARM	RESET CNT WEAR 3P	RCL 3P ERROR
RCL PHA OPENED	RESET CNT RCLS PHA	RCL PHA WEAR MON
RCL PHB OPENED	RESET CNT RCLS PHB	RCL PHB WEAR MON
RCL PHC OPENED	RESET CNT RCLS PHC	RCL PHC WEAR MON
RCL 3P OPENED	RESET CNT RCLS 3P	RCL 3P WEAR MON
RCL PHA CLOSED	RCL PHA FAIL TO OPEN	
RCL PHB CLOSED	RCL PHB FAIL TO OPEN	
RCL PHC CLOSED	RCL PHC FAIL TO OPEN	
RCL 3P CLOSED	RCL 3P FAIL TO OPEN	

For a detailed description of the signals see section *5.3.6 Switchgear settings*.

6.2.2.2 Single-Three Pole

The signals associated with the open and close commands to the recloser can be monitored at **Actual > Status > Recloser > Single-Three Pole**.

SP PHA OPEN	HOT LINE TAG OP
SP PHB OPEN	HOT LINE TAG PULSE
SP PHC OPEN	CLOSE PHA
SINGLE POLE OPEN	CLOSE PHB
3 POLE OPEN	CLOSE PHC
ANY PHASE OPEN	CLOSE 3(
TRIP PHA INPUT	CLOSE PHA INPUT
TRIP PHB INPUT	CLOSE PHB INPUT
TRIP PHC INPUT	CLOSE PHC INPUT
TRIP 3 PHASE INPUT	CLOSE 3P INPUT
BLK TRIP PHA	BLK CLOSE PHA
BLK TRIP PHB	BLK CLOSE PHB
BLK TRIP PHC	BLK CLOSE PHC
BLK 3P TRIP	BLK CLOSE 3P
OPEN PHA INPUT	1 POLE PHA TRIP
OPEN PHB INPUT	1 POLE PHB TRIP
OPEN PHC INPUT	1 POLE PHC TRIP
OPEN 3 PHASE INPUT	3 POLE TRIP
YELLOW HANDLE INPUT	
HOT LINE TAG INPUT	

For a detailed description of the signals, see *5.3.5.3 Single-pole and three-pole operands*.

6.2.3 Protection status

6.2.3.1 Protection blocks

(**Actual > Status > Protection > Protection Blocks**)

This screen shows the entire protection element blocks available. If the protection element is blocked, the green LED located on the right side of the text lights up and remains lit as long as the element remains blocked.

Protection elements block signals are configured at ***Setpoint > Relay Configuration > Protection Elements***.

Table 6-1: PROTECTION ELEMENTS BLOCK

IOC BLOCK SIGNALS	**TOC BLOCK SIGNALS**	**DIRECTIONAL BLOCKS**	**VOLTAGE BLOCKS**
PH IOC1 HIGH A /B / C BLK	PH TOC1 HIGH A /B /C BLK	PHASE DIR1 BLK INP	LOAD PHASE UV1 BLOCK
PH IOC2 HIGH A /B / C BLK	PH TOC2 HIGH A /B /C BLK	PHASE DIR2 BLK INP	LOAD PHASE UV2 BLOCK
PH IOC3 HIGH A /B / C BLK	PH TOC3 HIGH A /B /C BLK	PHASE DIR3 BLK INP	LOAD PHASE UV3 BLOCK
PH IOC1 LOW A /B / C BLK	PH TOC1 LOW A /B /C BLK	NEUTRAL DIR1 BLK INP	LOAD PHASE OV1 BLOCK
PH IOC2 LOW A /B / C BLK	PH TOC2 LOW A /B /C BLK	NEUTRAL DIR2 BLK INP	LOAD PHASE OV2 BLOCK
PH IOC3 LOW A /B / C BLK	PH TOC3 LOW A /B /C BLK	NEUTRAL DIR3 BLK INP	LOAD PHASE OV3 BLOCK
NEUTRAL IOC1 BLOCK	NEUTRAL TOC1 BLOCK	GROUND DIR1 BLK INP	LOAD NEUTRAL OV1 BLK
NEUTRAL IOC2 BLOCK	NEUTRAL TOC2 BLOCK	GROUND DIR2 BLK INP	LOAD NEUTRAL OV2 BLK
NEUTRAL IOC3 BLOCK	NEUTRAL TOC3 BLOCK	GROUND DIR3 BLK INP	LOAD NEUTRAL OV3 BLK
GROUND IOC1 BLOCK	GROUND TOC1 BLOCK	SENS GND DIR1 BLK IP	LOAD NEG SEQ OV1 BLOCK
GROUND IOC2 BLOCK	GROUND TOC2 BLOCK	SENS GND DIR2 BLK IP	LOAD NEG SEQ OV2 BLOCK
GROUND IOC3 BLOCK	GROUND TOC3 BLOCK	SENS GND DIR3 BLK IP	LOAD NEG SEQ OV3 BLOCK
SENS GND IOC1 BLK	SENS GND TOC1 BLOCK	**POWER BLOCKS**	SRC PHASE UV1 BLOCK
SENS GND IOC2 BLK	SENS GND TOC2 BLOCK	FWD PWR1 BLOCK	SRC PHASE UV2 BLOCK
SENS GND IOC3 BLK	SENS GND TOC3 BLOCK	FWD PWR2 BLOCK	SRC PHASE UV3 BLOCK
ISOLATED GROUND BLOCKS	NEG SEQ TOC1 BLOCK	FWD PWR3 BLOCK	SRC PHASE OV1 BLOCK
ISOLATED GND1 BLK	NEG SEQ TOC2 BLOCK	DIR PWR1 BLOCK	SRC PHASE OV2 BLOCK
ISOLATED GND2 BLK	NEG SEQ TOC3 BLOCK	DIR PWR2 BLOCK	SRC PHASE OV3 BLOCK
ISOLATED GND3 BLK	**THERMAL MODEL BLOCKS**	DIR PWR3 BLOCK	SRC NEUTRAL OV1 BLK
SETTING GROUPS BLOCK IP	THERMAL1 BLOCK	32N1 BLOCK	SRC NEUTRAL OV2 BLK
SETT GROUPS BLOCK	THERMAL2 BLOCK	32N2 BLOCK	SRC NEUTRAL OV3 BLK
GENERAL TRIP BLOCK	THERMAL3 BLOCK	32N3 BLOCK	SRC NEG SEQ OV1 BLOCK
GENERAL TRIP	**BROKEN CONDUCTOR BLK**	CT FAILURE BLOCK	SRC NEG SEQ OV2 BLOCK
	BROKEN CONDUCT1 BLK	2ND HRMC BLOCK	SRC NEG SEQ OV3 BLOCK
	BROKEN CONDUCT2 BLK	**FREQUENCY BLOCKS**	
	BROKEN CONDUCT3 BLK	OVERFREQ1 BLOCK	
		OVERFREQ2 BLOCK	
		OVERFREQ3 BLOCK	
		UNDERFREQ1 BLOCK	
		UNDERFREQ2 BLOCK	
		UNDERFREQ3 BLOCK	
		FREQ RATE 1 BLOCK	
		FREQ RATE 2 BLOCK	
		FREQ RATE 3 BLOCK	

6.2.3.2 Phase current

This screen shows the pickup and trip for all phase instantaneous and time overcurrent elements in the R650 and block and operation signals provided by the phase directional units. Any of these two events of any phase element lights up the corresponding LED in this screen, and it remains lit as the associated function remains in pickup or operation. All the values are provided for phases and total as shown on the table below.

This screen is accessed in menu: **Actual> Status > Protection > Phase Current**, and includes the following signaling LEDs:

Table 6-2: Phase current actual values

PHASE IOC ACTUAL VALUES	PHASE IOC ACTUAL VALUES	PHASE DIRECTIONAL ACTUAL VALUES
PH IOC1 HIGH A / B / C PKP	PH TOC1 HIGH A / B / C PKP	PHASE DIR1 BLOCK A
PH IOC1 HIGH A / B / C OP	PH TOC1 HIGH A / B / C OP	PHASE DIR1 A OP
PH IOC1 HIGH PKP	PH TOC1 HIGH PKP	PHASE DIR1 BLOCK B
PH IOC1 HIGH OP	PH TOC1 HIGH OP	PHASE DIR1 B OP
PH IOC2 HIGH A / B / C PKP	PH TOC2 HIGH A / B / C PKP	PHASE DIR1 BLOCK C
PH IOC2 HIGH A / B / C OP	PH TOC2 HIGH A / B / C OP	PHASE DIR1 C OP
PH IOC2 HIGH PKP	PH TOC2 HIGH PKP	PHASE DIR2 BLOCK A
PH IOC2 HIGH OP	PH TOC2 HIGH OP	PHASE DIR2 A OP
PH IOC3 HIGH A / B / C PKP	PH TOC3 HIGH A / B / C PKP	PHASE DIR2 BLOCK B
PH IOC3 HIGH A / B / C OP	PH TOC3 HIGH A / B / C OP	PHASE DIR2 B OP
PH IOC3 HIGH PKP	PH TOC3 HIGH PKP	PHASE DIR2 BLOCK C
PH IOC3 HIGH OP	PH TOC3 HIGH OP	PHASE DIR2 C OP
PH IOC1 LOW A / B / C PKP	PH TOC1 LOW A / B / C PKP	PHASE DIR3 BLOCK A
PH IOC1 LOW A / B / C OP	PH TOC1 LOW A / B / C OP	PHASE DIR3 A OP
PH IOC1 LOW PKP	PH TOC1 LOW PKP	PHASE DIR3 BLOCK B
PH IOC1 LOW OP	PH TOC1 LOW OP	PHASE DIR3 B OP
PH IOC2 LOW A / B / C PKP	PH TOC2 LOW A / B / C PKP	PHASE DIR3 BLOCK C
PH IOC2 LOW A / B / C OP	PH TOC2 LOW A / B / C OP	PHASE DIR3 C OP
PH IOC2 LOW PKP	PH TOC2 LOW PKP	
PH IOC2 LOW OP	PH TOC2 LOW OP	
PH IOC3 LOW A / B / C PKP	PH TOC3 LOW A / B / C PKP	
PH IOC3 LOW A / B / C OP	PH TOC3 LOW A / B / C OP	
PH IOC3 LOW PKP	PH TOC3 LOW PKP	
PH IOC3 LOW OP	PH TOC3 LOW OP	

6.2.3.3 Neutral current

This screen shows the pickup and trip for all neutral instantaneous and time overcurrent elements in the R650 and block and operation signals provided by the neutral directional units. Any of these two events of any neutral element lights up the corresponding LED in this screen, and it remains lit as the associated function remains in pickup or operation.

This screen is accessed in menu: **Actual > Status > Protection > Neutral Current**, and includes the following signaling LEDs:

Table 6-3: Neutral current actual values

NEUTRAL IOC ACTUAL VALUES	NEUTRAL TOC ACTUAL VALUES	NEUTRAL DIRECTIONAL ACTUAL VALUES
NEUTRAL IOC1 PKP	NEUTRAL TOC1 PKP	NEUTRAL DIR1 BLOCK
NEUTRAL IOC1 OP	NEUTRAL TOC1 OP	NEUTRAL DIR1 OP
NEUTRAL IOC2 PKP	NEUTRAL TOC2 PKP	NEUTRAL DIR2 BLOCK
NEUTRAL IOC2 OP	NEUTRAL TOC2 OP	NEUTRAL DIR2 OP
NEUTRAL IOC3 PKP	NEUTRAL TOC3 PKP	NEUTRAL DIR3 BLOCK
NEUTRAL IOC3 OP	NEUTRAL TOC3 OP	NEUTRAL DIR3 OP

6.2.3.4 Ground current

This screen shows the pickup and trip for all ground instantaneous and time overcurrent elements in the R650 and block and operation signals provided by the ground directional units. Any of these two events for any ground element light up the corresponding LED in this screen, and it remains lit as the associated function remains in pickup or operation.

This screen is accessed in menu: **Actual > Status > Protection > Ground Current**, and includes the following signaling LEDs:

Table 6-4: Ground current actual values

GROUND IOC ACTUAL VALUES	GROUND TOC ACTUAL VALUES	GROUND DIRECTIONAL ACTUAL VALUES
GROUND IOC1 PKP	GROUND TOC1 PKP	GROUND DIR1 BLOCK
GROUND IOC1 OP	GROUND TOC1 OP	GROUND DIR1 OP
GROUND IOC2 PKP	GROUND TOC2 PKP	GROUND DIR2 BLOCK
GROUND IOC2 OP	GROUND TOC2 OP	GROUND DIR2 OP
GROUND IOC3 PKP	GROUND TOC3 PKP	GROUND DIR3 BLOCK
GROUND IOC3 OP	GROUND TOC3 OP	GROUND DIR3 OP

6.2.3.5 Sensitive ground current

This screen shows the pickup and trip for all sensitive ground instantaneous, time overcurrent and isolated ground elements in the R650 and block and operation signals provided by the sensitive ground directional units. Any of these two events of any ground element lights up the corresponding LED in this screen, and it remains lit while the associated function remains in pickup or operation.

This screen is accessed in menu: **Actual > Status > Protection >Sensitive Ground Current**, and includes the following signaling LEDs:

Table 6-5: Sensitive ground current actual values

SENSITIVE GROUND IOC ACTUAL VALUES	SENSITIVE GROUND TOC ACTUAL VALUES	ISOLATED GROUND ACTUAL VALUES	SENSITIVE GROUND DIRECTIONAL ACTUAL VALUES
SENS GND IOC1 PKP	SENS GND TOC1 PKP	ISOLATED GND1 PKP	SENS GND DIR1 BLOCK
SENS GND IOC1 OP	SENS GND TOC1 OP	ISOLATED GND1 OP	SENS GND DIR1 OP
SENS GND IOC2 PKP	SENS GND TOC2 PKP	ISOLATED GND2 PKP	SENS GND DIR2 BLOCK
SENS GND IOC2 OP	SENS GND TOC2 OP	ISOLATED GND2 OP	SENS GND DIR2 OP
SENS GND IOC3 PKP	SENS GND TOC3 PKP	ISOLATED GND3 PKP	SENS GND DIR3 BLOCK
SENS GND IOC3 OP	SENS GND TOC3 OP	ISOLATED GND3 OP	SENS GND DIR3 OP

6.2.3.6 Negative sequence current

This screen shows the pickup and trip for negative sequence elements in the R650. Any of these two events of any ground element lights up the corresponding LED in this screen, and it remains lit while the associated function remains in pickup or operation.

This screen is accessed in menu: **Actual> Status > Protection >Negative Sequence Current**, and includes the following signaling LEDs:

Table 6-6: Negative sequence current actual values

NEGATIVE SEQUENCE TOC ACTUAL VALUES
NEG SEQ TOC1 PKP
NEG SEQ TOC1 OP
NEG SEQ TOC2 PKP
NEG SEQ TOC2 OP
NEG SEQ TOC3 PKP
NEG SEQ TOC3 OP

6.2.3.7 Thermal model

R650 units incorporate up to 3 thermal image elements. For each of them, this screen shows by means of green LEDs, the activation of the reset, alarm, operation and thermal image signals for each phase (A, B, C) and each unit (1, 2, 3). Any of the reset, alarm and operation signals light up the corresponding LED in this screen, and it remains lit as the associated function remains in reset, pickup or operation. This function also provides the thermal image value for all the phases and functions in percentage. All the values are provided individually for phases and for the three thermal elements.

This screen is accessed in menu: **Actual> Status > Protection >Thermal image**, and includes the following signaling LEDs:

Table 6-7: Thermal model actual values

THERMAL IMAGE RESET SIGNALS	THERMAL IMAGE ALARM SIGNALS	THERMAL IMAGE OPERATION SIGNALS	THERMAL IMAGE VALUE IN %
	THERMAL1 ALARM	THERMAL1 OP	
THERMAL1 A RST	THERMAL1 A ALARM	THERMAL1 A OP	THERMAL1 IMAGE A
THERMAL1 B RST	THERMAL1 B ALARM	THERMAL1 B OP	THERMAL1 IMAGE B
THERMAL1 C RST	THERMAL1 C ALARM	THERMAL1 C OP	THERMAL1 IMAGE C
	THERMAL2 ALARM	THERMAL2 OP	
THERMAL2 A RST	THERMAL2 A ALARM	THERMAL2 A OP	THERMAL2 IMAGE A
THERMAL2 B RST	THERMAL2 B ALARM	THERMAL2 B OP	THERMAL2 IMAGE B
THERMAL2 C RST	THERMAL2 C ALARM	THERMAL2 C OP	THERMAL2 IMAGE C
	THERMAL3 ALARM	THERMAL3 OP	
THERMAL3 A RST	THERMAL3 A ALARM	THERMAL3 A OP	THERMAL3 IMAGE A
THERMAL3 B RST	THERMAL3 B ALARM	THERMAL3 B OP	THERMAL3 IMAGE B
THERMAL3 C RST	THERMAL3 C ALARM	THERMAL3 C OP	THERMAL3 IMAGE C

6.2.3.8 Source Voltage

This screen shows the activation of all source voltage elements available in the R650. It can be accessed from the menu: **Actual > Status > Protection > Source Voltage**, and it includes the following signaling LEDs.

The values shown are:

Pickup and operation signals for phase to ground and phase-to-phase undervoltage elements and the three-phase signal for pickup and operation for the undervoltage element.

Pickup and operation for negative sequence overvoltage element.

Pickup and operation signals for phase-to-phase overvoltage elements and the three-phase signal for pickup and operation for the overvoltage element.

Pickup and operation for neutral overvoltage element.

Table 6-8: Source voltage actual values

UNDERVOLTAGE ACTUAL VALUES		OVERVOLTAGE ACTUAL VALUES	
SRC PHASE UV1 A PKP	SRC PHASE UV2 AB OP	SRC PHASE OV1 AB PKP	SRC NEGATIVE SEQ OV1 PKP
SRC PHASE UV1 A OP	SRC PHASE UV2 BC PKP	SRC PHASE OV1 AB OP	SRC NEGATIVE SEQ OV1 OP
SRC PHASE UV1 B PKP	SRC PHASE UV2 BC OP	SRC PHASE OV1 BC PKP	SRC NEGATIVE SEQ OV2 PKP
SRC PHASE UV1 B OP	SRC PHASE UV2 CA PKP	SRC PHASE OV1 BC OP	SRC NEGATIVE SEQ OV2 OP
SRC PHASE UV1 C PKP	SRC PHASE UV2 CA OP	SRC PHASE OV1 CA PKP	SRC NEGATIVE SEQ OV3 PKP
SRC PHASE UV1 C OP	SRC PHASE UV2 PKP	SRC PHASE OV1 CA OP	SRC NEGATIVE SEQ OV3 OP
SRC PHASE UV1 AB PKP	SRC PHASE UV2 OP	SRC PHASE OV1 PKP	**NEUTRAL OV ACTUAL VALUES**
SRC PHASE UV1 AB OP	SRC PHASE UV3 A PKP	SRC PHASE OV1 OP	SRC NEUTRAL OV1 PKP
SRC PHASE UV1 BC PKP	SRC PHASE UV3 A OP	SRC PHASE OV2 AB PKP	SRC NEUTRAL OV1 OP
SRC PHASE UV1 BC OP	SRC PHASE UV3 B PKP	SRC PHASE OV2 AB OP	SRC NEUTRAL OV2 PKP
SRC PHASE UV1 CA PKP	SRC PHASE UV3 B OP	SRC PHASE OV2 BC PKP	SRC NEUTRAL OV2 OP
SRC PHASE UV1 CA OP	SRC PHASE UV3 C PKP	SRC PHASE OV2 BC OP	SRC NEUTRAL OV3 PKP

SRC PHASE UV1 PKP	SRC PHASE UV3 C OP	SRC PHASE OV2 CA PKP	SRC NEUTRAL OV3 OP
SRC PHASE UV1 OP	SRC PHASE UV3 AB PKP	SRC PHASE OV2 CA OP	
SRC PHASE UV2 A PKP	SRC PHASE UV3 AB OP	SRC PHASE OV2 PKP	
SRC PHASE UV2 A OP	SRC PHASE UV3 BC PKP	SRC PHASE OV2 OP	
SRC PHASE UV2 B PKP	SRC PHASE UV3 BC OP	SRC PHASE OV3 AB PKP	
SRC PHASE UV2 B OP	SRC PHASE UV3 CA PKP	SRC PHASE OV3 AB OP	
SRC PHASE UV2 C PKP	SRC PHASE UV3 CA OP	SRC PHASE OV3 BC PKP	
SRC PHASE UV2 C OP	SRC PHASE UV3 PKP	SRC PHASE OV3 BC OP	
SRC PHASE UV2 AB PKP	SRC PHASE UV3 OP	SRC PHASE OV3 CA PKP	
		SRC PHASE OV3 CA OP	
		SRC PHASE OV3 PKP	
		SRC PHASE OV3 OP	

6.2.3.9 Load Voltage

This screen shows the activation of all load voltage elements available in the R650. It can be accessed from the menu: **Actual > Status > Protection > Load Voltage**, and it includes the following signaling LEDs.

The values shown are:

Pickup and operation signals for phase to ground and phase-to-phase undervoltage elements and the three-phase signal for pickup and operation for the undervoltage element.

Pickup and operation for negative sequence overvoltage element.

Pickup and operation signals for phase-to-phase overvoltage elements and the three-phase signal for pickup and operation for the overvoltage element.

Pickup and operation for neutral overvoltage element.

Table 6-9: Load voltage actual values

UNDERVOLTAGE ACTUAL VALUES		OVERVOLTAGE ACTUAL VALUES	NEUTRAL OV ACTUAL VALUES
LOAD PHASE UV1 A PKP	LOAD PHASE UV2 AB OP	LOAD PHASE OV1 AB PKP	LOAD NEUTRAL OV1 PKP
LOAD PHASE UV1 A OP	LOAD PHASE UV2 BC PKP	LOAD PHASE OV1 AB OP	LOAD NEUTRAL OV1 OP
LOAD PHASE UV1 B PKP	LOAD PHASE UV2 BC OP	LOAD PHASE OV1 BC PKP	LOAD NEUTRAL OV2 PKP
LOAD PHASE UV1 B OP	LOAD PHASE UV2 CA PKP	LOAD PHASE OV1 BC OP	LOAD NEUTRAL OV2 OP
LOAD PHASE UV1 C PKP	LOAD PHASE UV2 CA OP	LOAD PHASE OV1 CA PKP	LOAD NEUTRAL OV3 PKP
LOAD PHASE UV1 C OP	LOAD PHASE UV2 PKP	LOAD PHASE OV1 CA OP	LOAD NEUTRAL OV3 OP
LOAD PHASE UV1 AB PKP	LOAD PHASE UV2 OP	LOAD PHASE OV1 PKP	
LOAD PHASE UV1 AB OP	LOAD PHASE UV3 A PKP	LOAD PHASE OV1 OP	
LOAD PHASE UV1 BC PKP	LOAD PHASE UV3 A OP	LOAD PHASE OV2 AB PKP	
LOAD PHASE UV1 BC OP	LOAD PHASE UV3 B PKP	LOAD PHASE OV2 AB OP	
LOAD PHASE UV1 CA PKP	LOAD PHASE UV3 B OP	LOAD PHASE OV2 BC PKP	
LOAD PHASE UV1 CA OP	LOAD PHASE UV3 C PKP	LOAD PHASE OV2 BC OP	
LOAD PHASE UV1 PKP	LOAD PHASE UV3 C OP	LOAD PHASE OV2 CA PKP	
LOAD PHASE UV1 OP	LOAD PHASE UV3 AB PKP	LOAD PHASE OV2 CA OP	
LOAD PHASE UV2 A PKP	LOAD PHASE UV3 AB OP	LOAD PHASE OV2 PKP	
LOAD PHASE UV2 A OP	LOAD PHASE UV3 BC PKP	LOAD PHASE OV2 OP	
LOAD PHASE UV2 B PKP	LOAD PHASE UV3 BC OP	LOAD PHASE OV3 AB PKP	
LOAD PHASE UV2 B OP	LOAD PHASE UV3 CA PKP	LOAD PHASE OV3 AB OP	
LOAD PHASE UV2 C PKP	LOAD PHASE UV3 CA OP	LOAD PHASE OV3 BC PKP	
LOAD PHASE UV2 C OP	LOAD PHASE UV3 PKP	LOAD PHASE OV3 BC OP	
LOAD PHASE UV2 AB PKP	LOAD PHASE UV3 OP	LOAD PHASE OV3 CA PKP	
		LOAD PHASE OV3 CA OP	
		LOAD PHASE OV3 PKP	
		LOAD PHASE OV3 OP	

UNDERVOLTAGE ACTUAL VALUES	OVERVOLTAGE ACTUAL VALUES	NEUTRAL OV ACTUAL VALUES
	LOAD NEGATIVE SEQ OV1 PKP	
	LOAD NEGATIVE SEQ OV1 OP	
	LOAD NEGATIVE SEQ OV2 PKP	
	LOAD NEGATIVE SEQ OV2 OP	
	LOAD NEGATIVE SEQ OV3 PKP	
	LOAD NEGATIVE SEQ OV3 OP	

6.2.3.10 Power

Forward Power and directional power elements and Wattmetric Ground Fault elements.

These functions may have several applications, for example, small generating plants connected to the power system, to limit the supplied power and not to exceed its rated capacity.

If programmed conditions for any of the three elements are met, the corresponding LEDs lights up.

This screen shows the activation of all power elements available in the R650. It can be accessed from the menu: **Actual> Status > Protection >Power**, and it includes the following signaling LEDs.

Table 6-10: Power actual values

FORWARD POWER ACTUAL VALUES	DIRECTIONAL POWER ACTUAL VALUES	WATTMETRIC GROUND FAULT ACTUAL VALUES
FWD PWR1 STG1 PKP	DIR PWR1 STG1 PKP	32N1 PKP
FWD PWR1 STG1 OP	DIR PWR1 STG1 OP	32N1 OC PKP
FWD PWR1 STG2 PKP	DIR PWR1 STG2 PKP	32N1 OP
FWD PWR1 STG2 OP	DIR PWR1 STG2 OP	32N2 PKP
FWD PWR2 STG1 PKP	DIR PWR1 STG PKP	32N2 OC PKP
FWD PWR2 STG1 OP	DIR PWR1 STG OP	32N2 OP
FWD PWR2 STG2 PKP	DIR PWR2 STG1 PKP	32N3 PKP
FWD PWR2 STG2 OP	DIR PWR2 STG1 OP	32N3 OC PKP
FWD PWR3 STG1 PKP	DIR PWR2 STG2 PKP	32N3 OP
FWD PWR3 STG1 OP	DIR PWR2 STG2 OP	**WATTMETRIC GROUND POWER ACTUAL VALUES**
FWD PWR3 STG2 PKP	DIR PWR2 STG PKP	32N1 POWER
FWD PWR3 STG2 OP	DIR PWR2 STG OP	32N2 POWER
	DIR PWR3 STG1 PKP	32N3 POWER
	DIR PWR3 STG1 OP	
	DIR PWR3 STG2 PKP	
	DIR PWR3 STG2 OP	
	DIR PWR3 STG PKP	
	DIR PWR3 STG OP	

6.2.3.11 Frequency

R650 units incorporate three overfrequency and three underfrequency units. For each of them there are two magnitudes pickup and trip (operation).

Frequency elements are often used in generating plants, as well as in the connection of substations to the main system. Frequency monitoring is the base for synchronous machines protection application, with a couple of setting levels, as well as for the development of automatic shedding functions and underfrequency reset.

This screen shows the activation of all frequency elements available in the R650. It can be accessed from the menu: **Actual> Status > Protection >Frequency**, and it includes the following signaling LEDs.

Table 6-11: Frequency actual values

OVERFREQUENCY ACTUAL VALUES	UNDERFREQUENCY ACTUAL VALUES
OVERFREQ1 PKP	UNDERFREQ1 PKP
OVERFREQ1 OP	UNDERFREQ1 OP
OVERFREQ2 PKP	UNDERFREQ2 PKP
OVERFREQ2 OP	UNDERFREQ2 OP
OVERFREQ3 PKP	UNDERFREQ3 PKP
OVERFREQ3 OP	UNDERFREQ3 OP

6.2.3.12 Broken conductor

R650 units incorporate three Broken Conductor elements for special applications that may require different timing steps or levels for alarm or trip purposes.

The green LED lights up when the pickup or trip (operation) of each of the three available functions is activated. The three functions are identical and can be configured separately.

These functions compare the negative and positive sequence current levels per phase. If this magnitude exceeds a programmable threshold and is maintained for a programmable time delay, a tripping output is issued. If a pickup or operation is produced, the corresponding LED in this screen lights up.

This screen can be accessed at **Actual> Status > Protection > Miscellaneous**, and it includes the following signaling LEDs for the breaker failure function:

Table 6-12: Broken conductor actual values

BROKEN CONDUCTOR ACTUAL VALUES
BROKEN CONDUCT1 PKP
BROKEN CONDUCT1 OP
BROKEN CONDUCT2 PKP
BROKEN CONDUCT2 OP
BROKEN CONDUCT3 PKP
BROKEN CONDUCT3 OP

6.2.4 Control element status

6.2.4.1 Synchrocheck

This screen can be accessed at **Actual> Status > Control Elements > Synchrocheck**, and it includes the following signaling LEDs for the synchronism check function:

Table 6-13: Synchrocheck actual values

SYNCHROCHECK ACTUAL VALUES
SYNCHROCHECK BLK INP
SYNCHROCHECK OP
SYNCHK CLOSE PERM
SYNCHROCHECK COND OP
DEAD LOAD - DEAD SRC
DEAD LOAD - LIVE SRC
LIVE LOAD - DEAD SRC
SLIP CONDITION
SEC FREQ > LOAD FREQ
SEC FREQ < LOAD FREQ
FORCE SYNC TRAD
MAX FREQ DIFFERENCE
VOLTAGE DIFFERENCE
FREQ DIFFERENCE
SYNCHK VOLT REFERENCE

SYNCHROCHECK BLK INP: Block signal for the synchrocheck unit, configurable at **Setpoint > Relay Configuration > Control Elements**

SYNCHROCHECK OP: Closing permission signal in live load – live source conditions with an open breaker.

SYNCHK CLOSE PERM: General Closing permission of the Synchronism unit. It contemplates all possible situations, live load – live source conditions, and the closing permission logics (dead load – dead source, live load – dead source, dead load – live source). **Note**: in case the Function is disabled, the Closing permission signal is activated in order not to interfere with possible logic where it is included. If the synchronism unit is enabled, this signal only activates under the closing conditions established by setting.

SYNCHROCHECK COND OP: Closing permission according to permission logics.

DEAD LOAD - DEAD SRC: Closing permission in dead load – dead source condition.

DEAD LOAD - LIVE SRC: Closing permission in dead load – live source condition.

LIVE LOAD - DEAD SRC: Closing permission in live load – dead source condition.

SLIP CONDITION: Internal signal indicating frequency slip between the load voltage and source voltage phasors.

SEC FREQ > LOAD FREQ: Source Frequency higher than load frequency

SEC FREQ < LOAD FREQ: Source Frequency lower than load frequency

FORCE SYNC TRAD: This signal indicates that the traditional type has been forced by means of the dedicated input.

MAX FREQ DIFFERENCE: This signal indicates that the difference in frequency between the source and the load voltages is greater than the setpoint for frequency difference.

VOLTAGE DIFFERENCE: Voltage difference between the load and the source in volts (secondary values), only available if the Synchrocheck element is enabled.

FREQ DIFFERENCE: Frequency difference between the load and the source in Hz, only available if the Synchrocheck element is enabled.

SYNCHK VOLT REFERENCE: Indicates the phase that is being used for calculating the differences in magnitude, phase and frequency.

6.2.4.2 Autoreclose

This screen can be accessed at **Actual> Status > Control Elements > Autoreclose**, and it includes the following signaling LEDs for the Autoreclose function:

Table 6-14: Autoreclose actual values

AUTORECLOSER STATUS	DESCRIPTION
LOCKOUT PHA/B/C RESET LOCKOUT 3P RESET	If Manual Reset has been chosen as Lockout type, the assertion of this input reset the Lockout state after the breaker is closed and reclaim time fulfilled.
AR BLOCK INPUT	During the assertion of this input, the Autorecloser stays in the AR BLOCK state.
AR BLOCK PULSE	A pulse on this state operand sends the Autorecloser to the AR BLOCK state. The AR will remain in this state until an AR UNBLOCK pulse is received.
AR UNBLOCK PULSE	A pulse on this state unblocks the recloser.
AR HALT INPUT	Once activated, the timers of the AR are freeze. This input affects to all timers in the 'AR IN PROGRESS' state.
AR FORCE 3P MODE	
AR PHASE A/B/C RI AR 3P RI	Reclose initiation of the reclosing cycle on phase A/B/C or 3-phase.
AR DTL PHA/B/C AR DTL 3P	Autorecloser of the phase A/B/C or 3-phase is sent to LOCKOUT state.
AR PHA/B/C COORD AR 3P COORD	The assertion of this input provides a way to increase the SHOT COUNTER PHA of the AR.
AR PHA/B/C CLS COORD AR 3P CLS COORD	
AR PHA/B/C SKIP SHOT AR 3P SKIP SHOT	The activation of this input when AR is in 'AR PROGRESS' state increases the SHOT COUNTER PHA/B/C or 3P.
AR CLOSE PHA/B/C AR CLOSE 3P	This operand is sent to close phase A/B/C/3P of the breaker.
AR PHA/B/C LOCKOUT AR 3P LOCKOUT	Autoreclose in Lockout state
AR PHA/B/C IN PROGRESS AR 3P IN PROGRESS	Autoreclose is in the progress state, leading into a reclosing cycle
AR PHA/B/C READY AR 3P READY	Autoreclose is ready waiting for a reclose initiate event.
AR PHA/B/C BLOCK AR 3P B BLOCK	Autoreclose Blocked
AR PHA/B/C SHOT 0 / 1 / 2 / 3 / 4 AR 3P SHOT 0 / 1 / 2 / 3 / 4	Up to five separate shot counter operands are available. This state activates when the shot counter equals the actual number of shot.
AR PHA/B/C LAST SHOT AR 3P LAST SHOT	This state is raised when the last shot is reached.
AR DEAD TIME PHA/B/C AR DEAD TIME 3P	
AR RECLAIM TIME PHA/B/C AR RECLAIM TIME 3P	
AR RESET TIME PHA/B/C AR RESET TIME 3P	

AR PH A/B/C LCK AR 3P B LCK	This state keeps the cause that forces the Lockout State. NONE - Any Lockout cause. RCLS OPEN MANUALLY- A manually open of the phase A of the breaker has been produced during the reclosing cycle. RCLS FAIL TO CLOSE- The Phase A of the breaker has not closed as expected during the reclosing cycle. RCLS MAX NUMBER OF SHOTS- The maximum number of Shots has been reached. AR FAIL BY CONDITIONS- The Conditions before sending the CLOSE command are not fulfilled. RCLS FAIL BY ANOMALY- A Reclose initiate has been received during the reclose in progress cycle with the breaker open. RCLS FAIL TO OPEN- The Phase A of the Breaker has not been opened after reclose initiation input. RCLS MAX HALT TIME- The Autorecloser has been halted for more than the expected time.
AR PHA/B/C IN PRG AR 3P IN PRG	This operant keeps the internal state of the AR when the relay is into a reclosing cycle of the phase A. AR WAIT TO OPEN- The AR waits the breaker of phase A to be opened AR TIME TO CLOSE- The AR waits the braker of the phase A to be closed. AR WAIT CLOSE COND- The AR Waits the close conditions before sending the AR CLOSE PHASE A signal AR TIME TO RESET - The AR is waiting the reset timeout AR HALTED- The AR is in HALTED state
AR PHA/B/C STATE AR 3P STATE	
AR SHOT COUNTER PHA/B/C AR SHOT COUNTER 3P	
AutoRecSt 61850 PHA/B/C AutoRecSt 61850 3P	

The AUTORECLOSE INPUTS are signals configurable by the user at **Setpoint > Relay Configuration > Protection Elements**:

Table 6-15: AUTORECLOSE INPUTS

AR LEVEL BLOCK:	programmable signal to block the autoreclose unit by level
AR PULSE BLOCK:	programmable signal to block the autoreclose unit by pulse
AR PULSE UNBLOCK:	programmable signal to unblock the autoreclose unit by pulse
AR INITIATE:	programmable signal to initiate the autoreclose.
AR CONDS INPUT:	programmable signal to set the conditions to be met before executing a breaker close.

The AUTORECLOSE INTERNAL STATUS states are internal signals provided by the autoreclose unit:

Table 6-16: AUTORECLOSE INTERNAL STATUS

AR CLOSE BREAKER	Breaker close command given by the autoreclose
AR OUT OF SERVICE	Autoreclose out of service (Disabled)
AR READY	Autoreclose in service
AR LOCKOUT	Autoreclose in lockout status (finished cycled-definite trip)
AR BLOCK	Autoreclose blocked (by input, logic, others, etc).
AR RCL IN PROGRESS	Cycle in course (autoreclose in progress).
AR LCK BY ANOMALY	Autoreclose in “Lockout” by anomaly.
AR LCK BY FAIL OPEN	Autoreclose in “Lockout” by a failure in opening the breaker.
AR LCK BY FAIL CLOSE	Autoreclose in “Lockout” by a failure in closing the breaker.
AR LCK BY USER	Autoreclose in “Lockout” by manual close.
AR LCK BY CONDS	Autoreclose in “Lockout” by conditions. See input conditions configuration.
AR LCK BY TRIPS	Autoreclose in “Lockout” by maximum number of trips.
AR LCK BY SHOTS	Autoreclose in “Lockout” at the end of cycle – Definite trip.

AR BLK AFTER 1 SHOT	Signal sent by the autoreclose after the 1st shot.
AR BLK AFTER 2 SHOT	Signal sent by the autoreclose after the 2nd shot.
AR BLK AFTER 3 SHOT	Signal sent by the autoreclose after the 3rd shot.
AR BLK AFTER 4 SHOT	Signal sent by the autoreclose after the 4th shot.
AR BLOCK BY LEVEL	Autoreclose blocked by level. See AR block signals configuration
AR BLOCK BY PULSE	Autoreclose blocked by pulse. See AR block signals configuration
AR STATUS	Autoreclose status (in service – out of service)
AR LOCKOUT MODE	Relay “Lockout” status.
AR BLOCK MODE	Relay “Block” status
AutoRecSt_61850	Autorecloser status sent in IEC 61850. This value represent whether or not the auto reclosing is ready, in progress or successful. It is an enumerate type whose values are defined in IEC 61850-7-4 Edition 2.0 standard and it is available.

6.2.4.3 Breaker failure

This screen can be accessed at **Actual> Status > Control Elements > Breaker Failure**, and it includes the following signaling LEDs for the breaker failure function:

Table 6-17: Breaker failure actual values

BREAKER FAILURE STATUS
50BF BLOCK INPUT
50BF PHA/B/C INITIATE
50BF 3P INITIATE
50BF PH A/B/C RETRIP
50BF 3P RETRIP
50BF PHA/B/C INT ARC
50BF WO CURRENT
50BF PHA/B/C HISET TRIP
50BF 3P HISET TRIP
50BF PHA/B/C LOSET TRIP
50BF 3P LOSET TRIP
50BF PHA/B/C 2NDST TRIP
50BF 3P 2NDST TRIP

50BF PHA/B/C BLOCK INPUT:

50BF PHA/B/C INITIATE: External signal for breaker failure initiation on phase A. (Configurable at ***Settings> Relay Configuration > Protection Elements***.)

50BF 3P INITIATE: External signal for a three-phase breaker failure initiation. (Configurable at ***Settings> Relay Configuration > Protection Elements***.)

BF RETRIP PH A/B/C: Output to re-trip phase A of the breaker after an unsuccessful attempt to open it.

BF RETRIP 3P: Output to re-trip failure breaker after an unsuccessful attempt to open it.

INTERNAL ARC PH A/B/C: Output to indicate an internal arc condition on phase A of the breaker.

BF W/O CURRENT: Output to indicate a breaker failure condition without current.

BF PH A/B/C HISET TRIP: Output to indicate a High level breaker failure on phase A

BF PH A/B/C LOSET TRIP: Output to indicate a Low level breaker failure on phase A

BF 3P HISET TRIP: Output to indicate a three-phase High level breaker failure.

BF 3P LOSET TRIP: Output to indicate a three-phase Low level breaker failure.

BF PHA/B/C 2NDST TRIP: Output to indicate a second stage Trip condition on phase A.

BF 3P 2NDST TRIP: Output to indicate a three-phase second stage Trip condition.

6.2.4.4 VT fuse failure

This screen can be accessed at **Actual> Status > Control Elements >VT Fuse Failure**, and it includes only one LEDs for the VT fuse failure function, indicating the activation of the unit.

Table 6-18: VT fuse failure actual values

VT FUSE FAILURE ACTUAL VALUES
VT FUSE FAILURE

6.2.4.5 Setting groups

This screen can be accessed at **Actual> Status > Control Elements > Setting Groups**, and it includes activation signals for the relay setting groups change in the following signaling LEDs and an indication of the default active group.

Table 6-19: Setting group actual values

SETTING GROUPS ACTUAL VALUES
GROUP 1 ACT ON
GROUP 2 ACT ON
GROUP 3 ACT ON
GROUP 4 ACT ON
GROUP 5 ACT ON
GROUP 6 ACT ON
ACTIVE GROUP

6.2.4.6 Pulse counters

R650 units incorporate eight pulse counters. For each of them there are two magnitudes: the actual value and the freeze value.

This screen shows the activation of all pulse counters available in the R650. It can be accessed from the menu:

Actual> Status > Control Elements > Pulse counters, and it includes the following values.

Table 6-20: Pulse counter actual values

PULSE COUNTERS ACTUAL VALUES	
CntPulses Value 1	CntPulses Freeze 1
CntPulses Value 2	CntPulses Freeze 2
CntPulses Value 3	CntPulses Freeze 3
CntPulses Value 4	CntPulses Freeze 4
CntPulses Value 5	CntPulses Freeze 5
CntPulses Value 6	CntPulses Freeze 6
CntPulses Value 7	CntPulses Freeze 7
CntPulses Value 8	CntPulses Freeze 8
	Cnt Pulses Freeze
	Cnt Pulses Unfreeze
	Cnt Pulses Reset

6.2.4.7 Analog comparators

R650 units incorporate 20 analog comparators. This screen can be accessed from the menu:

Actual> Status > Control Elements >Analog Comparators and it includes the following signalling LEDs showing the ON/OFF status of the analog level.

Table 6-21: Analog comparators actual values

ANALOG COMPARATORS ACTUAL VALUES
Analog Level 01
Analog Level 02
Analog Level 03
Analog Level 04
Analog Level 05
Analog Level 06
Analog Level 07
Analog Level 08
Analog Level 09
Analog Level 10
Analog Level 11
Analog Level 12
Analog Level 13
Analog Level 14
Analog Level 15
Analog Level 16
Analog Level 17
Analog Level 18
Analog Level 19
Analog Level 20

6.2.4.8 Digital counters

This screen can be accessed at **Actual > Status > Control Elements > Digital Counters**, and it includes 24 LEDs for the 8 Digital Counters status, indicating which status is activate (HI, LO or EQ).

Table 6-22: Digital counter actual values

DIGITAL COUNTERS ACTUAL VALUES		
DIGCNT 1 HI	DIGCNT 1 LO	DIGCNT 1 FROZENVALUE
DIGCNT 2 HI	DIGCNT 2 LO	DIGCNT 2 FROZENVALUE
DIGCNT 3 HI	DIGCNT 3 LO	DIGCNT 3 FROZENVALUE
DIGCNT 4 HI	DIGCNT 4 LO	DIGCNT 4 FROZENVALUE
DIGCNT 5 HI	DIGCNT 5 LO	DIGCNT 5 FROZENVALUE
DIGCNT 6 HI	DIGCNT 6 LO	DIGCNT 6 FROZENVALUE
DIGCNT 7 HI	DIGCNT 7 LO	DIGCNT 7 FROZENVALUE
DIGCNT 8 HI	DIGCNT 8 LO	DIGCNT 8 FROZENVALUE
DIGCNT 1 EQ	DIGCNT 1 VALUE	DIGCNT 1 FROZENDATE
DIGCNT 2 EQ	DIGCNT 2 VALUE	DIGCNT 2 FROZENDATE
DIGCNT 3 EQ	DIGCNT 3 VALUE	DIGCNT 3 FROZENDATE
DIGCNT 4 EQ	DIGCNT 4 VALUE	DIGCNT 4 FROZENDATE
DIGCNT 5 EQ	DIGCNT 5 VALUE	DIGCNT 5 FROZENDATE
DIGCNT 6 EQ	DIGCNT 6 VALUE	DIGCNT 6 FROZENDATE
DIGCNT 7 EQ	DIGCNT 7 VALUE	DIGCNT 7 FROZENDATE
DIGCNT 8 EQ	DIGCNT 8 VALUE	DIGCNT 8 FROZENDATE

For each of the 8 digital counters, there exist independent and identical groups of actual values:

DIGCNT # HI [OFF: ON]: If this bit is activated, the counter value DIGCNT # VALUE is greater than the setting DigCNt #Compare value.

DIGCNT # EQ [OFF: ON]: If this bit is activated, the counter value DIGCNT # VALUE is equal than the setting DigCNt #Compare value.

DIGCNT # LO [OFF: ON]: If this bit is activated, the counter value DIGCNT # VALUE is lower than the setting DigCNt #Compare value.

(These 3 previous states are mutually exclusive: only one can be ON at the same time. If the counter is Disabled, the 3 of them are OFF.)

DIGCNT # VALUE [-2,147,483,648 : 2,147,483,647]: The specified counter current value.

DIGCNT # FROZENVALUE [-2,147,483,648 : 2,147,483,647]: The specified counter last captured (frozen) value.

DIGCNT # FROZENDATE [Valid date]: The specified counter last captured (frozen) date.

6.2.4.9 Cold load pickup

This screen can be accessed at **Actual> Status > Control Elements >Cold Load Pickup**, and it includes two LEDs for the Cold Load Pickup function, indicating two magnitudes; pickup and trip (operation).

Table 6-23: Cold load pickup actual values

COLD LOAD PICKUP
Cold Load PKP
Cold Load OP

6.2.4.10 60CTS Failure

This screen can be accessed at **Actual> Status > Control Elements > 60CTS Inhibit**, and it includes two LEDs for the Current Transformer Supervision element, indicating two magnitudes; pickup and trip (operation).

60 CTS Inhibit
60CTS Inhibit
CT Failure PKP
CT Failure OP

6.2.4.11 2nd Harmonic Inhibit

Second harmonic Inhibit actual values are available in Enervista 650 setup at **Actual Values>Control Elements> 2nd HRMC Inhibit**

Table 6-2: 2nd HRMC inhibit actual values

2nd HARMONIC STATUS	DESCRIPTION
2nd HARMONIC PKP	2nd Harmonic function has picked up
2nd HARMONIC OP	2nd Harmonic function has operated
2nd HARMONIC PHASE A	Shows % of 2nd harmonic in phase A
2nd HARMONIC PHASE B	Shows % of 2nd harmonic in phase B
2nd HARMONIC PHASE C	Shows % of 2nd harmonic in phase C

6.2.5 Protection & control status summary

Actual > Status > Protection Summary This screen shows a complete listing of all protection and control elements in the relay, showing their status (enabled or not) through the corresponding LED.

6.2.6 Snapshot event summary

Actual > Status > Snapshot Event Summary

The R650 provides via setting the possibility to enable or disable the snapshot event generation in the different functions available in the device.

This screen shows a complete listing of the snapshot event generation for all the protection, control and inputs/outputs elements in the relay, showing their status (enabled or not) through the corresponding LED.

6.2.7 MODBUS user map

The ModBus User Map consists of a selection of the most important 256 records in the complete ModBus Map regarding the application. By selecting these records and defining the user map appropriately, it is possible to read all the information included by a single ModBus reading operation, optimizing the refresh time.

This screen can be accessed at ***Actual> Status> ModBus User Map***, and it includes all the readings for the previously configured records in the ModBus memory map.

Table 6-24: MODBUS user map actual values

MODBUS USER MAP
Address 00
Address 01
...
Address 255

6.2.8 Switchgear status

Actual > Status > Switchgear Status

For a better understanding of the represented statuses in this screen, figure 6.1 shows the available "Switchgear" modules to be programmed in the R650. Each of them has a series of inputs/outputs that are the statuses represented on this screen. Separate signal for each switchgear device (for 1 to 12).

Each Switchgear module can be programmed at: **Setpoint > Relay Configuration >Switchgear**, and its statuses are as follows:

Table 6-25: Switchgear status

SWITCHGEAR 1 STATUS		SWITCHGEAR X STATUS		SWITCHGEAR 12 STATUS
SWITCH 1 A INPUT	...	SWITCH X A INPUT	...	SWITCH 12 A INPUT
SWITCH 1 B INPUT	...	SWITCH X B INPUT	...	SWITCH 12 B INPUT
SWITCH 1 A STATUS	...	SWITCH X A STATUS	...	SWITCH 12 A STATUS
SWITCH 1 B STATUS	...	SWITCH X B STATUS	...	SWITCH 12 B STATUS
SWITCH 1 OPEN	...	SWITCH X OPEN	...	SWITCH 12 OPEN
SWITCH 1 CLOSED	...	SWITCH X CLOSED	...	SWITCH 12 CLOSED
SWITCH 1 00_ERROR	...	SWITCH X 00_ERROR	...	SWITCH 12 00_ERROR
SWITCH 1 11_ERROR	...	SWITCH X 11_ERROR	...	SWITCH 12 11_ERROR
SWITCH 1 OPEN INIT	...	SWITCH X OPEN INIT	...	SWITCH 12 OPEN INIT
SWITCH 1 CLOSE INIT	...	SWITCH X CLOSE INIT	...	SWITCH 12 CLOSE INIT
SWGR 1 FAIL TO OPEN	...	SWGR X FAIL TO OPEN	...	SWGR 12 FAIL TO OPEN
SWGR 1 FAIL TO CLOSE	...	SWGR X FAIL TO CLOSE	...	SWGR 12 FAIL TO CLOSE

SWITCH **X** A INPUT	The LED lights up when the input associated with switchgear Contact A is activated.
SWITCH **X** B INPUT	The LED lights up when the input associated with switchgear Contact B is activated.
SWITCH **X** A STATUS	Status associated with Switchgear contact A. It is activated once the time required for the Switchgear module to acknowledge contact A has expired.
SWITCH **X** B STATUS	Status associated with Switchgear contact B. It is activated once the time required for the Switchgear module to acknowledge contact B has expired.
SWITCH **X** OPEN	Lights up when the associated switchgear is open
SWITCH **X** CLOSED	Lights up when the associated switchgear is closed
SWITCH **X** 00_ERROR	Output that represents the Switchgear status 00, considered as abnormal.
SWITCH **X** 11_ERROR	Output that represents the Switchgear status 11, considered as abnormal.
SWITCH **X** OPEN INIT	Programmable input that indicates the initiation of the Opening Operation for the considered switchgear.
SWITCH **X** CLOSE INIT	Programmable input that indicates the initiation of the closing Operation for the considered switchgear.
SWGR **X** FAIL TO OPEN	Output that represents a failure to open, from the associated external device (opening time exceeded)
SWGR **X** FAIL TO CLOSE	Output that represents a failure to close from the associated external device (closing time exceeded)

See the following figure:

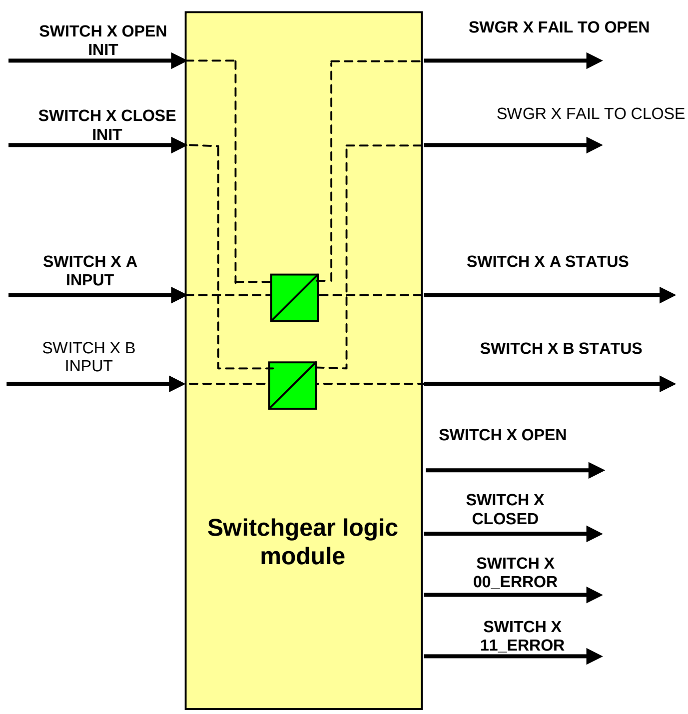


Figure 6-1: Switchgear contacts

6.2.9 FlexCurves

This screen can be accessed at **Actual> Status > Flex Curves**, and it includes the internal flex curves status.

If the LED associated with the FlexCurve status is lit up, this indicates that the user curve has been configured with new values (not default values).

Table 6-26: FlexCurve status

FLEX CURVES STATUS
FLEXCURVE A STATUS
FLEXCURVE B STATUS
FLEXCURVE C STATUS
FLEXCURVE D STATUS

6.2.10 System info

This screen can be accessed at **Actual> Status > System Info**. It can monitor the system parameters and the internal status of the Relay operating system.

6.2.10.1 Device Status

Information related with internal status and Self-test errors.

Self-Test Memory OK: LED associated lights in green if E2PROM is configured and working properly

Self-Test DSP Fault: LED associated lights in green if communication error between DSP and main processor.

Magnetics Fault: LED associated lights in green if communication error between DSP and magnetic module.

Logics Fault: PLC equations sent to the relay have an error or are incorrect.

Network Fault: Network configuration is incorrect

Order Code Fault: Order code and hardware configuration do not match

Device Not Calibrated: This value is active when the relay calibration settings are the default values (no calibration).

Calibration Error: Error shown when there is a problem in the calibration settings (wrong values).

Link Status Port E: Indicates connection on Ethernet port E

Link Status Port A: Indicates connection on Ethernet port A

Link Status Port B: Indicates connection on Ethernet port B

6.2.10.2 HW Versions

Information related with the HW version of the different components of the R650.

CPU Revision: Indicates the type of the CPU in the device:

Redundant Fiber Optic: 8, 16

Redundant Cooper Cable: 9, 17

Single Fiber Optic: 10, 18

Single Cooper Cable: 11, 19

Device HW Version: Current version of the HW in the device

FPGA Version: Current version of the bitstream running in CPU FPGA.

PRP HSR Version: Current version of the PRP_HSR bitstream running in the FPGA.

RSTP Version: Current version of the RSTP-Daisy Chain bitstream running in the FPGA.

LLA Version: Current version of the LLA bitstream running in the redundancy module FPGA.

Bypass Version: Current version of the Bypass bitstream running in the redundancy module FPGA.

IO Board F Boot Date: Date

IO Board F App Date:

6.2.10.3 FW Versions

HMI Version:	Relay display version
Firmware Version:	Main firmware version
Firmware Date:	Firmware application release date
DSP Version:	Digital Signal Processor firmware version
DSP Date:	Digital Signal Processor firmware release date
Boot Version:	Boot version
Boot Date:	Boot version release date
CAN CPU Boot Version:	Kinetis boot release date
CAN CPU Boot Date:	Kinetis boot release date
CAN CPU Load Version:	Kinetis bootloader version
CAN CPU Load Date:	Kinetis bootloader release date
CAN CPU App Version:	Kinetis application version
CAN CPU App Date:	Kinetis application release date

6.2.10.4 Unit Information

This menu shows information related with the order code and manufacturing data of the device.

Relay Model:	Order coder of the relay connected to Enervista 650 Setup
MAC address:	MAC address assigned to Ethernet port, Eth_E.
Serial number:	Serial number of the relay that is communicating with Enervista 650 Setup.
Manufacturing date:	Date when the relay, connected to Enervista 650 Setup, was assembled.
Calibration Date:	Date when the relay, connected to Enervista 650 Setup, was calibrated.

6.2.10.5 Configuration Information

This menu shows information related with the settings file and ICD file of the device.

ICD Status:	Information about status of ICD file stored in the R650. For detailed information go to Chapter 7, section 7.3.2.2 IEC 61850 CONFIGURATOR FEATURES FOR CONFIGURATION
ICD Status NotVal:	Information about validation of new ICD after being sent into the relay. For detailed information go to Chapter 7, section 7.3.2.2 IEC 61850 CONFIGURATOR FEATURES FOR CONFIGURATION
PLC Checksum:	Value of CRC of PLC equations. This value is read from the relay.
Settings checksum:	Value of CRC of relay settings. This value is read from the relay.

6.2.10.6 Maintenance

This menu shows different information related with internal parameters of the relay.

Display Type:	Relay's display model (refers to order code, basic or graphic)
	1. Basic display
	2. Graphic display
Total RAM:	Total RAM in the device
Used DRAM:	Used RAM in the device

Free RAM:	Available RAM in the device
DSP Counter:	Percentage of CPU in use
CPU Usage:	Percentage of CPU in use
Dsp Status:	Internal status of the DSP
Flash Usage:	FLASH memory in use
KINETIS Status:	Kinetis working mode
CPU MAX Usage:	Maximum measured CPU usage
Temp Current Value:	Current temperature of CPU. This value is displayed in Celsius units.
Temp Max Value:	Maximum temperature reached by CPU during operating mode after last reboot.
Temp Min Value:	Minimum temperature reached by CPU after last reboot.
Scan Cycle Average:	Mean time in nanoseconds that takes a Scan cycle to run
Scan Cycle Rate:	Every miliseconds a Scan cycle is run
Mag Temp Value:	Current temperature in magnetics module
Mag Temp Max Value:	Maximum temperature reached by the magnetics module after last reboot
Mag Temp Min Value:	Minimum temperature reached by the magnetics module after last reboot
Mag Vref Sup12V_H:	Current value of internal +12V rail power in the magnetics module
Mag Vref Sup12V_L:	Current value of internal -12V rail power in the magnetics module
Mag Vref Sup6V_H:	Current value of internal +6V rail power in the magnetics module
Mag Vref Sup6V_L:	Current value of internal -6V rail power in the magnetics module.

6.2.11 Record status

This screen shows part of the information related to the different records stored in the Relay, such as:

6.2.11.1 Fault reports

Actual> Status > Records Status > Fault Reports

Table 6-27: Fault report status

FAULT REPORT STATUS
FAULT REPORT TRIGG
CLEAR FAULT REPORTS
PreFault Ia Mod
PreFault Ia Ang
PreFault Ib Mod
PreFault Ib Ang
PreFault Ic Mod
PreFault Ic Ang
PreFault Vab Mod
PreFault Vab Ang
PreFault Vbc Mod
PreFault Vbc Ang
PreFault Vca Mod
PreFault Vca Ang
PreFault Ig Mod
PreFault Ig Ang
PreFault Isg Mod
PreFault Isg Ang
PostFault Ia Mod
PostFault Ia Ang
PostFault Ib Mod
PostFault Ib Ang
PostFault Ic Mod
PostFault Ic Ang
PostFault Vab Mod
PostFault Vab Ang
PostFault Vbc Mod
PostFault Vbc Ang
PostFault Vca Mod
PostFault Vca Ang
PostFault Ig Mod
PostFault Ig Ang
PostFault Isg Mod
PostFault Isg Ang
FAULT DATE
FAULT TYPE
FAULT LOCATION
FAULT REPORT NUMBER
R Primary
R Secondary
X Primary
X Secondary
FAULT RESISTANCE

PreFault values:	Prefault values for all the current and voltage units (Modulus (mod), Angle (deg))
PostFault values:	Postfault values for all the current and voltage units (Modulus (mod), Angle (deg))
R Primary/ R Secondary:	Primary/ Secondary Fault Resistance; this value represents the resistance in primary/ secondary values of the portion of the affected line until the defect.
Secondary fault resistance:	Resistance of Positive sequence x distance / Line Lenght;
X Primary/X Secondary:	Primary/ Secondary Fault Reactance. This value represents the reactance in primary/ secondary values of the portion of the affected line until the defect.
Secondary fault reactance:	Reactance of Positive sequence x distance / Line Lenght;
Fault resistance:	This value provides the estimated ground fault resistance in primary values of the fault seen by the R650 by neglecting the resistance of the affected portion of the line.
Fault report trigg:	This signal indicates whether the signal that initiates the calculation of the distance to the fault has been activated.
Clear fault reports:	This signal indicates the reset of fault reports.
Fault date:	Date and time of the last fault produced in the relay. In format (Day/Month/year Hour:minutes:seconds.milliseconds)
Fault type:	Type of the last fault produced in the Relay (phase to ground, phase to phase, three-phase, etc).
Fault location:	Location of the last fault produced in the relay.
Fault report number:	Number of fault reports

6.2.11.2 Control events

In the screen **Actual> Status > Records Status > Control Events**, the status of the signals configured to launch the control events can be seen, activated or not.

The R650 provides the possibility to configure 128 control events (at **Settings > Relay Configuration > Control Events**). In the **Actual > Records > Event Recorder > Control Events** it is possible to see and retrieve the recorded control events to a file, seeing the text and date and time and status of the preconfigured control event.

Table 6-28: Control event status

CONTROL EVENTS
CONTROL EVENT 1
CONTROL EVENT 2
...
CONTROL EVENT 128

6.2.11.3 Oscillography

Actual> Status > Records Status > Oscillography

The following figure shows the status of the different digital channels that can be programmed to be included in oscillography records. When the signal associated with a specific channel is active, its LED lights up on this screen.

This screen also shows the oscillography trigger status, active or inactive, by lighting up that channel.

Table 6-29: Oscillography status

OSCILLOGRAPHY
OSC DIG CHANNEL 1
OSC DIG CHANNEL 2
OSC DIG CHANNEL 3
OSC DIG CHANNEL 4
OSC DIG CHANNEL 5
OSC DIG CHANNEL 6
OSC DIG CHANNEL 7
OSC DIG CHANNEL 8
OSC DIG CHANNEL 9
OSC DIG CHANNEL 10
OSC DIG CHANNEL 11
OSC DIG CHANNEL 12
OSC DIG CHANNEL 13
OSC DIG CHANNEL 14
OSC DIG CHANNEL 15
OSC DIG CHANNEL 16
OSCILLO TRIGGER
NUMBER OF TRIGGERS
CYCLES PER RECORD
AVAILABLE RECORDS

The last three values shown are as follows:

NUMBER OF TRIGGERS: This is the number of the last oscillography record obtained in the relay. This value has a range of 0 to 999.

CYCLES PER RECORD: This is the number of cycles contained in the oscillography record; this value depends on the settings adjusted on the oscillography menu at ***Setpoint > Product Setup > Oscillography***.

AVAILABLE RECORDS: This is the number of available oscillography records in the relay.

Values for these last 3 fields are reset every time the oscillography settings are modified.

6.2.11.4 Data logger

Actual> Status > Records Status > Data Logger

Table 6-30: Data logger status

DATA LOGGER
OLDEST SAMPLE TIME
NEWEST SAMPLE TIME
DATA LOGGER CHANNELS
DATA LOGGER DAYS

OLDEST SAMPLE TIME: Date and time of the oldest value stored in the data logger.

NEWEST SAMPLE TIME: Date and time of the most recent value stored in the data logger

DATA LOGGER CHANNELS: Number of channels configured in the data logger

DATA LOGGER DAYS: Time in days during which, samples are stored without overwriting them.

6.2.11.5 Demand

Actual> Status > Records Status > Demand

Table 6-31: Demand status

DEMAND
DEMAND TRIGGER INP
DEMAND RESET INP

DEMAND TRIGGER INP: Signal used for triggering the demand in the case of Rolling demand.

DEMAND RESET INP: Signal to reset the demand.

These signals can be configured at ***Setpoint > Relay Configuration > Protection Elements***

6.2.11.6 Energy

Freeze/Unfreeze/reset Energy: These signals correspond to the relay energy counters statuses of freeze, unfreeze and reset.

Actual> Status > Records Status > Energy

Table 6-32: Energy status

ENERGY
FREEZE ENERGY CNT
UNFREEZE ENERGY CNT
RESET ENERGY CNT

FREEZE ENERGY CNT: Signal used to freeze the energy counters for measurement purposes.

UNFREEZE ENERGY CNT: Signal used to unfreeze the energy counters.

RESET ENERGY CNT: Signal to reset the energy measurements and set the values to zero.

These signals can be configured at ***Setpoint > Relay Configuration > Protection Elements***

6.2.11.7 RCL Last Statistics

For statistical purposes, the R650 stores the last opening and closing timing intervals. Registers are updated every new opening or closing command is sent to the recloser. The values stored are shown:

LAST OPEN/CLOSE STATISTICS		Units
PHA OPENING TIME	0.000	s
PHB OPENING TIME	0.000	s
PHC OPENING TIME	0.000	s
COIL A MAXOPEN CURRENT	0.00	A
COIL B MAXOPEN CURRENT	0.00	A
COIL C MAXOPEN CURRENT	0.00	A
PHA CLOSING TIME	0.000	s
PHB CLOSING TIME	0.000	s
PHC CLOSING TIME	0.000	s
COIL A MAXCLOSE CURRENT	0.00	A
COIL B MAXCLOSE CURRENT	0.00	A
COIL C MAXCLOSE CURRENT	0.00	A
PHA OPENING DATE	01-Jan-2000 00:00:00.000	
PHB OPENING DATE	01-Jan-2000 00:00:00.000	
PHC OPENING DATE	01-Jan-2000 00:00:00.000	
3P OPENING DATE	01-Jan-2000 00:00:00.000	
PHA CLOSING DATE	01-Jan-2000 00:00:00.000	
PHB CLOSING DATE	01-Jan-2000 00:00:00.000	
PHC CLOSING DATE	01-Jan-2000 00:00:00.000	
3P CLOSING DATE	01-Jan-2000 00:00:00.000	

PHA/B/C/3P OPENING TIME The R650 monitors the interval of time of the last opening operation. The time is taking between the opening command sent to the output board and the reception of the open state of the breaker.
If the R650 controller detects a fail to open condition, statistical open values are not updated. The maximum timeout to detect a fail to open/close condition is fixed to 5 seconds.

COIL A/B/C MAX OPEN CURRENT

The driving electronics board measures the flowing current during opening and closing operations. This measurement is used by the I/O board to limit the maximum flowing current during operations. It is based on the settings 'open max current' and 'close max current' programmed. When the flowing current throughout the coil overcomes the selected limit, the trip circuit is opened to avoid the flow of such higher currents. So, it is important to know by means of keeping a trace of which are the maximum currents used during opening/closing operations. This register stores the maximum open current flowing during the last successful opening period.

PHA/B/C/3P CLOSING TIME The R650 monitors the interval of time of the last closing operation. The time is taking between the closing command sent to the output board and the reception of the close state of the breaker.
If the R650 controller detects a fail to close condition, statistical close values are not updated. The maximum timeout to detect a fail to open/close condition is fixed to 5 seconds.

COIL A/B/C MAXCLOSE CURRENT

This register stores the maximum close current flowing during the last successful closing period.

PHA/B/C/3P OPENING DATE This register is updated with the date of the last successful opening operation.

PHA/B/C/3P CLOSING DATE This register is updated with the date of the last successful closing operation.

6.2.11.8 RCL Mean Statistics

The R650 calculates the mean values for opening and closing timing intervals. Registers are updated every new opening or closing command is sent to the recloser. The number of values used for calculating the mean is indicated in setting Statistic Integration Number.

The COIL A/B/C MAXCLOSE and COIL A/B/C MAXOPEN CURRENT are also updated with the maximum value of current flowing throughout the coil during the selected period.

The values are stored in a non-volatile memory.

LAST OPEN/CLOSE STATISTICS		Units
PHA OPENING TIME	0.000	s
PHB OPENING TIME	0.000	s
PHC OPENING TIME	0.000	s
COIL A MAXOPEN CURRENT	0.00	A
COIL B MAXOPEN CURRENT	0.00	A
COIL C MAXOPEN CURRENT	0.00	A
PHA CLOSING TIME	0.000	s
PHB CLOSING TIME	0.000	s
PHC CLOSING TIME	0.000	s
COIL A MAXCLOSE CURRENT	0.00	A
COIL B MAXCLOSE CURRENT	0.00	A
COIL C MAXCLOSE CURRENT	0.00	A

PHA/B/C/3P OPENING TIME Mean value for the opening time.

COIL A/B/C MAX OPEN CURRENT

This register stores the maximum open current flowing during the period for calculating the mean.

PHA/B/C/3P CLOSING TIME Mean value for the closing time.

COIL A/B/C MAXCLOSE CURRENT

This register stores the maximum close current flowing during the period for calculating the mean.

6.2.12 IEEE 1588 precision time protocol (PTP)

Actual> Status > IRIG-B PTP 1588

This screen shows the IRIG-B and PRP status. It includes the following signaling LEDs showing the FAILURE of the SNTP and IRIG-B and other statuses are provided.

SNTP - IRIGB - PTP1588 STATUS
SNTP FAILURE
IRIG-B FAILURE
RTC Sync Source
GrandMaster-ID LOW
GrandMaster-ID HIGH
PTP ACCURACY

The **RTC Sync Source** actual value is the time synchronizing source the relay is using at present. Possible sources are: Port A PTP Clock, Port B PTP Clock, IRIG B, SNTP and None.

Grandmaster ID is the grandmaster Identity code being received from the present PTP grandmaster if any. When the relay is not using any PTP grandmaster, this actual value is zero. The grandmaster Identity code is specified by PTP to be globally unique, so one can always know which clock is grandmaster in a system with multiple grandmaster-capable clocks.

PTP Accuracy is the estimated maximum time error at present in the Real Time Clock (RTC), considering the quality information embedded in the received time signal, how long the relay has had to lock to the time source, and in the case of time signal interruptions, the length of the interruption. The value 999,999,999 indicates that the magnitude of the estimated error is one second or more, or that the error cannot be estimated.

Note:

The R650 does not support the end-to-end delay mechanism, so it is not unexpected that changing the device to which the R650 is connected to this mode would cause the (NoPDelay) message. When PTP source clock is having "End to End clock delay" configured, and if R650 is receiving PTP packets from this clock R650 is getting synchronized and status is showing Synch'd (No Pdelay). Note that the relay does not allow manual overwriting of its RTC time if PTP is functional.

6.2.13 Redundancy

Actual> Status > Redundancy: This screen shows the port A and B statuses related to PRP, HSR and RSTP protocols.

REDUNDANCY
PRP_HSR A tx
PRP_HSR B tx
PRP_HSR A err
PRP_HSR B err
RSTP PortA State
RSTP PortB State

PRP_HSR A TX: This is the number of the transmitted messages over port A when PRP or HSR option is enabled.

PRP_HSR B TX: This is the number of the transmitted messages over port B when PRP or HSR option is enabled.

PRP_HSR A ERR: This value shows the number of messages received over port A with wrong LAN ID.

PRP_HSR B ERR: This value shows the number of messages received over port B with wrong LAN ID.

RSTP PortA State: This is the state of RSTP for port A (Discarding, Learning & Forwarding)

RSTP PortB State: This is the state of RSTP for port B (Discarding, Learning & Forwarding)

6.3 Metering

The R650 provides data measurements from current and voltage channels. The relay measures directly all RMS and phasor currents and voltages, frequency and frequency. Other derived measurements include: neutral current, neutral voltage, symmetrical components, frequency decay rate, power factor, power and energy measurements. Each quantity is updated every 1/8 of power system cycle and used to perform protection and monitoring functions.

All phasors and symmetrical components are referenced to the A-N Voltage phasor for Wye-connected VTs; to the A-B voltage phasor for delta-connected VTs.

The metering menu has been divided in several submenus:

Metering		
	Primary Values	Current
		Source Voltage
		Load Voltage
		Power
		Energy
		Demand
	Per Unit Values	Current
		Source Voltage
		Load Voltage
	Frequency	
	Power Quality	Current Harmonics
		Source Voltage Harmonics
		Load Voltage Harmonics

6.3.1 Primary values

6.3.1.1 Current

Actual> Metering > Primary Values > Current

Current	Value	Description
CT Ratio	1.000	Phase CT Ratio applied
CT Ratio Ig	1.000	Ground CT Ratio applied
CT Ratio Isg	1.000	Sensitive Ground CT Ratio applied
Ia angle	0.000 Deg	Phase A Angle
Ib angle	0.000 Deg	Phase B Angle
Ic angle	0.000 Deg	Phase C Angle
In angle	0.000 Deg	Neutral Current Angle
Ig angle	0.000 Deg	Ground Current Angle
Isg angle	0.000 Deg	Stv Ground Current Angle
Phasor Ia Primary	0.000 KA [A (*)]	DFT Phase A Primary current
Phasor Ib Primary	0.000 KA [A (*)]	DFT Phase B Primary current
Phasor Ic Primary	0.000 KA [A (*)]	DFT Phase C Primary current
Phasor In Primary	0.000 KA [A (*)]	DFT Neutral Primary current
Phasor Ig Primary	0.000 KA [A (*)]	DFT Ground Primary current
Phasor Isg Primary	0.000 KA [A (*)]	DFT Sensitive Ground Primary current
RMS Ia Primary	0.000 KA [A (*)]	RMS Phase A Primary current
RMS Ib Primary	0.000 KA [A (*)]	RMS Phase B Primary current

Current	Value	Description
RMS Ic Primary	0.000 KA [A (*)]	RMS Phase C Primary current
RMS In Primary	0.000 KA [A (*)]	RMS Neutral Primary current
RMS Ig Primary	0.000 KA [A (*)]	RMS Ground Primary current
RMS Isg Primary	0.000 KA [A (*)]	RMS Sensitive Ground Primary current
I0 Primary	0.000 KA [A (*)]	Primary Zero sequence
I1 Primary	0.000 KA [A (*)]	Primary Positive sequence
I2 Primary	0.000 KA [A (*)]	Primary Negative sequence

(*) This setting is only available for LEA voltage sensor types.

6.3.1.2 Source and Load Voltages

Actual> Metering > Primary Values > Source Voltage

Actual> Metering > Primary Values > Load Voltage

Source/Load Voltage	Value	Description
Source/Load Va Angle	0.000 Deg	Phase A Angle
Source/Load Vb Angle	0.000 Deg	Phase B Angle
Source/Load Vc Angle	0.000 Deg	Phase C Angle
Source/Load Vn Angle	0.000 Deg	Neutral Voltage Angle
Source/Load Vab Angle	0.000 Deg	AB Voltage Angle
Source/Load Vbc Angle	0.000 Deg	BC Voltage Angle
Source/Load Vca Angle	0.000 Deg	CA Voltage Angle
Source/Load V0 Primary	0.000 KV [V (*)]	Zero Sequence Primary voltage
Source/Load V1 Primary	0.000 KV [V (*)]	Pos. Sequence Primary voltage
Source/Load V2 Primary	0.000 KV [V (*)]	Neg. Sequence Primary voltage
Source/Load Vab Primary	0.000 KV [V (*)]	DFT Phase AB Primary voltage
Source/Load Vbc Primary	0.000 KV [V (*)]	DFT Phase BC Primary voltage
Source/Load Vca Primary	0.000 KV [V (*)]	DFT Phase CA Primary voltage
Source/Load Va Primary	0.000 KV [V (*)]	DFT Phase A Primary voltage
Source/Load Vb Primary	0.000 KV [V (*)]	DFT Phase B Primary voltage
Source/Load Vc Primary	0.000 KV [V (*)]	DFT Phase C Primary voltage
Source/Load Vn Primary	0.000 KV [V (*)]	Neutral Voltage in Primary value
Source/Load VT Ratio	1.000	Source/Load VT Ratio applied
Source/Load Voltage	0.000 KV [V (*)]	Source/Load Primary Voltage for synchrocheck calculations.

(*) This setting is only available for LEA voltage sensor types.

6.3.1.3 Power

Actual> Metering > Primary Values > Power

Power	Value	Description
Ph A Real Pwr Pri	0.000 MW [KW (*)]	Phase A Real Power in primary Values
Ph A Reactive Pwr Pri	0.000 MVar [KVar (*)]	Phase A Reactive Power in primary Values
Ph A Apparent Pwr Pri	0.000 MVA [KVA (*)]	Phase A Apparent Power in primary Values
Ph B Real Pwr Pri	0.000 MW [KW (*)]	Phase B Real Power in primary Values
Ph B Reactive Pwr Pri	0.000 MVar [KVar (*)]	Phase B Reactive Power in primary Values
Ph B Apparent Pwr Pri	0.000 MVA [KVA (*)]	Phase B Apparent Power in primary Values
Ph C Real Pwr Pri	0.000 MW [KW (*)]	Phase C Real Power in primary Values
Ph C Reactive Pwr Pri	0.000 MVar [KVar (*)]	Phase C Reactive Power in primary Values

Ph C Apparent Pwr Pri	0.000 MVA [KVA (*)]	Phase C Apparent Power in primary Values
3 Ph Real Pwr Pri	0.000 MW [KW (*)]	3 Phase Real Power in primary Values
3 Ph Reactive Pwr Pri	0.000 MVar [KVar (*)]	3 Phase Reactive Power in primary Values
3Ph Apparent Pwr Pri	0.000 MVA [KVA (*)]	3 Phase Apparent Power in primary Values
Ph A Power Factor	0.000	Phase A Power Factor
Ph B Power Factor	0.000	Phase B Power Factor
Ph c Power Factor	0.000	Phase C Power Factor
3 Ph Power Factor	0.000	3 Phase Power Factor

(*) This setting is only available for LEA voltage sensor types.

NOTE: For the three-phase power value, the system uses the ARON method, or two-wattmeters method.

NOTE 2: When both currents and voltages are not available in the R650, the default value for the power factor is zero.

6.3.1.4 Energy

Actual> Metering > Primary Values > Energy

Energy is only given in three phase primary values

Energy	Value	Description
Pos MWatthour Freeze	0.000 MWh [KWh (*)]	Freeze counter Value of Positive Real Energy in primary Values
Neg MWatthour Freeze	0.000 MWh [KWh (*)]	Freeze counter Value of Negative Real Energy in primary Values
Pos MVarhour Freeze	0.000 MVArh [KVArh (*)]	Freeze counter Value of Positive Reactive Energy in primary Values
Neg MVarhour Freeze	0.000 MVArh [KVArh (*)]	Freeze counter Value of Negative Reactive Energy in primary Values
Positive MWatthour	0.000 MWh [KWh (*)]	Positive Real Energy in primary Values
Negative MWatthour	0.000 MWh [KWh (*)]	Negative Real Energy in primary Values
Positive MVarhour	0.000 MVArh [KVArh (*)]	Positive Reactive Energy in primary Values
Negative MVarhour	0.000 MVArh [KVArh (*)]	Negative Reactive Energy in primary Values

(*) This setting is only available for LEA voltage sensor types.

When the energy counters reach the value (2ˆ 31)/1000 (approximately 2147483 MVArh and MWh), all the values are set to zero and counting restarts.

6.3.1.5 Demand

Actual> Metering > Primary Values > Demand

Values calculated for current demand and power demand can be monitored here. The calculations are according to settings in section *5.2.6 Demand settings*.

Demand	Value	Description
Demand IA	0.000 A	
Demand IA Max	0.000 A	
Demand IA Date	01-Jan-2000 00:00:00.000	
Demand IB	0.000 A	
Demand IB Max	0.000 A	
Demand IB Date	01-Jan-2000 00:00:00.000	
Demand IC	0.000 A	
Demand IC Max	0.000 A	
Demand IC Date	01-Jan-2000 00:00:00.000	
Demand IG	0.000 A	
Demand IG Max	0.000 A	
Demand IG Date	01-Jan-2000 00:00:00.000	

Demand ISG	0.000 A	
Demand ISG Max	0.000 A	
Demand ISG Date	01-Jan-2000 00:00:00.000	
Demand I2	0.000 A	
Demand I2 Max	0.000 A	
Demand I2 Date	01-Jan-2000 00:00:00.000	
Demand W	0.000 kW	
Demand W Max	0.000 kW	
Demand W Date	01-Jan-2000 00:00:00.000	
Demand VAr PWR	0.000 kVAr	
Demand VAr Max	0.000 kVAr	
Demand VAr Date	01-Jan-2000 00:00:00.000	
Demand VA PWR	0.000 kVA	
Demand VA Max	0.000 kVA	
Demand VA Date	01-Jan-2000 00:00:00.000	

6.3.2 Per Unit values

6.3.2.1 Current (per unit)

Actual> Metering > Per Unit Values > Current

Current	Value	Description
Phasor Ia	0.00 xCT	DFT Phase A current
RMS Ia	0.00 xCT	RMS Phase A current
Phasor Ib	0.00 xCT	DFT Phase B current
RMS Ib	0.00 xCT	RMS Phase B current
Phasor Ic	0.00 xCT	DFT Phase C current
RMS Ic	0.00 xCT	RMS Phase C current
Phasor In	0.00 xCT	DFT Neutral current
Phasor Ig	0.00 xCTg	DFT Ground current
Phasor Isg	0.00 xCTsg	DFT Sensitive Ground current
RMS Ig	0.00 xCTg	RMS Ground current
RMS Isg	0.00 xCTsg	RMS Sensitive Ground current
Zero seq. I0	0.00 xCT	Zero sequence Current
Positive seq. I1	0.00 xCT	Positive sequence Current
Negative seq. I2	0.00 xCT	Negative sequence Current

6.3.2.2 Source and Load Voltages (per unit)

Actual> Metering > Per Unit Values > Source Voltage

Actual> Metering > Per Unit Values > Load Voltage

Source/Load Voltage	Value	Description
Source/Load Phasor Vab	0.00 xVT	DFT Phase AB voltage
Source/Load Phasor Vbc	0.00 xVT	DFT Phase BC voltage
Source/Load Phasor Vca	0.00 xVT	DFT Phase CA voltage
Source/Load Phasor Van	0.00 xVT	DFT Phase A voltage
Source/Load Phasor Vbn	0.00 xVT	DFT Phase B voltage
Source/Load Phasor Vcn	0.00 xVT	DFT Phase C voltage

Source/Load Phasor Vn	0.00 xVT	DFT Neutral voltage
Source/Load Positive Seq. V1	0.00 xVT	Positive sequence of voltage
Source/Load Negative Seq. V2	0.00 xVT	Negative sequence of voltage
Source/Load Zero Seq. V0	0.00 xVT	Zero sequence of voltage
Source/Load Nominal Voltage	0.00 xVT	Nominal voltage Value
Source/Load Voltage	0.00 xVT	Source/Load Voltage for synchrocheck

6.3.3 Phasor diagram

Actual> Metering > Phasor Diagram

This window shows the phasors for voltage and current values, phase to phase, phase to ground and sequence values, provided by the unit. The angles provided by the unit are counter clockwise, all the angles are positive values, so for a system Va (0,0°), Vb (0,-120°), Vc (0,120°) the relay provides the following angles Va (0,0°), Vb (0,240°), Vc (0,120°).

The following figure shows the phasor diagram provided by EnerVista 650 Setup:

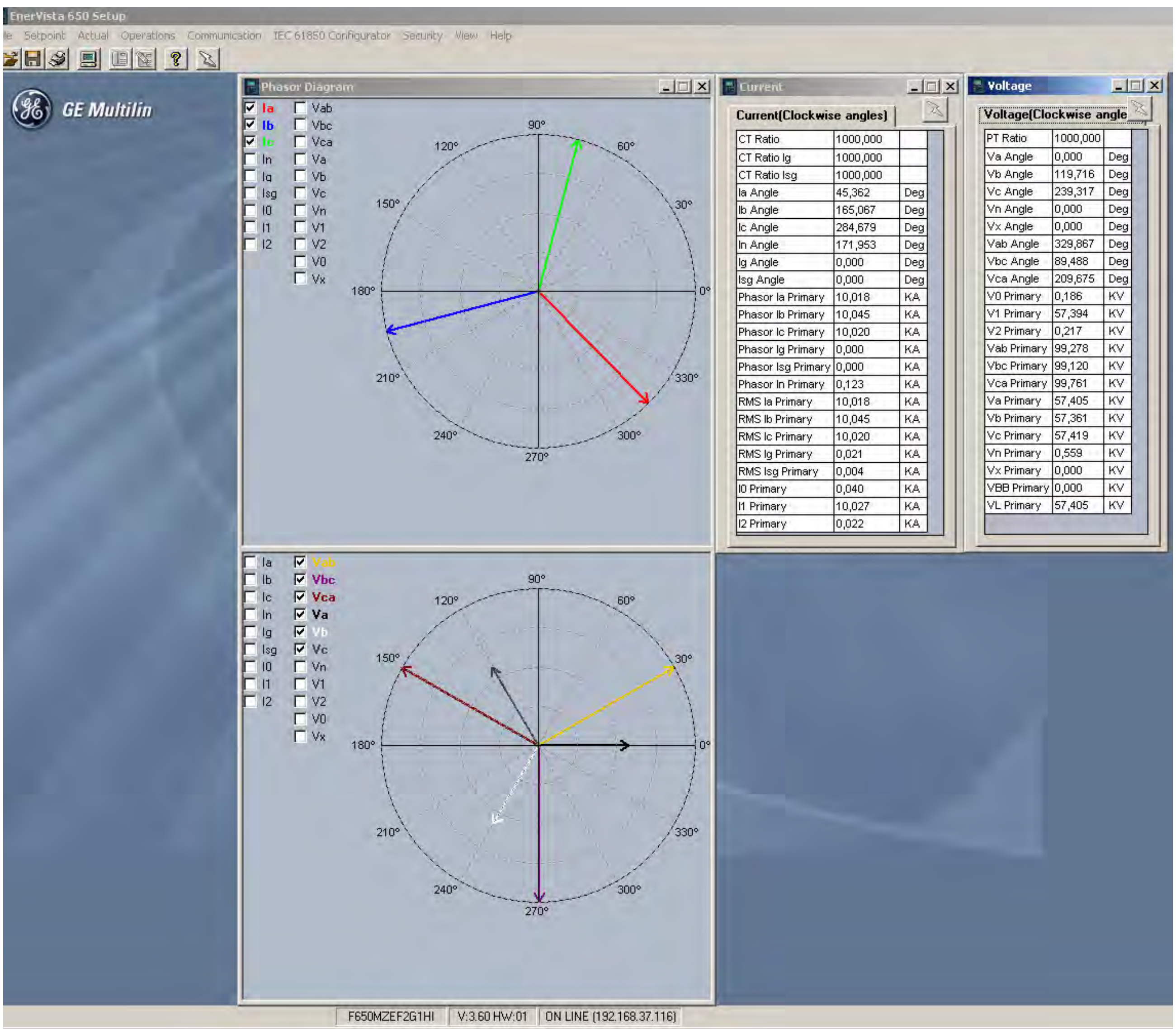


Figure 6-2: Phasor diagram

6.3.4 Frequency

Actual> Metering > Frequency

Frequency	Value	Description
Source Frequency	0.000 Hz	Frequency measured from source voltages
Load Frequency	0.000 Hz	Frequency measured from load voltages

6.3.5 Power Quality

6.3.5.1 Current Harmonics

Actual> Metering > Power Quality > Current Harmonics

Current	Value	Description
THD Phase A	0.0 %	Total Harmonic distortion PhA
THD Phase B	0.0 %	Total Harmonic distortion PhB
THD Phase C	0.0 %	Total Harmonic distortion PhC
2nd Harmonic	0.0% fo	Second harmonic
3rd Harmonic	0.0% fo	Third harmonic
4th Harmonic	0.0% fo	Fourth harmonic
5th Harmonic	0.0% fo	Fifth harmonic
6th Harmonic	0.0% fo	Sixth harmonic
7ht Harmonic	0.0% fo	Seventh harmonic
8th Harmonic	0.0% fo	Eighth harmonic
9th Harmonic	0.0% fo	Ninth harmonic
10th Harmonic	0.0% fo	Tenth harmonic
11th Harmonic	0.0% fo	Eleventh harmonic
12th Harmonic	0.0% fo	Twelfth harmonic
13th Harmonic	0.0% fo	Thirteenth harmonic
14th Harmonic	0.0% fo	Fourteenth harmonic
15th Harmonic	0.0% fo	Fifteenth harmonic

6.3.5.2 Source Voltage Harmonics

Actual> Metering > Power Quality > Source Voltage Harmonics

Source Voltage	Value	Description
THD Phase A	0.0 %	Total Harmonic distortion PhA
THD Phase B	0.0 %	Total Harmonic distortion PhB
THD Phase C	0.0 %	Total Harmonic distortion PhC
2nd Harmonic	0.0% fo	Second harmonic
3rd Harmonic	0.0% fo	Third harmonic
4th Harmonic	0.0% fo	Fourth harmonic
5th Harmonic	0.0% fo	Fifth harmonic
6th Harmonic	0.0% fo	Sixth harmonic
7ht Harmonic	0.0% fo	Seventh harmonic
8th Harmonic	0.0% fo	Eighth harmonic
9th Harmonic	0.0% fo	Ninth harmonic
10th Harmonic	0.0% fo	Tenth harmonic

11th Harmonic	0.0% fo	Eleventh harmonic
12th Harmonic	0.0% fo	Twelfth harmonic
13th Harmonic	0.0% fo	Thirteenth harmonic
14th Harmonic	0.0% fo	Fourteenth harmonic
15th Harmonic	0.0% fo	Fifteenth harmonic

6.3.5.3 Load Voltage Harmonics

Actual> Metering > Power Quality > Load Voltage Harmonics

Load Voltage	Value	Description
THD Phase A	0.0 %	Total Harmonic distortion PhA
THD Phase B	0.0 %	Total Harmonic distortion PhB
THD Phase C	0.0 %	Total Harmonic distortion PhC
2nd Harmonic	0.0% fo	Second harmonic
3rd Harmonic	0.0% fo	Third harmonic
4th Harmonic	0.0% fo	Fourth harmonic
5th Harmonic	0.0% fo	Fifth harmonic
6th Harmonic	0.0% fo	Sixth harmonic
7ht Harmonic	0.0% fo	Seventh harmonic
8th Harmonic	0.0% fo	Eighth harmonic
9th Harmonic	0.0% fo	Ninth harmonic
10th Harmonic	0.0% fo	Tenth harmonic
11th Harmonic	0.0% fo	Eleventh harmonic
12th Harmonic	0.0% fo	Twelfth harmonic
13th Harmonic	0.0% fo	Thirteenth harmonic
14th Harmonic	0.0% fo	Fourteenth harmonic
15th Harmonic	0.0% fo	Fifteenth harmonic

6.4 Inputs / outputs

Digital inputs and outputs are located in the same board. Depending on the relay model, the number of inputs and outputs varies.

6.4.1 Contact inputs

Actual > Inputs/Outputs > Contact inputs > Board X (being X the corresponding board in each case).

On the inputs screen, the LED associated with the activated input lights in green, if an input is not activated, the LED does not light up. The **Board X Status** LED indicates the status of the board; it is lit up if the board is correct and the communication or the Relay model is appropriate.

Table 6-33: Contact input activation signals

CONTACT INPUTS TYPE 1	CONTACT INPUTS TYPE 4		CONTACT INPUTS TYPE 5	CONTACT INPUTS TYPE 6
CONT IP_X_CC1 (CC1)	CONT IP_X_CC1 (CC1)	CONT IP_X_CC17 (CC17)	CONT IP_X_CC1 (CC1)	CONT IP_X_CC1 (CC1)
CONT IP_X_CC2 (CC2)	CONT IP_X_CC2 (CC2)	CONT IP_X_CC18 (CC18)	CONT IP_X_CC2 (CC2)	CONT IP_X_CC2 (CC2)
CONT IP_X_CC3 (CC3)	CONT IP_X_CC3 (CC3)	CONT IP_X_CC19 (CC19)	CONT IP_X_CC3 (CC3)	CONT IP_X_CC3 (CC3)
CONT IP_X_CC4 (CC4)	CONT IP_X_CC4 (CC4)	CONT IP_X_CC20 (CC20)	CONT IP_X_CC4 (CC4)	CONT IP_X_CC4 (CC4)
CONT IP_X_CC5 (CC5)	CONT IP_X_CC5 (CC5)	CONT IP_X_CC21 (CC21)	CONT IP_X_CC5 (CC5)	CONT IP_X_CC5 (CC5)
CONT IP_X_CC6 (CC6)	CONT IP_X_CC6 (CC6)	CONT IP_X_CC22 (CC22)	CONT IP_X_CC6 (CC6)	CONT IP_X_CC6 (CC6)
CONT IP_X_CC7 (CC7)	CONT IP_X_CC7 (CC7)	CONT IP_X_CC23 (CC23)	CONT IP_X_CC7 (CC7)	CONT IP_X_CC7 (CC7)
CONT IP_X_CC8 (CC8)	CONT IP_X_CC8 (CC8)	CONT IP_X_CC24 (CC24)	CONT IP_X_CC8 (CC8)	CONT IP_X_CC8 (CC8)
CONT IP_X_CC9 (Va_COIL1)	CONT IP_X_CC9 (CC9)	CONT IP_X_CC25 (CC25)	CONT IP_X_CC9 (CC9)	COIL A SUPERVISION
CONT IP_X_CC10 (Vb_COIL1)	CONT IP_X_CC10 (CC10)	CONT IP_X_CC26 (CC26)	CONT IP_X_CC10 (CC10)	COIL B SUPERVISION
CONT IP_X_CC11 (Va_COIL2)	CONT IP_X_CC11 (CC11)	CONT IP_X_CC27 (CC27)	CONT IP_X_CC11 (CC11)	COIL C SUPERVISION
CONT IP_X_CC12 (Vb_COIL2)	CONT IP_X_CC12 (CC12)	CONT IP_X_CC28 (CC28)	CONT IP_X_CC12 (CC12)	PH A COIL SUPERVISION OP
CONT IP_X_CC13 (O7_SEAL)	CONT IP_X_CC13 (CC13)	CONT IP_X_CC29 (CC29)	CONT IP_X_CC13 (CC13)	PH B COIL SUPERVISION OP
CONT IP_X_CC14 (O8_SEAL)	CONT IP_X_CC14 (CC14)	CONT IP_X_CC30 (CC30)	CONT IP_X_CC14 (CC14)	PH C COIL SUPERVISION OP
CONT IP_X_CC15 (SUP_COIL1)	CONT IP_X_CC15 (CC15)	CONT IP_X_CC31 (CC31)	CONT IP_X_CC15 (CC15)	COIL SUPERVISION OP
CONT IP_X_CC16 (SUP_COIL2)	CONT IP_X_CC16 (CC16)	CONT IP_X_CC32 (CC32)	CONT IP_X_CC16 (CC16)	VOLTAGE CAP SUPERVISION
BOARD X STATUS		BOARD X STATUS	BOARD X STATUS	BOARD F STATUS

6.4.2 Contact output status

Actual > Inputs/Outputs > Contact Output Status > Board X (being X the corresponding board in each case).

The corresponding Outputs screen displays the activation of a contact output by lighting in green the associated LED. This screen shows the real status of the contact output, which corresponds to the transformation of the output activation signal (Contact output operate), by the logic applied to this output in **Setpoint > Inputs/Outputs >Contact I/O > Board X**

NOTE: Both in the outputs menu as in the rest of menus available under "**Actual**", several screens can be viewed at the same time to facilitate analysis.

Table 6-34: Contact output status, board F type 6

CONTACT OUTPUT STATUS BOARD F
COIL A OPEN
COIL A CLOSE
COIL B OPEN
COIL B CLOSE
COIL C OPEN
COIL C CLOSE

Table 6-35: Contact output status, board type 1

CONTACT OUTPUT STATUS
CONT OP_X_01
CONT OP_X_02
CONT OP_X_03
CONT OP_X_04
CONT OP_X_05
CONT OP_X_06
CONT OP_X_07
CONT OP_X_08
BOARD X STATUS

6.4.3 Contact output operates

Actual > Inputs/Outputs > Contact Output Operates > Board X (being X the corresponding board in each case).

CONTACT OUTPUT OPERATES
CONT OP OPER_X_01
CONT OP OPER_X_02
CONT OP OPER_X_03
CONT OP OPER_X_04
CONT OP OPER_X_05
CONT OP OPER_X_06
CONT OP OPER_X_07
CONT OP OPER_X_08
BOARD X STATUS

These screens are available for all boards incorporated in the relay model, which can be F, G, H, and/or J.

This screen shows the activated or deactivated status of those variables used internally to operate a contact output.

Signals shown on this screen are configured in the Outputs screen inside the ***Setpoint > Relay Configuration*** menu, either directly by selecting the signals provided by the relay, or selecting a signal provided by the logic configured at ***Setpoint > Logic Configuration.***

These logic signals (Contact Output Operates), when being transformed by the outputs logic configured at ***Setpoint > Inputs/Outputs >Contact I/O > Board X*** become ***Contact Output*** signals. This output logic can be POSITIVE, NEGATIVE, pulse, latched, etc.

Operation example of output contacts:

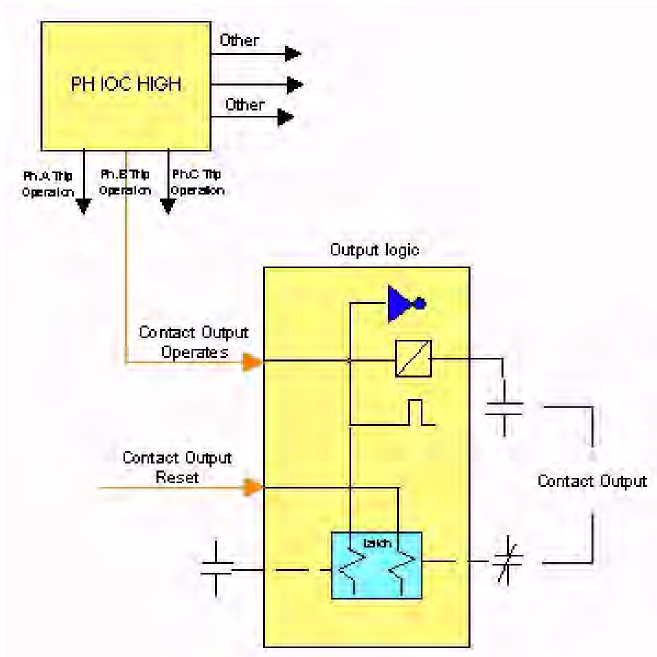


Figure 6-3: Output contact operation

6.4.4 Contact output resets

Actual > Inputs/Outputs > Contact Output Resets > Board X (being X the corresponding board in each case).

Boards types 1 and 2 have both 8 outputs, so the representation is the same for both types as shown in

If the reset signal is active, the green LED lights up. Otherwise, it remains unlit.

CONTACT OUTPUT RESETS
CONT OP RESET_X_01
CONT OP RESET_X_02
CONT OP RESET_X_03
CONT OP RESET_X_04
CONT OP RESET_X_05
CONT OP RESET_X_06
CONT OP RESET_X_07
CONT OP RESET_X_08
BOARD X STATUS

The last LED in this screen, labeled **Board Status**, indicates the general board status.

This output reset Command is only be effective if **latch** has been selected for **Output Type** on the I/O board, thus the contact output has been configured to emulate function 86 (latching relay).

Configuration for the contact output reset signal is set at ***Setpoint > Relay Configuration > Outputs > Contact Output Reset***.

6.4.5 I/O board status

Actual > Inputs/Outputs > I/O Board Status

This screen is used for verifying the status of I/O boards. If all the I/O boards, one (F) or both (F and G) depending on the relay model, are correctly inserted in their tracks and are in good state and communicating through the internal CAN bus, the green LED remains lit.

I/O boards accessible through the external CAN bus are labeled as H and J. In order to start working with the external I/O boards is necessary to select the appropriated I/O board type for each slot (H or J for the CIO module) at **Setpoint > Inputs/Outputs >Contact I/O > Board H and J**. Otherwise the relay will not start communicating through the external CAN bus to the related board.

If one of the boards has been extracted, or the relay model does not match the installed hardware, the corresponding LED remains unlit.

I/O BOARD STATUS
BOARD F STATUS
BOARD G STATUS
BOARD H STATUS
BOARD J STATUS

For all I/O board screens described above, the last LED provides this same information individually.

6.4.6 Virtual inputs

Actual > Inputs/Outputs > Virtual Inputs > Virtual Input Latched > Virtual Input Self-Reset

"Virtual Inputs" are signals transmitted by communications. The EnerVista 650 Setup provides a tool to set virtual inputs through ModBus at **Setpoint > Inputs /Outputs /Virtual inputs** that is only available in online mode (communicating to the relay). There are two available groups of 32 signals each: Latched inputs and Self-reset inputs, and all of them can be used internally to perform operations, new logics in the PLC, etc.

In this actual values screen the status of the assigned virtual inputs can as shown on

VIRTUAL INPUTS LATCHED	VIRTUAL INPUTS SELF-RESET
LATCHED VIRT IP 1	SELF-RST VIRT IP 1
LATCHED VIRT IP 2	SELF-RST VIRT IP 2
...	...
LATCHED VIRT IP 32	SELF-RST VIRT IP 32

6.4.7 Virtual outputs

Actual > Inputs/Outputs > Virtual Outputs

This screen provides the status of the 512 configurable virtual outputs (internal variables) used in the logic scheme. The virtual outputs are set from 000 to 511.

The configuration of the logic associated with the virtual output is in the ***Setpoint > Logic Configuration*** tool provided by EnerVista 650 Setup program.

VIRTUAL OUTPUT STATUS
VIRTUAL OUTPUT 000
VIRTUAL OUTPUT 001
...
VIRTUAL OUTPUT 511

6.4.8 Remote outputs

Actual > Inputs/Outputs > Remote Outputs > DNA

This screen provides the status of the 32 DNA remote outputs.

Table 6-36: DNA STATUS

DNA STATUS
DNA 1
DNA 2
DNA 3
...
DNA 32

Actual > Inputs/Outputs > Remote Outputs > UserSt

This screen provides the status of the 64 UserSt remote outputs.

Table 6-37: USER ST STATUS

USERst STATUS
UserSt 1
UserSt 2
UserSt 3
...
UserSt 64

Actual > Inputs/Outputs > Remote Outputs > Remote GOOSE Dig Outputs

This screen provides the status of the 32 Remote GOOSE Digital Outputs.

Table 6-38: Remote GOOSE digital output status

REMOTE GOOSE DIG OUTPUTS STATUS
Rem GOOSE Dig Out 1
Rem GOOSE Dig Out 2
Rem GOOSE Dig Out 3
...
Rem GOOSE Dig Out 32

6.4.9 Remote inputs

Actual > Inputs/Outputs > Remote Intputs > Remote Input

This screen provides the status of the 32 remote inputs.

remote inputs STATUS
Remote Input 1
Remote Input 2
Remote Input 3
...
Remote Input 32

Actual > Inputs/Outputs > Remote Intputs > Remote Device

This screen provides the status of the 16 remote devices.

remote device STATUS
Remote Device 1
Remote Device 2
Remote Device 3
...
Remote Device 16

Actual > Inputs/Outputs > Remote Outputs > Remote GOOSE Digital Inputs

This screen provides the status of the 32 Remote GOOSE Digital Inputs.

REMOTE GOOSE DIG INPUTS STATUS
Rem GOOSE Dig Inp 1
Rem GOOSE Dig Inp 2
Rem GOOSE Dig Inp 3
...
Rem GOOSE Dig Inp 32

Actual > Inputs/Outputs > Remote Outputs > Remote GOOSE Analog Inputs

This screen provides the values of the 16 Remote GOOSE Analog Inputs. Eight of them are float type and the other eight are integer type.

REMOTE GOOSE ANALOG INPUTS STATUS
Rem Ana Inp FLOAT 1
Rem Ana Inp FLOAT 2
Rem Ana Inp FLOAT 3
...
Rem Ana Inp FLOAT 8
Rem Ana Inp INT 1
Rem Ana Inp INT 2
Rem Ana Inp INT 3
...
Rem Ana Inp INT 8

6.4.10 Analog inputs

Actual > Inputs/Outputs > Analog Intputs > Board X

This screen provides the values of the analog inputs.

analog inputs values
Analog_Inp_X_01
Analog_Inp_X_02
Analog_Inp_X_03
...
Analog_Inp_X_08

6.4.11 Virtual output latched

Actual > Inputs/Outputs > Virtual Output Latched

This screen provides the values of virtual output latched

VIRTUAL OUTPUT LATCHED
V.O. Latched 1
V.O. Latched 2
V.O. Latched 3
....
V.O. Latched 16

6.4.12 RIOs

Actual > Inputs/Outputs > RIOs

This screen provides the values of virtual output analogues, integer and float values

INTEGER VALUES	FLOAT VALUES
INT32_000	FLT32_000
INT32_001	FLT32_001
INT32_002	FLT32_002
....	...
INT32_049	FLT32_049

6.5 Records

6.5.1 Event recorder

6.5.1.1 All snapshot events

Actual > Records > Event Recorder > All Snapshot Events

By selecting this option, the R650 provides a general list of all snapshot events stored in the relay up to the request moment:

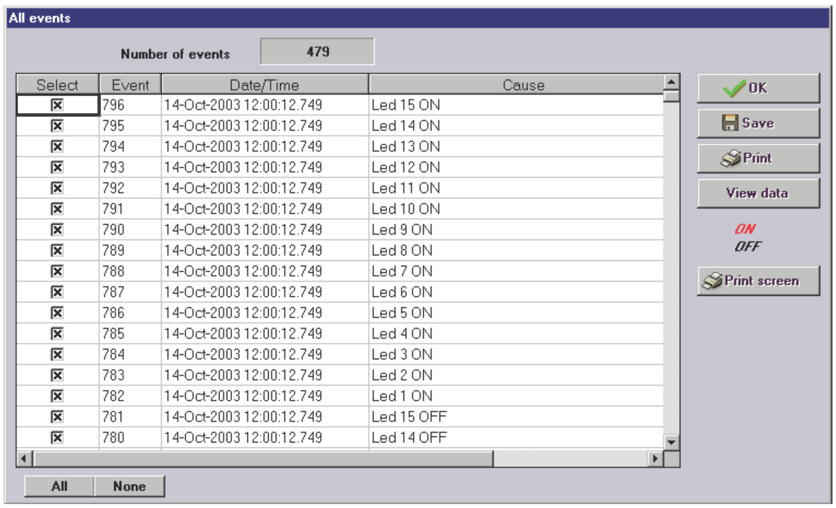


Figure 6-4: Event recorder - all snapshot events

The different options available on this screen are as follows:

Save: It allows saving the Snapshot events information obtained in the relay in a CSV format file.

Print: It allows printing the viewed data.

View data: It allows to view the information contained in the selected event, such as the event number, date and time, cause of the event, as well as the voltage and current values in the moment of the event (see Figure 6-5: Snapshot event details).

There is a "**Select**" option, which is used for selecting the events that are required to appear when the screen information is printed or saved.

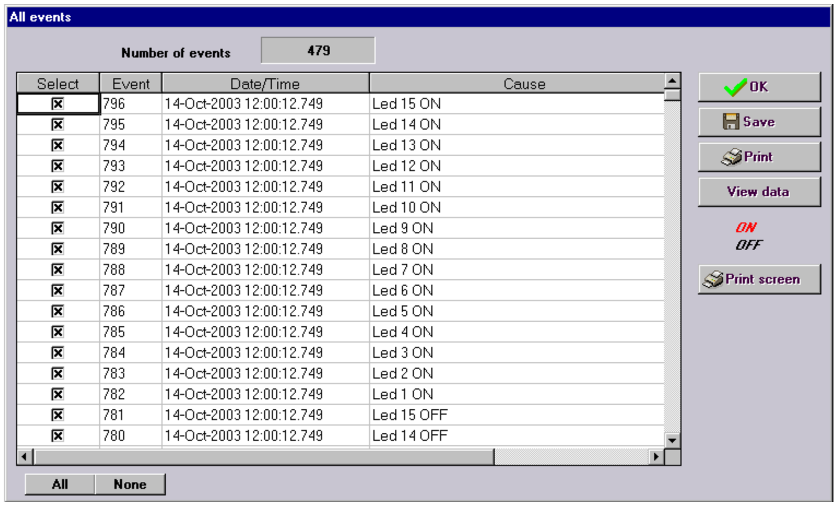


Figure 6-5: Snapshot event details

6.5.1.2 New snapshot events

Actual > Records > Event Recorder > New Snapshot Events

This screen shows new Snapshot events, updated since the last time that this menu was accessed; there are three possible ways to access new events; in local mode (COM2-HMI), remote mode (COM1) and via Ethernet (ETH_1/ETH2 or ETH_E/ ETH_A/ETH_B)

It is the same type of screen as shown on all snapshot event retrieval.

6.5.1.3 Control events

Actual > Records > Event Recorder > Control Events

This screen is identical to the previous ones. The difference is that this screen displays only control events, i.e., those events configured in section **Setpoint > Relay Configuration > Events**. There are a total of 128 configurable events and 64 non-configurable switchgear events.

In this screen, red or black color for a specific event indicates whether it is activated (to 1) or in standby (to 0)

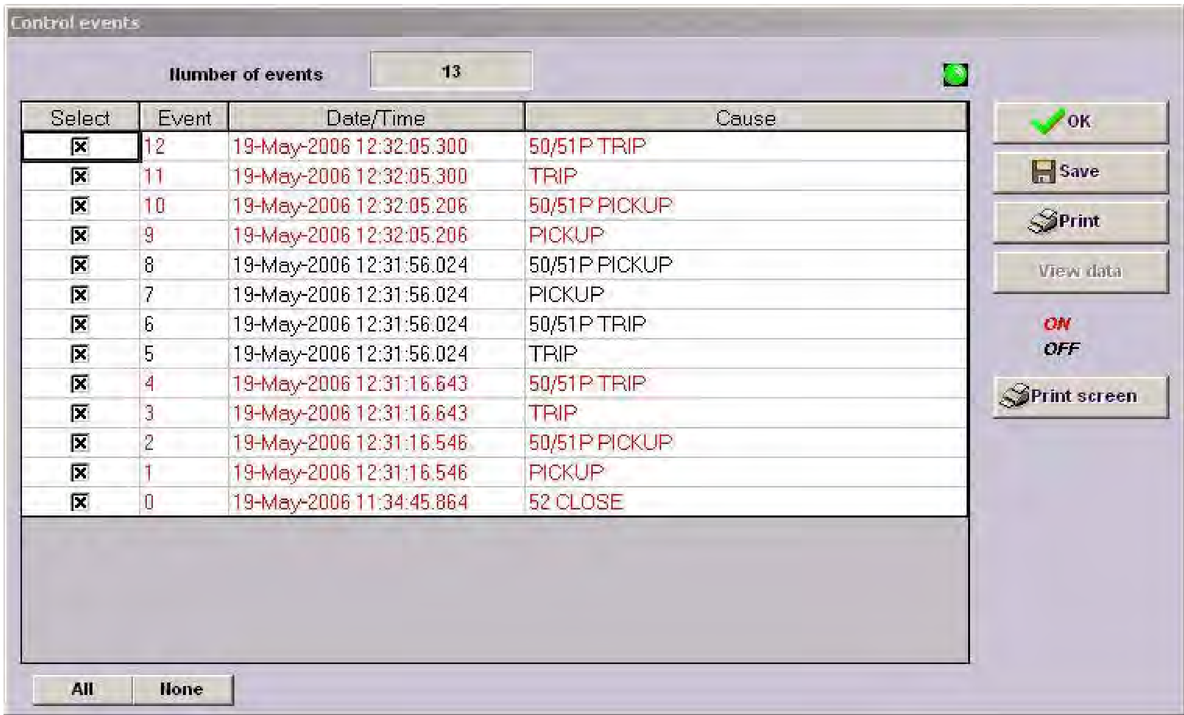


Figure 6-6: Control events

6.5.1.4 Alarm panel

The alarm panel can be accessed at **Actual > Records > Event Recorder > Alarm Panel**.

The following screen provides information about the issued alarms. The screen shows information about their status: active not acknowledged, active acknowledged and not active. The user can either acknowledge all alarms at the same time, or do it partially by selecting the alarms to be acknowledged.

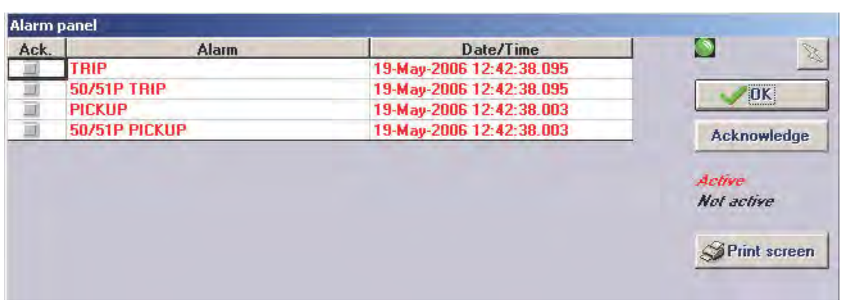


Figure 6-7: Alarm panel

6.5.2 Waveform capture

The ***Actual > Records > Waveform Capture*** screen displays a list of all oscillography records available in the relay. The R650 stores oscillography records from 1 to 999; this is the index of the obtained oscillography record. This screen allows selecting the records to be saved among all records available. Download of these records is done through the selected connection in the "***Communication > Computer***" menu, either serial mode or Ethernet.

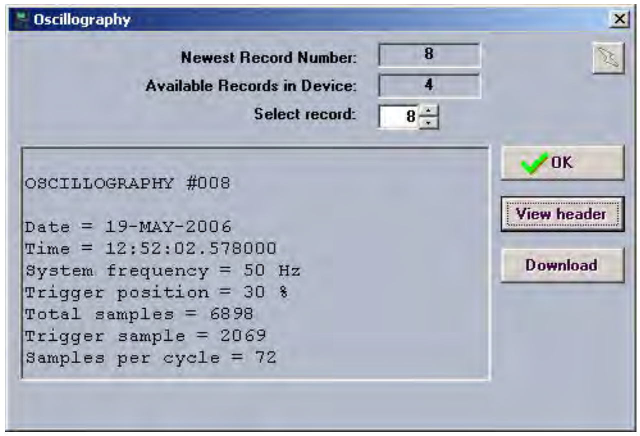


Figure 6-8: Oscillography record retrieval, EnerVista 650 Setup

The screen shows all the available records in the Relay, and by clicking on each of them, the system displays the heading information for that record, allowing downloading the information to a disk. Once the file to be downloaded has been selected, the oscillography record can be opened using GE-OSC software.

GE-OSC is GE proprietary software that is not distributed together with EnerVista 650 Setup. This program is a COMTRADE viewer and analysis software for oscillography files.

If the user does not have the GE-OSC tool, the oscillography record can be stored and viewed using any other analysis tool capable of reproducing COMTRADE.1999 files.

When using GE-OSC software, this program requires the use of a template for each relay. If there is a stored template for R650 relays (as shown in the following figure), select the template and click **Open Selected Template**. The program then prepares to view oscillography and digital records using the options in available menus (Waveforms and Digital Flags). Otherwise, select the **Create New Template** option, and the program helps create a new template. See the GE-OSC software instruction manual for details.

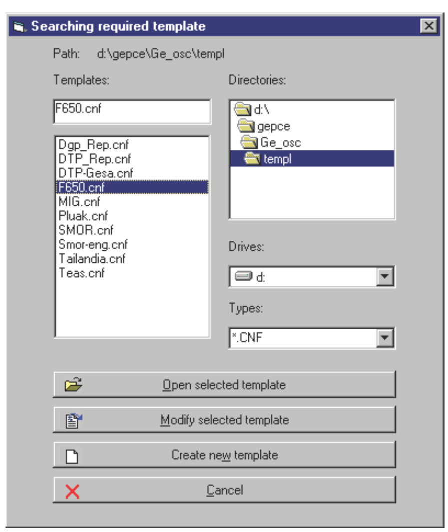


Figure 6-9: GE-OSC oscillography analysis software

Note that any settings change in the oscillography removes all the information stored up to that moment.

6.5.3 Fault report

When selecting the **Actual > Records > Fault Report** menu, EnerVista 650 Setup shows the following screen, indicating the fault reports available in the relay.

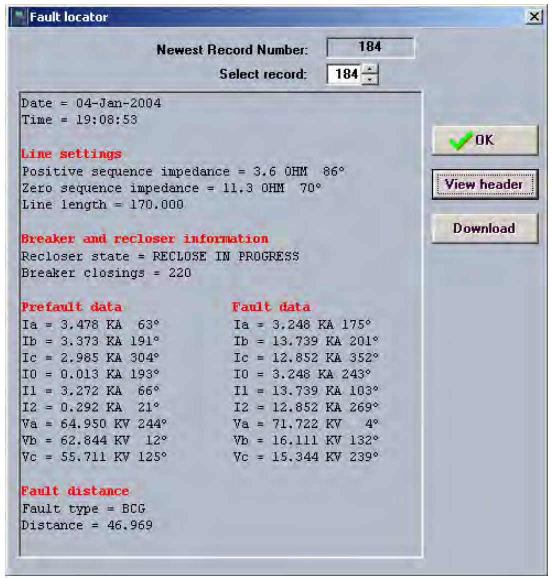


Figure 6-10: Fault report retrieval, EnerVista 650 Setup

When selecting one of the records, a new screen details the following information:

- Date
- Time
- Pre-fault current and voltage in primary values
- Fault current and voltage in primary values
- Fault type
- Distance to the fault

The operation of this screen is similar to that of the previous oscillography screen, being in this case the number of fault reports a fixed number (10), instead of variable and setting-selected like as in the previous case.

Once a fault report is selected, its heading description is displayed, showing pre-fault information, fault information and the distance to the fault. This file can be downloaded to the computer in a CSV format file.

Fault report file retrieval can be performed via serial or Ethernet communications. Note that any settings change in the fault report remove all information stored up to that moment.

6.5.4 Data logger

The access menu is **Actual > Records > Data Logger**. Once open, this menu shows a screen containing the information monitored by the relay according to the settings adjusted at **Setpoint > Product Setup > Data Logger**, where the user can select which analog channels are recorded, as well as the sampling rate.

Note that any settings change in the data logger removes all information stored up to that moment.

The data logger screen diagram shows the time during which the displayed values have been obtained.

The upper part of the window shows the time when the oldest sample was taken, as well as the time when the most recent value was taken.

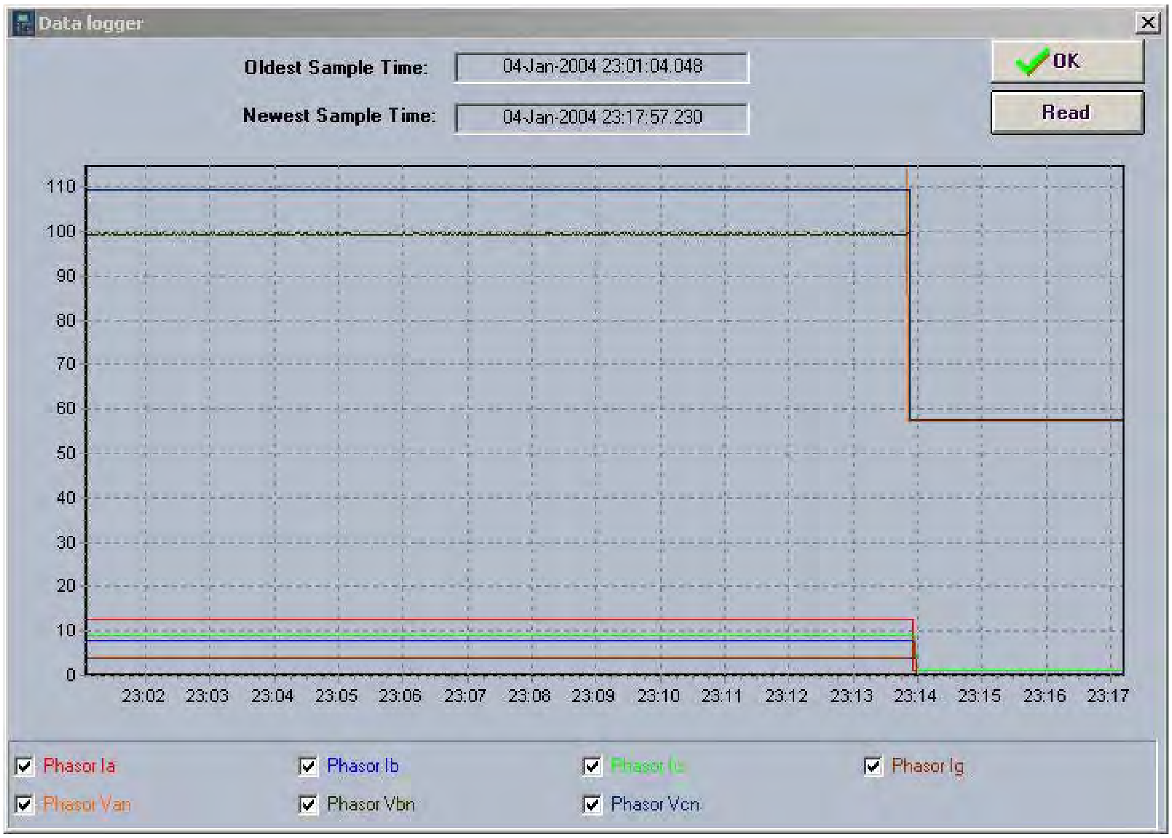


Figure 6-11: Data logger

This screen offers the possibility of storing the data logger record obtained for a further analysis, in COMTRADE format.

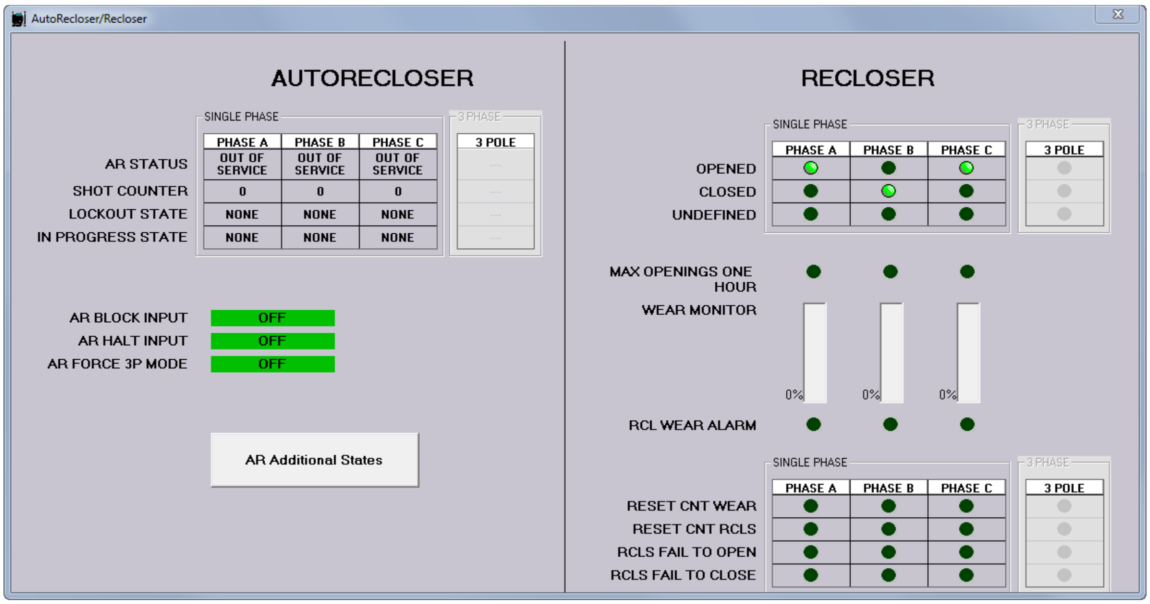
Data Logger file retrieval can be performed only via Ethernet communications.

NOTE: Data logger information takes several minutes to be available.

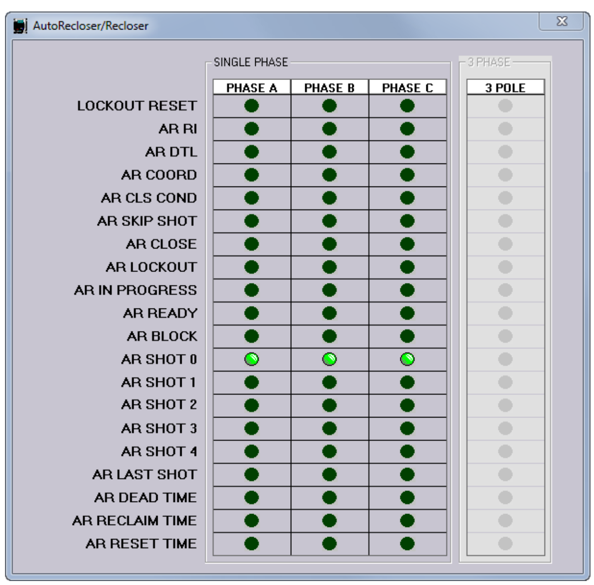
6.6 Autorecloser / Recloser

The current state of the Autorecloser/Recloser is found under **Actual > Autorecloser/Recloser**.

Details of the autorecloser functionality are described in section *5.5.3.1 Autoreclose functional description*.



Click **SR Additional States** to view further autorecloser states.



R650 Recloser Controller

Chapter 7: IEC 61850 protocol

This chapter outlines the IEC 61850 communications protocol. The IEC 61850 protocol applies when ordered with the product. (Check the order code to determine whether IEC 61850 is included with your product).

7.1 IEC 61850 Overview

This section contains a description of IEC 61850, an International Electrotechnical Commission (IEC) series of documents entitled *Communication Networks and Systems for Power Utility Automation*. IEC 61850 is a series of international standards and technical reports applicable to power utility automation systems (PUAS). It includes semantics, abstract communication services, specific communication services, performance specifications, network engineering guidelines, configuration description methodologies, and engineering processes. The objective of the standard is to provide a framework to achieve interoperability among the intelligent electronic devices (IEDs) from different suppliers, and interoperability among software configuration tools from different suppliers. Interoperability in this case is the ability for IEDs to operate on the same network or communication path sharing information and commands, and for configuration tools to understand each other's configuration files. The standards can be obtained from the IEC (http://www.iec.ch).

650 models with an IEC 61850 option support both the IEC61850 GOOSE and IEC 61850 MMS Server service:

- 650 Family relays with firmware version below 7.00 firmware: As per IEC 61850 standard Edition 1
- 650 Family relays with firmware version from 7.00 to 7.50: As per IEC 61850 standard Edition 2
- F650- Feeder protection relay for firmware version 7.52 or above: As per IEC 61850 standard Edition 1 or 2 (depending on the CID file selected and sent to the relay)
- C650-Digital Bay Controller for firmware version 7.52 or above: As per IEC 61850 standard Edition 1
- R650 Recloser Controller: As per IEC 61850 standard Edition 1

The GOOSE messaging service provides the 650 relay unit the ability to Publish/Subscribe Digital Input Status and its Quality and Timestamp to and from other IEDs which support the GOOSE messaging service, while the server support allows remote a control center, RTU/Gateway, local HMI or other client role devices access to the relay for monitoring and control. The configuration of IEC61850 services is accomplished using the 650 IEC61850 configuration software, EnerVista 650 Setup software. A reboot is required before any changes made in the IEC61850 configuration take effect in the R650 relay.

These models support also Generic Substation State Events (GSSE).

7.2 IEC 61850 generic substation state event (GSSE)

7.2.1 Overview

IEC 61850 specifies two types of peer-to-peer data transfer services: Generic Substation State Events (GSSE) and Generic Object Oriented Substation Events (GOOSE). Both GSSE and GOOSE messages are designed to be short, reliable, and high priority.

GSSE services are compatible with UCA 2.0 GOOSE. IEC 61850 GOOSE services provide virtual LAN (VLAN) support, Ethernet priority tagging, and Ethertype Application ID configuration. The support for VLANs and priority tagging allows for the optimization of Ethernet network traffic. GOOSE messages can be given a higher priority than standard Ethernet traffic, and they can be separated onto specific VLANs. Because of the additional features of GOOSE services versus GSSE services, it is recommended that GOOSE be used wherever backwards compatibility with GSSE (or UCA 2.0 GOOSE) is not required.

Devices that transmit GSSE and/or GOOSE messages also function as servers. Each GSSE publisher contains a "GSSE control block" to configure and control the transmission. Each GOOSE publisher contains a "GOOSE control block" to configure and control the transmission. The transmission is also controlled via device settings. These settings can be seen in the ICD and/or SCD files, or in the device configuration software or files. IEC 61850 recommends a default priority value of 4 for GOOSE. Ethernet traffic that does not contain a priority tag has a default priority of 1. More details are specified in IEC 61850 part 8-1. IEC 61850 recommends that the Ethertype Application ID number be configured according to the GOOSE source. A common number may be used for all GOOSE transmitters in a system. More details are specified in IEC 61850 part 8-1.

GSSE messages contain a fixed set of digital points. IEC 61850 GOOSE messages can, in general, contain any configurable data items. When used by the remote input/output feature, IEC 61850 GOOSE messages contain the same data as GSSE messages. The GSSE message structure contains space for 128 bit pairs representing digital point state information. In addition to digital point states, GSSE/GOOSE messages identify the originator of the message and provide other information required by the communication specification. All devices listen to network messages and capture data only from messages that have originated from selected devices

7.2.2 Remote communication

The IEC 61850 specification includes features that are used to cope with the loss of communication between transmitting and receiving devices. Each transmitting device sends a GSSE/GOOSE message upon a successful power-up, when the state of any included point changes, or after a specified interval, four times the Hold Time setting value, if a change-of-state has not occurred.

Receiving devices are constantly monitoring the communications network for the messages they require, as recognized by the identification of the originating device carried in the message. If the receiving relay has not received another message from the originating device when the specified timeout period elapses, the remote device is declared to be non-communicating, so it uses the programmed default state for all points from that specific remote device.

If a message is received from a remote device before the interval of four times the Hold Time expires, all points for that device are updated to the states contained in the message. The status of a remote device can be displayed.

Remote inputs and outputs provide a means of exchanging digital state information between Ethernet-networked devices. The GSSE facility provides for 32 remote inputs and 64 remote outputs.

7.2.3 GSSE configuration

GSSE messages contain a number of double point status data items. These items are transmitted in two pre-defined data structures named DNA and UserSt. Each DNA and UserSt item is referred to as a 'bit pair'. GSSE messages are transmitted in response to state changes in any of the data points contained in the message. GSSE messages always contain the same number of DNA and UserSt bit pairs. Depending on the configuration, only some of these bit pairs may have values that are of interest to receiving devices.

The relay provides 32 "DNA" bit pairs that represent the state of two pre-defined events and 64 "UserSt" bit pairs, which are status bits representing user-definable events.

GSSE service can be configured using the EnerVista 650 Setup program in the menu **Setpoint > Input/Outputs > Remote Comm**s.

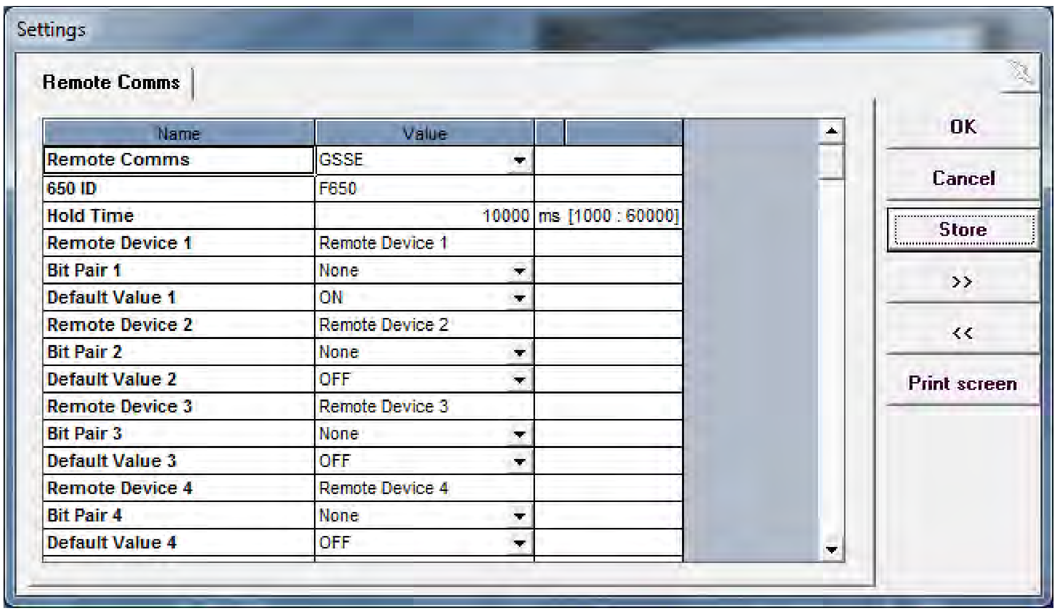
Remote Comms must be set to "GSSE" to enable GSSE configuration.

650 ID represents the IEC 61850 GSSE application ID name string sent as part of each GSSE message. This string identifies the GSSE message to the receiving device.

Hold time is used to calculate the interval, if a change-of-state has not occurred, that the device waits to send GSSE message.

Remote Device (1 to 32) is used to select specific remote devices by entering the exact identification (ID) assigned to these devices. A maximum of 32 devices can be configured for receiving GSSE messages.

Bit Pair (1 to 32) is used to assign the data from the GSSE message to remote inputs.



Name	Value		
Remote Comms	GSSE		
650 ID	F650		
Hold Time	10000	ms [1000 : 60000]	
Remote Device 1	Remote Device 1		
Bit Pair 1	None		
Default Value 1	ON		
Remote Device 2	Remote Device 2		
Bit Pair 2	None		
Default Value 2	OFF		
Remote Device 3	Remote Device 3		
Bit Pair 3	None		
Default Value 3	OFF		
Remote Device 4	Remote Device 4		
Bit Pair 4	None		
Default Value 4	OFF		

Figure 7-1: Remote communication

Default Value (1 to 32) selects the logic state for this point if the local relay has just completed startup or the remote device sending the point is declared to be non-communicating. The following choices are available:

- ON value defaults the input to Logic 1.
- OFF value defaults the input to Logic 0.
- Latest OFF freezes the input in case of lost communications. If the latest state is not known, such as after relay power-up but before the first communication exchange, the input defaults to Logic 0. When communication resumes, the input becomes fully operational.
- Latest ON freezes the input in case of lost communications. If the latest state is not known, such as after relay power-up but before the first communication exchange, the input defaults to Logic 1. When communication resumes, the input becomes fully operational.

Destination MAC Data (1 to 3): If a valid multicast Ethernet MAC address is entered, this address is used as the destination MAC address for GSSE messages. If a valid multicast Ethernet MAC address is not entered (for example, 00 00 00 00 00 00), the device uses the source Ethernet MAC address as the destination, with the multicast bit set.

GSSE RemDevice (1 to 24) MAC Data (1 to 3) is used to filter receiving messages.

GSSE PORT sets the network port through messaging will be done. Possible values are "Port A", "Port B" or "Both".

7.2.4 Remote inputs

Remote inputs, which create PLC operands at the receiving relay, are extracted from GSSE messages originating in remote devices. The relay provides 32 remote inputs, each of which can be selected from a list consisting of 96 selections: DNA-1 to DNA-32 and UserSt-1 to UserSt-64. The function of DNA and UserSt bits is in both cases the same so user can assign a Remote input either of them through the Bit Pair 1 to 32 field (see figure 1). They can be configured using the EnerVista 650 Setup program in the menu **Setpoint > Input/Outputs > Remote Comms**.

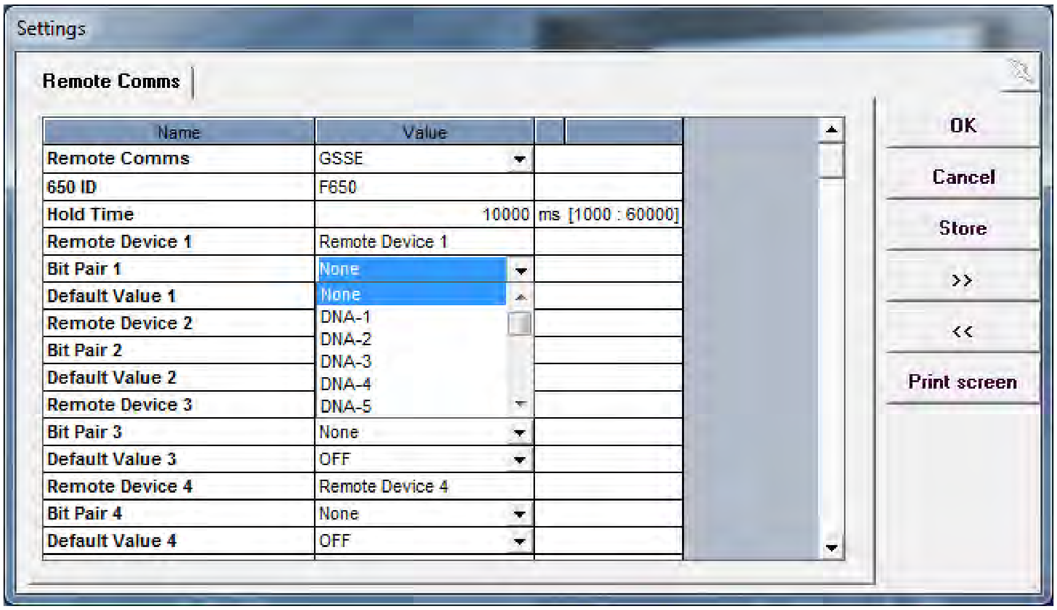


Figure 7-2: Remote communication (remote inputs)

7.2.5 Remote outputs

7.2.5.1 DNA bit pairs

Remote Outputs (1 to 32) are PLC operands inserted into GSSE messages that are transmitted to remote devices on a LAN. Each digital point in the message must be programmed to carry the state of a specific PLC operand, except reserved points DNA1 and DNA2. The complete operand setting represents a specific DNA function to be transmitted. These states are displayed in the R650 relay and in the EnerVista 650 Setup software in the menu **Actual Values > Input/Outputs > Remote Outputs > DNA**.

Each DNA point can only be programmed in the EnerVista 650 Setup software in the menu **Setpoint > Relay Configuration > Remote Outputs**.

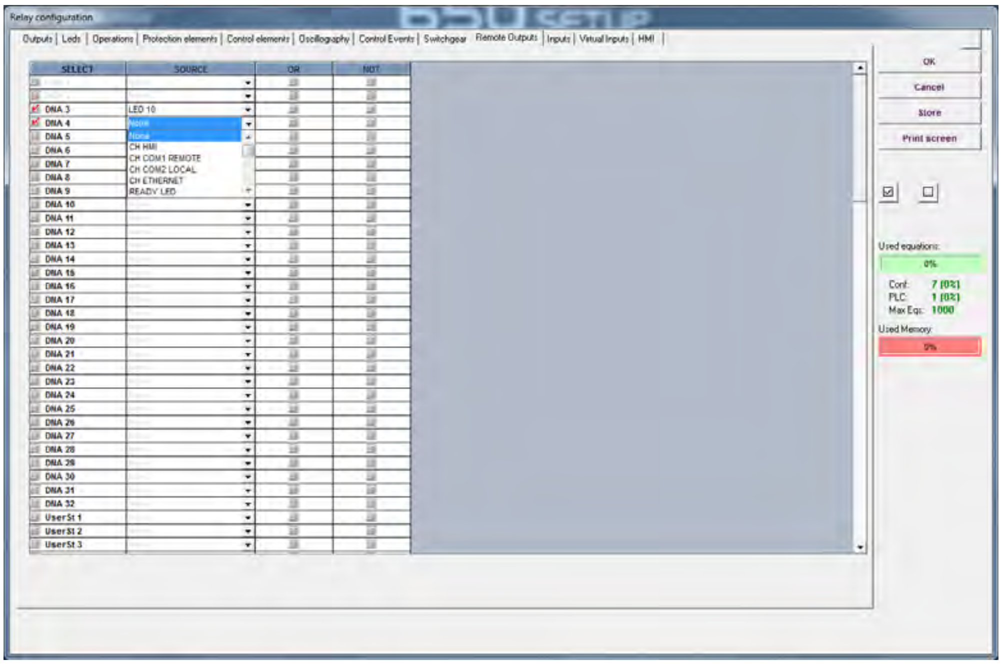


Figure 7-3: Remote outputs (DNA)

7.2.5.2 UserSt bit pairs

Remote Outputs 1 to 64 originates GSSE messages to be transmitted to remote devices. Each digital point in the message must be programmed to carry the state of a specific PLC operand. The UserSt (User Setpoint) setting is used to select the operand which represents a specific UserSt function to be transmitted. These states are displayed in the R650 relay and in the EnerVista 650 Setup software in the menu **Actual Values > Input/Outputs > Remote Outputs > UserSt**.

Each User Set point can only be programmed and displayed in EnerVista 650 Setup in the menu **Setpoint > Relay Configuration > Remote Outputs**.

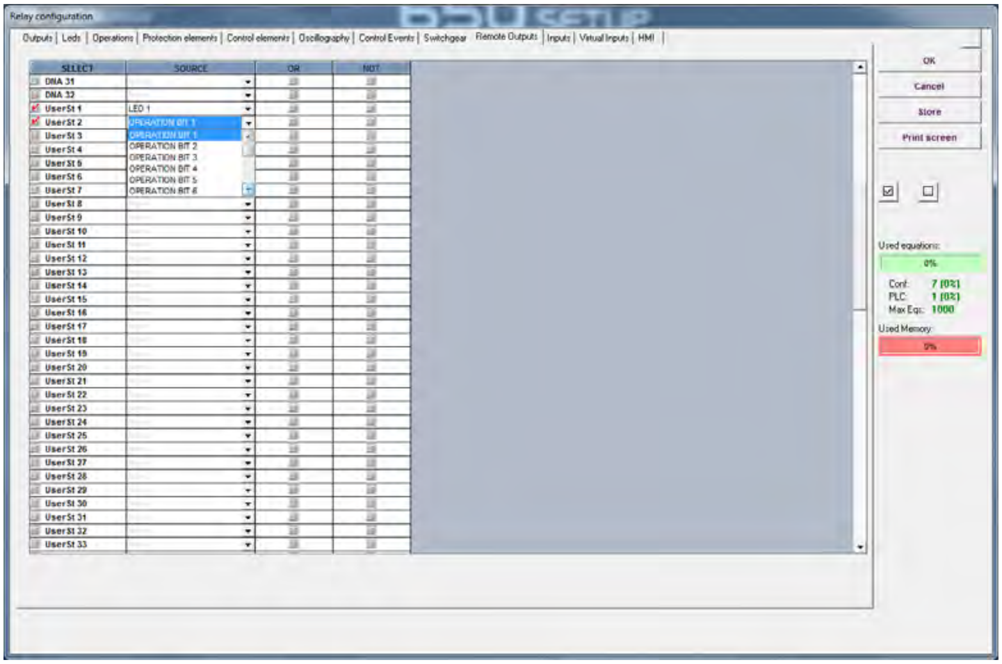


Figure 7-4: Remote outputs (UserSt)

7.3 IEC 61850 Edition 2 profile for R650

7.3.1 Overview

IEC 61850 is a series of standards describing client/server and peer-to-peer communications, substation design and configuration, testing, environmental and project standards.

The 10 parts of the standard IEC 61850 are as listed in the following tables:

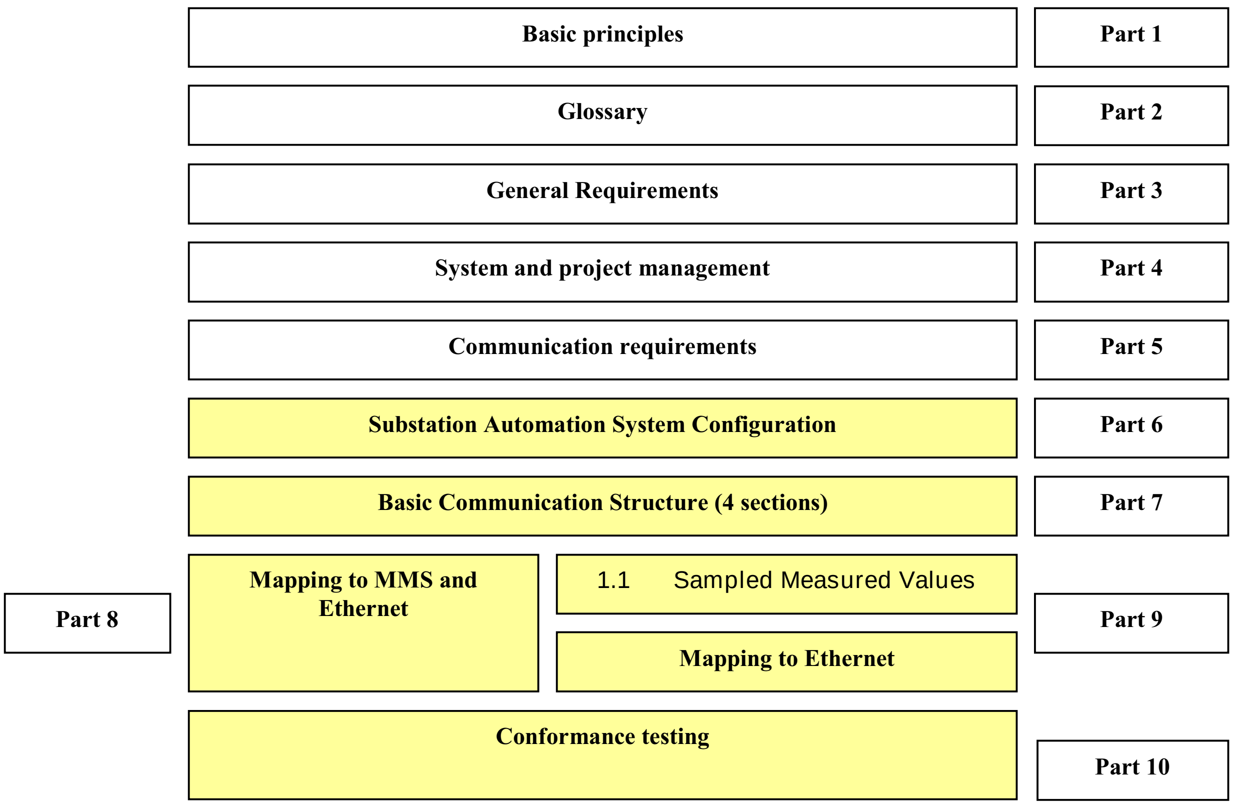
1.1.1 System Aspects Part 1: Introduction and Overview Part 2: Glossary Part 3: General Requirements Part 4: System and Project Management Part 5: Communication Requirements for Functions and Device Models
1.1.2 Configuration Part 6: Configuration Description Language For Communication In Electrical Substations Related To IEDs
1.1.3 Testing Part 10: Conformance Testing

The following parts define how the IED behaves:

1.1.4 Data Models Basic Communication Structure for Substations and Feeder Equipment Part 7-4: Compatible Logical Node Classes and Data Classes Part 7-3: Common Data Classes
1.1.5 Abstract Communications Basic Communication Structure for Substations and Feeder Equipment Part 7-2: Abstract Communication Services Interface (ACSI) Part 7-1: Principles and Models
1.1.6 Mapping to real Communication Networks (SCSM) Specific Communication Service Mapping (SCSM) Part 8-1: Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3 Part 9-1: Sampled Values Over Serial Unidirectional Multidrop Point to Point Link Part 9-2: Sampled values over ISO/IEC 8802-3 Mapping on a IEEE 8802-3 based Process Bus

These documents can be obtained from the IEC (http://www.iec.ch). It is strongly recommended that all those involved with any IEC 61850 implementation obtain this document set.

7.3.1.1 Scope and outline of IEC 61850



Parts 3, 4, and 5 of the standard start by identifying the general and specific functional requirements for communications in a substation. These requirements are then used as forcing functions to aid in the identification of the services and data models needed, application protocol required, and the underlying transport, network, data link, and physical layers that meet the overall requirements.

The major architectural construct that 61850 adopts is that of "abstracting" the definition of the data items and the services, that is, creating data items/objects and services that are independent of any underlying protocols. The abstract definitions then allow "mapping" of the data objects and services to any other protocol that can meet the data and service requirements.

The definition of the abstract services is found in part 7.2 of the standard and the abstraction of the data objects (referred to as Logical Nodes) is found in part 7.4.

In as much as many of the data objects are made up of common pieces (such as Status, Control, Measurement, Substitution), the concept of "Common Data Classes" or "CDC" was developed which defined common building blocks for creating the larger data objects. The CDC elements are defined in part 7.3.

Given the data and services abstract definitions, the final step was one of "mapping" the abstract services into an actual protocol. Section 8.1 defines the mapping of the abstract data object and services onto the Manufacturing Messaging Specification - MMS2 and sections 9.1 and 9.2 define the mapping of the Sample Measured Values (unidirectional point-to-point and bi-directional multipoint accordingly) onto an Ethernet data frame. The 9.2 document defines what has become known as the Process Bus.

From a system perspective, there is a significant amount of configuration that is required in order to put all the pieces together and have them work. In order to facilitate this process and to eliminate much of the human error component, an XML based Substation Configuration Language (SCL) was defined in part 6. It allows the formal description of the relations between the substation automation system and the substation. At the application level, the substation topology itself and the relation of the substation structure to the SAS functions (logical nodes) configured on the IEDs can be described. Each device must provide an SCL file that describes the configuration of itself.

Finally, part 10 defines a testing methodology in order to determine "conformance" with the numerous protocol definitions and constraints defined in the standard.

7.3.2 Communication profiles

The R650 relay supports IEC61850 server services over TCP/IP. This profile requires the R650 to have an IP address to establish communications. It is possible to have up to five simultaneous connections.

7.3.3 TCP connection timing

A built-in TCP/IP connection timeout is configurable from 120 to 1800 seconds with a default value of 120 seconds. This timeout is employed by the R650 to detect “dead” connections. If there is no data traffic on a TCP connection for greater than the configured timeout duration, the connection is aborted by the server. Therefore, when using IEC61850 reporting, clients should configure report control block items such that an integrity report is issued al least once every configured timeout. If other MMS data is being polled on the same connection al least once every configured timeout duration, this timeout does not apply.

7.3.4 MMS protocol

IEC 61850 specifies the use of the Manufacturing Message Specification (MMS) at the upper (application) layer for transfer of real-time data. This protocol has been in existence for a number of years and provides a set of services suitable for the transfer of data within a substation LAN environment. Actual MMS protocol services are mapped to IEC 61850 abstract services in IEC 61850-8-1.

The exact structure and values of the supported IEC61850 logical nodes can be seen by connecting to a R650 relay with an MMS browser, such as “MMS Object Explorer and AXS4-MMS” DDE/OPC server from Sisco Inc.

7.3.5 Peer-to-peer communication

Peer-to-peer communication of a digital state information (remote inputs/outputs) is supported using the IEC61850 GOOSE/GSE services. This feature allows digital points to be exchanged between IEC 61850 conforming devices.

7.3.6 File services

MMS file services are supported to allow transfer of oscillography, event record, or other files from a R650 relay.

7.3.7 IEC 61850 conformance statements

This section describes conformity with IEC 61850.

7.3.7.1 Abbreviations and acronyms

- ASCI Abstract Communication Service Interface
- SCSM Specific Communication Service Mapping
- SCL Substation Configuration Language
- GSE Generic Substation Events
- GOOSE Generic Object Oriented Substation Events
- GSSE Generic Substation Status Events
- SVC Sampled Value Control
- LCB Log Control Block
- PICS Protocol Implementation Conformance Statement
- MICS Model Implementation Conformance Statement
- PIXIT Protocol Implementation extra Information for Testing
- TICS Technical Issues Conformance Statement

7.3.7.2 Definitions of the ISO/OSI reference model

Communications are based on the OSI Reference Model (OSI/IEC 7498-1) for a multi-layer communication function, to achieve stable data exchange.

The table below shows the ISO Application (A) and Transport (T) profiles.

- An ISO **A profile** is a set of specifications and declarations regarding the top three layers of the ISO/OSI reference model (i.e. the application, presentation, and session layers).
- The **T profile** is a set of specifications and declarations regarding the lower four layers (i.e. transport, network, data link, and physical layers).

Table 7-1: OSI reference model and profiles

Application layer	A Profile
Presentation layer	
Session layer	
Transport layer	T Profile
Network layer	
Data link layer	
Physical layer	

A and T profiles can be combined in various ways to form different types of services and information items that can be exchanged. The services specified in Part 7-2 of the IEC61850 standard are mapped onto four different combinations of the profiles. These four combinations are used for

- Client/server services,
- GOOSE/GSE management services,
- GSSE services,
- Time synchronization,
- Services for measured value sampling.

7.3.7.3 Conformance statements for R650 devices

For R650 relays whose order code contains Communication protocol "7", product protocol and model implementation conformance statements are described in the following sections:

- 7.3.7.4 PICS for R650 relays on page 7–11 (R650-PICS_v800)
- 7.3.7.5 MICS for R650 relays on page 7–16 (R650-MICS_v800)
- 7.3.7.6 TICS for R650 relays on page 7–67 (R650-TICS_v800)
- 7.3.7.7 PIXIT for R650 relays on page 7–70 (R650-PIXIT_v800)

7.3.7.4 PICS for R650 relays

Reference documentation: **R650-PICS_v800**.

This document describes the:

- ACSI Conformance Statement
- PICS ("Protocol Implementation Conformance Statement") for 650 family of relays.

1 General

The following ACSI conformance statements are used to provide an overview and details about R650 Recloser controller, with firmware 8.00:

- ACSI BASIC conformance statement.
- ACSI MODELS conformance statement.
- ACSI SERVICE conformance statement.

The statements specify the communication features mapped to IEC 61850-8-1 First Edition and/or Edition 2.

2 ASCI basic conformance statement

The basic conformance statement is defined in Table 7-2: Basic conformance statement

Table 7-2: Basic conformance statement

		Client/ Subscriber	Server/ Publisher	Value/ Comments
Client-Server roles				
B11	**Server** side (of TWO-PARTY-APPLICATION-ASSOCIATION)	-	Y	
B12	**Client** side of (TWO-PARTY-APPLICATION-ASSOCIATION)	-		
SCSMs supported				
B21	**SCSM**: IEC 6185-8-1 used	-	Y	
B22	**SCSM**: IEC 6185-9-1 used	-		Ed2:Deprecated
B23	**SCSM**: IEC 6185-9-2 used	-		
B24	**SCSM**: other	-		
Generic substation event model (GSE)				
B31	**Publisher** side	-	Y	
B32	**Subscriber** side	Y	-	

Transmission of sampled value model (SVC)				
B41	**Publisher** side			
B42	**Subscriber** side			
– Y = supported N or empty = not supported				

3 ACSI models conformance statement

The ACSI models conformance statement is defined in Table 7-3: ACSI models conformance statement.

Table 7-3: ACSI models conformance statement

		Client/ Subscriber	Server/ Publisher	Value/ Comments
If **Server or Client** side (B11/12) supported				
M1	**Logical device**	-	Y	
M2	**Logical node**	-	Y	
M3	**Data**	-	Y	
M4	**Data set**	-	Y	
M5	**Substitution**			
M6	**Setting group control**	-	Y	
	Reporting			
M7	**Buffered report control**	-	Y	
M7-1	sequence-number	-	Y	
M7-2	report-time-stamp	-	Y	
M7-3	reason-for-inclusion	-	Y	
M7-4	data-set-name	-	Y	
M7-5	data-reference	-	Y	
M7-6	buffer-overflow	-	Y	
M7-7	entryID	-	Y	
M7-8	BufTm	-	Y	
M7-9	IntgPd	-	Y	
M7-10	GI	-	Y	
M7-11	conf-revision	-	Y	
M8	**Unbuffered report control**	-	Y	
M8-1	sequence-number	-	Y	
M8-2	report-time-stamp	-	Y	
M8-3	reason-for-inclusion	-	Y	
M8-4	data-set-name	-	Y	
M8-5	data-reference	-	Y	
M8-6	BufTm	-	Y	
M8-7	IntgPd	-	Y	
M8-8	GI	-	Y	
M8-9	conf-revision	-	Y	
	Logging			
M9	**Log control**	-		
M9-1	IntgPd	-		
M10	**Log**	-		
M11	**Control**	-	Y	
M17	File Transfer		Y	
M18	Application association		Y	
M19	GOOSE Control Block		Y	
M20	Sampled Value Control Block			

If **GSE** (B31/32) is supported				
M12	**GOOSE**		Y	
M13	**GSSE**			Deprecated
If **SVC** (B41/B42) is supported				
M14	Multicast SVC			
M15	Unicast SVC			
For all IEDs				
M16	**Time**	Y	Y	
Y = service is supported N or empty = service is not supported				

1.4 ACSI service conformance statement

The ACSI service conformance statement is defined in Table 7-4: ACSI service conformance statement.

Table 7-4: ACSI service conformance statement

	Ed	ACSI Service	AA: TP/MC	Client Sub(C)	Server Pub(S)	Comments
Server						
S1	1,2	GetServerDirectory(LOGICAL-DEVICE)	TP		Y	
Application association						
S2	1,2	Associate	TP		Y	
S3	1,2	Abort	TP		Y	
S4	1,2	Release	TP		Y	
Logical device						
S5	1,2	GetLogicalDeviceDirectory	TP		Y	
Logical node						
S6	1,2	GetLogicalNodeDirectory	TP		Y	
S7	1,2	GetAllDataValues	TP		Y	
Data						
S8	1,2	GetDataValues	TP		Y	
S9	1,2	SetDataValues	TP		Y	
S10	1,2	GetDataDirectory	TP		Y	
S11	1,2	GetDataDefinition	TP		Y	
Data set						
S12	1,2	GetDataSetValues	TP		Y	
S13	1,2	SetDataSetValues	TP		N	
S14	1,2	CreateDataSet	TP		N	
S15	1,2	DeleteDataSet	TP		N	
S16	1,2	GetDataSetDirectory	TP		Y	
Substitution						
S17	1	SetDataValues	TP		N	Ed1 only
Setting group control						
S18	1,2	SelectActiveSG	TP		Y	
S19	1,2	SelectEditSG	TP		Y	

S20	1,2	SetEditSGValues	TP		Y	
S21	1,2	ConfirmEditSGValues	TP		Y	
S22	1,2	GetEditSGValues	TP		Y	
S23	1,2	GetSGCBValues	TP		Y	

Reporting						
Buffered report control block (BRCB)						
S24	1,2	Report	TP		Y	
S24-1	1,2	data-change (dchg)			Y	
S24-2	1,2	quality-change (qchg)			Y	
S24-3	1,2	data-update (dupd)			N	
S25	1,2	GetBRCBValues	TP		Y	
S26	1,2	SetBRCBValues	TP		Y	
Unbuffered report control block (URCB)						
S27	1,2	Report	TP		Y	
S27-1	1,2	data-change (dchg)			Y	
S27-2	1,2	quality-change (qchg)			Y	
S27-3	1,2	data-update (dupd)			N	
S28	1,2	GetURCBValues	TP		Y	
S29	1,2	SetURCBValues	TP		Y	

Logging						
Log control						
S30	1,2	GetLCBValues	TP		N	
S31	1,2	SetLCBValues	TP		N	
Log						
S32	1,2	QueryLogByTime	TP		N	
S33	1,2	QueryLogAfter	TP		N	
S34	1,2	GetLogStatusValues	TP		N	

Generic substation event model (GSE)						
GOOSE						
S35	1,2	SendGOOSEMessage	MC		Y	
GOOSE Control Block						
S36	1,2	GetGoReference	TP			
S37	1,2	GetGOOSEElementNumber	TP			
S38	1,2	GetGoCBValues	TP		Y	
S39	1,2	SetGoCBValues	TP		Y	
GSSE (Ed2:61850-7-2 Annex C)						
S40	1,2	SendGSSEMessage	MC		N	Deprecated
GSSE Control Block (Ed2:61850-7-2 Annex C)						
S41	1,2	GetGsReference	TP		N	Deprecated
S42	1,2	GetGSSEDataOffset	TP		N	Deprecated
S43	1,2	GetGsCBValues	TP		N	Deprecated
S44	1,2	SetGsCBValues	TP		N	Deprecated

Transmission of sampled value model (SVC)						
Multicast SV						
S45	1,2	SendMSVMessage	MC		N	Use for 9-2LE or IEC 61869-9
Multicast Sampled Value Control Block						
S46	1,2	GetMSVCBValues	TP		N	
S47	1,2	SetMSVCBValues	TP		N	
Unicast SV						
S48	1,2	SendUSVMessage	TP		N	
Unicast Sampled Value Control Block						
S49	1,2	GetUSVCBValues	TP		N	
S50	1,2	SetUSVCBValues	TP		N	

Control						
S51	1,2	Select	TP		Y	SBO Normal Security
S52	1,2	SelectWithValue	TP		Y	SBO Enhanced Security
S53	1,2	Cancel	TP		Y	
S54	1,2	Operate	TP		Y	
S55	1,2	CommandTermination	TP		Y	
S56	1,2	TimeActivatedOperate	TP		N	

File transfer						
S57	1,2	GetFile	TP		Y	
S58	1,2	SetFile	TP		N	
S59	1,2	DeleteFile	TP		N	
S60	1,2	GetFileAttributeValues	TP		Y	
S61	1,2	GetServerDirectory (FILE)	TP		Y	

Time						
T1	1,2	Time resolution of internal clock	-		2ms	nearest negative power of 2 in seconds
T2	2	Time accuracy of internal clock	-			TL (ms) (low accuracy), T3 < 7) (only Ed2)
	1,2		-			T0 (ms) (<= 10 ms), 7 <= T3 < 9)
	1,2		-			T1 (µs) (<= 1 ms), 10 <= T3 < 13
	1,2		-			T2 (µs) (<= 100 µS), 13 <= T3 < 15
	1,2		-			T3 (µs) (<= 25 µS), 15 <= T3 < 18
	1,2		-			T4 (µs) (<= 4 µS), 18 <= T3 < 20
	1,2		-		Y	T5 (µs) (<= 1 µS), T3 >= 20)
T3	1,2	Supported TimeStamp resolution	-		1ms	nearest negative power of 2 in seconds

7.3.7.5 MICS for R650 relays

Reference documentation: **R650-MICS_v8_00**.

1 Introduction

This model implementation conformance statement is applicable for R650 Recloser Controller, with firmware 8.00.

This MICS document specifies the modelling extensions compared to IEC 61850 edition 2. For the exact details on the standardized model please compare the ICD substation configuration file: "<R650.icd>", version <1.0>.

This document describes the:

- Logical Nodes List
- Logical Nodes and Extensions
- Enum types implementation

1.1 Logical Node List

L: System Logical Nodes
LPHD (Physical device information)
LLN0 (Logical node zero)
LGOS (GOOSE subscription)
GoCB (GOOSE Control Block Class definition)
C: Logical Nodes for control
CSWI (Switch controller)
CILO (Interlocking)
P: Logical Nodes for protection functions
PIOC (Instantaneous overcurrent)
PTOC (Time overcurrent)
PTOF (Overfrequency)
PTUF (Underfrequency)
PTUV (Undervoltage)
PTOV (Overvoltage)
PDOP (Power)
PTTR (Thermal overload)
PTRC (Protection trip conditioning)
R: Logical nodes for protection related functions
RBRF (Breaker failure)
RDIR (Directional element)
RFLO (Fault Locator)
RREC (Autoreclosing)
RSYN (Synchrocheck)
G: Logical Nodes for generic references
GGIO (Generic process I/O)
M: Logical Nodes for metering and measurement
MMXU (Measurement)
MSQI (Sequence and imbalance)
MMTR (Metering)
MHAI (Harmonics measurement)
X: Logical Nodes for switchgear
XSWI (Circuit switch)

2 Logical Nodes and Extensions

Notation:

M: Data is mandatory in the IEC-61850-7-4.

O: Data is optional in the IEC-61850-7-4 and is used in the device.

E: Data is an extension to the IEC-61850-7-4.

2.1 System Logical Nodes. LN Group: L

2.1.1LPHD (Physical device information)

LPHD class				
Attribute Name	Attr. Type	Explanation	M/O	Notes
LPHD		Physical device information	M	
Data				
Common Logical Node Information				
PhyNam	geDPL	Physical device name plate	M	
PhyHealth	geHealthENS	Physical device health	M	
Proxy	geSPS	Indicates if this LN is a proxy	M	

2.1.2 LLN0 (Logical node zero)

LLN0 class				
Attribute Name	Attr. Type	Explanation	M/O	notes
LLN0		Logical node zero		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL_1	Name plate	M	
Loc	geSPS	Local control behavior	O	
OpTmh	geINS	Operation time	O	
GoCB (ACSI class GOOSE control block)				
GoCB	GoCB			

2.1.3 LGOS (GOOSE subscription)

This LN Logical is used for monitoring GOOSE messages, diagnosing the subscription state of a GOOSE message and has 24 instances inside the device

LGOS class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
LGOS		Logical node zero		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
St	geSPS	Status of the subscription	M	
LastStNum	geINS	Last state number received	O	
ConfRevNum	geINS	Expected conf. revision num.	O	
GoCBRef	geORG	Ref. to the subscribed GOOSE control block	O	

2.1.4 GoCB (GOOSE control block class definition)

GoCB class			
Attribute Name	**Attr. Type**	**FC**	**notes**
GoEna	BOOLEAN	GO	Enable (TRUE), disable (FALSE)
GoID	VISIBLE STRING65	GO	
DatSet	Object Reference	GO	

ConfRev	INT32U	GO	
NdsCom	BOOLEAN	GO	
DstAddress	PHYCOMADDR	GO	

2.2 Logical Nodes for control. LN Group: C

2.2.1 CSWI (Switch controller)

a) geCSWI

This logical node has 12 switchgear (CSWI1 to CSWI12) and 4 switchgear for Recloser (recPhsACSWI1, recPhsBCSWI1, recPhsCCSWI1, rec3PCSWI1)).

CSWI class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
CSWI		Switch controller		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	Status-only
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Controls				
Loc	geSPS	Local operation	M	Local/Remote
Pos	geDPC_1	Switch position	M	Breaker open, close

2.2.2 CILO (Interlocking):

a) geCILO

This logical node has 12 interlock switchgear (CILO1 to CILO12) and 4 interlock switchgear for Recloser (recPhsACILO1, recPhsBCILO1, recPhsCCILO1, rec3PCILO1)).

CILO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
CILO		Switch controller		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
EnaOpn	geSPS	Enable Open	M	
EnaCls	geSPS	Enable Close		

2.3 Logical Nodes for protection functions. LN Group:P

2.3.1 PIOC (Instantaneous overcurrent)

a) phsPIOC

This logical node class is used for phase instantaneous overcurrent and has 6 instances inside the device.

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	

Status Information				
Str	gePhsACD	Start	O	IOC PKP
Op	gePhsACT	Operate	M	IOC OP
Blk	geSPS	Block	O	
Settings				
PIOCEna	geSPG_2	Function	O	
InMagTyp	geING_0_2	Input	O	
StrVal	geFloatASG_2	Pickup level	O	
OpDlTmms	geING_8_2	Trip delay	O	
RsDlTmms	geING_8_2	Reset delay	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

b) ndPIOC

This logical node class is used for neutral instantaneous overcurrent if setting group option is enable and has 3 instances inside the device.

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	geNeutACD	Start	O	IOC PKP
Op	geNeutACT	Operate	M	IOC OP
Blk	geSPS	Block	O	
Settings				
PIOCEna	geSPG_2	Function	O	
StrVal	geFloatASG_2	Pickup level	O	
OpDlTmms	geING_8_2	Trip delay	O	
RsDlTmms	geING_8_2	Reset delay	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

c) gndPIOC

This logical node class is used for ground fault instantaneous overcurrent. There are 3 instances of this logical node inside the device.

PIOC class				
Attribute Name	Attr. Type	Explanation	M/O	notes
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	O	IOC PKP
Op	gePhsACT	Operate	M	IOC OP
Blk	geSPS	Block	O	
Settings				
PIOCEna	geSPG	Function	O	
InMagTyp	geING_0	Input	O	
StrVal	geFloatASG	Pickup level	O	
OpDlTmms	geING_8	Trip delay	O	
RsDlTmms	geING_8	Reset delay	O	

SnpshtEvEna	geSPG	Snapshot events enabled	O	

d) hsePIOC

This logical node class is used for ground fault instantaneous overcurrent. There are 3 instances of this logical node inside the device..

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	O	IOC PKP
Op	gePhsACT	Operate	M	IOC OP
Blk	geSPS	Block	O	
Settings				
PIOCEna	geSPG_2	Function	O	
InMagTyp	geING_0_2	Input	O	
StrVal	geFloatASG_2	Pickup level	O	
OpDlTmms	geING_8_2	Trip delay	O	
RsDlTmms	geING_8_2	Reset delay	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

e) IsoGndPIOC

This logical node class is used for isolated ground overcurrent and has 3 instances inside the device.

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	O	IOC PKP
Op	gePhsACT	Operate	M	IOC OP
Blk	geSPS	Block	O	
Settings				
PIOCEna	geSPG_2	Function	O	
VhStr	geIntASG_2	Vh level	O	
VlStr	geIntASG_2	Vl level	O	
IhStr	geFloatASG_1_2	Ih level	O	
IlStr	geFloatASG_1_2	Il level	O	
OpDlTmms	geING_8_2	Trip delay	O	
RsDlTmms	geING_8_2	Reset delay	O	

SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

f) BknCndPIOC

This logical node class is used for broken conductor function and has 3 instances inside the device.

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	O	IOC PKP
Op	gePhsACT	Operate	M	IOC OP
Blk	geSPS	Block	O	
Settings				
PIOCEna	geSPG_2	Function	O	
StrVal	geFloatASG_2	Pickup level	O	
OpDlTmms	geING_8_2	Trip delay	O	
BlkCurrent	geFloatASG_1_2	Operation Threshold	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

2.3.2 PTOC (Time overcurrent)

a) phsPTOC

This logical node class is used for phase time overcurrent and has 6 instances inside the device.

PTOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PTOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	O	TOC PKP
Op	gePhsACT	Operate	M	TOC OP
Blk	geSPS	Block	O	TOC BLK
Settings				
PTOCEna	geSPG_2	Function	O	
InMagTyp	geING_0_2	Input	O	
StrVal	geFloatASG_2	Pickup level	O	
TmACrv	geCURVE_3	Curve	O	
VolRst	geSPG_2	Voltage Restraint	O	
TmMult	geFloatASG_2	TD Multiplier	O	

RsMod	geING_0_2	Reset	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

b) ndPTOC

This logical node class is used for neutral time overcurrent and has 3 instances inside the device.

PTOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PIOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	geNeutACD	Start	O	TOC PKP
Op	geNeutACT	Operate	M	TOC OP
Blk	geSPS	Block	O	TOC BLK
Settings				
PTOCEna	geSPG_2	Function	O	
StrVal	geFloatASG_2	Pickup level	O	
TmACrv	geCURVE_3	Curve	O	
TmMult	geFloatASG_2	TD Multiplier	O	
RsMod	geING_0_2	Reset	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

c) gndPTOC

This logical node class is used for ground time overcurrent. There are 3 instances inside of this logical node inside the device.

PTOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PTOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	M	TOC PKP
Op	PhsACT	Operate	M	TOC OP
Blk	geSPS	Block	O	TOC BLK
Settings				
PTOCEna	geSPG_2	Function	O	
InMagTyp	geING_0_2	Input	O	
StrVal	geFloatASG_2	Pickup level	O	
TmACrv	geCURVE_3	Curve	O	
TmMult	geFloatASG_2	TD Multiplier	O	
RsMod	geING_0_2	Reset	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

d) hsePTOC

This logical node class is used for sensitive ground time overcurrent. There are 3 instances inside of this logical node inside the device.

PTOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PTOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	M	TOC PKP
Op	PhsACT	Operate	M	TOC OP
Blk	geSPS	Block	O	TOC BLK
Settings				
PTOCEna	geSPG_2	Function	O	
InMagTyp	geING_0_2	Input	O	
StrVal	geFloatASG_2	Pickup level	O	
TmACrv	geCURVE_3	Curve	O	
TmMult	geFloatASG_2	TD Multiplier	O	
RsMod	geING_0_2	Reset	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

e) NgSeqPTOC

This logical node class is used for negative sequence time overcurrent function and has 3 instances inside the device.

PTOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PIOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	O	TOC PKP
Op	gePhsACT	Operate	M	TOC OP
Blk	geSPS	Block	O	TOC BLK
Settings				
PTOCEna	geSPG_2	Function	O	
StrVal	geFloatASG_2	Pickup level	O	
TmACrv	geCURVE_3	Curve	O	
TmMult	geFloatASG_2	TD Multiplier	O	
RsMod	geING_0_2	Reset	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

2.3.3 PTOF (OverFrequency)

a) PTOF

This logical node class is used for phase overfrequency and has 3 instances inside the device.

PTOF class				
Attribute Name	**Attribute type**	**Explanation**	**M/O/C/E**	**Notes**
PTOF		Overfrequency		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	Status-only
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name Plate	M	
Status information				
Str	geGeneralACD	Start	M	TOF PKP
Op	geGeneralACT	Operate	M	TOF OP
Blk	geSPS	Block	O	TOF BLK
Settings				
PTOFEna	geSPG_2	Function	O	
StrVal	geFloatASG_2	Start value (frequency)	O	
BlkVal	geIntASG_2	Voltage block value	O	
OpDlTmms	geING_8_2	Operate delay time	O	
RsDlTmms	geING_8_2	Reset delay time	O	
FreqSource	geSPG_2	Frequency source	E	
SnpshtEvEna	geSPG_2	Snapshot events enabled	E	

2.3.4 PTUF (UnderFrequency)

a) PTUF

This logical node class is used for phase underfrequency and has 3 instances inside the device.

PTUF class				
Attribute Name	**Attribute type**	**Explanation**	**M/O/C/E**	**Notes**
PTUF		Underfrequency		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	Status-only
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name Plate	M	
Status information				
Str	geGeneralACD	Start	M	TUF PKP
Op	geGeneralACT	Operate	M	TUF OP
Blk	geSPS	Block	O	TUF BLK
Settings				
PTOFEna	geSPG_2	Function	O	
StrVal	geFloatASG_2	Start value (frequency)	O	
BlkVal	geIntASG_2	Voltage block value	O	
OpDlTmms	geING_8_2	Operate delay time	O	
RsDlTmms	geING_8_2	Reset delay time	O	
FreqSource	geSPG_2	Frequency source	E	
SnpshtEvEna	geSPG_2	Snapshot events enabled	E	

2.3.5 PTUV (Undervoltage)

a) LphsPTUV

This logical node class is used for load phase undervoltage and has 3 instances inside the device.

PTUV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PTUV		Undervoltage		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	geGeneralACD	Start	M	TUV PKP
Op	geGeneralACT	Operate	M	TUV OP
Blk	geSPS	Block	O	TUV BLK
StrPhGn	gePhsACD_1	Pickup Phase-Ground	O	
OpPhGn	gePhsACT_1	Operate Phase-Ground	O	
StrPhPh	gePhsACD_1	Pickup Phase-Phase	O	
OpPhPh	gePhsACT_1	Operate Phase-Phase	O	
Settings				
PTUVEna	geSPG_2	Function	O	
InMod	geING_0_2	Mode	O	
StrVal	geFloatASG_2	Start value	O	
TmVCrv	geCURVE_4	Operating curve type	O	
TmMult	geFloatASG_2	Time dial multiplier	O	
DeaLinVal	geFloatASG_1_2	Minimum Voltage	O	
PhLogic	geING_0_2	Logic	O	
BkrMon	geSPG_2	Supervised by 52	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

b) SphsPTUV

This logical node class is used for source phase undervoltage and has 3 instances inside the device.

PTUV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PTUV		Undervoltage		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	geGeneralACD	Start	M	TUV PKP
Op	geGeneralACT	Operate	M	TUV OP
Blk	geSPS	Block	O	TUV BLK
StrPhGn	gePhsACD_1	Pickup Phase-Ground	O	
OpPhGn	gePhsACT_1	Operate Phase-Ground	O	
StrPhPh	gePhsACD_1	Pickup Phase-Phase	O	
OpPhPh	gePhsACT_1	Operate Phase-Phase	O	
Settings				
PTUVEna	geSPG_2	Function	O	
InMod	geING_0_2	Mode	O	
StrVal	geFloatASG_2	Start value	O	
TmVCrv	geCURVE_4	Operating curve type	O	
TmMult	geFloatASG_2	Time dial multiplier	O	

DeaLinVal	geFloatASG_1_2	Minimum Voltage	O	
PhLogic	geING_0_2	Logic	O	
BkrMon	geSPG_2	Supervised by 52	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

2.3.6 PTOV (Overvoltage)

a) LphsPTOV

This logical node class is used for load phase overvoltage and has 3 instances inside the device

PTOV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	M	TOV PKP
Op	gePhsACT	Operate	M	TOV OP
Blk	geSPS	Block	O	TOV BLK
Settings				
PTOVEna	geSPG_2	Function	O	
StrVal	geFloarASG_2	Start value	O	
OpDlTmms	geING_8_2	Operate delay time	O	
RsDlTmms	geING_8_2	Reset delay time	O	
PhLogic	geING_0_2	Logic	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

b) SphsPTOV

This logical node class is used for source phase overvoltage and has 3 instances inside the device

PTOV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	M	TOV PKP
Op	gePhsACT	Operate	M	TOV OP
Blk	geSPS	Block	O	TOV BLK
Settings				
PTOVEna	geSPG_2	Function	O	
StrVal	geFloarASG_2	Start value	O	
OpDlTmms	geING_8_2	Operate delay time	O	
RsDlTmms	geING_8_2	Reset delay time	O	
PhLogic	geING_0_2	Logic	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

c) LneuPTOV

This logical node class is used for load neutral overvoltage and has 3 instances inside the device.

PTOV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	GeneralACD	Start	M	TOV PKP
Op	GeneralACT	Operate	M	TOV OP
Blk	geSPS	Block	O	TOV BLK
Settings				
PTOVEna	geSPG_2	Function	O	
StrVal	geFloatASG_2	Start value	O	
OpDlTmms	geING_8_2	Operate delay time	O	
RsDlTmms	geING_8_2	Reset delay time	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

d) SneuPTOV

This logical node class is used for source neutral overvoltage and has 3 instances inside the device.

PTOV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	GeneralACD	Start	M	TOV PKP
Op	GeneralACT	Operate	M	TOV OP
Blk	geSPS	Block	O	TOV BLK
Settings				
PTOVEna	geSPG_2	Function	O	
StrVal	geFloatASG_2	Start value	O	
OpDlTmms	geING_8_2	Operate delay time	O	
RsDlTmms	geING_8_2	Reset delay time	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

e) LngSeqPTOV

This logical node class is used for load negative sequence overvoltage and has 3 instances inside the device.

PTOV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	geGeneralACD	Start	M	TOV PKP
Op	geGeneralACT	Operate	M	TOV OP
Blk	geSPS	Block	O	TOV BLK
Settings				
PTOVEna	geSPG_2	Function	O	
StrVal	geIntASG_2	Start value	O	
OpDlTmms	geING_8_2	Operate delay time	O	
RsDlTmms	geING_8_2	Reset delay time	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

f) SngSeqPTOV

This logical node class is used for source negative sequence overvoltage and has 3 instances inside the device.

PTOV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	geGeneralACD	Start	M	TOV PKP
Op	geGeneralACT	Operate	M	TOV OP
Blk	geSPS	Block	O	TOV BLK
Settings				
PTOVEna	geSPG_2	Function	O	
StrVal	geIntASG_2	Start value	O	
OpDlTmms	geING_8_2	Operate delay time	O	
RsDlTmms	geING_8_2	Reset delay time	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

2.3.7 PDOP (Directional Overpower)

a) FwdPDOP

This logical node class is used to model the forward overpower function and has 3 instances inside the device.

PDOP class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PDOP		Overpower		
Data				
Common Logical Node Information				

Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	M	Stage 1 PKP
Op	gePhsACT	Operate	M	Stage 1 OP
Blk	geSPS_1	Block	O	
S2Str	gePhsACD_2	Start	O	Stage 2 PKP
S2Op	gePhsACT_1	Operate	O	Stage 2 OP
Settings				
PDOPEna	geSPG_2	Function	O	
BlkCloseTmms	geING_0_2	Blk time after close	O	
StrVal	geFloatASG_2	Stage 1 Tap	O	
OpDlTmms	geING_8_2	Stage 1 Time	O	
S2StrVal	geFloatASG_1_2	Stage 2 Tap	O	
S2OpDlTmms	geING_0_2	Stage 2 Time	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

b) DirPDOP

This logical node class is used to model the directional overpower function and has 3 instances inside the device.

PDOP class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PDOP		Overpower		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	M	
Op	gePhsACT	Operate	M	
Blk	geSPS_1	Block	O	
S1Str	gePhsACD_2	Start	O	Stage 1 PKP
S1Op	gePhsACT_1	Operate	O	Stage 1 OP
S2Str	gePhsACD_2	Start	O	Stage 2 PKP
S2Op	gePhsACT_1	Operate	O	Stage 2 OP
Settings				
PDOPEna	geSPG_2	Function	O	
BlkCloseTmms	geING_0_2	Blk time after close	O	
S1DirPwrAng	geFloatASG_1_2	Dir Power Angle 1	O	
S1StrVal	geFloatASG_1_2	Stage 1 Tap	O	
S1OpDlTmms	geING_0_2	Stage 1 Time	O	
S2DirPwrAng	geFloatASG_1_2	Dir Power Angle 2	O	
S2StrVal	geFloatASG_1_2	Stage 2 Tap	O	
S2OpDlTmms	geING_0_2	Stage 2 Time	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

c) WattPDOP

This logical node class is used to model the wattmeter ground overpower function and has 6 instances inside the device.

PDOP class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PDOP		Overpower		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	M	
Op	gePhsACT	Operate	M	
Blk	geSPS_1	Block	O	
SupStr	gePhsACD_2	Start	O	
Settings				
PDOPEna	geSPG_2	Function	O	
OVStrVal	geFloatASG_1_2	Voltage Pickup Level	O	
InMagTyp	geING_0_2	Current Selection	O	
OCStrVal	geFloatASG_1_2	OC Pickup level	O	
OCStrDlTmms	geING_0_2	OC Pickup Delay	O	
PWStrVal	geFloatASG_1_2	Power Pickup	O	
ChrAng	geFloatASG_1_2	MTA	O	
PWStrDlTmms	geING_0_2	Power Pickup Delay	O	
Curve	geING_0_2	Curve	O	
MltTmms	geING_0_2	Multiplier	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

2.3.10 PTTR (Thermal overload)

a) PTTR

This logical node is used to model the thermal overload functions and has 3 instances inside the device.

PTTR class				
Attribute Name	Attribute type	Explanation	M/O/C/E	Notes
PTTR		Thermal overload		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	Status-only
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name Plate	M	
Status information				
Op	gePhsACT	Operate	M	Thermal OP
Blk	geSPS_1	Block	O	Thermal BLK
AlmThm	geSPS	Thermal alarm	O	
AlmThmPhA	geSPS_1	Thermal alarm phase A	E	
AlmThmPhB	geSPS_1	Thermal alarm phase B	E	
AlmThmPhC	geSPS_1	Thermal alarm phase C	E	
Settings				
PTTREna	geSPG_2	Thermal overload enable	E	
ConsTmmHeat	geFloatASG_1_2	Heat time constant	E	
ConsTmmCool	geFloatASG_1_2	Cool time constant	E	
StrVal	geFloatASG_2	Pickup level	O	
AlmVal	geFloatASG_2	Alarm level	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	E	

2.3.11 PTRC (Protection trip conditioning)

a) PTRC General trip

This logical node shall be used to connect the operate outputs of one or more protection functions to a common trip to be transmitted to XCBR logical node and has 1 instance inside the device.

PTRC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
PTRC		Trip bus		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Op	geGeneralACT	Operate	M	

2.4 Logical Nodes for protection related functions. LN Group: R

2.4.1 RBDR (Disturbance recorder channel binary)

a) RBDR

This logical node class is used for the disturbance binary recorder and has 1 instance inside the device.

RDIR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
RBDR		Disturbance recorder channel binary		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	Status only
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
ChTrg	geSPS	Channel Triggered	M	
DigCh01	geSPS		E	
...	...	...	...	
DigChn16	geSPS		E	

2.4.2 RBRF (Breaker failure)

a) RBRF

This logical node class is used for breaker failure and has 1 instance inside the device.

RREC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
RBRF		Breaker failure element	O	
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
OpEx	geGeneralACT	Direction	M	
OpExPhA	geGeneralACT_1	Breaker Failure Phase A Initiate		
OpExPhB	geGeneralACT_1	Breaker Failure Phase B Initiate		
OpExPhC	geGeneralACT_1	Breaker Failure Phase C Initiate		
OpEx3P	geGeneralACT_1	Breaker Failure Three Pole Initiate		

2.4.3 RDIR (Directional element)

a) phsRDIR

This logical node class is used for phase directional elements and has 3 instances inside the device.

RDIR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
RDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Dir	gePhsACD	Direction	M	
Op	gePhsACT	Operate	O	
Blk	geSPS	Block	O	
BlkIn	geGeneralACT_1	Block Input	O	
Settings				
RDIREna	geSPG_2	Function	O	
ChrAng	geFloatASG_2	Characteristic angle	O	
PolOpMod	geING_0_2	Direction	O	
BlkMod	geING_0_2	Block Logic	O	
BlkValV	geFloatASG_2	Minimum operating current	O	
VMemTms	geFloatASG_1_2	Voltage Memory Time	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

b) ndRDIR

This logical node class is used for neutral directional elements and has 3 instances inside the device.

RDIR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
RDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Dir	geNeutACD	Direction	M	
Op	geNeutACT	Operate	O	
Blk	geSPS	Block	O	
BlkIn	geGeneralACT_1	Block Input	O	
Settings				
RDIREna	geSPG_2	Function	O	
ChrAng	geFloatASG_2	Characteristic angle	O	
PolOpMod	geING_0_2	Direction	O	
PolQty	geENG_2	Polarizing quantity	O	
BlkMod	geING_0_2	Block Logic	O	
BlkValV	geFloatASG_2	Minimum operating current	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

c) gndRDIR

This logical node class is used for ground directional elements and has 3 instances inside the device

RDIR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
RDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Dir	geNeutACD	Direction	M	
Op	geNeutACT	Operate	O	
Blk	geSPS	Block	O	
BlkIn	geNeutACT_1	Block Input	O	
Settings				
RDIREna	geSPG_2	Function	O	
ChrAng	geFloatASG_2	Characteristic angle	O	
PolOpMod	geING_0_2	Direction	O	
PolQty	geENG_2	Polarizing quantity	O	
BlkMod	geING_0_2	Block Logic	O	
BlkValV	geFloatASG_2	Minimum operating current	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

d) hseRDIR

This logical node class is used for sensitive ground directional elements and has 3 instances inside the device.

RDIR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
RDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Dir	geGeneralACD	Direction	M	
Op	geGeneralACT	Operate	O	
Blk	geSPS	Block	O	
BlkIn	geGeneralACT_1	Block Input	O	
Settings				
RDIREna	geSPG_2	Function	O	
ChrAng	geFloatASG_2	Characteristic angle	O	
PolOpMod	geING_0_2	Direction	O	
BlkMod	geING_0_2	Block Logic	O	
BlkValV	geFloatASG_2	Minimum operating current	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

2.4.4 RDRE (Disturbance recorder function)

a) RDRE

This logical node class is used for the disturbance recloser and has 1 instance inside the device.

RREC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
RDRE		Disturbance recorder channel		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	Status only
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
RcdMade	geSPS	Recording Made	M	
FltNum	geINS	Fault Number	M	
CycRcd	geINS_1	Cycles per Record	M	
RcdNum	geINS_1	Available Records	M	
Settings				
RDREEna	geSPG	Oscillography function enable	M	
TrgPos	geING_0	Trigger position	O	
SmpCyc	geENG_3	Samples per cycle	O	
MaxNumRcd	geING_8	Maximum number of records	O	
RcdMod	geENG_4	Recorder operation mode	O	
SnpshtEvEna	geSPG	Snapshot events enabled	O	

2.4.4 RFLO (Fault Locator):

a) RFLO

This logical node class is used for fault locator and has 1 instance inside the device.

RFLO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
RFLO		Fault locator element		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
FltRprtTrg	geSPS_1	Fault Report Trigger	O	
ClrFltRprts	geSPS_1	Clear fault reports	O	
FltZ	geFloatCMV	Fault impedance	M	
FltDiskm	geFloatMV_3	Fault distance in km	O	
RPriFlt	geFloatMV_2	Primary Fault Resistance	O	
XPriFlt	geFloatMV_2	Primary Fault Reactance	O	
RSeFlt	geFloatMV_2	Secondary Fault Resistance	O	
XSeFlt	geFloatMV_2	Secondary Fault Reactance	O	
RFault	geFloatMV_2	Fault Resistance	O	
FltTyp	geINS_1	Fault type	O	
FltRprtNum	geINS_1	Fault report number	O	
PreFltIaMod	geFloatMV_2	Prefault Ia module	O	
PreFltIaAng	geFloatMV_2	Prefault Ia angle	O	
PreFltIbMod	geFloatMV_2		O	
PreFltIbAng	geFloatMV_2		O	
PreFltIcMod	geFloatMV_2		O	
PreFltIcAng	geFloatMV_2		O	
PreFltIgMod	geFloatMV_2		O	
PreFltIgAng	geFloatMV_2		O	
PreFltIsgMod	geFloatMV_2		O	
PreFltIsgAng	geFloatMV_2		O	
PreFltVabMod	geFloatMV_2		O	
PreFltVabAng	geFloatMV_2		O	
PreFltVbcMod	geFloatMV_2		O	
PreFltVbcAng	geFloatMV_2		O	
PreFltVcaMod	geFloatMV_2		O	
PreFltVcaAng	geFloatMV_2		O	
PstFltIaMod	geFloatMV_2	Postfault Ia module	O	
PstFltIaAng	geFloatMV_2	Postfault Ia angle	O	
PstFltIbMod	geFloatMV_2		O	
PstFltIbAng	geFloatMV_2		O	
PstFltIcMod	geFloatMV_2		O	
PstFltIcAng	geFloatMV_2		O	
PstFltIgMod	geFloatMV_2		O	
PstFltIgAng	geFloatMV_2		O	
PstFltIsgMod	geFloatMV_2		O	
PstFltIsgAng	geFloatMV_2		O	
PstFltVabMod	geFloatMV_2		O	
PstFltVabAng	geFloatMV_2		O	
PstFltVbcMod	geFloatMV_2		O	
PstFltVbcAng	geFloatMV_2		O	
PstFltVcaMod	geFloatMV_2		O	
PstFltVcaAng	geFloatMV_2		O	
Settings				
RFLOEna	geSPG	Function		
Z1Mod	geFloatASG_1	Pos.Seq. Module		

Z1Ang	geIntASG_1	Pos.Seq. Angle		
Z0Mod	geFloatASG_1	Zero Seq. Module		
Z0Ang	geIntASG_1	Zero Seq. Angle		
LinLenkm	geFloatASG	Line length		
ShwFltHMI	geSPG	Show fault in HMI		
SnpshtEvEna	geSPG	Snapshot Events enabled		
PhCtPol	geSPG	Phase CT Polarity		

2.4.6 RREC (Autoreclosing)

a) RREC

This logical node class is used for autoreclosing and has 1 instance inside the device.

RREC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
RREC		Autoreclosing Element		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
OpCls	geGeneralACT	Direction	M	
OpClsPhA	geGeneralACT_1	AR Phase A Operate		
OpClsPhB	geGeneralACT_1	AR Phase B Operate		
OpClsPhC	geGeneralACT_1	AR Phase C Operate		
OpCls3P	geGeneralACT_1	AR Three Pole Operate		
AutoRecSt	geAutoRecStENS	Autoreclose status	M	
AutoRecStPhA	geAutoRecStENS_1	Phase A status	M	
AutoRecStPhB	geAutoRecStENS_1	Phase B status	M	
AutoRecStPhC	geAutoRecStENS_1	Phase C status	M	
AutoRecSt3P	geAutoRecStENS_1	3 Pole status	M	
AutoRecLoPhA	geINS_1	Phase A Lockout	O	
AutoRecLoPhB	geINS_1	Phase B Lockout	O	
AutoRecLoPhC	geINS_1	Phase C Lockout	O	
AutoRecLo3P	geINS_1	3 Pole Lockout	O	
AutoRecBlkPhA	geINS_1	Phase A Block	O	
AutoRecBlkPhB	geINS_1	Phase B Block	O	
AutoRecBlkPhC	geINS_1	Phase C Block	O	
AutoRecBlk3P	geINS_1	3 Pole Block	O	
Settings				
RRECEna	geSPG	Function	O	
MaxNumShot	geING_0	Max. Number Shots	O	
Rec1Tmms1	geING_8	Dead Time 1	O	
Rec1Tmms2	geING_8	Dead Time 2	O	
Rec1Tmms3	geING_8	Dead Time 3	O	
Rec1Tmms4	geING_8	Dead Time 4	O	
RclTmms	geING_8	Reclaim time		
CondEna	geSPG	Cond. Permission		
HaltTms	geFloatASG_1	Halt Time		
RsTms	geFloatASG_1	Reset Time		
CondTms	geFloatASG_1	Condition Time		
LOTyp	geSPG	Lockout Type		
CrdTms	geFloatASG_1	Coordination Time		
RsShtTms	geFloatASG_1	Reset Shot Time		
SnpshtEvEna	geSPG	Snapshot events enabled	O	

2.4.7 RSYN (Synchronism-check)

This logical node class is used modelling the synchrocheck function and has 1 instance inside the device

RSYN class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RSYN		Synchronism-check		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
SynBlkIn	geSPS_1	Block signal	O	
SynOp	geSPS_1	Closing permission signal	O	
Rel	geSPS	Release	M	
SynCondOp	geSPS_1	Closing perm. according to logic	O	
DLDSOp	geSPS_1	Closing perm. in DLDS condition	O	
LLDSOp	geSPS_1	Closing perm. in LLDS condition	O	
LLDBOp	geSPS_1	Closing perm. in LLDB condition	O	
HzInd	geSPS	Frequency difference indicator	O	
SrHzHiLdHz	geSPS_1	Source frequency > Load frequency	O	
SrHzLoLdHz	geSPS_1	Load	O	
FrcSynTrad	geSPS_1	Force Synchrocheck Traditional	O	
MaxHzInd	geSPS_1	Max Frequency Difference Indicator	O	
SynVRef	geSynVRefENS	Synchrocheck Voltage Reference	O	
Measured values				
DifVClc	geFloatMV	Calculated difference in voltage	O	
DifHzClc	geFloatMV	Calculated difference in frequency	O	
Settings				
RSYNEna	geSPG	Function	O	
SynTyp	geSPG	Sycnhrocheck type	O	
DeaSrVal	geFloatASG_1	Dead source voltage level	O	
LivSrVal	geFloatASG_1	Live source voltage level	O	
DeaLdVal	geFloatASG_1	Dead load voltage level	O	
LivLdVal	geFloatASG_1	Live load voltage level	O	
DifV	geFloatASG	Difference voltage	O	
DifAng	geFloatASG	Difference angle	O	
DifHz	geIntASG	Difference frequency	O	
TotTmms	geING_8	Total time of synch. process	O	
DLDSEna	geSPG	Dead load - dead source permission	O	
LLDSEna	geSPG	Live load - dead source permission	O	
DLLSEna	geSPG	Dead load - live source permission	O	
MaxCLSAng	geFloatASG_1	Max Allowed CLS Angle	O	
RLCClsTms	geFloatASG_1	RLC Closing Time	O	
SnpshtEvEna	geSPG	Snapshot events enabled	O	

2.5 Logical Nodes for generic references. LN Group: G

2.5.1 GGIO (Generic process I/O)

a) geBoardGGIO

This logical node class is used is used to map digital and analogue inputs of 4 I/O boards F, G, H and J.

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
BoardSt	SPS_1	Board status	O	
Ind1	geSPS	Status contact input 1	O	
Ind2	geSPS	Status contact input 2	O	
..	..	..	..	
Ind32	geSPS	Status contact input 32	O	
Ind33	geSPS	Status contact output 1	O	
..	..		..	
Ind48	geSPS	Status contact output 16	O	
Measured and metered values				
AnIn1	geFloatMV	Analog input 1	O	
AnIn2	geFloatMV	Analog input 2	O	
..	..		..	
AnIn8	geFloatMV	Analog input 8	O	
Settings				
VThrldA	geIntASG_1	Voltage threshold A	O	
VThrldB	geIntASG_1	Voltage threshold B	O	
VThrldC	geIntASG_1	Voltage threshold C	O	
VThrldD	geIntASG_1	Voltage threshold D	O	
DbceTmmsA	geING_0	Debounce time A	O	
DbceTmmsB	geING_0	Debounce time B	O	
DbceTmmsC	geING_0	Debounce time C	O	
DbceTmmsD	geING_0	Debounce time D	O	
InTyp01	geING_0	Type input 1	O	
InTyp02	geING_0	Type input 2	O	
..	..	..	..	
InTyp32	geING_0	Type input 32	O	
DlInTmms01	geING_0	Delay time input 1	O	
DlInTmms02	geING_0	Delay time input 2	O	
..	..	..	..	
DlInTmms32	geING_0	Delay time input 32	O	
OutLogic01	geING_0	Logic output 1	O	
OutLogic02	geING_0	Logic output 2	O	
..	..	..	..	
OutLogic16	geING_0	Logic output 16	O	
OutTyp01	geING_0	Type output 1	O	
OutTyp02	geING_0	Type output 2	O	
..		..	..	
OutTyp16	geING_0	Type output 16	O	

PlsOutTmms01	geING_0	Pulse time output 1	O	
PlsOutTmms02	geING_0	Pulse time output 2	O	
..	..		..	
PlsOutTmms16	geING_0	Pulse time output 16	O	
Rng01	geING_0	Range analog input 1	O	
Rng02	geING_0	Range analog input 2	O	
..	..	..	..	
Rng08	geING_0	Range analog input 8	O	
OscTmmsA	geING_0	Oscillation time A	O	
OscTmmsB	geING_0	Oscillation time B	O	
OscTmmsC	geING_0	Oscillation time C	O	
OscTmmsD	geING_0	Oscillation time D	O	
NumChgs	geING_0	Number of transient changes	O	
SnpshtEvEna	geSPG	Snapshot Events enabled	O	

b) geVirtualGGIO

This logical node class is used is used to map the latched and self reset virtual Inputs.

GGIO class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	
Beh	geINS	behavior	M	
Health	geINS	Health	M	
NamPlt	geLPL	Name plate	M	
Controls				
DPCSO1	geSPC	Virtual Input 1	O	
DPCSO1	geSPC	Virtual Input 2	O	
..	..	..	..	
DPCSO64	geSPC	Virtual Input 32	O	

c) geEventsGGIO

This logical node class is used to map data from the list of any all internal digital states (PLC control events).

GGIO class				
Attribute Name	**Attribute Type**	Explanation	**M/O/E**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	
Beh	geINS	behavior	M	
Health	geINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Ind1	geSPS	Control Event 1	O	
Ind2	geSPS	Control Event 2	O	
....	....	....	....	
Ind192	geSPS	Control Event 32	O	

d) geRemoteInputsGGIO

This logical node class is used to map data from incoming GOOSE messages.

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Ind1	geSPS	Remote digital input 1	O	
Ind2	geSPS	Remote digital input 2	O	
..	..	..	..	
Ind64	geSPS	Remote digital input 32	O	
AnIn1	geFloatMV	Remote float input 1	O	
AnIn2	geFloatMV	Remote float input 2	O	
..	..	..	..	
AnIn8	geFloatMV	Remote float input 8	O	
AnIn9	geIntMV_1	Remote integer input 1	O	
AnIn10	geIntMV_1	Remote integer input 2	O	
..	..	..	..	
AnIn16	geIntMV_1	Remote integer input 8	O	
Settings				
OscTmms	geING_0	Oscillation time remote inputs	O	
NumChgs	geING_0	Number of transient changes	O	

e) geRemoteOutputsGGIO

This logical node class is used to map PLC digital states for outgoing GOOSE messages.

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Ind1	geSPS	Remote digital output 1	O	
Ind2	geSPS	Remote digital output 2	O	
..	..	..	..	
Ind32	geSPS	Remote digital output 32	O	

f) DigitalCountersGGIO:

This logical node is used for modelling the eight digital counters of R650 relay.

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Cnt1	geBCR_2	Digital counter 1	O	
..	..	..	..	
Cnt8	geBCR_2	Digital counter 8	O	
CntBlk1	geSPS_1	Digital counter 1 block	O	
..	..	..		
CntBlk8	geSPS_1	Digital counter 8 block	O	
CntHi1	geSPS_1	Digital counter 1 high	O	
..	..	..		
CntHi8	geSPS_1	Digital counter 8 high	O	
CntEq1	geSPS_1	Digital counter 1 equal	O	
..	..	..		
CntEq8	geSPS_1	Digital counter 8 equal	O	
CntLo1	geSPS_1	Digital counter 1 low	O	
..	..	..		
CntLo8	geSPS_1	Digital counter 8 low	O	
CntUp1	geSPS_1	Digital counter 1 up	O	
..	..	..		
CntUp8	geSPS_1	Digital counter 8 up	O	
CntDwn1	geSPS_1	Digital counter 1 down	O	
..	..	..		
CntDwn8	geSPS_1	Digital counter 8 down	O	

CntSetPre1	geSPS_1	Digital counter 1 set preset	O	
..	..	..		
CntSetPre8	geSPS_1	Digital counter 8 set preset	O	
CntRst1	geSPS_1	Digital counter 1 reset	O	
..	..	..		
CntRst8	geSPS_1	Digital counter 8 reset	O	
CntFrzRst1	geSPS_1	Digital counter 1 FreezeReset	O	
..	..	..		
CntFrzRst8	geSPS_1	Digital counter 8 FreezeReset	O	
CntFrzCnt1	geSPS_1	Digital counter 1 FreezeCount	O	
..	..	..		
CntFrzCnt8	SPS_1	Digital counter 8 FreezeCount	O	

2.6 Logical Nodes for metering and measurement. LN Group: M

2.6.1 MMXU (Metering)

a) geMMXU_1

MMXU class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
MMXU		Measurement		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Measured values				
TotW	geFloatMV	Total active power (P)	O	
TotVAr	geFloatMV	Total reactive power (Q)	O	
TotVA	geFloatMV	Total apparent power (S)	O	
TotPF	geFloatMV	Average power factor (PF)	O	
LdHz	geFloatMV	Load Frequency	O	
LdPPV	geFloatDEL_1	Phase to phase load voltages (VL1L2,...)	O	
LdPhV	geFloatPhsWYE_1	Phase to ground load voltages (VL1ER, ...)	O	
SrPPV	geFloatDEL_1	Phase to phase source voltages (VL1L2,...)	O	
SrPhV	geFloatPhsWYE_1	Phase to ground source voltages (VL1ER, ...)	O	
A	geFloatWYE	Phase currents (IL1, ...)	O	
SrHz	geFloatMV_1	Source Frequency		

2.6.2 MSQI (Sequence and imbalance)

a) geMSQI_1

MSQI class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
MSQI		Measurement		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Measured values				
SeqA	geFloatSEQ		O	
LdSeqV	geFloatSEQ_1		O	
SrSeqV	geFloatSEQ_1		O	

2.6.3 MMTR

a) geMMTR

MMTR class				
Attribute Name	Attr. Type	Explanation	M/O	notes
MMTR		Measurement		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Measured values				
SupWh	geBCR		O	
SupVArh	geBCR		O	
DmdWh	geBCR		O	
DmdVArh	geBCR		O	
CntPsWh	geFloatMV_1		O	
CntNgWh	geFloatMV_1		O	
CntPsVArh	geFloatMV_1		O	
CntNgVArh	geFloatMV_1		O	

2.6.4 MHAI (Harmonics Measurement)

a) geCMHAI

MHAI class				
Attribute Name	Attr. Type	Explanation	M/O	notes
MHAI		Measurement		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Measured values				
Hz	geFloatMV	Load Frequency	O	
ThdA	geFloatWYE_2	Current Total Harmonic Distortion	O	
HAVal2	geFloatWYE_3	Current 2nd Harmonic	O	
HAVal3	geFloatWYE_3	Current 3rd Harmonic	O	
HAVal4	geFloatWYE_3	Current 4th Harmonic	O	
HAVal5	geFloatWYE_3	Current 5th Harmonic	O	
HAVal6	geFloatWYE_3	Current 6th Harmonic	O	
HAVal7	geFloatWYE_3	Current 7th Harmonic	O	
HAVal8	geFloatWYE_3	Current 8th Harmonic	O	
HAVal9	geFloatWYE_3	Current 9th Harmonic	O	
HAVal10	geFloatWYE_3	Current 10th Harmonic	O	
HAVal11	geFloatWYE_3	Current 11th Harmonic	O	
HAVal12	geFloatWYE_3	Current 12th Harmonic	O	
HAVal13	geFloatWYE_3	Current 13th Harmonic	O	
HAVal14	geFloatWYE_3	Current 14th Harmonic	O	
HAVal15	geFloatWYE_3	Current 15th Harmonic	O	

b) geVMHAI

1 logical node for Source Voltage harmonics measurement (SrcVMHAI) and 1 logical node for Load Voltage harmonics measurement (LodVMHAI)

MHAI class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
MHAI		Measurement		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Measured values				
Hz	geFloatMV	Source/Load Frequency	O	
ThdA	geFloatWYE_3	Source/Load Voltage Total Harmonic Distortion	O	
HVVal2	geFloatWYE_3	Source/Load Voltage 2nd Harmonic	O	
HVVal3	geFloatWYE_3	Source/Load Voltage 3rd Harmonic	O	
HVVal4	geFloatWYE_3	Source/Load Voltage 4th Harmonic	O	
HVVal5	geFloatWYE_3	Source/Load Voltage 5th Harmonic	O	
HVVal6	geFloatWYE_3	Source/Load Voltage 6th Harmonic	O	
HVVal7	geFloatWYE_3	Source/Load Voltage 7th Harmonic	O	
HVVal8	geFloatWYE_3	Source/Load Voltage 8th Harmonic	O	
HVVal9	geFloatWYE_3	Source/Load Voltage 9th Harmonic	O	
HVVal10	geFloatWYE_3	Source/Load Voltage 10th Harmonic	O	
HVVal11	geFloatWYE_3	Source/Load Voltage 11th Harmonic	O	
HVVal12	geFloatWYE_3	Source/Load Voltage 12th Harmonic	O	
HVVal13	geFloatWYE_3	Source/Load Voltage 13th Harmonic	O	
HVVal14	geFloatWYE_3	Source/Load Voltage 14th Harmonic	O	
HVVal15	geFloatWYE_3	Source/Load Voltage 15th Harmonic	O	

2.7 Logical Nodes for switchgear. LN Group: X

2.7.1 XSWI (Circuit switch)

a) geXSWI

This logical node has 12 switchgear (XSWI1 to XSWI12) and 3 switchgear for Recloser (recPhsAXSWI1, recPhsBXSWI1, recPhsCXSWI1, rec3PCSWI1)

XCBR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
XSWI		Circuit switch		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Loc	geSPS	Local operation	M	Local / Remote
EEHealth	geEEHealthENS	Ext. equipment health	O	
OpCnt	geINS	Operation counter	M	Breaker openings
Controls				
Pos	geDPC_2	Switch position	M	Breaker open, close
BlkOpn	geSPC_1	Block opening	M	Virtual output
BlkClr	geSPC_1	Block closing	M	Virtual output
SwTyp	geSwTypENS	Switch type	M	
SwOpCap	geSwOpCapENS	Switch operating capability		

b) geR650XSWI

This logical node has 1 switchgear for Recloser (rec3PCSWI1))

XCBR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**notes**
XSWI		Circuit switch		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Loc	geSPS	Local operation	M	Local / Remote
EEHealth	geEEHealthENS	Ext. equipment health	O	
OpCnt	geINS	Operation counter	M	Breaker openings
Controls				
Pos	geDPC_2	Switch position	M	Breaker open, close
BlkOpn	geSPC_1	Block opening	M	Virtual output
BlkClr	geSPC_1	Block closing	M	Virtual output
SwTyp	geSwTypENS	Switch type	M	
SwOpCap	geSwOpCapENS	Switch operating capability		
Settings				
RecTyp	geENG_5	Recloser Type	O	
MaxOpnh	geING_8_1	Maximum number of openings in 1 hour	O	
WrMonEna	geSPG	Wear Monitor Function	O	
WrMonAlm	geFloatASG_1	Wear Monitor Alarm	O	
IntrDtyA1	geFloatASG_1	Interrupting Duty Current 1	O	
IntrDtyOp1	geING_8_1	Maximum number of operations by interrupting from 15 to 20 % of the maximum interrupting current	O	
IntrDtyA2	geFloatASG_1	Interrupting Duty Current 2	O	
IntrDtyOp2	geING_8_1	Maximum number of operations by interrupting from 45 to 55 % of the maximum interrupting current	O	
IntrDtyA3	geFloatASG_1	Interrupting Duty Current 3	O	
IntrDtyOp3	geING_8_1	Maximum number of operations by interrupting from 90 to 100 % of the maximum interrupting current	O	
MaxOpn	geING_8_1	Maximum number of openings	O	
MaxIntrA	geFloatASG_1	Maximum interrupted current	O	
StatIntNum	geING_8_1	Statistics Integer Number	O	
SnpshtEvEna	geSPG	Snapshot Events enabled	O	
TrMod	geENG_6	Trip Mode	O	
TrSealMinTms	geFloatASG_1	Trip seal-in minimum time	O	
YllwHndlTms	geFloatASG_1	Yellow handle timer	O	
MinASup	geFloatASG_1	Minimum current supervision	O	
SPlTPEvEna	geSPG	Single-Three Pole Snapshot Events enabled	O	

3. Common Data Class

3.1 Common Data Class for status information

3.1.1 Single Point Status (SPS)

SPS class (Single point status)					
geSPS					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Boolean	ST	dchg		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geSPS_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Boolean	ST	dchg		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.1.2 Integer Status (INS)

INS class (Integer status)					
geINS					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	INT32	ST	dchg		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geINS_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Boolean	ST	dchg		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.1.3 Enumerated Status (ENS)

ENS class (Enumerated status)					
geAutoRecStENS (AutoRecSt)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enum	ST	dchg	Ready,InProgress,Successful,..	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					

d	Vstring255	DC			O
geAutoRecStENS_1 (AutoRecStPhA)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enum	ST	dchg	Ready,InProgress,Successful,..	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geBehENS (Beh)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enum	ST	dchg	On,blocked,test,test/blocked,Off	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geHealthENS (Health)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enum	ST	dchg	Ok,Warning,Alarm	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geEEHealthENS (EEHealth)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	INT32	ST	dchg	Ok,Warning,Alarm	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geCBOpCapENS (CBOpCap)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enumerated	ST	dchg	None,Open,Close-Open,...	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geSwOpCapENS (SwOpCap)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enumerated	ST	dchg	None,Open,Close,...	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geSwTypENS (SwTyp)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enumerated	ST	dchg	Load Break,Disconnector,...	M

q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geSynVRefENS (SynVRef)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enumerated	ST	dchg	Invalid, Va, Vb, Vc, Vab...	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.1.4 Protection activation information (ACT)

ACT class (Protection activation information)					
gePhsACT					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	dchg		M
phsA	Boolean	ST	dchg		O
phsB	Boolean	ST	dchg		O
phsC	Boolean	ST	dchg		O
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
configuration, description and extension					
d	Vstring255	DC			O
gePhsACT_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	dchg		M
phsA	Boolean	ST	dchg		O
phsB	Boolean	ST	dchg		O
phsC	Boolean	ST	dchg		O
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geNeutACT					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	dchg		M
neut	Boolean	ST	dchg		O
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
configuration, description and extension					
d	Vstring255	DC			O
geNeutACT_1					

Attribute Name	Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute					
control and status					
general	Boolean	ST	dchg		M
neut	Boolean	ST	dchg		O
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geGeneralACT					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	dchg		M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
configuration, description and extension					
d	Vstring255	DC			O
geGeneralACT_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	dchg		M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.1.5 Directional protection activation information (ACD)

ACD class (Directional protection activation information)					
gePhsACD					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
phsA	Boolean	ST	Dchg		GC_2(1)
dirPhsA	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(1)
phsB	Boolean	ST	dchg		GC_2(2)
dirPhsB	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(2)
phsC	Boolean	ST	dchg		GC_2(3)
dirPhsC	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(3)
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
gePhsACD_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					

general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
phsA	Boolean	ST	Dchg		GC_2(1)
dirPhsA	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(1)
phsB	Boolean	ST	dchg		GC_2(2)
dirPhsB	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(2)
phsC	Boolean	ST	dchg		GC_2(3)
dirPhsC	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(3)
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geNeutACD					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geNeutACD_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geGeneralACD					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geGeneralACD_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.1.6 Binary counter reading (BCR)

BCR class (Binary counter reading)					
geBCR					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
		control and status			
actVal	Int64	ST	Dchg		M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
		configuration, description and extension			
units	Unit	CF			O
pulsQty	Float32	CF			M
d	Vstring255	DC			O
geBCR_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
		control and status			
actVal	Int64	ST	dchg		M
frVal	Int64	ST	dchg		GC_2_1
frTm	Utctime	ST			GC_2_1
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
		configuration, description and extension			
pulsQty	Float32	CF			M
frEna	Boolean	CF			GC_2_1
strTm	Utctime	CF			GC_2_1
frPd	Int32	CF			GC_2_1
frRs	Boolean	CF			GC_2_1
d	Vstring255	DC			O
geBCR_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
		control and status			
actVal	Int64	ST	dchg		M
frVal	Int64	ST	dchg		GC_2_1
frTm	Utctime	ST			GC_2_1
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
		configuration, description and extension			
pulsQty	Float32	CF			M
frEna	Boolean	CF			GC_2_1
strTm	Utctime	CF			GC_2_1
frPd	Int32	CF			GC_2_1
frRs	Boolean	CF			GC_2_1
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.2 Common data class specifications for measurand information

3.2.1 Measured Value (MV)

MV class (Measured value)					
geFloatMV					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
instMag	FloatAnalogueValue	MX	------		O
f	FLOAT32				GC_1
mag	FloatAnalogueValue	MX	dchg		M
f	FLOAT32				GC_1
range	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, description and extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
db	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
hhLim	FloatAnalogueValue				
f	FLOAT32				GC_1
hlim	FloatAnalogueValue				
f	FLOAT32				GC_1
lLim	FloatAnalogueValue				
f	FLOAT32				GC_1
llLim	FloatAnalogueValue				
f	FLOAT32				GC_1
min	FloatAnalogueValue				
f	FLOAT32				GC_1
max	FloatAnalogueValue				
f	FLOAT32				GC_1
limDb	INT32U				
d	Vstring255	DC			O
geFloatMV_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
instMag	FloatAnalogueValue	MX	------		O
f	FLOAT32				GC_1
mag	FloatAnalogueValue	MX	dchg		M
f	FLOAT32				GC_1
range	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, description and extension					

units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
db	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
hhLim	FloatAnalogueValue				
f	FLOAT32				GC_1
hlim	FloatAnalogueValue				
f	FLOAT32				GC_1
lLim	FloatAnalogueValue				
f	FLOAT32				GC_1
llLim	FloatAnalogueValue				
f	FLOAT32				GC_1
min	FloatAnalogueValue				
f	FLOAT32				GC_1
max	FloatAnalogueValue				
f	FLOAT32				GC_1
limDb	INT32U				
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geFloatMV_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
mag	FloatAnalogueValue	MX	dchg		M
f	FLOAT32				GC_1
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, description and extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geFloatMV_3					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
mag	FloatAnalogueValue	MX	dchg		M
f	FLOAT32				GC_1
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, description and extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
d	Vstring255	DC			O
geFloatMV_4					

Attribute Name	Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute					
measured attributes					
instMag	FloatAnalogueValue	MX	------		O
f	FLOAT32				GC_1
mag	FloatAnalogueValue	MX	dchg		M
f	FLOAT32				GC_1
range	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, description and extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
db	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
hhLim	FloatAnalogueValue				
f	FLOAT32				GC_1
hlim	FloatAnalogueValue				
f	FLOAT32				GC_1
lLim	FloatAnalogueValue				
f	FLOAT32				GC_1
llLim	FloatAnalogueValue				
f	FLOAT32				GC_1
min	FloatAnalogueValue				
f	FLOAT32				GC_1
max	FloatAnalogueValue				
f	FLOAT32				GC_1
limDb	INT32U				
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, description and extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
d	Vstring255	DC			O
geIntMV					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
instMag	IntAnalogueValue	MX	------		O
i	INT32				GC_1
mag	IntAnalogueValue	MX	dchg		M
i	INT32				GC_1
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, description and extension					

units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
db	INT32U	CF			O
d	Vstring255	DC			O
geIntMV_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
instMag	IntAnalogueValue	MX	------		O
i	INT32				GC_1
mag	IntAnalogueValue	MX	dchg		M
i	INT32				GC_1
range	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, description and extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
db	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
hhLim	IntAnalogueValue				
i	INT32U				GC_1
hlim	IntAnalogueValue				
i	UINT32				GC_1
lLim	IntAnalogueValue				
i	INT32U				GC_1
llLim	IntAnalogueValue				
i	INT32U				GC_1
min	IntAnalogueValue				
i	INT32U				GC_1
max	IntAnalogueValue				
i	INT32U				GC_1
limDb	INT32U				
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.2.2 Complex Measured Value (CMV)

CMV class (Complex measured value)					
geFloatCMV					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
instCVal	FloatVector	MX	------		O
mag	FloatAnalogueValue				
f	FLOAT32				
cVal	FloatVector	MX	dchg		M
mag	FloatAnalogueValue				
f	FLOAT32				
range	ENUMERATED(Byte)	MX	dchg		O
rangeAng	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
configuration, description and extension					
units	Unit	CF			O
SIUnit	Byte				M
Multiplier	Byte				O
db	INT32U	CF			O
dbAng	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
rangeAngC	RangeConfig	CF			O
d	Vstring255	DC			O
geFloatCMV_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
instCVal	FloatVector	MX	------		O
mag	FloatAnalogueValue				
f	FLOAT32				
cVal	FloatVector	MX	dchg		M
mag	FloatAnalogueValue				
f	FLOAT32				
range	ENUMERATED(Byte)	MX	dchg		O
rangeAng	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
configuration, description and extension					
units	Unit	CF			O
SIUnit	Byte				M
Multiplier	Byte				O
db	INT32U	CF			O
dbAng	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
rangeAngC	RangeConfig	CF			O

d	Vstring255	DC			O
dataNs	Vstring255	EX			M
geFloatCMV_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
instCVal	FloatVector	MX	------		O
mag	FloatAnalogueValue				
f	FLOAT32				
cVal	FloatVector	MX	dchg		M
mag	FloatAnalogueValue				
f	FLOAT32				
range	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
configuration, description and extension					
units	Unit	CF			O
SIUnit	Byte				M
Multiplier	Byte				O
db	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
d	Vstring255	DC			O

3.2.3 Phase to ground related measured values of a three phase system (WYE)

WYE class					
geFloatPhsWYE					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
phsA	geFloatCMV				GC_1
phsB	geFloatCMV				GC_1
phsC	geFloatCMV				GC_1
neut	geFloatCMV				GC_1
configuration, description and extension					
d	Vstring255	DC			O
geFloatWYE					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
phsA	geFloatCMV				GC_1
phsB	geFloatCMV				GC_1
phsC	geFloatCMV				GC_1
neut	geFloatCMV				GC_1
net	geFloatCMV				GC_1
res	geFloatCMV				GC_1
configuration, description and extension					
d	Vstring255	DC			O
geFloatWYE_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
phsA	geFloatCMV				GC_1
phsB	geFloatCMV				GC_1
phsC	geFloatCMV				GC_1

configuration, description and extension					
d	Vstring255	DC			O
geFloatWYE_3					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
phsA	geFloatCMV				GC_1
phsB	geFloatCMV				GC_1
phsC	geFloatCMV				GC_1
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			M

3.2.4 Phase to phase related measured values of a three phase system (DEL)

DEL class (Phase to phase related measured values of a three phase system)					
geFloatDEL					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
phsAB	CMV_0				GC_1
phsBC	CMV_0				GC_1
phsCA	CMV_0				GC_1
configuration, description and extension					
d	Vstring255	DC			O

3.2.5 Sequence (SEQ)

SEQ class (Sequence)					
geFloatSEQ					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
c1	CMV_0				GC_1
c2	CMV_0				GC_1
c3	CMV_0				GC_1
Measured attributes					
seqT	enumerated	MX		Pos-neg-zero | dir-quad-zero	O
configuration, description and extension					
d	Vstring255	DC			O

3.3 Common data class specifications for controllable status information

3.3.1 Controllable single point (SPC)

SPC class						
geSPC						
Attribute Name		**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute						
control and status						
stVal		Boolean	ST		FALSE | TRUE	AC_ST
q		Quality	ST			AC_ST
t		TimeStamp	ST			AC_ST
control and status						
Oper	ctlVal	Boolean	CO			AC_CO_M
	origin	Originator	CO			AC_CO_M
	orCat	ENUMERATED				M
	orIdent	OCTECT64				M
	ctlNum	INT8U	CO			M
	T	Btime6	CO			M
	Test	Boolean	CO			M
	Check	ENUMERATED	CO			M
configuration, description and extension						
ctlModel		ENUMERATED	CF		ctlModel	M
operTimeout		INT32U	CF			AC_CO_O
d		Vstring255	DC			O
geSPC_1						
Attribute Name		**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute						
control and status						
stVal		Boolean	ST		FALSE | TRUE	AC_ST
Q		Quality	ST			AC_ST
t		TimeStamp	ST			AC_ST
configuration, description and extension						
ctlModel		ENUMERATED	CF		**ctlModel_1**	M
d		Vstring255	DC			O

3.3.2 Controllable double point (DPC)

DPC class (Controllable double point)						
geDPC						
Attribute Name		**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute						
control and status						
Oper	ctlVal	Boolean	CO			AC_CO_M
	origin	Originator	CO,ST			AC_CO_M
	orCat	ENUMERATED				M
	orIdent	OCTECT64				M
	ctlNum	INT8U	CO,ST			M
	T	Btime6	CO			M
	Test	Boolean	CO			M
	Check	ENUMERATED	CO			M
stVal		CODE ENUM	ST	dchg	intermediate-state | off | on | bad-state	M
q		BVstring13	ST	qchg		AC_ST
t		Utctime	ST			AC_ST
configuration, description and extension						
ctlModel		ENUMERATED	CF			M

operTimeout		INT32U	CF			AC_CO_O
d		Vstring255	DC			O
geDPC_1						
Attribute Name		**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute						
control and status						
Oper	ctlVal	Boolean	CO			AC_CO_M
	origin	Originator	CO,ST			AC_CO_M
	orCat	ENUMERATED				M
	orIdent	OCTECT64				M
	ctlNum	INT8U	CO,ST			M
	T	Btime6	CO			M
	Test	Boolean	CO			M
	Check	ENUMERATED	CO			M
Cancel						
SBO						
SBOw						
stVal		CODE ENUM	ST	dchg	intermediate-state | off | on | bad-state	M
q		BVstring13	ST	qchg		AC_ST
t		Utctime	ST			AC_ST
configuration, description and extension						
ctlModel		ENUMERATED	CF			M
sboTimeout		INT32U	CF			AC_CO_O
sboClass		ENUMERATED	CF			AC_CO_O
operTimeout		INT32U	CF			AC_CO_O
d		Vstring255	DC			O
geDPC_2						
Attribute Name		**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute						
control and status						
stVal		CODE ENUM	ST	dchg	intermediate-state | off | on | bad-state	M
q		BVstring13	ST	qchg		AC_ST
t		Utctime	ST			AC_ST
configuration, description and extension						
ctlModel		ENUMERATED	CF			M
d		Vstring255	DC			O

3.3.3 Controllable enumerated status (ENC)

ENC class (Controllable integer status)					
geModENC (type Mod)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enum	ST	dcgh		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
ctlModel	ENUMERATED	CF			M
d	Vstring255	DC			O

3.4 Common data class specifications for status settings

3.4.1 Single point setting (SPG)

SPG class					
geSPG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Boolean	SP			AC_NSG_M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geSPG_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Boolean	SG			AC_SG_M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geSPG_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Boolean	SG			AC_SG_M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			O

3.4.2 Integer status setting (ING)

ING class					
geING_0					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Boolean	SP			AC_NSG_M
configuration, description and extension					
minVal	INT32	CF			O
maxVal	INT32	CF			O
stepSize	INT32	CF			O
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geING_0_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Boolean	SG			AC_SG_M
configuration, description and extension					
minVal	INT32	CF			O
maxVal	INT32	CF			O
stepSize	INT32	CF			O
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geING_8					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					

setVal	Boolean	SP			AC_NSG_M
configuration, description and extension					
minVal	INT32	CF			O
maxVal	INT32	CF			O
stepSize	INT32	CF			O
d	Vstring255	DC			O
geING_8_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Boolean	SP			AC_NSG_M
configuration, description and extension					
minVal	INT32	CF			O
maxVal	INT32	CF			O
stepSize	INT32	CF			O
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geING_8_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Boolean	SG			AC_SG_M
configuration, description and extension					
minVal	INT32	CF			O
maxVal	INT32	CF			O
stepSize	INT32	CF			O
d	Vstring255	DC			O

3.4.3 Enumerated status setting (ENG)

ENG class					
geENG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Enumerated	SP		PolQty	AC_NSG_M
configuration, description and extension					
d	Vstring255	DC			O
geENG_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Enumerated	SG		PolQty	AC_SG_M
configuration, description and extension					
d	Vstring255	DC			O
geENG_3					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Enumerated	SG		PolQty	AC_SG_M
configuration, description and extension					
dataNs	Vstring255	EX			O
d	Vstring255	DC			O
geENG_4					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					

setting					
setVal	Enumerated	SG		PolQty	AC_SG_M
configuration, description and extension					
dataNs	Vstring255	EX			O
d	Vstring255	DC			O
geENG_5					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Enumerated	SG		PolQty	AC_SG_M
configuration, description and extension					
dataNs	Vstring255	EX			O
d	Vstring255	DC			O
geENG_6					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Enumerated	SG		PolQty	AC_SG_M
configuration, description and extension					
dataNs	Vstring255	EX			O
d	Vstring255	DC			O

3.4.4 Object reference setting

ORG class					
geORG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setSrcRef	ObjectReference	SP		Object reference	M
configuration, description and extension					
d	Vstring255	DC			O

3.5 Common data class specifications for analogue settings

3.5.1 Analoque setting (ASG)

ASG class					
geIntASG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setMag	IntAnalogueValue	SP			AC_NSG_M
i	INT32				GC_1
configuration, description and extension					
units	Unit	CF			
minVal	IntAnalogueValue	CF			O
i	INT32				GC_1
maxVal	IntAnalogueValue	CF			O
i	INT32				GC_1
stepSize	IntAnalogueValue	CF			O
i	INT32				GC_1
d	Vstring255	DC			O
geIntASG_1					

Attribute Name	Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute					
setting					
setMag	IntAnalogueValue	SP			AC_NSG_M
i	INT32				GC_1
configuration, description and extension					
units	Unit	CF			
minVal	IntAnalogueValue	CF			O
i	INT32				GC_1
maxVal	IntAnalogueValue	CF			O
i	INT32				GC_1
stepSize	IntAnalogueValue	CF			O
i	INT32				GC_1
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geIntASG_3					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setMag	IntAnalogueValue	SG			AC_SG_M
i	INT32				GC_1
configuration, description and extension					
units	Unit	CF			
minVal	IntAnalogueValue	CF			O
i	INT32				GC_1
maxVal	IntAnalogueValue	CF			O
i	INT32				GC_1
stepSize	IntAnalogueValue	CF			O
i	INT32				GC_1
d	Vstring255	DC			O
geFloatASG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setMag	FloatAnalogueValue	SP			AC_NSG_M
f	FLOAT32				GC_1
configuration, description and extension					
Units	Unit	CF			
minVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
maxVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
stepSize	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
d	Vstring255	DC			O
geFloatASG_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					

setMag	FloatAnalogueValue	SP			AC_NSG_M
f	FLOAT32				GC_1
configuration, description and extension					
Units	Unit	CF			
minVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
maxVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
stepSize	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
d	Vstring255	DC			O
dataNs	Vstring255	EX			O

geFloatASG_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setMag	FloatAnalogueValue	SG			AC_SG_M
f	FLOAT32				GC_1
configuration, description and extension					
Units	Unit	CF			
minVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
maxVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
stepSize	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
d	Vstring255	DC			O

3.6 Common data class specifications for description information

3.6.1 Device name plate (geDPL)

geDPL class (Device name plate)					
geDPL					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
vendor	Vstring255	DC			M
hwRev	Vstring255	DC			O
swRev	Vstring255	DC			O
serNum	Vstring255	DC			O
model	Vstring255	DC			O

3.6.2 Logical node name plate (LPL)

LPL class (Logical node name plate)					
geLPL					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
vendor	Vstring255	DC			M
swRev	Vstring255	DC			M
d	Vstring255	DC			M
configRev	Vstring255	DC			AC_LN0_M
geLPL_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
vendor	Vstring255	DC			M
swRev	Vstring255	DC			M
d	Vstring255	DC			M
configRev	Vstring255	DC			AC_LN0_M
ldNs	Vstring255	EX			O

7.3.7.6 TICS for R650 relays

Reference documentation: **R650-TICS_v800**.

This document describes the:

- Introduction
- TICS Template

1 Introduction

This document provides a template for the tissues conformance statement (TICS). According to the UCA QAP the TICS is required to perform a conformance test and is referenced on the final certificate.

In this TICS template only tissues with a "green" status are considered since they become mandatory and thus must be included in the UCA Device conformance test procedures.

"Green" Tissues listed in this document represent the current status of all Tissues for a date of the document creation. As for some of the remaining tissues, they are not yet included in the test procedures, either because they are just a recommendation or optional within the IEC 61850 documents, or because their respective proposals are not defined in such detail to be implemented or tested, or because they are simply not applicable, just editorial, with no change for implementation and testing.

The supported ("Sup") column indicates:

- Y: yes, the tissue is implemented in the device.
- N: no, the tissue is not implemented in the device.
- N.A.: not applicable, the tissue is not applicable for the device.

2 TICS Template

Tissue No.	Description	Supported? (Y / N / N.A.)
IEC 61850 Part 6		
658	Tracking related features	NA
663	FCDA element cannot be a "functionally constrained logical node"	Y
668	Autotransformer modeling	NA
687	SGCB ResvTms	NA
719	ConfDataSet - maxAttributes definition is confusing	Y
721	Log element name	NA
768	bType VisString65 is missing	Y
770	Goose ID max. length is 129 characters	Y
779	object references	Y
788	SICS S56 from optional to mandatory	NA
789	ConfLdName as services applies to both server and client	Y
804	valKind and IED versus System configuration	NA
806	Max length of log name inconsistent between -6 and -7-2	NA
807	Need a way to indicate if "Owner" present in RCB	NA
822	Extension of IED capabilities	NA
823	ValKind for structured data attributes	NA
824	Short addresses on structured data attributes	NA
825	Floating point value	NA

Tissue No.	Description	Supported? (Y / N / N.A.)
845	SGCB ResvTms	NA
IEC 61850 Part 6		
853	SBO and ProtNs	NA
855	Recursive SubFunction	NA
856	VoltageLevel frequency and phases	NA
857	Function/SubFunction for ConductingEquipment	NA
886	Missing 8-1 P-types	NA
901	tServices as AP or as IED element	NA
936	SupSubscription parameter usage is difficult	NA
1168	doName and daName of ExtRef; doName may have one dot (DO.SDO)	NA
1175	IPv6 address lowercase only	NA
IEC 61850 Part 7-1		
828	Data model namespace revision IEC 61850-7-4:2007[A]	Y
1151	simulated GOOSE disappears after 1st appearance when LPHD.Sim = TRUE	NA
1196	Extensions to standardized LN classes made by third parties	NA
IEC 61850 Part 7-2		
778	AddCause values - add value not-supported	Y
780	What are unsupported trigger option at a control block?	Y
783	TimOper Resp- ; add Authorization check	NA
786	AddCause values 26 and 27 are switched	Y
820	Mandatory ACSI services (use for PICS template)	NA
858	typo in enumeration ServiceType	NA
861	dchg of ConfRev attribute	NA
876	GenLogicalNodeClass and SGCB, GoCB, MsvCB, UsvCB	NA
1038	Loss of Info Detection After Resynch	NA
1050	GTS Phycomaddr definition in SCL	NA
1062	Entrytime not used in CDC	NA
1071	Length of DO name	Y
1091	The sentence "The initial value of EditSG shall be 0", has to be stated in part 7.2 not in 8.1	NA
1127	Missing owner attribute in BTS and UTS	NA
1163	Old report in URCB	NA
1202	GI not optional	Y
IEC 61850 Part 7-3		
697	persistent command / PulseConfig	NA
698	Wrong case is BAC.dB attribute	NA
722	Units for 'h' and 'min' not in UnitKind enumeration.	NA
919	Presence Condition for sVC	NA
925	Presence of i or f attribute - Problem with writing	NA
926	Presence Conditions within RangeConfig	Y
IEC 61850 Part 7-4		
671	mistake in definition of Mod & Beh	NA
674	CDC of ZRRC.LocSta is wrong	NA
675	SIML LN	NA
676	Same data object name used with different CDC	NA
677	MotStr is used with different CDC in PMMS and SOPM LN classes	NA
679	Remove CycTrMod Enum	NA
680	SI unit for MHYD.Cndct	NA

Tissue No.	Description	Supported? (Y / N / N.A.)
681	Enum PIDAlg	NA
682	ANCR.ParColMod	NA
683	Enum QVVR.IntrDetMth	NA
685	Enum ParTraMod	NA
686	New annex H - enums types in XML	NA
694	Data object CmdBlk	NA
696	LSVS.St (Status of subscription)	NA
712	interpretation of quality operatorBlocked	NA
713	DO Naming of time constants in FFIL	NA
724	ANCR.Auto	NA
725	Loc in LN A-group	NA
734	LLN0.OpTmh vs. LPHD.OpTmh	NA
735	ISAF.Alm and ISAF.AlmReset	NA
736	PFSign	NA
742	GAPC.Str, GAPC.Op and GAPC.StrVal	NA
743	CCGR.PmpCtl and CCGR.FanCtl	NA
744	LN STMP, EEHealth and EEName	NA
772	LPHD.PwrUp/PwrDn shall be transient	NA
773	Loc, LocKey and LocSta YPSH and YLTC	NA
774	ITCI.LocKey	NA
775	KVLV.ClsLim and OpnLim	NA
776	LPHD.OutOv/InOv and LCCH.OutOv/InOv	NA
800	Misspelling in CSYN	NA
802	CCGR and Harmonized control authority	NA
808	Presence condition of ZMOT.DExt and new DOs	NA
831	Setting of ConfRevNum in LGOS	NA
838	Testing in Beh=Blocked	NA
844	MFLK.PhPiMax, MFLK.PhPiLoFil, MFLK.PhPiRoot DEL->WYE	NA
849	Presence conditions re-assessing in case of derived statistical calculation	NA
877	QVUB -settings should be optional	NA
909	Remove ANCR.ColOpR and ColOpL	NA
920	Resetable Counter is NOT resetable	NA
932	Rename AVCO.SptVol to AVCO.VolSpt	NA
939	Change CDC for ANCR.FixCol	NA
991	LGOS: GoCBRef (as well as LSVS.SvCBRef) should be mandatory	NA
1007	PTRC as fault indicator - Update of description required	Y
1044	TapChg in AVCO	NA
1077	Rename DOnames within LTIM	NA
IEC 61850 Part 8-1		
784	Tracking of control (CTS)	NA
817	Fixed-length GOOSE float encoding	NA
834	File dir name length 64	Y
951	Encoding of Owner attribute	NA
1040	More associate error codes	NA
1178	Select Response+ is non-null value	Y

Note: Tissues 675, 735, 772, 775, 776, 878 are not relevant for conformance testing

Compare the TISSUE database for more details: www.tissues.iec61850.com

7.3.7.7 PIXIT for R650 relays

Reference documentation: **R650-PIXIT_v800**.

This document describes the:

- PIXIT for Association Model
- PIXIT for Server model
- PIXIT for Dataset model
- PIXIT for Reporting model
- PIXIT for Generic substation events model
- PIXIT for Control model
- PIXIT for Time and time synchronisation model
- PIXIT for File transfer model

This document specifies the protocol implementation extra information for testing (PIXIT) of the IEC 61850 interface in 650 family of relays.

Together with the PICS and the MICS the PIXIT forms the basis for a conformance test according to IEC 61850-10.

Contents of this document: Each chapter specifies the PIXIT for each applicable ACSI service model as structured in IEC 61850-10.

1 Pixit For Association Model

ID	ED	Description	Value / Clarification
As1	1	Maximum number of clients that can set-up an association simultaneously	5
As2	1,2	TCP_KEEPALIVE value. The recommended range is 1..20s	5 seconds but if no application message is detected within the As3 value, the device closes the connection.
As3	1,2	Lost connection detection time	120 seconds (Configurable)
As4	-	Authentication is not supported yet	
As5	1,2	What association parameters are necessary for successful association	Transport selector Y Session selector Y Presentation selector Y AP Title N AE Qualifier N
As6	1,2	If association parameters are necessary for association, describe the correct values e.g.	Transport selector 0001 Session selector 0001 Presentation selector 00000001 AP Title NA AE Qualifier NA
As7	1,2	What is the maximum and minimum MMS PDU size	Max MMS PDU size 120000 Min MMS PDU size32000.
As8	1,2	What is the maximum start up time after a power supply interrupt	90 seconds

2 PIXIT for Server model

ID	ED	Description	Value / Clarification
Sr1	1,2	Which analogue value (MX) quality bits are supported (can be set by server)	Validity: Y Good, Y Invalid, N Reserved, Y Questionable N Overflow Y OutofRange Y BadReference N Oscillatory Y Failure N OldData N Inconsistent N Inaccurate Source: N Process N Substituted N Test N OperatorBlocked
Sr2	1,2	Which status value (ST) quality bits are supported (can be set by server)	Validity: Y Good, Y Invalid, N Reserved, Y Questionable N BadReference Y Oscillatory Y Failure N OldData N Inconsistent N Inaccurate Source: Y Process Y Substituted Y Test N OperatorBlocked
Sr3	-	What is the maximum number of data object references in one GetDataValues request	Deprecated
Sr4	-	What is the maximum number of data object references in one SetDataValues request	Deprecated
Sr5	1	Which Mode values are supported [1]	On Y [On-]Blocked N Test N Test/Blocked N Off N

1. IEC 61850-6:2009 clause 9.5.6 states that if only a subrange of the enumeration value set is supported, this shall be indicated within an ICD file by an enumeration type, where the unsupported values are missing

3 PIXIT for Dataset model

ID	ED	Description	Value / Clarification
Ds1	1	What is the maximum number of data elements in one data set (compare ICD setting)	576
Ds2	1	How many persistent data sets can be created by one or more clients (this number includes predefined datasets)	NOT SUPPORTED
Ds3	1	How many non-persistent data sets can be created by one or more clients	NOT SUPPORTED

4 PIXIT for Substitution model

ID	ED	Description	Value / Clarification
Sb1	1	Are substituted values stored in volatile memory	NOT SUPPORTED

5 PIXIT for Setting group control model

ID	ED	Description	Value / Clarification
Sg1	1	What is the number of supported setting groups for each logical device	3 groups for “PRO” logical device 3
Sg2	1,2	What is the effect of when and how the non-volatile storage is updated (compare IEC 61850-8-1 $16.2.4)	The server saves to non-volatile storage 25 seconds after confirmation.
Sg3	1	Can multiple clients edit the same setting group	No
Sg4	1	What happens if the association is lost while editing a setting group	Lost Permission and EditSG = 0
Sg5	1	Is EditSG value 0 allowed	Yes
Sg6	2	When ResvTms is not present how long is an edit setting group locked	While EditSG > 0

6 PIXIT for Reporting model

ID	ED	Description	Value / Clarification
Rp1	1	The supported trigger conditions are (compare PICS)	integrity Y data change Y quality change Y data update N general interrogation Y
Rp2	1	The supported optional fields are	sequence-number Y report-time-stamp Y reason-for-inclusion Y data-set-name Y data-reference Y buffer-overflow Y entryID Y conf-rev Y segmentation Y
Rp3	1,2	Can the server send segmented reports	Y

Rp4	1,2	Mechanism on second internal data change notification of the same analogue data value within buffer period (Compare IEC 61850-7-2 $14.2.2.9)	Send report immediately
Rp5	1	Multi client URCB approach (compare IEC 61850-7-2:2003 $14.2.1)	Each URCB is visible to all clients
Rp6	-	What is the format of EntryID	Deprecated
Rp7	1,2	What is the buffer size for each BRCB or how many reports can be buffered	Buffer size = 50000 Bytes
Rp8	-	Pre-configured RCB attributes that are dynamic, compare SCL report settings	Deprecated
Rp9	1	May the reported data set contain: - structured data objects - data attributes	 Y Y (timestamp attributes are not supported)
Rp10	1,2	What is the scan cycle for binary events Is this fixed, configurable	Event Driven Fixed
Rp11	1	Does the device support to pre-assign a RCB to a specific client in the SCL	N
Rp12	2	After restart of the server is the value of ConfRev restored from the original configuration or retained prior to restart	Restored from original configuration

7 PIXIT for Logging model

ID	ED	Description	Value / Clarification
Lg1	1,2	What is the default value of LogEna (Compare IEC 61850-8-1 $17.3.3.2.1, the default value should be FALSE)	NOT SUPPORTED
Lg2	-	What is the format of EntryID	Deprecated
Lg3	1,2	Are there are multiple Log Control Blocks that specify the Journaling of the same MMS NamedVariable and TrgOps and the Event Condition (Compare IEC 61850-8-1 $17.3.3.3.2)	NOT SUPPORTED
Lg4	1	Pre-configured LCB attributes that cannot be changed online	NOT SUPPORTED

8 PIXIT for GOOSE publish model

ID	ED	Description	Value / Clarification
Gp1	1,2	Can the test (Ed1) / simulation (Ed2) flag in the published GOOSE be set	N
Gp2	1	What is the behavior when the GOOSE publish configuration is incorrect	DUT keeps GoEna=F. Configuration tool does not allow wrong configuration to be uploaded into device. E.g.: empty dataset.
Gp3	-	Published FCD supported common data classes are	SPS, INS, ENS, ACT, ACD, MV, CMV, SAV, WYE, DEL, SEQ, INC, ENC, SPC, DPC, INC, ENC. (Only the elements with FC=ST or MX are published).
Gp4	1,2	What is the slow retransmission time Is it fixed or configurable	Configured by SCL or GoCB MaxTime
Gp5	1,2	What is the fastest retransmission time Is it fixed or configurable	Fixed. MinTime = 5 ms
Gp6	1,2	Can the GOOSE publish be turned on / off by using SetGoCBValues(GoEna)	Y
Gp7	1,2	What is the initial GOOSE sqNum after restart	sqNum = 1

Gp8	1	May the GOOSE data set contain: - structured data objects (FCD) - timestamp data attributes	Y Y (timestamp attributes are not supported)
Gp9	2	How is the retransmission curve after a change.	sqNum = 0 New change sqNum = 1 -> 5ms later with TAL = 1000 sqNum = 2 -> 10ms later with TAL = 1000 sqNum = 3 -> 15ms later with TAL = 4000 sqNum = 4 -> 1000ms later with TAL = Update time* multipled by 4 sqNum = 5 -> Update time* later with TAL = Update time* multipled by 4 sqNum = 6-> Update time* later with TAL = Update time* multipled by 4 sqNum = 7 .... ***Update time** is configured in the ICT

9 PIXIT for GOOSE subscribe model

ID	ED	Description	Value / Clarification
Gs1	1,2	What elements of a subscribed GOOSE header are checked to decide the message is valid and the allData values are accepted? If yes, describe the conditions. Notes: · the VLAN tag may be removed by a ethernet switch and shall not be checked · the simulation flag shall always be checked (Ed2) · the ndsCom shall always be checked (Ed2)	Y destination MAC address Y APPID N gocbRef Y timeAllowedtoLive N datSet Y goID N t N stNum N sqNum Y simulation / test N confRev Y ndsCom Y numDatSetEntries
Gs2	1,2	When is a subscribed GOOSE marked as lost (TAL = time allowed to live value from the last received GOOSE message)	message does not arrive after TAL
Gs3	1,2	What is the behavior when one or more subscribed GOOSE messages isn't received or syntactically incorrect (missing GOOSE)	Message is ignored, but when the next correct message is received, it proceeds as normal.
Gs4	1,2	What is the behavior when a subscribed GOOSE message is out-of-order	Message proceeds
Gs5	1,2	What is the behavior when a subscribed GOOSE message is duplicated	Message is ignored
Gs6	1	Does the device subscribe to GOOSE messages with/without the VLAN tag	Y, with the VLAN tag Y, without the VLAN tag
Gs7	1	May the GOOSE data set contain: - structured data objects (FCD) - timestamp data attributes	Y N
Gs8	1,2	Subscribed FCD supported common data classes are	DUT can receive all kinds of data but only digitals can be mapped.
Gs9	1,2	Are subscribed GOOSE with test=T (Ed1) / simulation=T (Ed2) accepted in test/simulation mode	N

Gs10	2	What is the behavior when a subscribed GOOSE message with TAL = 0 is received by the subscriber.	The message is ignored. The mechanism applies where the new GOOSE message is not received within a TAL.
Gs11	2	What is the behavior when a subscribed GOOSE message hasn't the expected data structure.	The message is ignored. The mechanism applies where the new GOOSE message is not received within a TAL.

10 PIXIT for Control model

ID	ED	Description	Value / Clarification
Ct1	-	What control models are supported (compare PICS)	Deprecated
Ct2	1,2	Is the control model fixed, configurable and/or dynamic	Configurable & Dynamic
Ct3	-	Is TimeActivatedOperate supported (compare PICS or SCL)	Deprecated
Ct4	-	Is "operate-many" supported (compare sboClass)	Deprecated
Ct5	1	Will the DUT activate the control output when the test attribute is set in the SelectWithValue and/or Operate request (when N test procedure Ctl2 is applicable)	N
Ct6	-	What are the conditions for the time (T) attribute in the SelectWithValue and/or Operate request	Deprecated
Ct7	-	Is pulse configuration supported (compare pulseConfig)	Deprecated
Ct8	1,2	What is the behavior of the DUT when the check conditions are set Is this behavior fixed, configurable, online changeable	N synchrocheck N interlock-check DUT ignores the check value and always perform the check

Ct9	1,2	Which additional cause diagnosis are supported	Y Unknown Y Not-supported Y Blocked-by-switching-hierarchy N Select-failed Y Invalid-position Y Position-reached N Step-limit Y Blocked-by-Mode N Blocked-by-process N Blocked-by-interlocking N Blocked-by-synchrocheck Y Command-already-in-execution N Blocked-by-health N 1-of-n-control N Abortion-by-cancel Y Time-limit-over N Abortion-by-trip Y Object-not-selected Edition 1 specif values: N Parameter-change-in-execution Edition 2 specific values: Y Object-already-selected N No-access-authority N Ended-with-overshoot N Abortion-due-to-deviation N Abortion-by-communication-loss N Blocked-by-command N None Y Inconsistent-parameters Y Locked-by-other-client N Parameter-change-in-execution
Ct10	1,2	How to force a “test-not-ok” respond with SelectWithValue request	Device in local mode
Ct11	1,2	How to force a “test-not-ok” respond with Select request	
Ct12	1,2	How to force a “test-not-ok” respond with Operate request	DOns: Sending T=1 SBOns: Sending T=1 DOes: Sending T=1 SBOes: Sending T=1
Ct13	1,2	Which origin categories are supported / accepted	N bay-control Y station-control Y remote-control N automatic-bay Y automatic-station Y automatic-remote N maintenance N process

Ct14	1,2	What happens if the orCat value is not supported or invalid	DOns: control is rejected (Oper- ObjectAccessDenied). SBOns: control is rejected (Oper- ObjectAccessDenied). DOes: control is rejected (Oper- ServiceError, ObjectAccessDenied). SBOes: control is rejected (SBOw- ServiceError, ObjectAccessDenied).
Ct15	1,2	Does the IED accept a SelectWithValue / Operate with the same control value as the current status value Is this behavior configurable	DOns: N SBOns: N DOes: N SBOes: N Configurable N
Ct16	1,2	Does the IED accept a select/operate on the same control object from 2 different clients at the same time	DOns: N SBOns: N DOes: N SBOes: N
Ct17	1	Does the IED accept a Select/SelectWithValue from the same client when the control object is already selected (Tissue #334)	SBOns: N SBOes: N
Ct18	1,2	Is for SBOes the internal validation performed during the SelectWithValue and/or Operate step	SelectWithValue and Operate
Ct19	-	Can a control operation be blocked by Mod=Off or [On-]Blocked (Compare PIXIT-Sr5)	Deprecated
Ct20	1,2	Does the IED support local / remote operation	Y (Only for XCBR)
Ct21	1,2	Does the IED send an InformationReport with LastApplError as part of the Operate response- for control with normal security	SBOns: N DOns: N
Ct22	2	How to force a “parameter-change-in-execution”	SBOns:Not Applicable SBOes:Not Applicable

11 PIXIT for Time synchronisation model

ID	ED	Description	Value / Clarification
Tm1	1,2	What time quality bits are supported (may be set by the IED)	Y LeapSecondsKnown N ClockFailure Y ClockNotSynchronized.
Tm2	1,2	Describe the behavior when the time server(s) ceases to respond What is the time server lost detection time	On one time server: An event is generated On all time servers: An event is generated 60 seconds
Tm3	1,2	How long does it take to take over the new time from time server	2 seconds
Tm4	1,2	When is the time quality bit “ClockFailure” set	Never
Tm5	1,2	When is the time quality bit “Clock not Synchronized” set	60 seconds after the time server(s) ceases to respond.
Tm6	-	Is the timestamp of a binary event adjusted to the configured scan cycle	Deprecated
Tm7	1	Does the device support time zone and daylight saving	Y

Tm8	1,2	Which attributes of the SNTP response packet are validated	Y Leap indicator not equal to 3 Y Mode is equal to SERVER N OriginateTimestamp is equal to value sent by the SNTP client as Transmit Timestamp Y RX/TX timestamp fields are checked for reasonableness Y SNTP version 3 and/or 4 N other (describe)
Tm9	1,2	Do the COMTRADE files have local time or UTC time and is this configurable	Local N
		<additional items>	

12 PIXIT for File transfer model

ID	ED	Description	Value / Clarification
Ft1	1	What is structure of files and directories Where are the COMTRADE files stored Are comtrade files zipped and what files are included in each zip file	 /COMTRADE N
Ft2	1,2	Directory names are separated from the file name by	"/"
Ft3	1	The maximum file name size including path (recommended 64 chars)	255 chars
Ft4	1,2	Are directory/file name case sensitive	Case sensitive
Ft5	1,2	Maximum file size for SetFile	
Ft6	1	Is the requested file path included in the MMS fileDirectory respond file name	Y
Ft7	1	Is the wild char supported MMS fileDirectory request	No
Ft8	1,2	Is it allowed that 2 clients get a file at the same time	Y same file Y different files
Ft9	1,2	Which files can be deleted	

13 PIXIT for Service tracking model

ID	ED	Description	Value / Clarification
Tr1	2	Which ACSI services are tracked by LTRK.GenTrk	Not Applicable

7.4 IEC 61850 FUNCTIONALITY

7.4.1 Client Connections

The 650 Family relay supports up to five IEC61850 concurrent client connections, i.e a maximum of 5 different IEC 61850 clients can connect to it

7.4.2 GOOSES

650 relays support transmission and reception of configurable IEC 61850 Generic Object Oriented Substation Event (GOOSE). If GOOSES communications want to be enable, Remote comms setting must be set to GOOSE in Enervista 650 Setup at Setpoint > Input/Output > Remote Comms

Configurable GOOSE is recommended for implementations that require GOOSE data transfer between 650 relays and devices from other manufacturers.

7.4.2.1 TRANSMISSION GOOSES

A maximum of four different transmission GOOSE applications are supported. Data Sets for transmissions GOOSES can have a maximum of 128 elements and can be leaf elements (Data Attributes), or complex structures (Data Objects).

7.4.2.2 RECEPTION GOOSES

650 relays can be subscribed up to 24 different remote devices. A maximum of 32 Remote Inputs (digital signals), 32 Remote Goose Digital inputs and 16 Remote Goose Analog Inputs can be configured to be subscribed to.

The elements of Data Sets for reception GOOSEs can be of any types supported in IEC 61850 standard and can be both leaf elements (Data Attributes) and compelx structures (Data Objects). However R650 relay can map to its internal variables incoming data of type Boolean, Float, Integer and any of the bits from Bitstring data type.

7.4.3 IEC 61850 Server

The IEC 61850 Server (i.e., 650 relay) reports data to the IEC 61850 Client, such as Local HMI, RTU and Gateway with the information of logical device, data sets, data control block, logical nodes and their data attributes.

7.4.3.1 LOGICAL DEVICES AND REPORTS

Supported buffered and un-buffered report, the report triggers are shown in the following Supported Triggers list.

Supported Triggers List:

- Data-Change
- Quality-Change
- Integrity
- General Interrogation

Supported buffered and un-buffered report option fields are shown in the following Field list.

Field List:

- Sequence number
- Report time stamp
- Reason-for-inclusion
- Dataset-name
- Data-reference
- Buffer-overflow (Buffered reports only)

- Entry id (Buffered reports only)
- Conf- revision

Report control block configuration settings are modified from IEC61850 configurator writing directly in a CID file. There is no Modbus register assigned to those. The datasets for reports are fully configurable with CDCs from any Logical Node. The Description field in the LN is fixed text and it cannot be updated from the Modbus settings

By default,

- if Unbuffered report is selected, 5 Unbuffered Report Control Blocks are created. This figure can be modified from 1 to 5.
- If Buffered report is selected, 1 Unbuffered Report Control Block is created. This figure can be modified from 1 to 5.

7.5 IEC 61850 Status

7.5.1 GOOSES Status

Different status information related with GOOSE transmission/reception process that can be checked through Enervista 650 Setup:

In **Actual > Inputs/Outputs > Remote Inputs > Remote GOOSE Digital Inputs**:

Rem GOOSE Dig Inp X - Provides status of Remote Goose Digital input X that relay is subscribed to. The green LED lights up if Remote GOOSE Digital Input was set to 1 last time it was received and it turns off if the last Remote GOOSE Digital Input was set to 0.

There is a maximum of 32 Remote GOOSE Digital Inputs that the relay can be subscribed to.

In A**ctual > Inputs/Outputs > Remote Inputs > Remote Inputs**:

Remote Input X - Provides status of Remote input X that relay is subscribed to. The green LED lights up if Remote Input was set to 1 last time it was received and it turns off if the last Remote Input was set to 0

There is a maximum of 32 Remote Inputs that relay can be subscribed to. These remote inputs are digital signals.

In **Actual > Inputs/Outputs > Remote Inputs > Remote GOOSE Analog Inputs:**

Rem GOOSE Ana Inp X- This is the last analog value received in the Remote GOOSE Analog Input configured.

The relay can be subscribed to up to maximum of 8 different float remote GOOSE analog values and 8 different integer remote GOOSE analog values.

In **Actual > Inputs/Outputs > Remote Inputs > Remote Devices:**

Remote Device X - Provides information about status of device that is transmitting GOOSES, that the relay is subscribed to. The green LED lights up if remote device is transmitting GOOSES and it turns off if GOOSE communication is lost with this remote device.

A maximum of 24 different Remote devices can be configured in CID

ALL REM DEV ONLINE - Provides status of Remote Devices that are transmitting GOOSES that the relay is subscribed to. If GOOSE communication with all configured Remote Devices is active, the green LED lights up. If GOOSE communication is lost with any of configured remote devices, it turns off.

In **Actual > Inputs/Outputs > Remote Outputs > Remote GOOSE Digital Outputs:**

Rem GOOSE Dig Out X - Provides status of Remote Goose Digital outputs that are configured to be transmitted by the relay. The green LED lights up if Remote GOOSE Digital Output is set to 1 and it turns off if Remote GOOSE Digital Output is set to 0

7.5.2 IEC 61850 CID Status

Internal Status of CID and its validation can be checked in Enervista in the following path:

Actual Values > Status > System Info > Conf Info

ICD Edition:

This field shows which IEC 61850 Edition if CID that relays is working with. For R650. See 7.1 IEC 61850 Overview on page 7–1.

ICD FILE STATUS:

This field provides status of CID that is running in the relay.

ICD FILE STATUS	UNKNOWN: When the relay has not the IEC61850 protocol in the relay model the ICD status is unknow to the unit.
	ICD ERROR: There is an error in the ICD file and the relay ICD is not operative. To solve this issue it is necessary to send a correct ICD to the relay using the IEC61850 configurator tool. When the ICD error is raised the IEC 61850 is not operative (the IEC 61850 client, reports and gooses do not work). It is advisable to include the ICD ERROR in the main error signal configured for specific applications.
	MODIFIED: The settings have been changed in the icd but they are still not written in the icd file in the relay
	IN PROGRESS: The icd setting are being written to the file in the relay.
	OK WITHOUT DAIS: The relay has not got the "Use DOI &DAI" setting enabled (true) and it is working properly with the ICD file.
	OK: The relay has got the "Use DOI &DAI" setting enabled (true) and it is working properly with the ICD file. When that setting is set to true the icd setting prevails over the relay settings
	DEAFULT: There is no CID file in notvalidated neither in validated and default CID has been loaded. After a reboot, default CID file is considered as a normal CID file.
	ERROR HEADER CID: there is a discrepancy in the information about product model or firmware version between the firmware of the relay and the CID file. If this message is displayed, relay shall not be able to communicate by using IEC 61850 until this discrepancy is solved. CID version and firmware version must match in order to get complete functional relay.
	ERROR SG CID is displayed if the relay has the Setting Group function disabled but the managed CID file has the Settings Groups available or the relay has the Setting Group function enabled but the managed CID file has the Settings Groups not available.

ICD STATUS NOTVAL:

This field provides information about the NotValidated folder, which is the folder where CIDs that are sent to the relay are stored prior to be validated and marked "Valid".

ICD STATUS NOTVAL	UNKNOWN: No 61850 protocol
	ERROR: The CID file in notvalidated is not valid
	NOTVALIDATED EMPTY: There is no CID file in notvalidated
	IN PROGRESS: The icd setting are being written to the file in the relay.
	PASSED TO VALIDATED: New valid CID file in notvalidated y and passed to validated
	ERROR HEADER CID: There is a discrepancy in the information about product model or firmware version between the firmware of the relay and the CID file. If this message is displayed, relay shall not be able to communicate by using IEC 61850 until this discrepancy is solved. CID version and firmware version must match in order to get complete functional relay.

NOTICE

1. WATCH OUT! If the ICD status is "MODIFIED" or "IN PROGRESS" it is not advisable to switch off the unit because the latest settings would not be stored in the unit.

2. In the case that ERROR SG CID is displayed in the ICD Status, ensure that the managed CID has Setting Group enabled if the Setting Groups function is enabled, or ensure that the managed CID has Setting Group disabled if the Setting Groups function is disabled.

3. Take into in account that if ERROR HEADER CID value is displayed in the ICD STATUS or ICD STATUS NOT VAL section in **Actual Values > Status > System info**, the relay cannot communicate using IEC 61850 until this discrepancy is resolved. CID version and firmware version must match for a fully functional relay.

7.6 IEC 61850 Configurator

7.6.1 Overview

The 650 family relays support the IEC 61850 protocol which is identified by order code option "6" or "7" (Communication protocol option). This configuration tool can be used with 650 family relays supporting IEC 61850 communication protocol and with firmware version 3.60 or above.

The "IEC 61850 Configurator" tool is located in the top-level menu in EnerVista 650 Setup and it can be used to browse and edit 650 relay's CID/IEC files:

- ICD/CID Settings
- Reports
- GOOSE Reception
- GOOSE Transmission

Figure 7-5: IEC61850 configurator menu location

Important Notes:

For firmware versions below 3.60, basic IEC 61850 configuration is located in **Setpoint > 61850 Configuration** (Domain name parameters, Ethernet parameters, MMXU parameters). With this tool some 61850 parameters can be configured in the *650.icd file, and then the .icd file can be uploaded to the relay.

7.6.2 Online/Offline operation modes

Two different working modes can be distinguished in the IEC 61850 Configurator: Offline mode and Online mode.

Offline Operation Mode: When user is not communicating with 650 Family relay, IEC 61850 Configurator tool can be used to work offline mode. In this case, if IEC 61850 Configurator menu is clicked at the menu toolbar in Enervista, the following windows prompts to allow selection of the IED version to be configured.

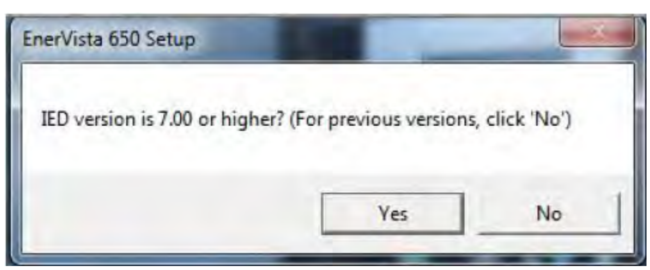


Figure 7-6: IED version verification

- Click **Yes** to browse and edit CID/ICD files for firmware versions above 7.XX
- Click **No** to browse and edit IEC files for firmware versions below 7.XX

Online Operation Mode: When communicating with an R650 using the Enervista 650 Setup software, the IEC61850 Configurator tool allows access to the CID/IEC of the connected device, or to send a previously configured file.

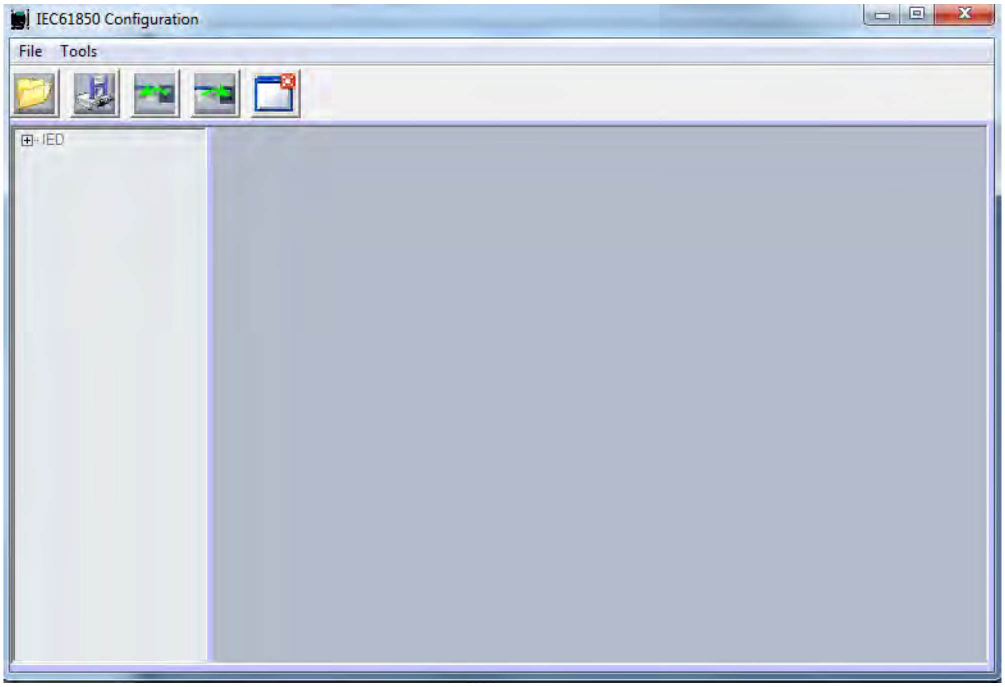


Figure 7-7: IEC 61850 Configurator main screen

7.6.3 IEC 61850 configurator details

The IEC61850 Configurator allows editing in all sections of the IEC61850 CID file. Other operations cannot be performed in the EnerVista 650 Setup software if the IEC 61850 Configurator is open. Close the IEC61850 session to perform other operations.

In the following sections, detailed information about CID configuration for firmware version 8.00 is described. These same steps apply to CID configuration for all 650 family firmware versions 7.00 and above.

7.6.3.1 IEC 61850 configurator interface.

Four different areas can be identified in IEC 61850 configurator interface, as shown in the figure that follows:

- "Menu toolbar
- Quick menu toolbar
- IEC 61850 IED Explorer window
- Configuration area

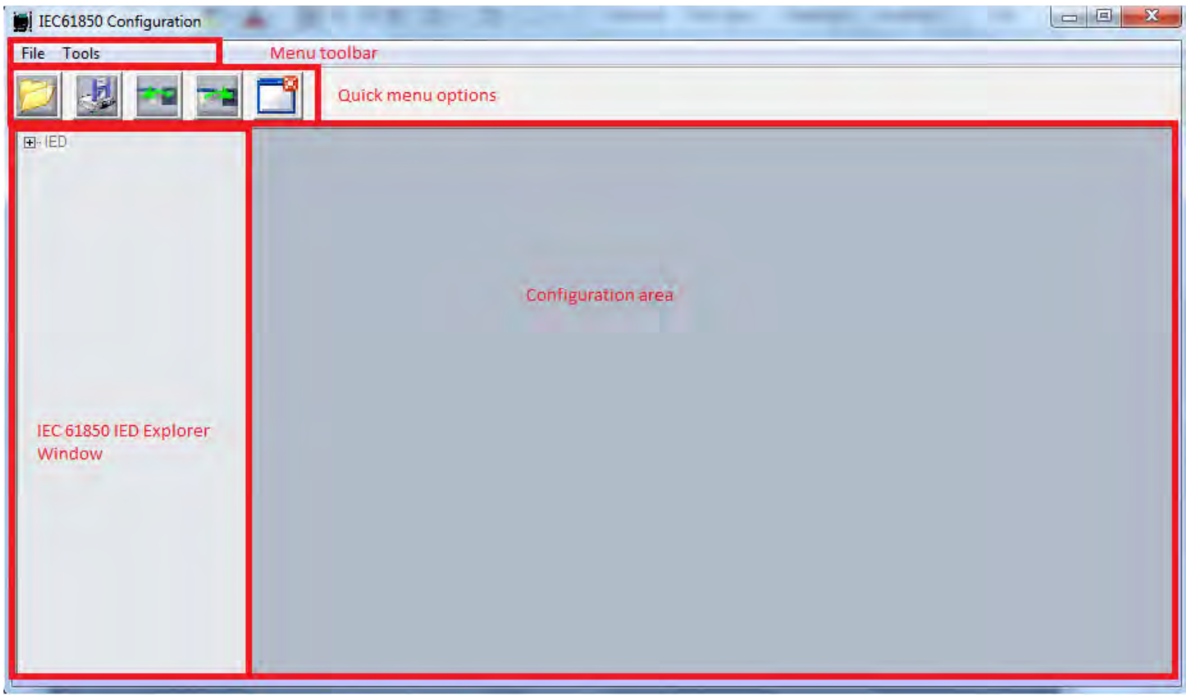


Figure 7-8: IEC 61850 Configurator interface

7.6.3.1.1 Menu toolbar

Two menus available in this area:

File Menu:

Open *.cid file

Save *cid file

Received *cid file from device

Send *cid file to the relay

See 7.6.3.1.2 Quick Menu Toolbar for detailed information

Tools Menu: (CID conversion tools)

A CID file converter menu option is available in the IEC 61850 Configurator menu: **Tools > ConvertCIDFiles**. The CID file converter enables CID file conversion, allowing for conversion of CID files in parallel with relay firmware updates. The main parts of the CID file that are maintained are the configurable fields at the Communication and IED levels, the public and private Settings, Datasets, Report Control Blocks, GOOSE Transmission Control Blocks and GOOSE Reception.

To convert a CID file, follow these steps:

1. In the IEC61850 Configurator, select **Tool > ConvertCIDFiles**.

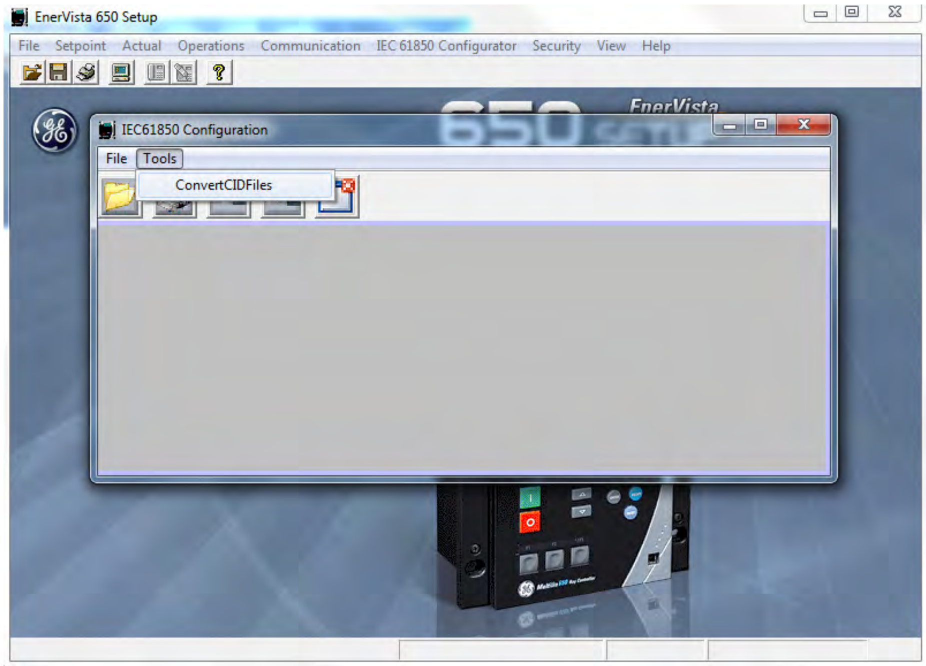


Figure 7-9: ConvertCIDFiles option

2. Select a CID file to convert in the **CID file (*.cid)** field.

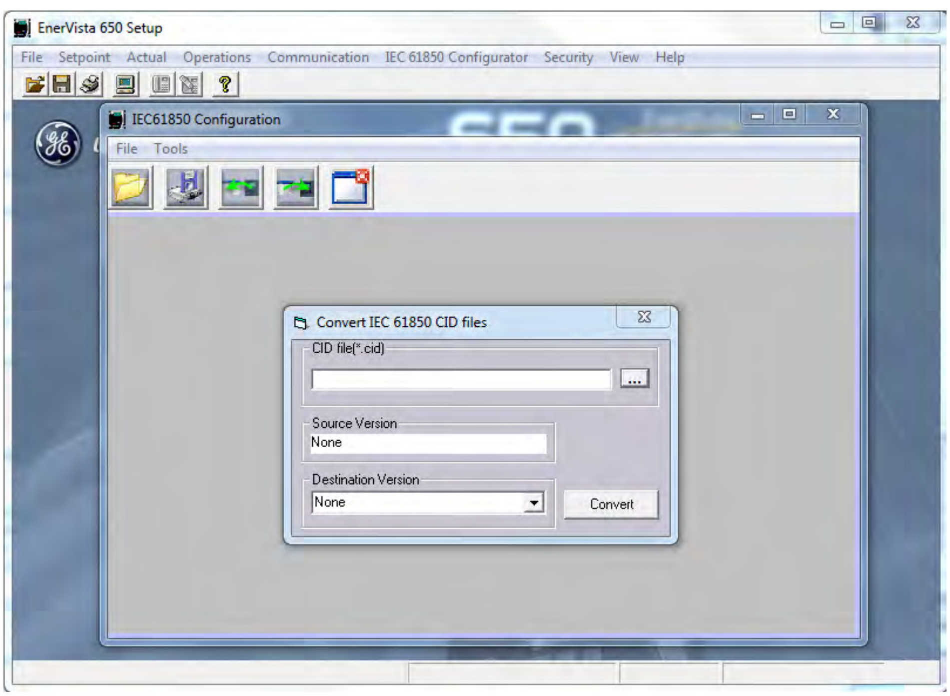
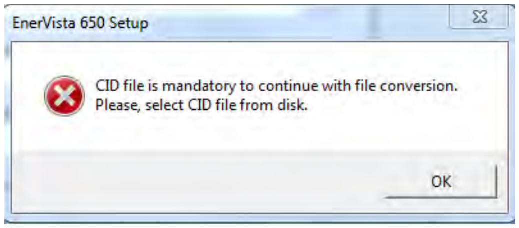


Figure 7-10: Main window in IEC61850 CID files conversion tool

3. If no **CID file** is selected, an error message is displayed.



4. The CID file Converter fills in the firmware version of the selected CID file under **Source Version**. Select the new firmware version for the CID file under **Destination Version**.

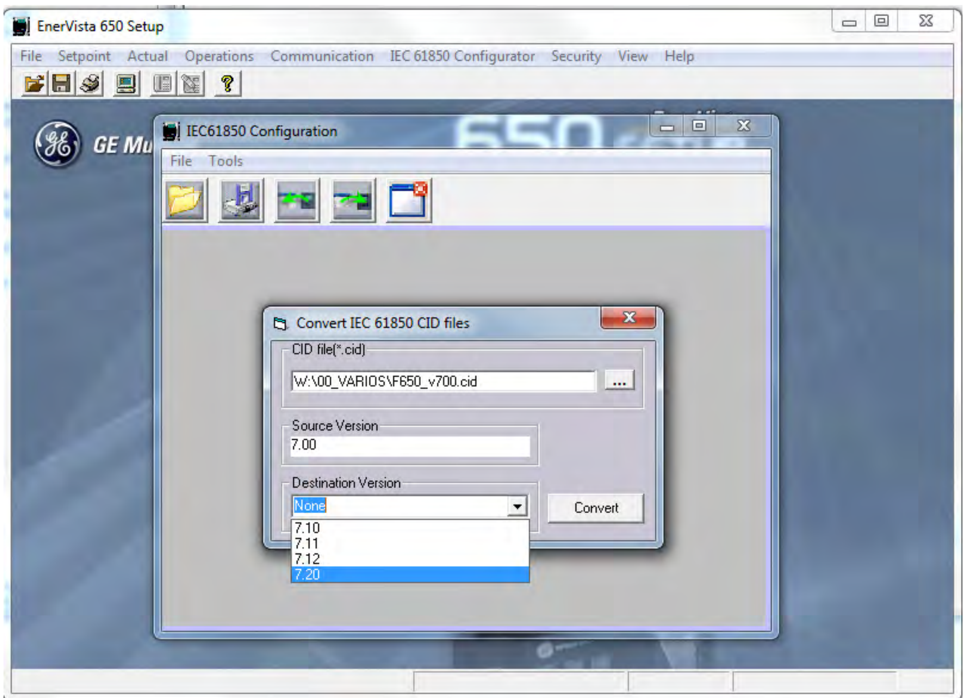
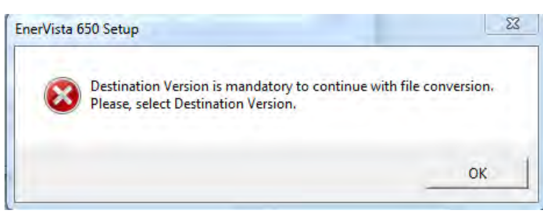


Figure 7-11: Selection of CID files versions

5. If no **Destination Version** is selected, an error message is displayed.



Note: For successful conversion, the default CID file templates installed with the Enervista 650 Setup must be in the installed folder location with their original names, as shown.

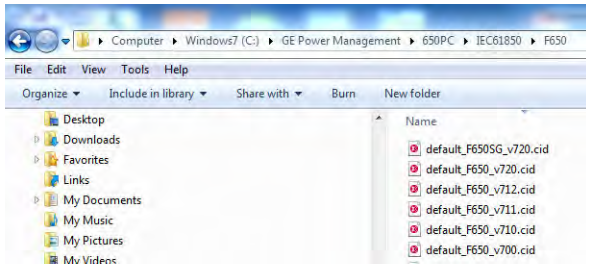


Figure 7-12: Requirements for CID conversion

6. Click **Convert** to start the conversion process. When the conversion is finished, a successful conversion message is displayed, followed by a message confirming the name and location of the converted file.

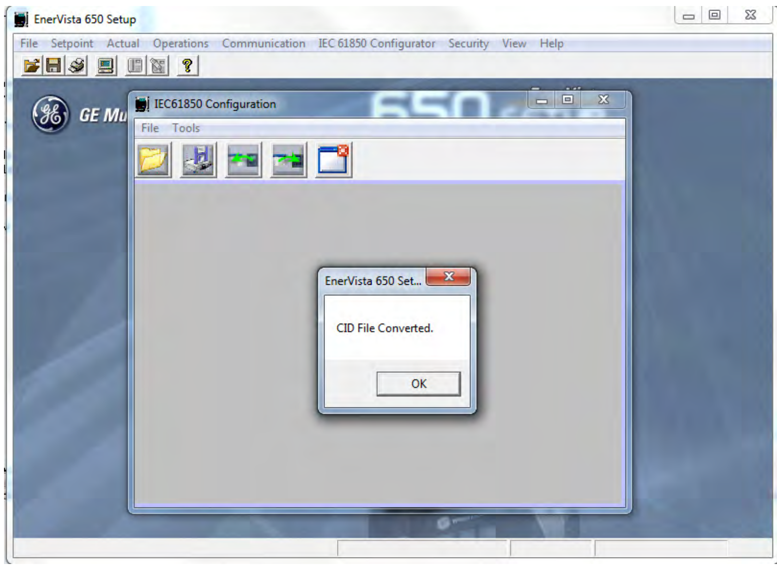


Figure 7-13: Successful CID conversion

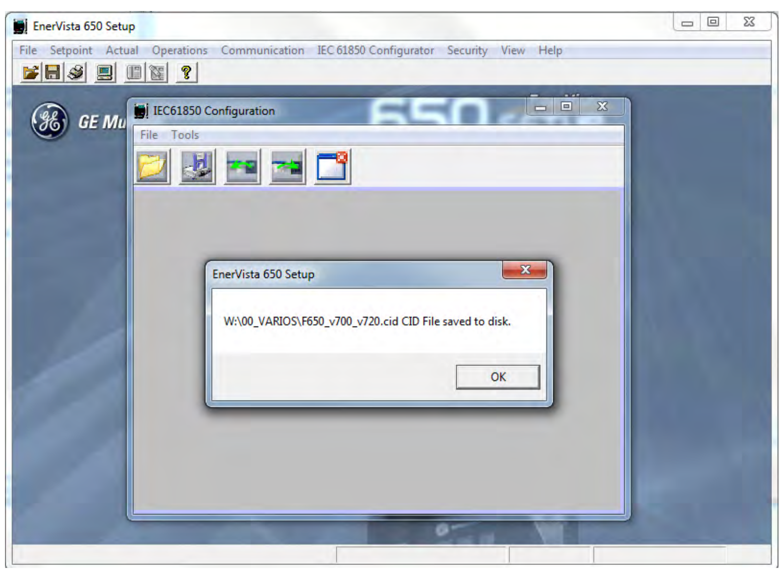
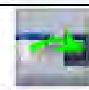


Figure 7-14: CID file created and saved to disk

7.6.3.1.2 Quick Menu Toolbar

Menu Action	Tool Bar Icons
Open *.cid file	
Save*.cid file	
Receive CID file from device	
Send CID file to device	
Exit	

Open *CID file

The **Open *CID file** menu allows the user to work in offline mode to configure IEC 61850 protocol in 650 devices. In that occasion, the tool shall work with *.cid file extension which contain the icd file from the device.

Find the "default_R650_vXXX.cid" corresponding to the firmware version related to Enervista installation in the Enervista 650 Setup software default files.

To download the active CID file from the relay:

1. Open the Enervista Setup software, and click **IEC 61850 Configurator** on the menu bar.
2. Select **File > Receive CID file from device**, or click the download button.
3. Connect to the relay as prompted if you are not already connected.

   Once the download completes, a message displays indicating a successful download. The CID file can then be saved locally.
4. Select **File > Open *.cid file**, or click the **Open** button. Select the CID file to view and edit in the IEC 61850 Configurator.
5. Check the title bar of the IEC61850 Configurator to see the name of the CID file, as shown in the figure below.

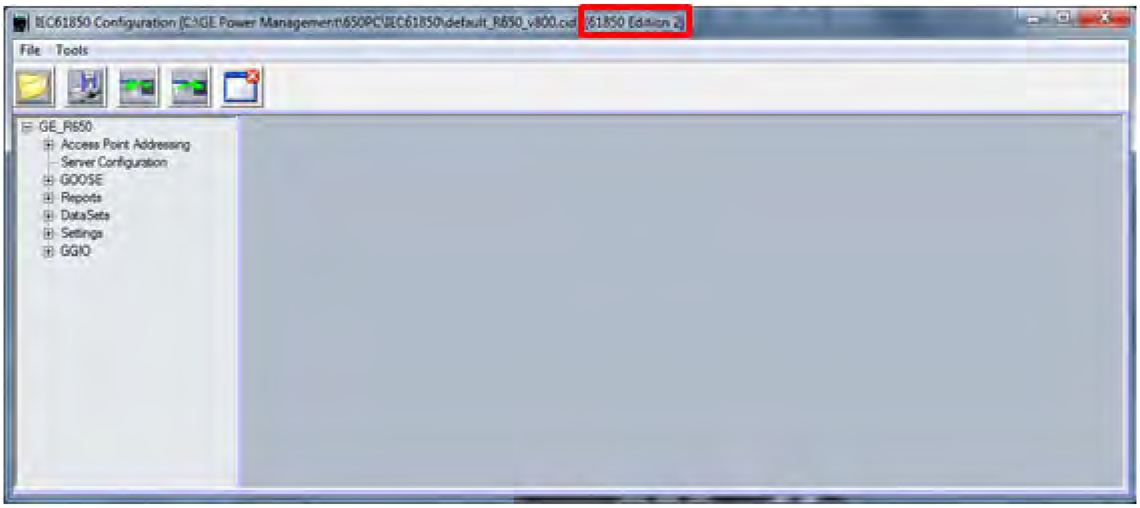


Figure 7-15: Information about the IEC 61850 Edition

For all scenarios, after opening the file all ICD data is displayed in the tree on the left and the user can start configuring the IEC 61850 protocol in 650 devices.

To determine whether the relay is working with CID Edition 1 or Edition 2, check **Enervista > Actual Values > System Info** for firmware versions above 7.60.

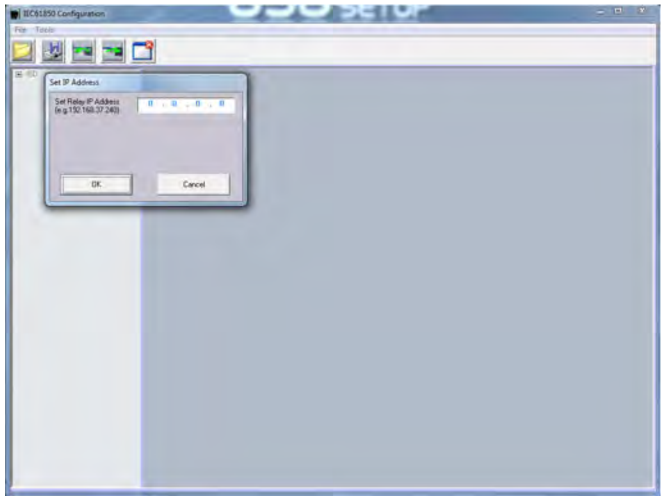
Save CID file

After modifying the files using this tool the user can save them in the computer under the *.cid format, using the **Save *cid file** option.

Receive CID file from device

Select the option **Receive CID file from device** to retrieve the IEC 61850 files from the 650 device for visualization or further modifications.

- If the user is already communicating with the 650 device using the **Modbus/TCP** option in the **Communication** menu the retrieve files options are performed over the IP Address selected in the **Communication** menu.
- If the user is not communicating with a relay when the **Receive CID file from device** option is selected, the program pops up a menu asking for the IP Address of the unit.



Enter the IP address and click OK to initiate connection.

- "If connection fails, an error message is shown (see below).
- "If file transfer is performed successfully, a success message is shown.

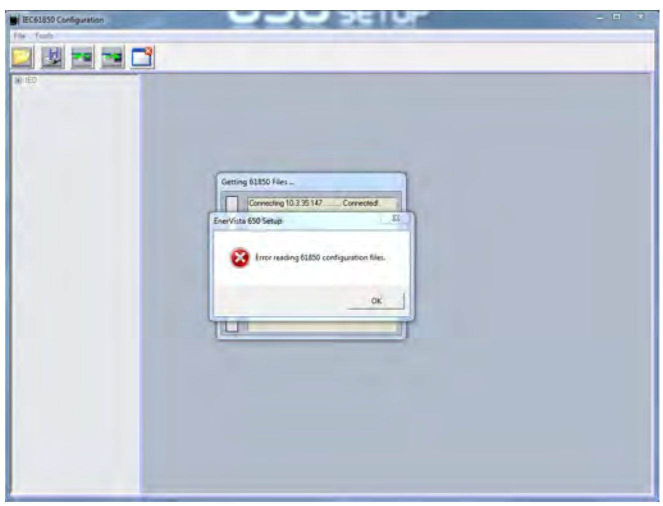


Figure 7-16: Error message pop up window

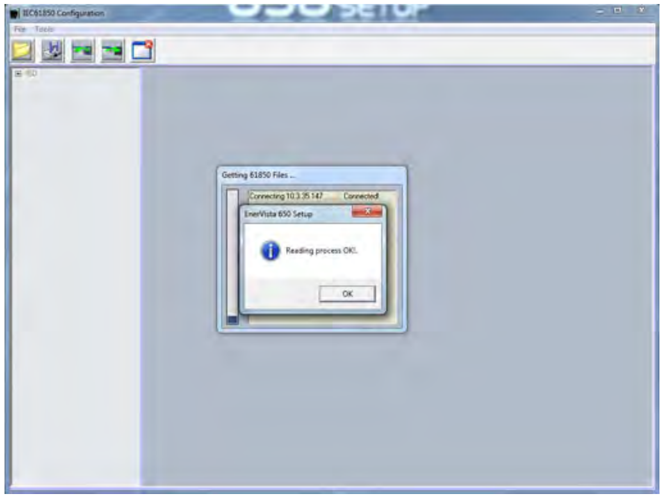


Figure 7-17: File transfer successfully performed

After retrieving the CID file it can be saved on the local PC by clicking the **Open** button and selecting the received file. All ICD data is displayed in the tree on the left, and the IEC 61850 protocol is ready to configure.

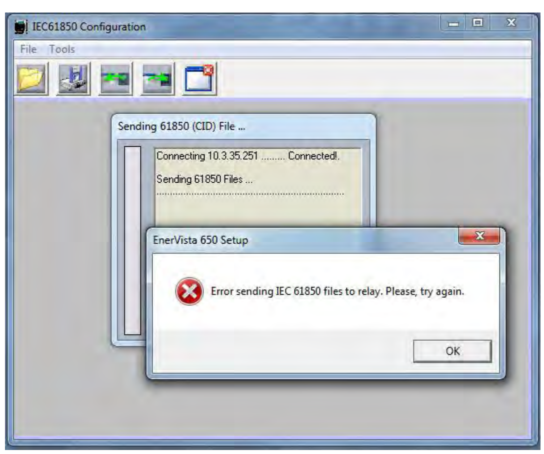
Send CID file to device

The user can send the IEC 61850 files to the 650 relays using the **Send IEC 61850/CID file to device** menu, this menu can be user either in offline or online mode.

If the user is already communicating with the 650 device using the **Modbus/TCP** option in the **Communication** menu the send files options are performed over the IP Address selected on the **Communication** menu.

If the user is working in offline mode using the **Open IEC 61850/CID file from disk** option, when the "**end IEC 61850 file to device** option is selected, the program shall pop up a window to introduce the IP Address.

- "If file transfer fails, error message shall be displayed.
- "If file is successfully sent, the program shall pop up a message asking to reboot the relay, as shown.



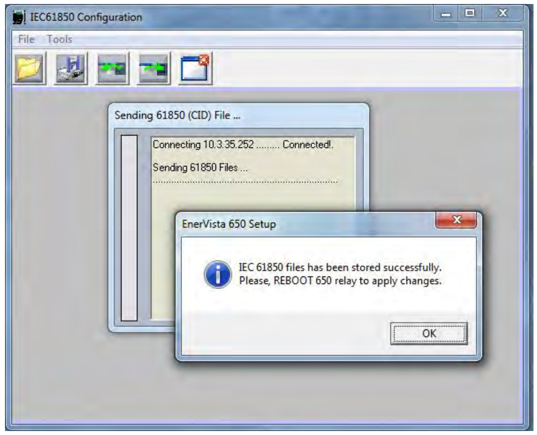


Figure 7-18: Send file successfully performed

These pop-up menus also appear the **Send IEC 61850 file to device** option is selected after retrieving the files using the **Receive IEC 61850 file from device**.

Exit

When **Exit** is selected, the program prompts to save the configuration to disk or send it to the relay.

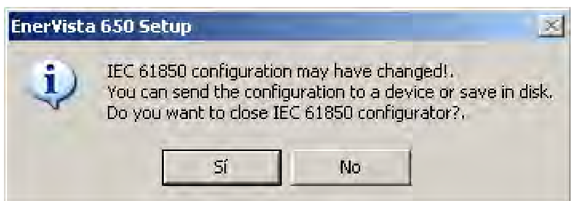


Figure 7-19: EXIT IEC 61850 CONFIGURATOR

7.6.3.1.3 IEC 61850 IED Explorer Window

After opening a CID file, the IED Explorer "tree" will be displayed in this area. Six different items are available in this menu:

- Access Point Addressing
- Server Configuration
- Settings
- DataSets
- Reports
- GOOSE

To Modify the Parameters

1. Select a parameter in the ICD Explorer window to open the Attributes window in the right part of the screen.
2. In the Configuration area, double click in the parameter column of the table and enter the new value for that setting. To confirm changes, double-click out of parameter field.

Access Point Addressing

Following settings can be configured in this section.

SETTING	PARAMETER
IP	0.0.0.0
IP-SUBNET	0.0.0.0
IP-GATEWAY	0.0.0.0
OSI-AP-Title	1,3,9999,1,1
OSI-AE-Qualifier	12
OSI-PSEL	00000001
OSI-SSEL	0001
OSI-TSEL	0001
GOOSE-Port	0
MMS-Port	102
MMS-Connection-Timeout	120 s

- IP, IP-SUBNET, IP-GATEWAY: The parameters are the configured ETH_A IP details configured in the device through Enervista: **Setpoints > Product Setup > Communications > Network**
- OSI-AP-Title, OSI-AE-Qualifier, OSI-PSEL, OSI-SSEL, OSI-TSEL: The parameters must be configured according to the IEC 61850 standard
- GOOSE-port: Three different options are available in this dropbox depending which port wants to be selected for GOOSE transmission (ETHA-ETHB-Both) the user to change the GOOSE port number for GOOSE communication.
- MMS-Port: The range of the setting is 1 to 65535, in steps of 1. The setting allows the user to change the TCP port number for MMS connections.
- MMS- Connection-Timeout: The setting is useful for detecting "fail" IEC 61850 connections. The timer must be application specific for IEC 61850. If there is no data traffic on an established connection for more than this setting time, the connection is disconnected from the server

Server Configuration

SETTING	PARAMETER
IED NAME	GE_R650
UseDoiDai	false
PRO functional IdName	PRO
CON functional IdName	CON

- IED NAME: Up to 64 alphanumeric characters. The IED Name represents the MMS domain name (IEC 61850 logical device) where all IEC/MMS logical nodes are located. Valid characters for these values are upper and lowercase letters, numbers, and the underscore (_) character, and the first character in the string must be a letter. This conforms to the IEC 61850 standard. Default value is "GEDevice"
- UseDoiDai:
  - If this setting is set to false: the relay works only with the settings located in the relay's memory and the changes performed on the ICD in settings related with the protection and control functions are only stored on the ICD file but not updated in the relay.
  - If this setting is set to true, you are selecting the ICD file settings to prevail over the relay settings. This means that after changing settings in the ICD and powering the relay off and on the unit works with the settings included in the ICD.

  All setting changes performed through the HMI or EnerVista 650 Setup are automatically updated over the ICD file, likewise if there is any change in the ICD file these changes are updated in the relay settings. The relay starts working with the new ICD file after sending the file to the unit and powering the relay off and on.
- PRO functional IdName: ID name of logical device where all protection logical nodes are available. The logical device name is used to identify the IEC 61850 logical device that exists within the R650 and this name is composed of two parts: the IED NAME and the PRO/CON functional IdName. Default name for PRO functional IdName is PRO
- CON functional IdName: ID name of logical device where all control logical nodes are available. Default name for CON functional IdName is CON

Settings

Four different levels are available under setting section:

- Deadbands
- Commands
- Timeouts
- Scales

DEADBANDS

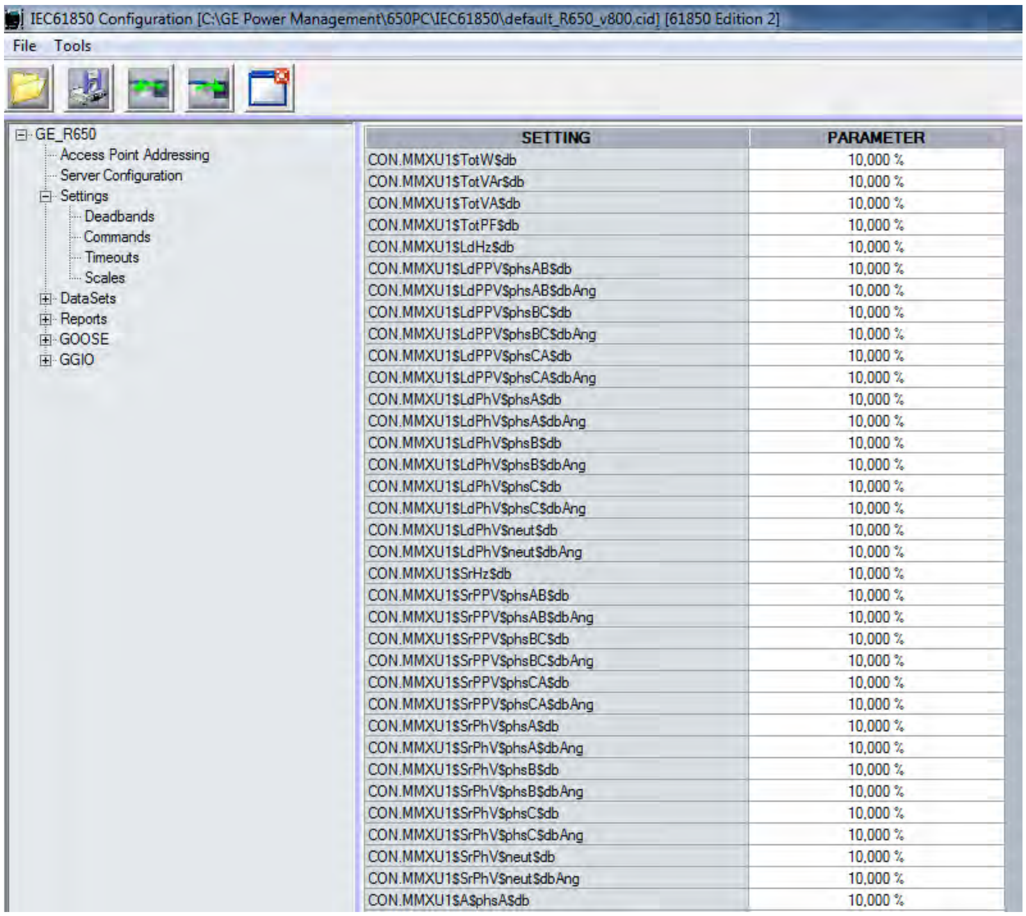


Figure 7-20: Configuration of deadbands for MMXU

Range: 1 to 100.000 %

The MMXU deadband settings represent the deadband values used to determine when to update the MMXU "mag" and "cVal" values from the associated "instmag" and "instcVal" values. The "mag" and "cVal" values are used for the IEC 61850 buffered and unbuffered reports. The settings correspond to the associated "db" data items in the CF functional constraint of the MMXU logical node, as per the IEC 61850 standard. According to IEC 61850-7-3, the db value "shall represent the percentage of difference between the maximum and minimum in units of 0.001%". Thus, it is important to know the maximum value for each MMXU measured quantity, since this represents the 100.00% value for the deadband and therefore A value of 1000 represents the 1% of the scale.

The equations to calculate minimum (min) and maximum (max) values in the MMXU nodes of R650 are as follows:

MMXU Node Value	**To Calculate Min/Max**
TotW , TotVar (MW, MVAr)	For Voltage Reference= Load Side VLx max = (Phase CT Primary/Phase CT Secondary) /1000) *32*Phase CT Secondary * 0.001 *(Load VT Ratio /1000) * 10*0.001 min = -max For Voltage Reference= Source Side VLx max = (Phase CT Primary/Phase CT Secondary) /1000) *32*Phase CT Secondary * 0.001 *(Source VT Ratio /1000) * 10*0.001 min = -max
TotVA (MVA)	max = (Phase CT Primary * 160) * (Phase VT Ratio * 10) / 1000 min = 0
Hz dbAng angle dB = (DB percentage* 360)	max = 70 min = 0
Hz Rte	max = 15 min = -15
LdPPV/LdPhV/LdSeq (kV)	max= Load VT Ratio /1000 * 10 * 0.001; min = 0
SrPPV/SrPhV /SrSeq (measurement in kV)	max= Source VT Ratio /1000 * 10 * 0.001; min = 0
A$phsA, phsB, phsC (kA) SeqA$c1, c2 ,c3	max=((Phase CT Primary/Phase CT Secondary) /1000)*32*Phase CT Secondary*0.001 min = 0
A$neut (kA)	max=((Ground CT Primary/Ground CT Secondary) /1000)*32*Ground CT Secondary*0.001 min = 0
A$net (kA)	max=((Ground CT Primary/Ground CT Secondary) /1000)*32*Ground CT Secondary*0.001 min = 0
A$res (kA)	max=((Stv Gnd CT Primary/Ground CT Secondary) /1000)*32*Stv Gnd CT Secondary*0.001 min = 0
dbAng	angle dB = (DB percentage* 360)

See the following list of supported parameters for R650 relay

Settings	
CON.MMXU1$TotW$db	CON.CMHAI1$HAVal6$phsC$db
CON.MMXU1$TotVAr$db	CON.CMHAI1$HAVal7$phsA$db
CON.MMXU1$TotVA$db	CON.CMHAI1$HAVal7$phsB$db
CON.MMXU1$TotPF$db	CON.CMHAI1$HAVal7$phsC$db
CON.MMXU1$LdHz$db	CON.CMHAI1$HAVal8$phsA$db
CON.MMXU1$LdPPV$phsAB$db	CON.CMHAI1$HAVal8$phsB$db
CON.MMXU1$LdPPV$phsAB$dbAng	CON.CMHAI1$HAVal8$phsC$db
CON.MMXU1$LdPPV$phsBC$db	CON.CMHAI1$HAVal9$phsA$db
CON.MMXU1$LdPPV$phsBC$dbAng	CON.CMHAI1$HAVal9$phsB$db
CON.MMXU1$LdPPV$phsCA$db	CON.CMHAI1$HAVal9$phsC$db
CON.MMXU1$LdPPV$phsCA$dbAng	CON.CMHAI1$HAVal10$phsA$db
CON.MMXU1$LdPhV$phsA$db	CON.CMHAI1$HAVal10$phsB$db
CON.MMXU1$LdPhV$phsA$dbAng	CON.CMHAI1$HAVal10$phsC$db
CON.MMXU1$LdPhV$phsB$db	CON.CMHAI1$HAVal11$phsA$db
CON.MMXU1$LdPhV$phsB$dbAng	CON.CMHAI1$HAVal11$phsB$db
CON.MMXU1$LdPhV$phsC$db	CON.CMHAI1$HAVal11$phsC$db
CON.MMXU1$LdPhV$phsC$dbAng	CON.CMHAI1$HAVal12$phsA$db

Settings	
CON.MMXU1$LdPhV$neut$db	CON.CMHAI1$HAVal12$phsB$db
CON.MMXU1$LdPhV$neut$dbAng	CON.CMHAI1$HAVal12$phsC$db
CON.MMXU1$SrHz$db	CON.CMHAI1$HAVal13$phsA$db
CON.MMXU1$SrPPV$phsAB$db	CON.CMHAI1$HAVal13$phsB$db
CON.MMXU1$SrPPV$phsAB$dbAng	CON.CMHAI1$HAVal13$phsC$db
CON.MMXU1$SrPPV$phsBC$db	CON.CMHAI1$HAVal14$phsA$db
CON.MMXU1$SrPPV$phsBC$dbAng	CON.CMHAI1$HAVal14$phsB$db
CON.MMXU1$SrPPV$phsCA$db	CON.CMHAI1$HAVal14$phsC$db
CON.MMXU1$SrPPV$phsCA$dbAng	CON.CMHAI1$HAVal15$phsA$db
CON.MMXU1$SrPhV$phsA$db	CON.CMHAI1$HAVal15$phsB$db
CON.MMXU1$SrPhV$phsA$dbAng	CON.CMHAI1$HAVal15$phsC$db
CON.MMXU1$SrPhV$phsB$db	CON.SrcVMHAI1Hzdb
CON.MMXU1$SrPhV$phsB$dbAng	CON.SrcVMHAI1$ThdV$phsA$db
CON.MMXU1$SrPhV$phsC$db	CON.SrcVMHAI1$ThdV$phsB$db
CON.MMXU1$SrPhV$phsC$dbAng	CON.SrcVMHAI1$ThdV$phsC$db
CON.MMXU1$SrPhV$neut$db	CON.SrcVMHAI1$HVVal2$phsA$db
CON.MMXU1$SrPhV$neut$dbAng	CON.SrcVMHAI1$HVVal2$phsB$db
CON.MMXU1AphsA$db	CON.SrcVMHAI1$HVVal2$phsC$db
CON.MMXU1AphsA$dbAng	CON.SrcVMHAI1$HVVal3$phsA$db
CON.MMXU1AphsB$dbAng	CON.SrcVMHAI1$HVVal3$phsB$db
CON.MMXU1AphsC$db	CON.SrcVMHAI1$HVVal3$phsC$db
CON.MMXU1AphsC$dbAng	CON.SrcVMHAI1$HVVal4$phsA$db
CON.MMXU1Aneut$db	CON.SrcVMHAI1$HVVal4$phsB$db
CON.MMXU1Aneut$dbAng	CON.SrcVMHAI1$HVVal4$phsC$db
CON.MMXU1Anet$db	CON.SrcVMHAI1$HVVal5$phsA$db
CON.MMXU1Anet$dbAng	CON.SrcVMHAI1$HVVal5$phsB$db
CON.MMXU1Ares$db	CON.SrcVMHAI1$HVVal5$phsC$db
CON.MMXU1Ares$dbAng	CON.SrcVMHAI1$HVVal6$phsA$db
CON.MSQI1$SeqA$c1$db	CON.SrcVMHAI1$HVVal6$phsB$db
CON.MSQI1$SeqA$c2$db	CON.SrcVMHAI1$HVVal6$phsC$db
CON.MSQI1$SeqA$c3$db	CON.SrcVMHAI1$HVVal7$phsA$db
CON.MSQI1$LdSeqV$c1$db	CON.SrcVMHAI1$HVVal7$phsB$db
CON.MSQI1$LdSeqV$c2$db	CON.SrcVMHAI1$HVVal7$phsC$db
CON.MSQI1$LdSeqV$c3$db	CON.SrcVMHAI1$HVVal8$phsA$db
CON.MSQI1$SrSeqV$c1$db	CON.SrcVMHAI1$HVVal8$phsB$db
CON.MSQI1$SrSeqV$c2$db	CON.SrcVMHAI1$HVVal8$phsC$db
CON.MSQI1$SrSeqV$c3$db	CON.SrcVMHAI1$HVVal9$phsA$db
CON.MMTR1$CntPsWh$db	CON.SrcVMHAI1$HVVal9$phsB$db
CON.MMTR1$CntNgWh$db	CON.SrcVMHAI1$HVVal9$phsC$db
CON.MMTR1$CntPsVArh$db	CON.SrcVMHAI1$HVVal10$phsA$db
CON.MMTR1$CntNgVArh$db	CON.SrcVMHAI1$HVVal10$phsB$db
CON.RFLO1$FltZ$db	CON.SrcVMHAI1$HVVal10$phsC$db
CON.RFLO1$FltZ$dbAng	CON.SrcVMHAI1$HVVal11$phsA$db
CON.GGIO1$AnIn1$db	CON.SrcVMHAI1$HVVal11$phsB$db
CON.GGIO1$AnIn2$db	CON.SrcVMHAI1$HVVal11$phsC$db
CON.GGIO1$AnIn3$db	CON.SrcVMHAI1$HVVal12$phsA$db
CON.GGIO1$AnIn4$db	CON.SrcVMHAI1$HVVal12$phsB$db
CON.GGIO1$AnIn5$db	CON.SrcVMHAI1$HVVal12$phsC$db
CON.GGIO1$AnIn6$db	CON.SrcVMHAI1$HVVal13$phsA$db
CON.GGIO1$AnIn7$db	CON.SrcVMHAI1$HVVal13$phsB$db

Settings	
CON.GGIO1$AnIn8$db	CON.SrcVMHAI1$HVVal13$phsC$db
CON.GGIO2$AnIn1$db	CON.SrcVMHAI1$HVVal14$phsA$db
CON.GGIO2$AnIn2$db	CON.SrcVMHAI1$HVVal14$phsB$db
CON.GGIO2$AnIn3$db	CON.SrcVMHAI1$HVVal14$phsC$db
CON.GGIO2$AnIn4$db	CON.SrcVMHAI1$HVVal15$phsA$db
CON.GGIO2$AnIn5$db	CON.SrcVMHAI1$HVVal15$phsB$db
CON.GGIO2$AnIn6$db	CON.SrcVMHAI1$HVVal15$phsC$db
CON.GGIO2$AnIn7$db	CON.LodVMHAI1Hzdb
CON.GGIO2$AnIn8$db	CON.LodVMHAI1$ThdV$phsA$db
CON.GGIO3$AnIn1$db	CON.LodVMHAI1$ThdV$phsB$db
CON.GGIO3$AnIn2$db	CON.LodVMHAI1$ThdV$phsC$db
CON.GGIO3$AnIn3$db	CON.LodVMHAI1$HVVal2$phsA$db
CON.GGIO3$AnIn4$db	CON.LodVMHAI1$HVVal2$phsB$db
CON.GGIO3$AnIn5$db	CON.LodVMHAI1$HVVal2$phsC$db
CON.GGIO3$AnIn6$db	CON.LodVMHAI1$HVVal3$phsA$db
CON.GGIO3$AnIn7$db	CON.LodVMHAI1$HVVal3$phsB$db
CON.GGIO3$AnIn8$db	CON.LodVMHAI1$HVVal3$phsC$db
CON.GGIO4$AnIn1$db	CON.LodVMHAI1$HVVal4$phsA$db
CON.GGIO4$AnIn2$db	CON.LodVMHAI1$HVVal4$phsB$db
CON.GGIO4$AnIn3$db	CON.LodVMHAI1$HVVal4$phsC$db
CON.GGIO4$AnIn4$db	CON.LodVMHAI1$HVVal5$phsA$db
CON.GGIO4$AnIn5$db	CON.LodVMHAI1$HVVal5$phsB$db
CON.GGIO4$AnIn6$db	CON.LodVMHAI1$HVVal5$phsC$db
CON.GGIO4$AnIn7$db	CON.LodVMHAI1$HVVal6$phsA$db
CON.GGIO4$AnIn8$db	CON.LodVMHAI1$HVVal6$phsB$db
CON.rinGGIO1$AnIn1$db	CON.LodVMHAI1$HVVal6$phsC$db
CON.rinGGIO1$AnIn2$db	CON.LodVMHAI1$HVVal7$phsA$db
CON.rinGGIO1$AnIn3$db	CON.LodVMHAI1$HVVal7$phsB$db
CON.rinGGIO1$AnIn4$db	CON.LodVMHAI1$HVVal7$phsC$db
CON.rinGGIO1$AnIn5$db	CON.LodVMHAI1$HVVal8$phsA$db
CON.rinGGIO1$AnIn6$db	CON.LodVMHAI1$HVVal8$phsB$db
CON.rinGGIO1$AnIn7$db	CON.LodVMHAI1$HVVal8$phsC$db
CON.rinGGIO1$AnIn8$db	CON.LodVMHAI1$HVVal9$phsA$db
CON.rinGGIO1$AnIn9$db	CON.LodVMHAI1$HVVal9$phsB$db
CON.rinGGIO1$AnIn10$db	CON.LodVMHAI1$HVVal9$phsC$db
CON.rinGGIO1$AnIn11$db	CON.LodVMHAI1$HVVal10$phsA$db
CON.rinGGIO1$AnIn12$db	CON.LodVMHAI1$HVVal10$phsB$db
CON.rinGGIO1$AnIn13$db	CON.LodVMHAI1$HVVal10$phsC$db
CON.rinGGIO1$AnIn14$db	CON.LodVMHAI1$HVVal11$phsA$db
CON.rinGGIO1$AnIn15$db	CON.LodVMHAI1$HVVal11$phsB$db
CON.rinGGIO1$AnIn16$db	CON.LodVMHAI1$HVVal11$phsC$db
CON.RSYN1$DifVClc$db	CON.LodVMHAI1$HVVal12$phsA$db
CON.RSYN1$DifHzClc$db	CON.LodVMHAI1$HVVal12$phsB$db
CON.CMHAI1Hzdb	CON.LodVMHAI1$HVVal12$phsC$db
CON.CMHAI1$ThdA$phsA$db	CON.LodVMHAI1$HVVal13$phsA$db
CON.CMHAI1$ThdA$phsB$db	CON.LodVMHAI1$HVVal13$phsB$db
CON.CMHAI1$ThdA$phsC$db	CON.LodVMHAI1$HVVal13$phsC$db
CON.CMHAI1$HAVal2$phsA$db	CON.LodVMHAI1$HVVal14$phsA$db
CON.CMHAI1$HAVal2$phsB$db	CON.LodVMHAI1$HVVal14$phsB$db
CON.CMHAI1$HAVal2$phsC$db	CON.LodVMHAI1$HVVal14$phsC$db

Settings	
CON.CMHAI1$HAVal3$phsA$db	CON.LodVMHAI1$HVVal15$phsA$db
CON.CMHAI1$HAVal3$phsB$db	CON.LodVMHAI1$HVVal15$phsB$db
CON.CMHAI1$HAVal3$phsC$db	CON.LodVMHAI1$HVVal15$phsC$db
CON.CMHAI1$HAVal4$phsA$db	
CON.CMHAI1$HAVal4$phsB$db	
CON.CMHAI1$HAVal4$phsC$db	
CON.CMHAI1$HAVal5$phsA$db	
CON.CMHAI1$HAVal5$phsB$db	
CON.CMHAI1$HAVal5$phsC$db	
CON.CMHAI1$HAVal6$phsA$db	
CON.CMHAI1$HAVal6$phsB$db	

COMMANDS

In the R650 relay IEC 61850 controllable data exist in logical nodes vinGGIO, XCBR and CSWI:

- vinGGIO maps to Virtual Inputs of R650.
- XCBR represents the circuit breaker
- CSWI logical nodes represent switchgear of R650 relay.
- recPhXCSWI and rec3PCSW logical nodes represent recloser (One pole and three pole)

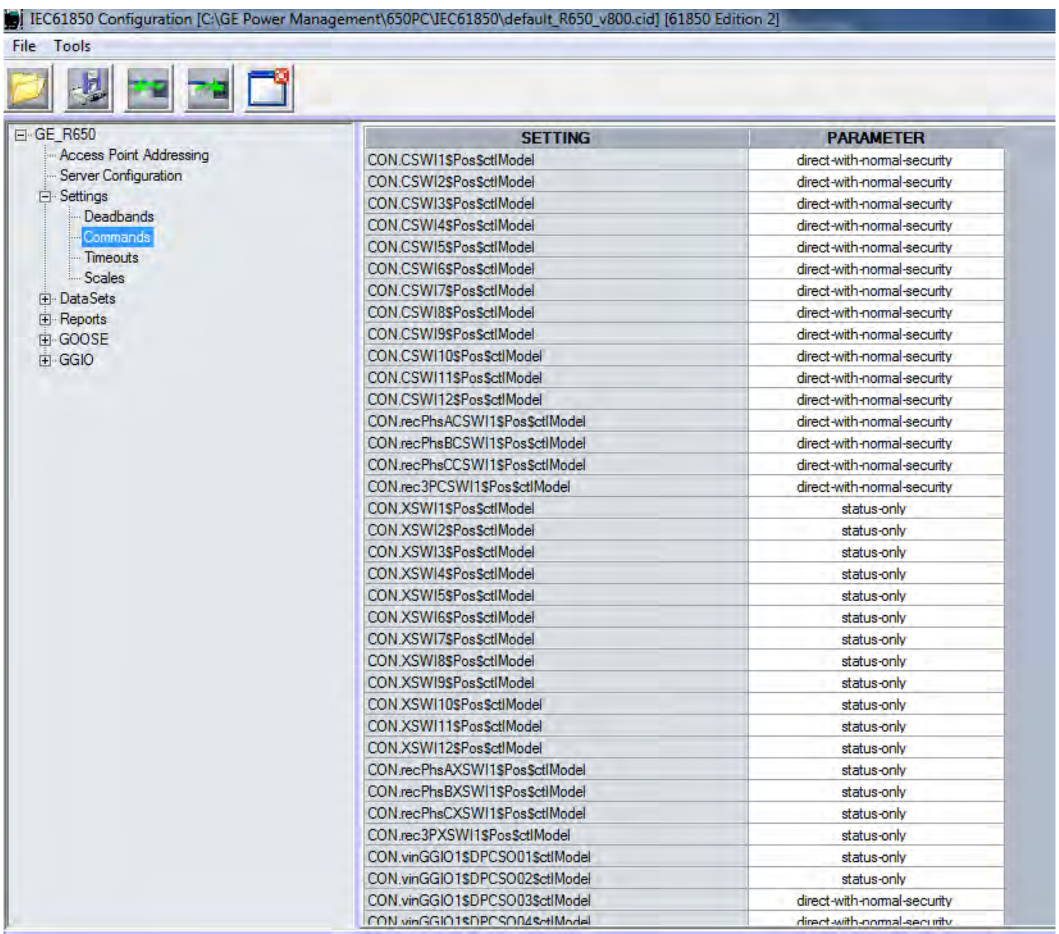


Figure 7-21: Commands

vinGGIO

Controllable data in vinGGIO logical node are SPCSO1 - SPCSO64 and DPCSO1 - DPCSO16. Signals SPCSO1 - SPCSO32 map to 32 Virtual Inputs Latched in R650 relay and signals SPCSO33 - SPCSO64 map to Virtual Inputs Self-Reset. DPCSO1 - DPCSO16 are double control points and operate on pairs of Virtual Inputs Latched. Thus DPCSO1 - DPCSO16 map to 32 Virtual Inputs Latched and an operation of one attribute DPCSO always operate on two Virtual Inputs Latched, one Virtual Input of the pair is set to "1" and the other Virtual Input of the pair is set to "0". In vinGGIO logical node only control mode "direct control with normal security" can be used.

XCBR, CSWI, recPhXCSWI

Controllable data in these logical nodes are Pos (position) objects. These are operations used to change state of breaker, switch or recloser.

R650 relays supports all four IEC 61850 control modes (ctlModel), which are:

- Direct control with normal security (direct-with-normal-security)
- SBO control with normal security (sbo-with-normal-security)
- Direct control with enhanced security (direct-with-enhanced-security)
- SBO control with enhanced security (sbo-with-enhanced-security)

TIMEOUTS

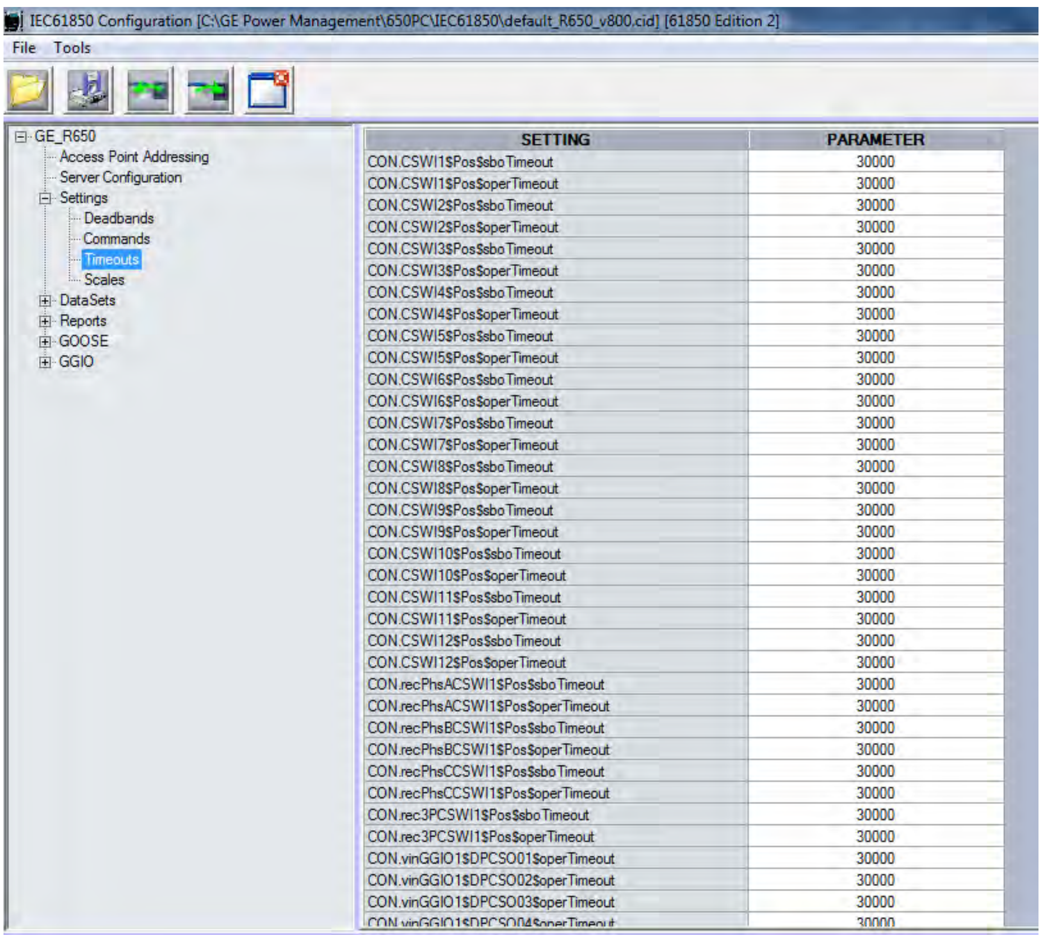


Figure 7-22: Timeouts

There is a configurable timeout for SBO control modes and for operation in logical nodes listed above. The value range for SBO timeout is 500 ms - 60 seconds.

The sboClass attribute can only have value "operate-once", "operate-many" pattern is not supported in IEC 61850 SBO controls in 650 relay.

DataSet

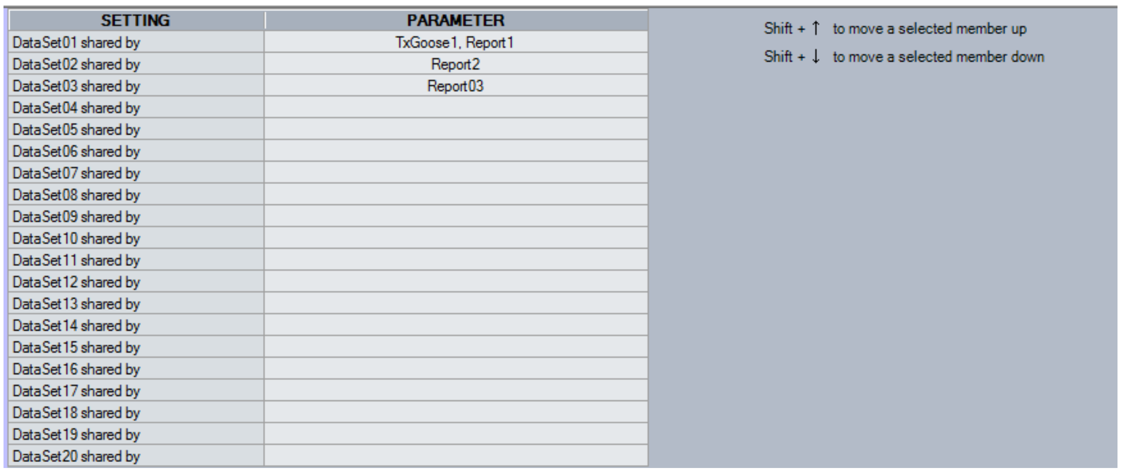
Two different sections will be differentiated under this section:

- Summary
- DataSetXX

SUMMARY

In this screen, user can find a list with information about where a configured DataSetXX has been used (Report and/or GOOSE).

If a DataSetXX is shared by more than one Report/GOOSE, all elements will be listed in DataSetXX Parameter field, separated by commas.



SETTING	PARAMETER
DataSet01 shared by	TxGoose1, Report1
DataSet02 shared by	Report2
DataSet03 shared by	Report03
DataSet04 shared by	
DataSet05 shared by	
DataSet06 shared by	
DataSet07 shared by	
DataSet08 shared by	
DataSet09 shared by	
DataSet10 shared by	
DataSet11 shared by	
DataSet12 shared by	
DataSet13 shared by	
DataSet14 shared by	
DataSet15 shared by	
DataSet16 shared by	
DataSet17 shared by	
DataSet18 shared by	
DataSet19 shared by	
DataSet20 shared by	

Figure 7-23: DataSetXX summary view

DataSetXX:

In this section, configure up to 20 different DataSets as follows:

DataSetXX name: It must be assigned initially. The first character of this attribute must be a letter (upper or lower case). The rest must be a number, a letter (upper or lower case or a "_". The number of characters allowed in 32

If this name is not configured, the following message will prompt when trying to drag any new element:

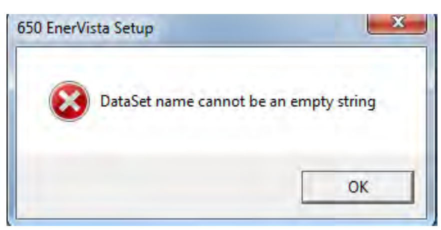


Figure 7-24: DataSet name not configured.

DataSetXX MemberX: After DataSet name is defined, members can be adding by dragging and dropping elements from the complete data model of the IED displayed below to the Data Set.

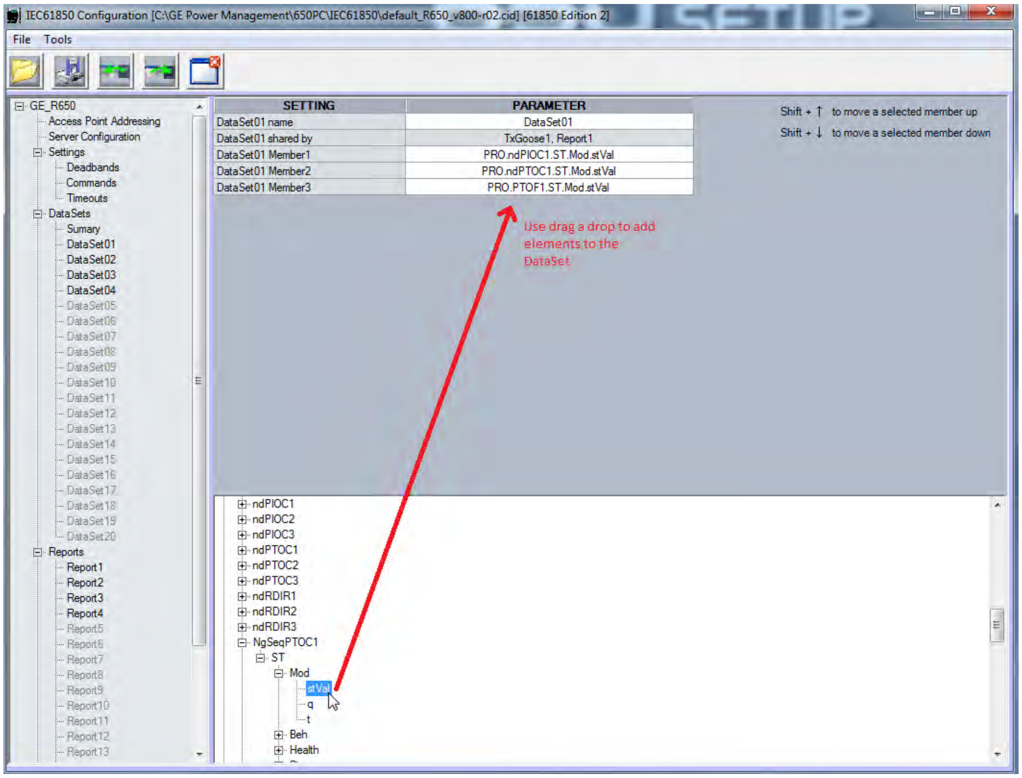


Figure 7-25: Adding attributes to a DataSet

There is a counter in the right-up corner of configuration area where users can visualize how many basic attributes have been added to a DataSetXX. This counter will increase automatically when basic attributes are dragged and dropped.

For example id CON.MMXU1.MX.A.net.cVal is dragged and dropped into DataSet, counter will be increased in two as there are two basic attributes in it (CON.MMXU1.MX.A.net.cVal.mag and CON.MMXU1.MX.A.net.cVal .ang)

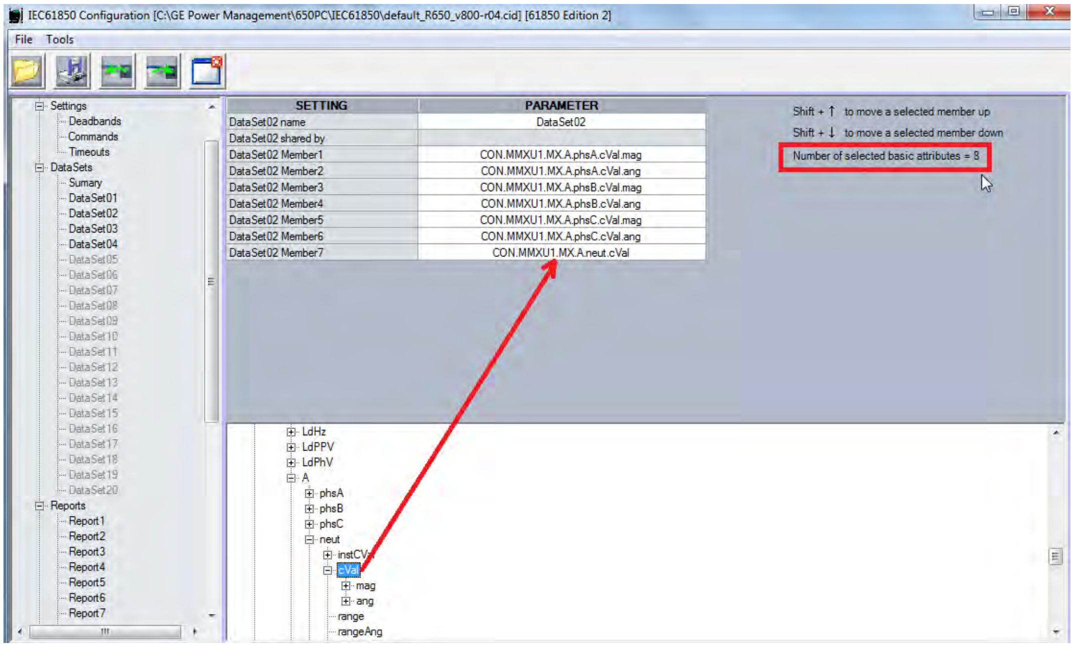


Figure 7-26: Basic attributes counter

To change the Order of the configured DataSet:

1. Select DataSet Member to be moved.
2. Click on Shift and up/down key.

To delete a Dataset Member:

1. Click on DataMember.
2. Press **SUPR** key.

To remove a DataSetXX:

1. Select DataSetXX in the IEC 61850 IED Explorer window.
2. Click right-button and select **Delete DataSet** as shown:

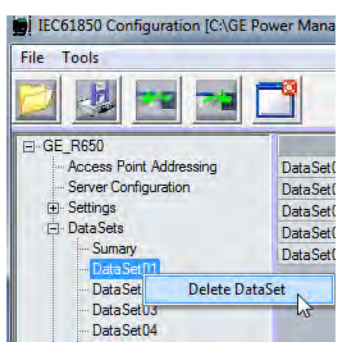


Figure 7-27: Delete DataSet

Reports

The 650 family relay supports both IEC 61850 buffered and unbuffered reporting. The device has configurable reports, which include user-defined Data Sets and Report Control Blocks.Reporting is based on Data Sets, which are collections of Data that can be included in Reports. The Report Control Block is a group of parameters which permit IEC 61850 customization of the reports being sent by the IEC 61850 server. For example, the IntgPd parameter of the Report Control Block contains the value in milliseconds of the interval between Integrity Reports sent by IEC 61850 servers.

A 650 family relay can have up to 20 different reports and up to 20 different Data Sets linked (only one DataSet can be linked to one Report). In the reports, each Dataset can be configured with a maximum of 576 Dataset Members.

All settings/datasets assigned to different reports can configured as described in this section. Up to 20 different reports can be configured.

SETTING	PARAMETER
Report1 Name	Report1
Report1 RptID	1
Report1 DatSet	DataSet01
Report1 ConfRev	1
Report1 OptFlds	Click to view or edit (223)
Report1 BufTm	0 ms
Report1 TrgOps	Click to view or edit (5)
Report1 IntgPd	60 ms
Report1 Buffered	True
Report1 Max Clients	1

ReportX Name:

The first character in the value of this attribute must be a letter (upper or lower case). The rest of the characters must be a number, a letter (upper or lower case) or a "_". The maximum number of characters allowed in IEC61850 Configurator is 30 and IEC61850 MMS Library adds 2 more characters indicating the number of the instance of the RCB depending on the number of IEC61850 clients configured

ReportX RptID:

The attribute RptID is the client-specified report identifier of the RCB that has caused the generation of the report.

ReportX DatSet:

This dropbox lists only DataSets configured in DataSet section with less than 576 DataSet Members. Select the Dataset that is going to be assigned to Report X,

ReportX ConfRev:

It represents the configuration revision number of the control block

ReportX OptFlds:

Different options for report triggers are listed in this dropbox list. One or more options the report triggers are shown in the Supported Triggers list:

- Data-Change
- Quality-Change
- Integrity
- General Interrogation

ReportX BufTm:

This setting is only considered if ReportX Buffer setting is set to true. In case of an event that causes a report the server will wait for BufTm ms for other events. All data that is to be reported because of events in this time span is sent in a single report. If connection with client is lost, events will be logged during BufTm and they will be sent when client connects again.

ReportX IntgPd

Only working if general interrogation is configured in trigger options. The integrity period specifies an interval in ms for the periodic sending of intergrity reports.

ReportX Buffered:

The standard distinguishes between two types of reporting: buffered reporting and unbuffered reporting. With buffered reporting reports are buffered by the server in case a connection to the client is interrupted. This way reports can be sent after the client has connected again. Buffered reporting is configured through buffered report control blocks (BRCB). Unbuffered reporting is configured through unbuffered report control blocks (URCB).

If it set to true, report will be configured as buffered report control block (BRCB). If set to false, report will be configured as unbuffered report control block (URCB)

ReportX Max Clients:

Number of clients that can be connected to a report control block. Up to 5 different clients can be configured

GOOSE

TxGOOSE

In this section, configure four different transmission GOOSE: TXGOOSEX.

SETTING	PARAMETER
TxGOOSE1 Name	TxGoose1
TxGOOSE1 Desc.	
TxGOOSE1 GoID	TxGOOSE1
TxGOOSE1 DataSet	DataSet01
TxGOOSE1 CONFREV	1
TxGOOSE1 Enabled	true
TxGOOSE1 DST MAC	01-0C-CD-01-00-01
TxGOOSE1 VLAN PRIORITY	4
TxGOOSE1 VLAN ID	000
TxGOOSE1 ETYPE APPID	0000
TxGOOSE1 MAX TIME	10000

Figure 7-28: Transmitted GOOSE settings

TxGOOSEX Name:

The first character in the value of this attribute must be a letter (upper or lower case). The rest of the characters must be a number, a letter (upper or lower case) or a "_". The maximum number of characters allowed is 32.

TxGOOSEX Desc:

The maximum number of characters allowed is 32.

TxGOOSEX GoID:

The maximum number of characters allowed is 129

TxGOOSEX DataSet:

Select DataSet to be tramistted in this TxGOOSE. Only DataSets configured with 128 elements or less will be displayed in this dropbox.

TxGOOSEX CONFREV:

It can be used to indicate GOOSE configuration revision

TxGOOSEX Enabled:

To enable/disable transmission GOOSE

TxGOOSEX DST MAC:

The standard MAC address limit. 6 pairs of letters (from A to F, upper case or lower case) or numbers separated by colons.

Make sure to configure the MAC with the least significant bit in the most significant byte, set to 1. Example: 01: 0C: CD: 00: 00: 04

TxGOOSEX VLAN PRIORITY:

A number from 0 to 7 can be configured. IEC 61850 recommends a default priority value of 4 for GOOSE. Ethernet traffic that does not contain a priority tag has a default priority of 1. More details are specified in IEC 61850 part 8-1.

TxGOOSEX VLAN ID:

The maximum number of characters allowed is 3. IEC61850 Configurator allows characters limited to 0 to 9, A to F and it saves in the CID file the hexadecimal value (max FFF).

TxGOOSEX ETYPE APPID:

All characters must be numerical. The maximum number of characters allowed is 4. IEC61850 Configurator allows characters limited to 0 to 9, A to F and it saves in the CID file the hexadecimal value (max FFFF).

IEC 61850 recommends that the Ethertype Application ID number be configured according to the GOOSE source. In the R650, the transmitted GOOSE Application ID number must match the configured receive Application ID number in the receiver. A common number may be used for all GOOSE transmitters in a system. More details are specified in IEC 61850 part 8-1.

TxGOOSEX MAX TIME:

Time allowed to live. The maximum time packet remains alive after transmission. It must be configured in ms

Mapping TxGOOSES

For transmission GOOSE you can create Data Sets with drag-and-drop selecting the desired data attributes in the data model tree and dragging them to the DataSet panel. Data Sets can be directly formed by attributes of all Logical Nodes. For example they can contains status of protection functions as:

- PTOC1.ST.Op.phsA- "Time Overcurrent Function 1 Operate Phase A"
- PTUF2.ST.Str.general- "Underfrequency Function 2 Trip General"
- XCBR1.ST.Pos.stVal- "Circuit Breaker Position"
- etc.

There is also a dedicated logical node in R650 which can be used for mapping of internal signals to be transmitted via GOOSE. This logical node is rouGGIO1. It contains 32 digital indications with associated quality flags and timestamps. rouGGIO1 permits flexible mapping of any of relay's digital signals to outgoing GOOSE messages. This can be useful when transmission via GOOSE of internal signals that are not mapped to any IEC 61850 logical node in the R650 is required. An example of such signals are "Virtual Outputs" which are internal variables of R650 derived from PLC logic equations.

Mapping of signals to rouGGIO1 indications is performed in EnerVista 650 Setup software in menu **Setpoint > Relay Configuration > Remote Outputs**. rouGGIO1 indications are called **Rem GOOSE Dig Out 1**, **Rem GOOSE Dig Out 2**, etc. in this menu, and are listed after the DNA and UserSt bits.

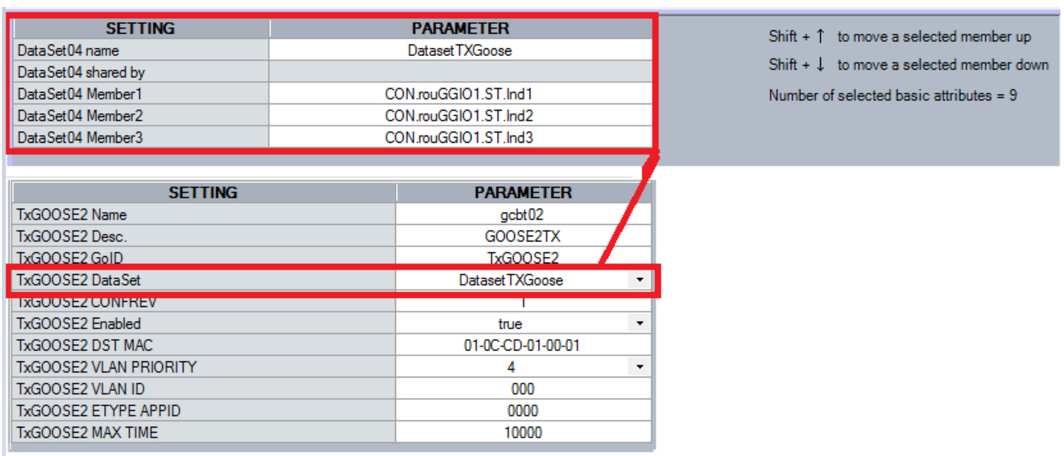


Figure 7-29: Example of rouGGIO mapping in Dataset

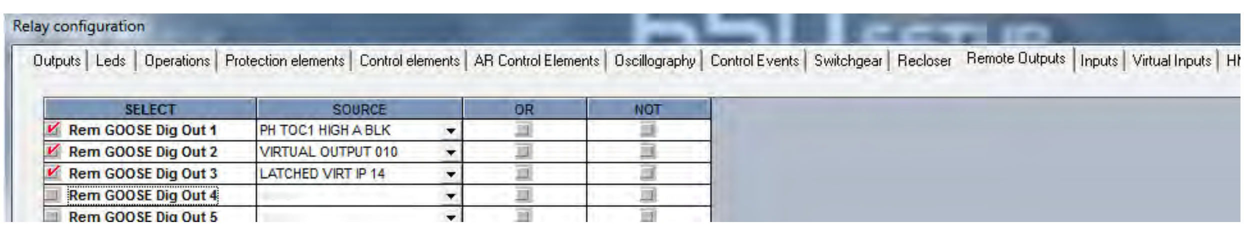


Figure 7-30: Example of rouGGIO mapping in Setpoint > Relay configuration

RxGOOSE

650 relays can subscribe to up to 24 different remote devices. A maximum of 32 Remote Inputs (digital signals), 32 Remote Goose Digital Inputs, and 16 Remote Goose Analog Inputs can be configured as subscriptions.

Mapping RxGOOSES

In order to configure reception of configurable GOOSE in a 650 relay, it is necessary to have the ICD/CID file of the sending IED. This means that the first transmission GOOSE must be configured in the sender, and then the ICD/CID file must be imported using the **IEC 61850 Configurator** tool in the EnerVista 650 Setup software.

To import a CID file from a remote IED:

1. In the IED list panel, select LGOS X, right-click and select **Add IED** to add a new IED for GOOSE reception. Up to 24 different CIDs can be imported.

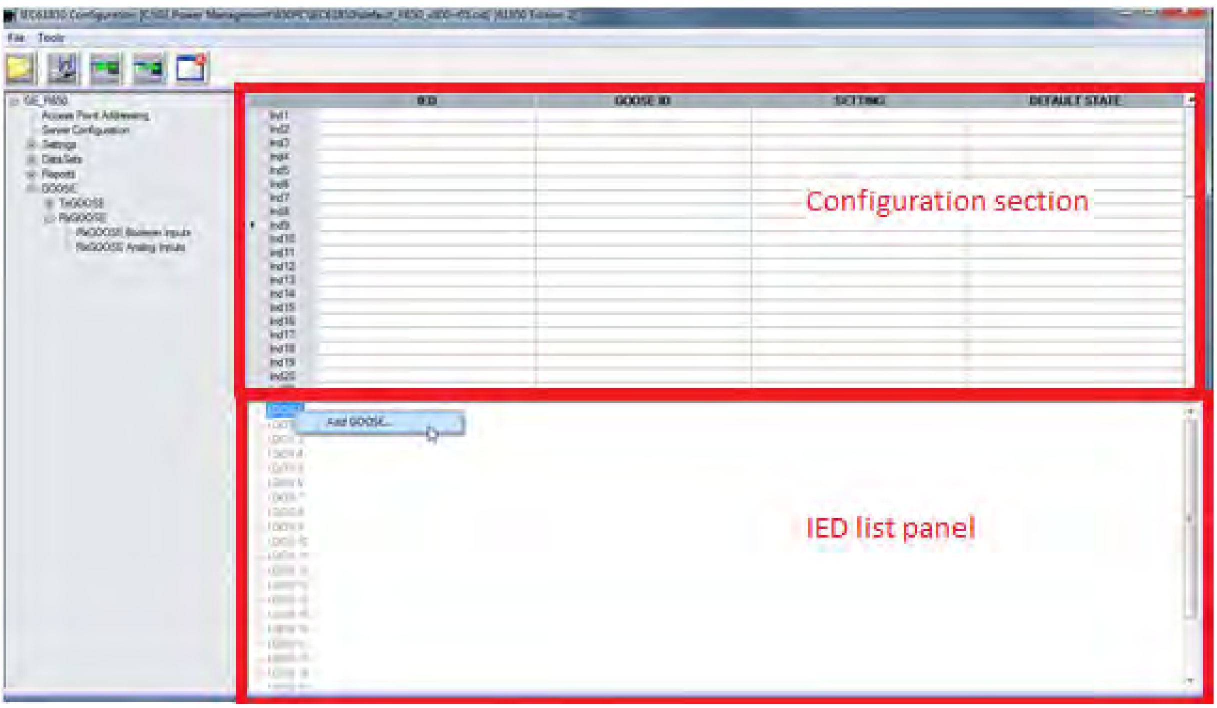


Figure 7-31: Import CID file

2. A pop-up window allows selection of the CID file to import, with transmission GOOSES previously configured.

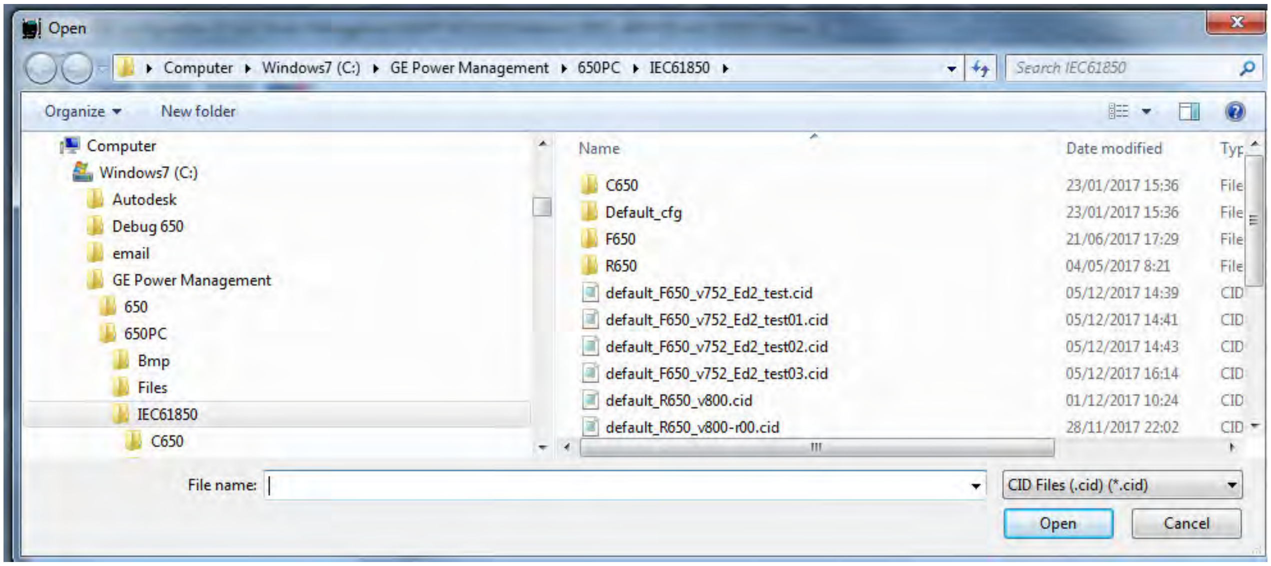


Figure 7-32: CID file selection

3. After selecting the CID file, all configured transmission GOOSES are imported and all GOOSE FCDAs are displayed as shown:

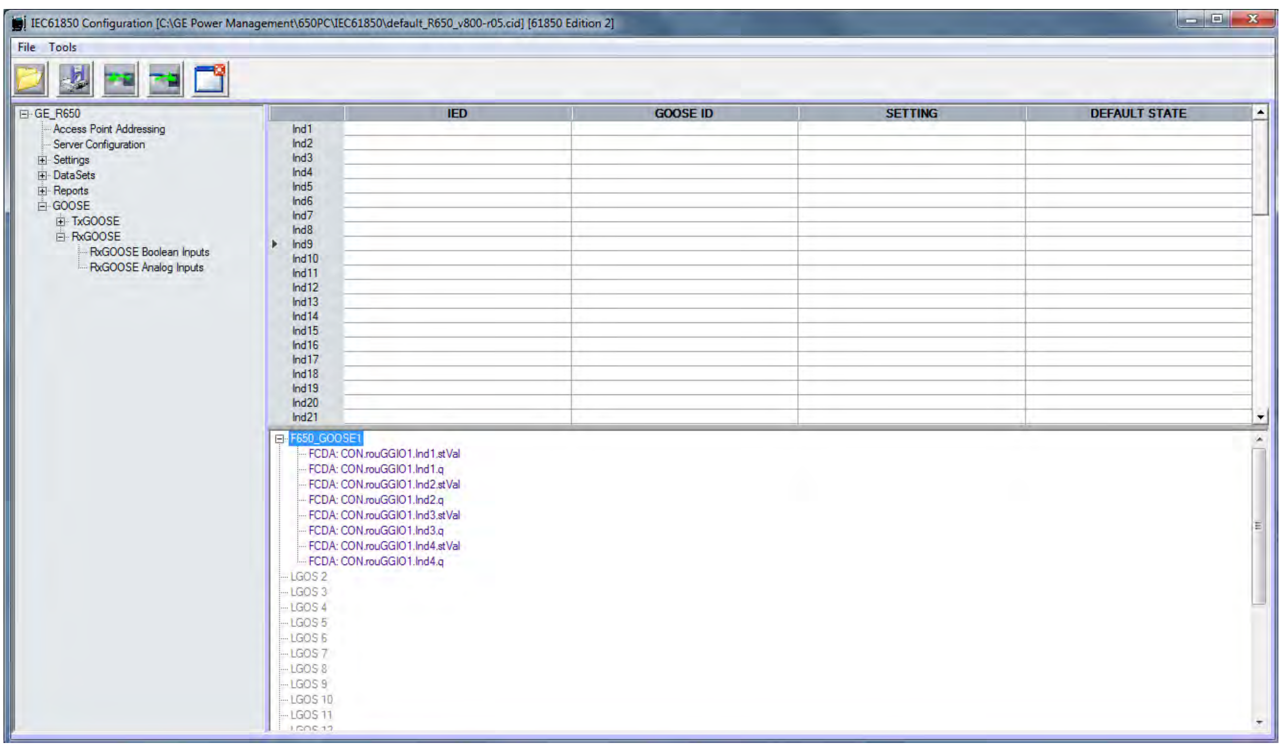


Figure 7-33: Imported CID file

4. If any imported transmission GOOSE needs to be deleted, updated, moved up/down or the header needs to be edited, right-click on the imported GOOSE in the IED panel list

Figure 7-34: Transmission GOOSE menu

If a new CID is imported and it contains a GOOSE ID that it is already present in the IED panel list, the following message displays and no transmission GOOSES from the imported CID are added to IED panel list.

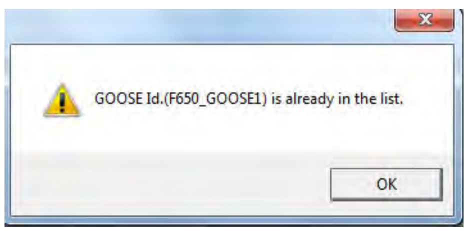


Figure 7-35: Warning message: Same GOOSE ID detected

Up to 32 Remote Inputs and 32 Goose Digital Inputs can be configured in a reception goose (RXGOOSE). The configuration section shows a list with 64 different rows. The first 32 values are shown on the Remote Goose Digital Inputs screen and the remaining 32 values are on the Remote Inputs screen.

To configure RxGOOSE Boolean Inputs follow these steps:

1. Boolean signals can be dragged and dropped from an imported remote IED transmission GOOSE into the Configuration section.

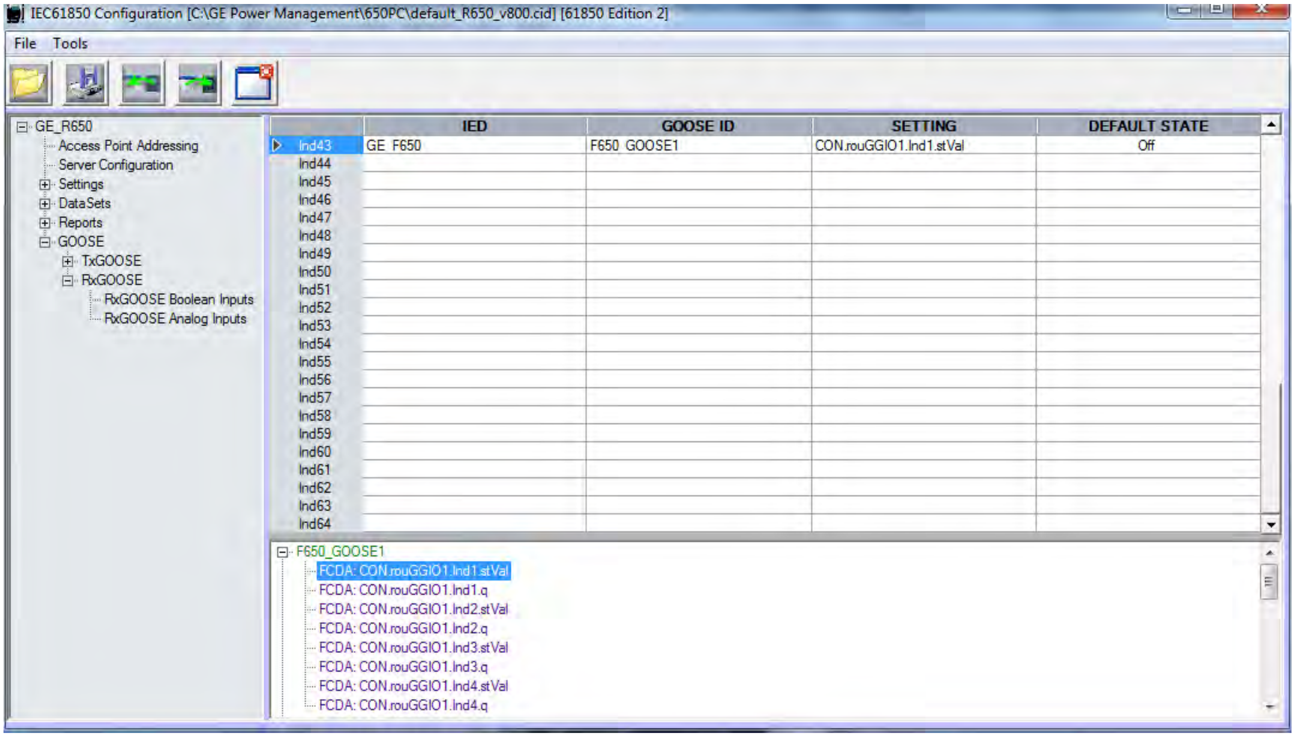


Figure 7-36: RXGOOSE Boolean Input

2. When a boolean signal is dragged and dropped into any IndX element, four columns show the following information:
   - **IED**: IED name configured in imported CID
   - **GOOSE ID**: Goose ID configured in imported CID
   - **SETTING**: FCDA of boolean signal from imported CID that has been dragged and dropped into the configuration area.
   - **DEFAULT STATE**: Value that signal shows when status has not been updated from the remote device.

Removing Boolean inputs:

- To remove a configured boolean signal, right-click on it and select **Remove Input**.

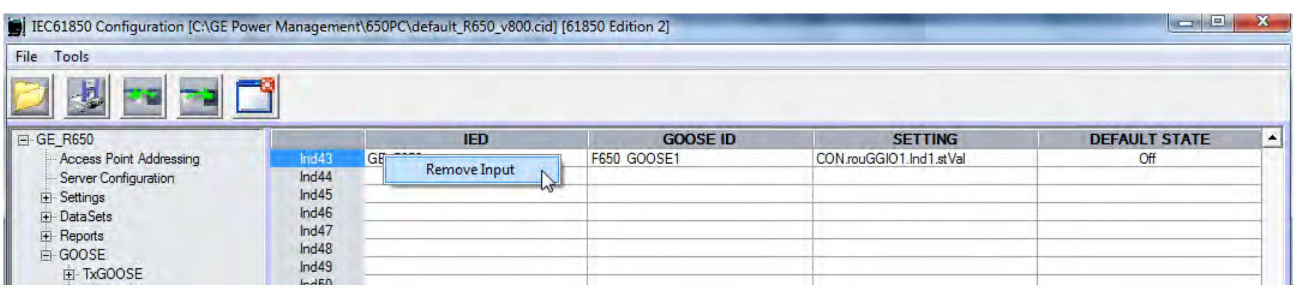


Figure 7-37: RXGOOSE Boolean input - Remove Input

To configure quality bits, follow these steps

1. Quality bits of Boolean signals can be dragged and dropped from an imported remote IED transmission GOOSE into the Configuration section. When a quality bit is dragged and dropped, a pop-up window opens to allow the selection of one of the thirteen quality bits available.

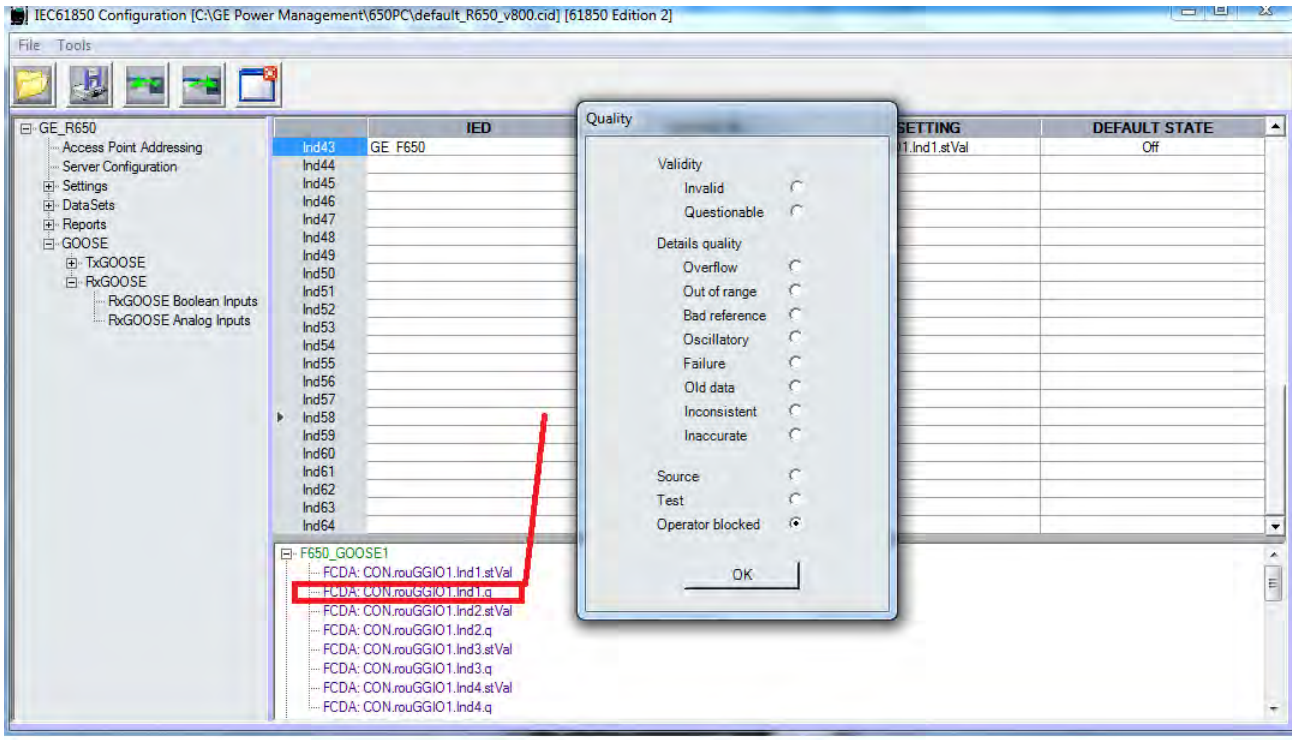
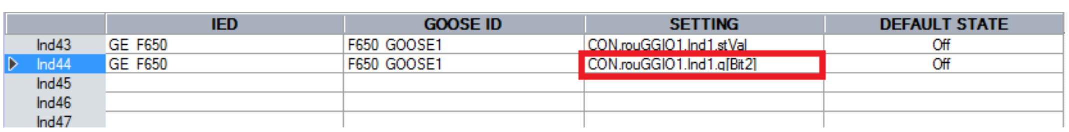


Figure 7-38: RXGOOSE Boolean input - Quality bit selection

2. Once a quality bit is selected, click **OK**, and the selected quality bit is shown in the Setting column of the Configuration area.



	IED	GOOSE ID	SETTING	DEFAULT STATE
Ind43	GE_F650	F650_GOOSE1	CON.rouGGIO1.Ind1.stVal	Off
Ind44	GE_F650	F650_GOOSE1	CON.rouGGIO1.Ind1.q[Bit2]	Off
Ind45				
Ind46				
Ind47				

Figure 7-39: RXGOOSE Boolean input - Selected quality bits shown

To configure RxGOOSE Analog Inputs, follow these steps:

Up to 8 float analog inputs (AnInX.mag.f) and 8 integer analog inputs (AnInX.mag.i) can configured in RXGOOSE Analog Inputs, as shown:

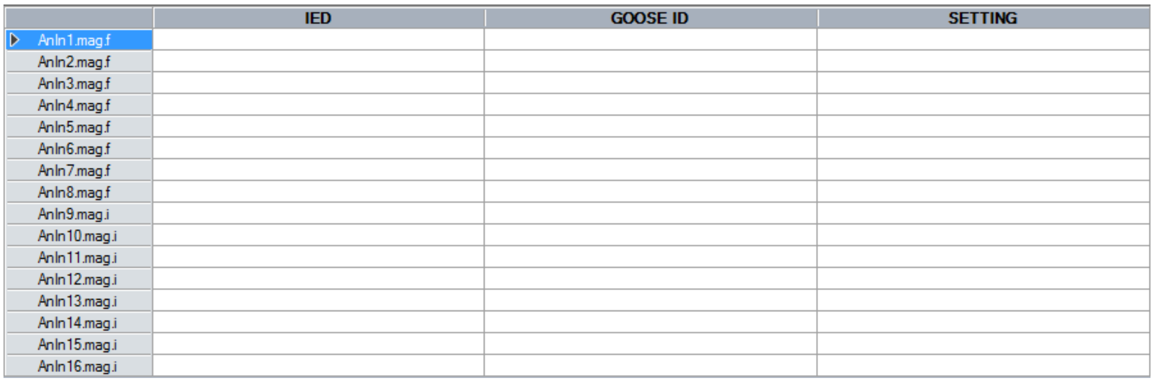


Figure 7-40: RXGOOSE Analog Inputs

1. Add both float and Integer analog inputs by dragging and dropping values from the transmission GOOSES imported in the IED Panel list into AnInX.mag.X rows in the Configuration section.
2. When an analog signal is dragged and dropped into any element, three columns show the following information:
   - **IED**: IED name configured in imported CID
   - **GOOSE ID**: Goose ID configured in imported CID
   - **SETTING**: FCDA of Analog signal from imported CID that it has been dragged and dropped into configuration area.

   If the analog signal being dragged and dropped has been previously added from the IED panel list, the following warning message pops up:

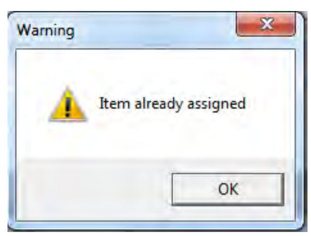
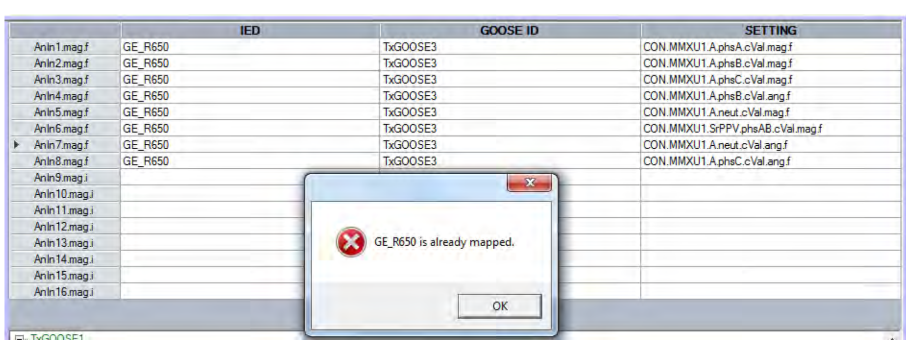


Figure 7-41: Warning message - Duplicate item

When all 8 Analog Inputs of one type (such as float) have been mapped, and an additional float analog value is dragged a dropped into the Configuration area, an error message is shown

:



In order to replace an Analog Input, first remove the existing Analog Input.

Removing Analog inputs:

- To remove a configured analog signal, right-click it and select **Remove Input**.

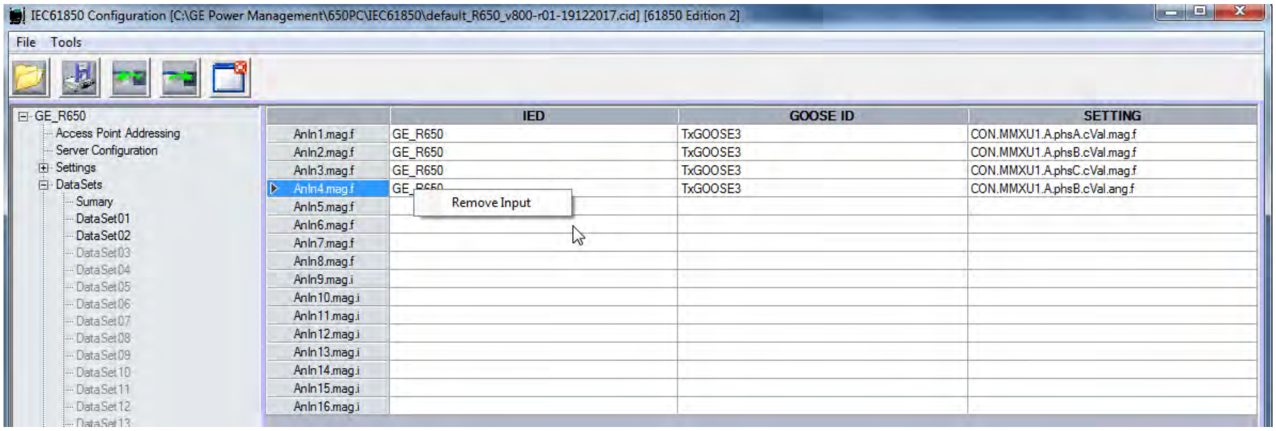


Figure 7-42: RXGOOSE Analog input- Removing inputs

R650 Recloser Controller

Chapter 8: Security

8.1 Adding users

New users can only be added by users that have **Administrator Access (or Admin Rights)**. The **Enable Security** check box located in the **Security** > **User Management** window must be enabled.

Remember: (**In order to add new users and assign user rights**)

- **must be logged in with Administrator Permission**
- **and Enable Security checkbox must be enabled**

8.1.1 User rights

NOTE: Only Administrators have access to the User Management dialog box.

Following is a list of all of the User Rights Options available to be granted to users, and their functions.

Table 8-1: User rights and functions

RIGHT	FUNCTION
Delete Entry	If this box is checked when the Administrator exits the User Management dialog box, the program asks to confirm the delete before the selected user is permanently deleted from the list.
Admin.	WARNING: When this box is checked, the user becomes an EnerVista 650 Setup Administrator, receiving all Administrative rights.
Actual Values	When this box is checked, the user is able to *view* **Actual Values** and all records excluding event recorder.
Settings	When this box is checked, the user is able to *view and modify* **Settings (Protection, control, inputs/outputs and calibration)**.
Commands	When this box is checked, the user is able to use **Commands**.
Event Recorder	When this box is checked, the user is able to use **Event Recorder**.
Force IO	When this box is checked, the user is able to use **Force IO** application.
Logic Configuration	When this box is checked, the user is able to *view and modify* **Relay Configuration and Logic Configuration**.
Upgrade	When this box is checked, the user is able to **upgrade firmware, bootware** and to **upload** and **download info files to/from relay.**

By default, Administrator and Service users are created with "password" as default password.

8.2 Changing passwords

Users are prompted to change their password after the first successful log in or through clicking **Security** from the toolbar, and choose **Change Password**.

Figure 8-1: Change security

When the operator enters a new password for the first time, he/she should also enter a personal question that only they can answer. There is a limit of 50 characters available to enter the personal question. One example, as in the above diagram, would be "What is my mother's maiden name?". This question is posed to the user if the user forgets their password and would like to know what their password was.

8.3 Enabling security

EnerVista 650 Setup Security Control is disabled by default. Users don't have to log in through user name and password after installation and are granted access as Administrator.

Security Control can be enabled through **Security** from the tool bar when logged on as an Administrator. Click **User Management**:

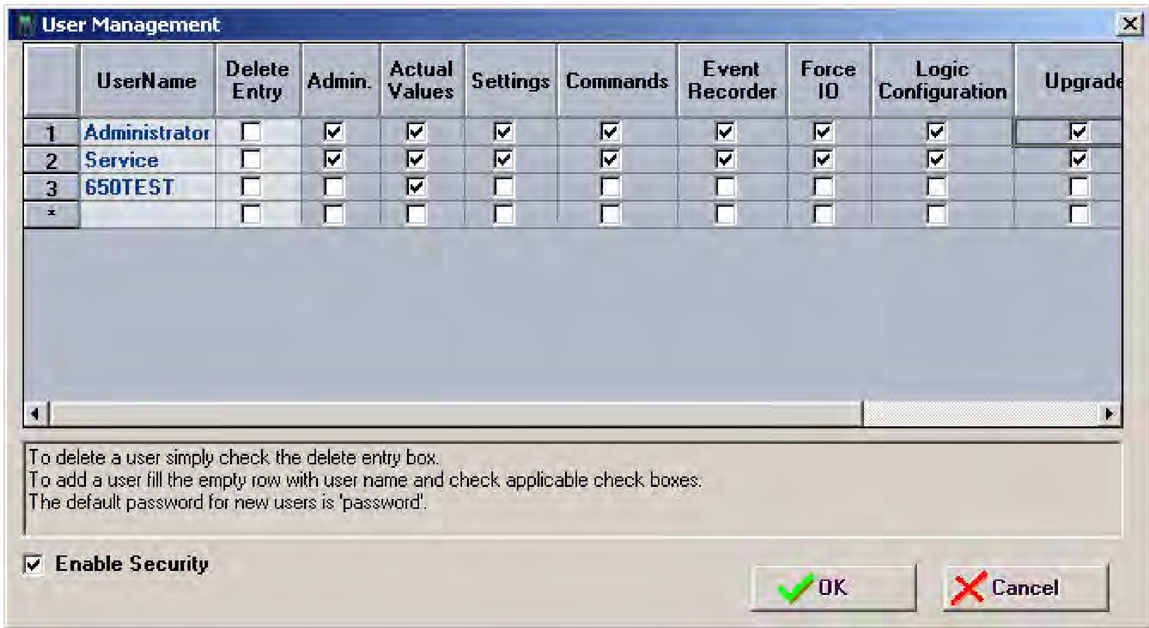


Figure 8-2: Enabling security

Security Control is enabled by checking the **ENABLE SECURITY** check box. The first time the enable security option is selected it is necessary to close and reopen the EnerVista 650 Setup software to start working under security management.

8.4 Logging into EnerVista 650 Setup

Users have to log on in order to use EnerVista 650 Setup program after Security Control has been enabled. After the start up of EnerVista 650 Setup, a dialog prompts for user name and password.

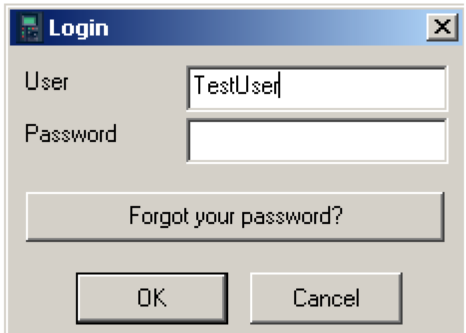


Figure 8-3: Login user

The user name field displays the last log in user name as default, in this example, TestUser. For the first log in session of any user name, the default password is "password". The user is prompt to change the password to something else after the first successfully log in.

Log on can also be done by clicking **Security** from the toolbar and choose **Login New User**. The user is prompted with the same log in dialog box for a different user name and password combination.

In case a user has forgotten their log in password, the **Forgot Password** function can be used to retrieve the password.

Figure 8-4: Forgot your password?

A question, which is pre-set by the user, is asked. The password is retrieved for entering the right answer.

R650 Recloser Controller

Chapter 9: Bootcode and firmware upgrade

This section explains how to upgrade the R650 firmware code.

9.1 Communication parameters

1. Ethernet Connection/Type - Firmware upgrade processes require Ethernet communications. It is strongly recommended to use a direct connection between the PC and the relay using a Cross-Over RJ45 Ethernet cable, instead a direct connection through a hub or switch.

2. Relay IP Address - It must be assigned a IP address to the relay in the Ethernet parameters via HMI at **Product Setup > Communication > Ethernet > Ethernet E, A** or **B** menu or via Enervista 650 Setup at **Setpoint > Product Setup > Communication Settings > Network (Ethernet) E, A** or **B** as shown in the Table below.

Table 9-1: Ethernet parameters

PRODUCT SETUP > COMMUNICATION SETTINGS > NETWORK (ETHERNET)			
NAME	**EVALUE**	**UNITS**	**RANGE**
IP Address Oct1	192		[0 : 255]
IP Address Oct2	168		[0 : 255]
IP Address Oct3	37		[0 : 255]
IP Address Oct4	177		[0 : 255]
Netmask Oct1	255		[0 : 255]
Netmask Oct2	255		[0 : 255]
Netmask Oct3	255		[0 : 255]
Netmask Oct4	0		[0 : 255]

PRODUCT SETUP > COMMUNICATION SETTINGS > ROUTING			
NAME	**EVALUE**	**UNITS**	**RANGE**
Default RT GWY Oct1	192		[0 : 255]
Default RT GWY Oct2	168		[0 : 255]
Default RT GWY Oct3	37		[0 : 255]
Default RT GWY Oct4	10		[0 : 255]

3. Example of IP Address Configuration:

The IP address and other parameters already assigned in the process are:
IP Address:192.168.37.177
Netmask:255.255.255.0
Gateway:192.168.37.10

Note: To assure that the configuration is correctly setup it is possible to perform a ping command from the PC.

Then the PC settings should be the same pattern as follows:

IP Address:192.168.37.xxx

Netmask:255.255.255.0

Gateway:192.168.37.10 (if desired)

Where XXX is a number between 0 and 255 that is not assigned to any other device to avoid collisions.

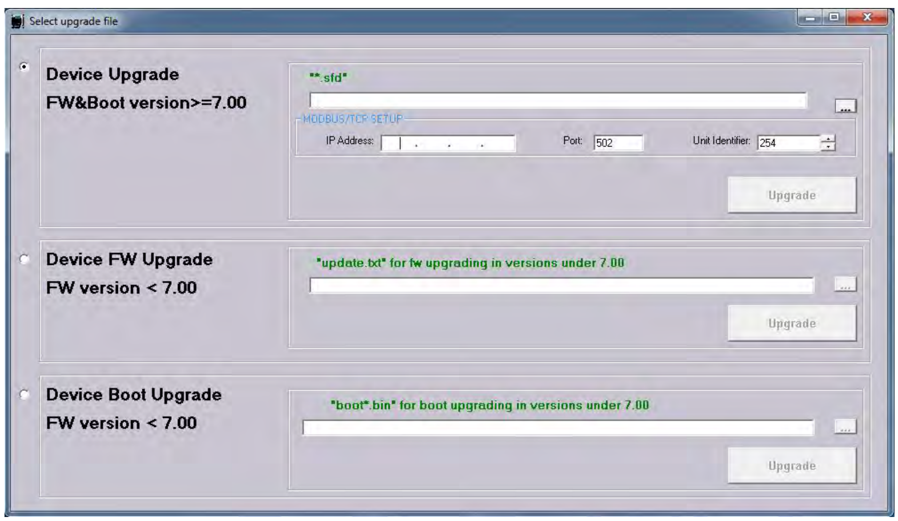
9.2 Firmware version upgrade

9.2.1 Introduction

1. The relay settings and configuration will be lost, so it is advisable to save them to a file.
2. In case of error during the firmware upgrading process, the user can repeat the whole process as many times as necessary.
3. Firmware upgrading process should be done using the EnerVista 650 Setup software and Ethernet connection (Port ETH_E, A or B) via **Cross-Over RJ45 Ethernet cable.**

9.2.2 Firmware upgrade

1. Once the communication with the relay through Ethernet connection has been verified, enter the EnerVista 650 Setup program, select Communication and the **Upgrade Relay** option on the top menu bar.



2. Select **Device Upgrade FW&Boot>=7.00** and click [...] to browse for the file. The appropriate *.SFD file should be obtained from, http://www.gegridsolutions.com/index.htm or from The Technical Service Dept. at any GE Multilin facility. The file must be saved in the root drive or in the desktop of the PC. Choose the corresponding firmware file for upgrading the device.

3. Enter communication parameters for the relay being upgraded and click **Upgrade.**

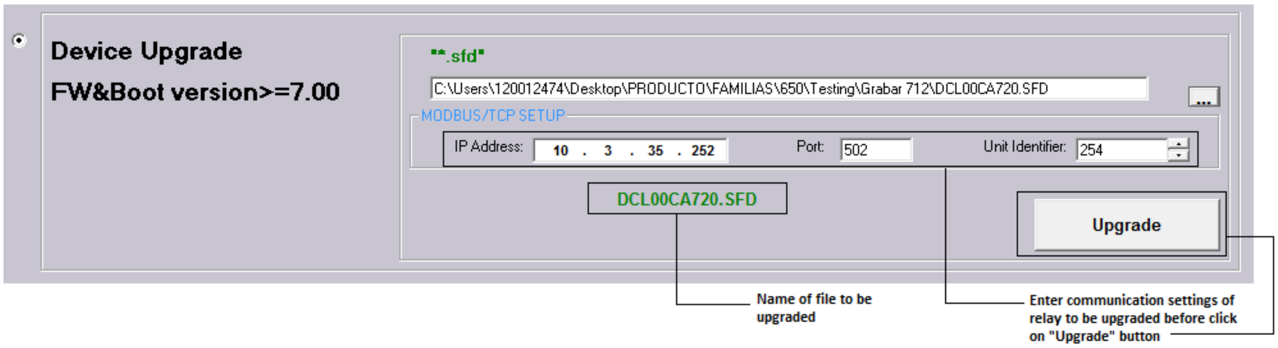
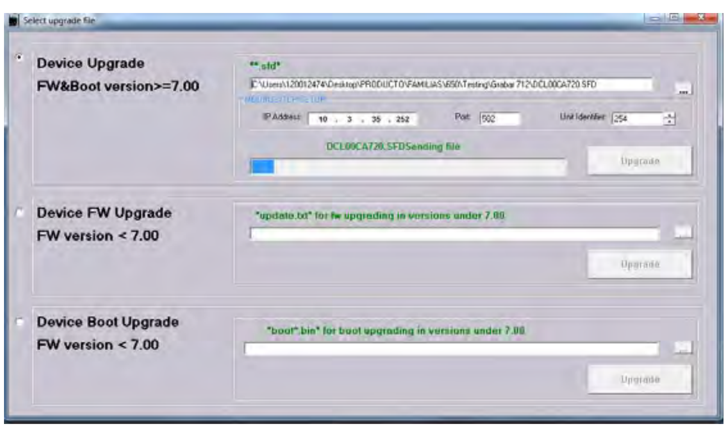


Figure 9-1: Relay communication parameters

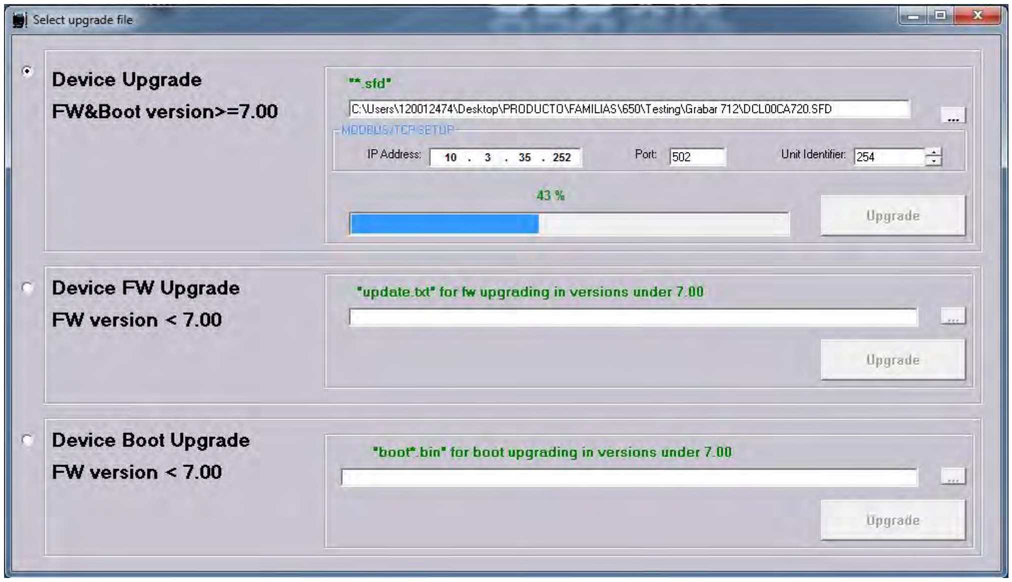
If the IP address is incorrect one, the following message is shown:

4. If the IP address is correctly set, then the message "*.SFD Sending file" is displayed. A sending file status bar shows the progress of the upgrade.

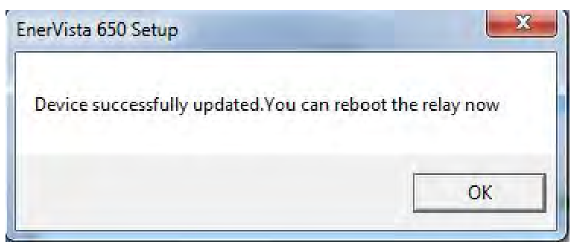


5. If the file is not sent successfully, an unsuccessful message is displayed.

6. After sending the file successfully, the upgrade process starts:



7. When the flashing upgrade process finishes, a message is displayed requesting a relay reboot.



8. User settings and logic files downloading

When upgrading the firmware the entire settings and relay configuration are reset to factory default values. Then the User is committed to download the settings, configuration and logic files to the relay in order to get it fully operative.

Calibration settings and configuration must be loaded to the relay once the upgrade process has finished.

To recover and download the different files to the relay use Enervista 650 Setup and at the top menu bar choose:

- **Communication > Calibration > Set Calibration Files**: to restore in the relay the calibration settings if necessary.
- **File > Config File (*.650) Converter**: to convert the setting and configuration file *.650 for the relay (if it was in a previous version format).
- **File > Send Info to Relay**: to send the new settings and configuration file to the unit.

9.2.3 Order code upgrade process

In the case of a relay model with specialized functionality (or a new order code requirement) with password requirement (see model selection), the program requests a password to continue.

1. To reach the window where the password is requested, the user must be communicating with the relay (ONLINE MODE). On the File menu the following submenu is available (for firmware versions above 7.00):

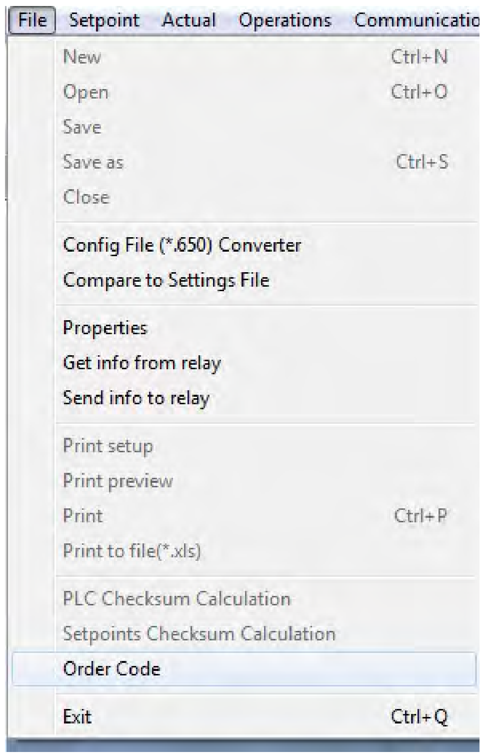


Figure 9-2: Order code submenu

2. Click Order Code on the menu and the following window is displayed:

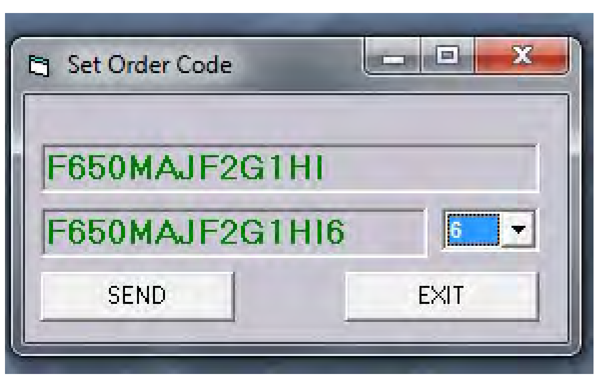


Figure 9-3: Set order code

3. This window only allows changing the last digit, which refers to supported communications protocols options. Click Send:

Figure 9-4: Password requirement (special models)

4. The users must contact GE Multilin and provide the following parameters in their order:
   - Unit serial number
   - Current model option (before memory upgrade)
   - Desired model option (after memory upgrade)
   - Unit MAC address (available in the identification label)

5. Once the password is obtained, enter it when prompted.Tthe following messages appear if the password is correct.:

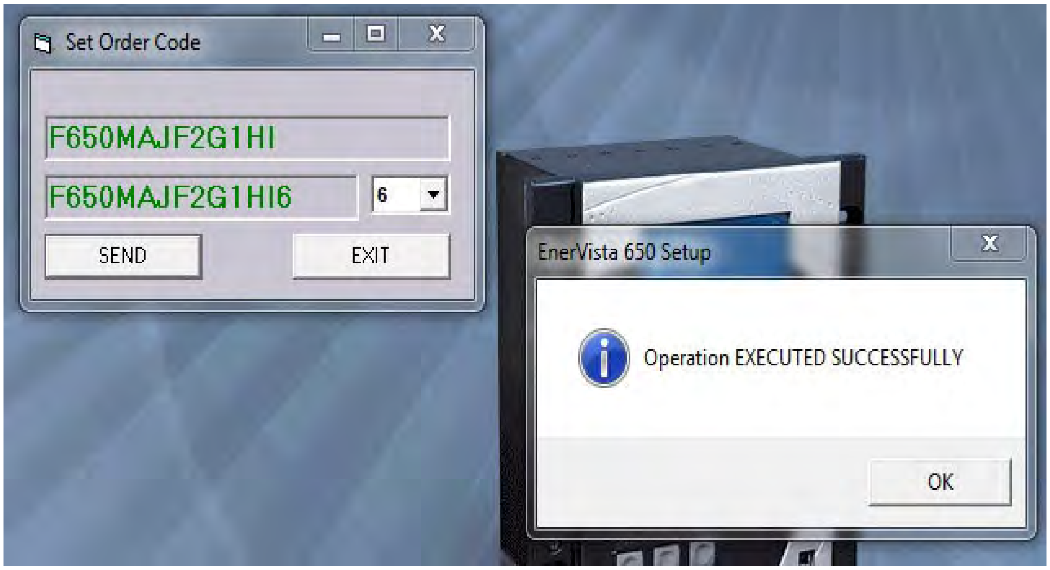


Figure 9-5: Executed successfully

6. After the successful operation, the SEND button is disabled. It is not allowed to make another change from here, so it can be seen what changes have been made. The new order code appears on the status bar.

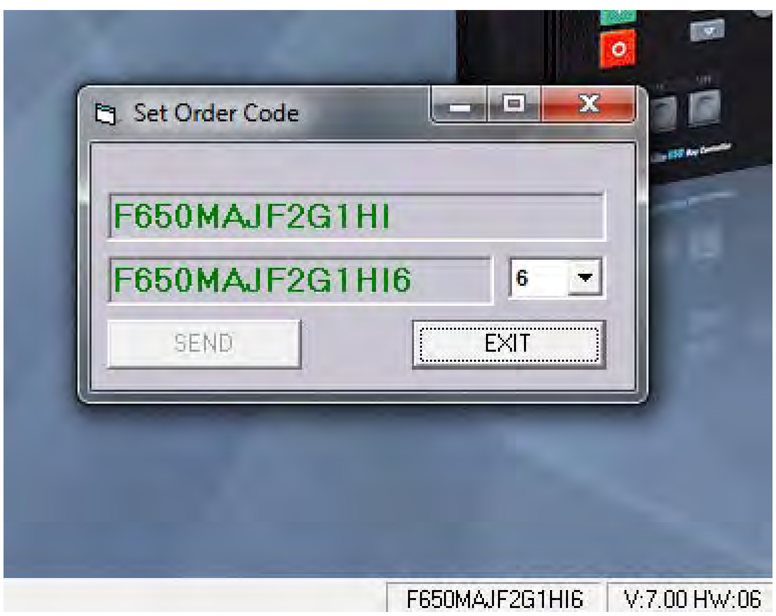


Figure 9-6: New order code

9.3 Summary of main firmware upgrade steps

1. Install the proper version of the EnerVista 650 Setup software.
2. Connect an Ethernet cable to the rear Ethernet port (a cross-over cable for back-to-back connection and straight-through cable for hub or switch).
3. Set the appropriate IP address in the relay.
4. Set the appropriate IP address in the PC.
5. In the EnerVista 650 Setup software, select **Communication > Upgrade Relay**.
6. Select the appropriate file (DCL000CAXXX.SDF) for the upgrade.
7. Enter the IP address, serial number, and unit identifier of the relay as prompted.
8. Click **Upgrade File** to initiate the upgrade process.
9. Reboot the relay as required by the upgrade program to complete the upgrade process.
10. All setting and configuration are now set to the factory default.
11. Send new settings and configuration files to the relay if needed.

NOTICE **See chapter 13 R650 trouble shooting guide, if there is any problem during the upgrading process.**

R650 Recloser Controller

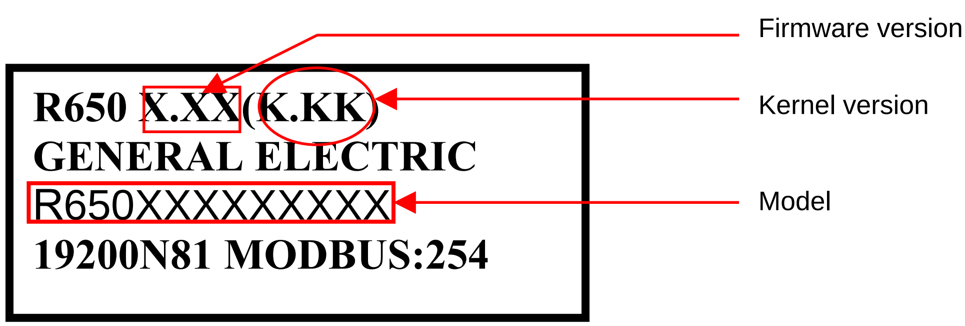
Chapter 10: Commissioning

10.1 Visual inspection

Verify that the relay has not suffered any damage during transportation, and that all screws are correctly fixed, and all relay terminal boards are in good condition.

Verify that the information shown on the relay front plate corresponds to the data shown on the display, and to the requested relay model.

Display information:



10.2 Out of service setting

The unit Relay Out of Service setting is configured in **Setpoint > System Setup > Miscellaneous**. When this setting is set to DISABLE, internal logic monitors different internal status/errors and also the **Out of Service** status. The **Out of Service** status can be configured in **Relay Configuration > Protection Elements**, where any digital signal available in the drop-box list can be configured as the input.

When internal logic is running, the relay goes into **OUT OF SERVICE** under the following circumstances:

- If any of following internal errors reports status indicated below:
  - **Self-Test Memory OK**: Status set to 0 which means internal memory is faulty
  - **Self-Test DSP Fault**: Status set to 1 which means that there is a communication error between DSP and the main processor. After this error occurs, measurements are frozen for 10 seconds and then they drop to zero.
  - **Magnetics Fault**: Status set to 1 which indicates a communication error between DSP and the magnetic module. After this error occurs, measurements are frozen for 10 seconds and then they drop to zero.
  - **Logic Fault**: Status set to 1 which indicates PLC equations sent to the relay have an error or are incorrect.
  - **Order Code Fault**: Status set to 1 which means the order code and hardware configuration do not match
  - **Calibration Error**: Status set to 1 which means there is a problem in the calibration settings (wrong values).
  - **Board Status**: Status set to 0 indicates that an I/O board is faulty or it does not correspond to the type configured. When this error occurs due to faulty board, status of inputs/outputs remain as they were just before it went to the faulty state.
- Or if Out of Service status (Signal configured in **Relay Configuration > Protection Elements**) is set to 1.

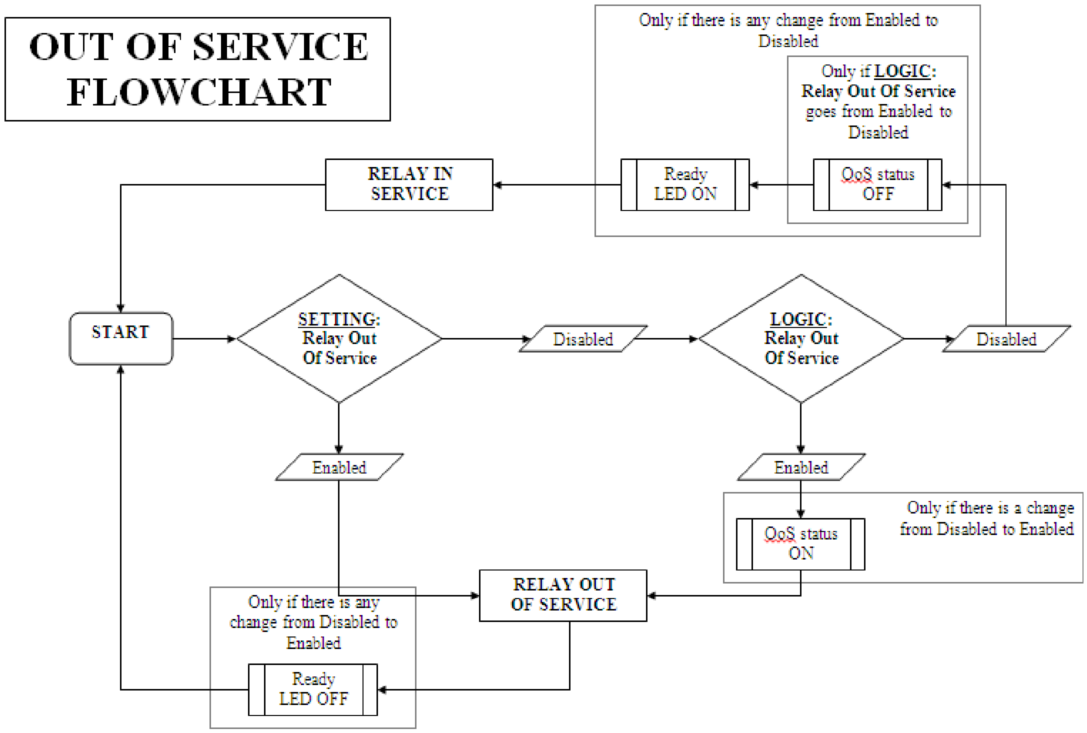
When the **Out of Service** status goes to ON, or the setting has been changed to Enabled, the ready LED changes to red. Be careful if the ready LED is linked to an output, because the output will not change its state.

When relay is OUT OF SERVICE, the following services stop working as expected:

- Protection functions will stop working.
- Output will not operate. For example, if an output is closed and the unit goes to the Out of Service state, the output is kept closed even if the state that closed it changes and would otherwise open the output. When the unit goes out of the Out of Service state, the output is then opened.
- Measurements will continue to be displayed unless the cause of the OUT OF SERVICE is a Self-Test DSP Fault or Magnetics Fault.
- PLC will continue running.
- Communications will continue working.

Please, note that if the cause for OUT OF SERVICE is Self-Test Memory OK, this could affect the services listed above.

The following figure shows the flow chart of these states:



10.3 General considerations, power supply network

All devices running on AC current are affected by frequency. As a non-sine wave is the result of a fundamental wave plus a series of harmonics from this fundamental wave, we can infer that devices running on AC current are influenced by the applied waveform.

For a correct testing of relays running on AC current, it is fundamental to use a current and/or voltage senoidal waveform. The pureness of a senoidal wave (lack of harmonics) cannot be expressed specifically for a specific relay. However, any relay incorporating sintonized circuits, R-L and R-C circuits, is affected by non-senoidal waveforms, as in the case of R650.

These relays respond to the voltage waveform in a different way to the majority of AC current voltmeters. If the power supply network used for the testing contains wide harmonics, the voltmeter and relay responses are different.

Relays have been calibrated in factory using a Network of 50 or 60 Hz with a minimum harmonic content. When the relay is tested, a power supply network with no harmonics in its waveform must be used.

The ammeters and chronometers used for testing the pickup current and relay operation time must be calibrated and their accuracy must be better than the relay's. The power supply used in the tests must remain stable, mainly in the levels near the operation thresholds.

It is important to point out that the accuracy with which the test is performed depends on the network and on the instruments used. Functional tests performed with unsuitable power supply network and instruments are useful to check that the relay operates properly and therefore its operating characteristics are verified in an approximate manner. However, if the relay would be calibrated in these conditions, its operational characteristics would be outside the tolerance range values.

The following sections detail the list of tests for verifying the complete relay functionality.

10.4 Isolation tests

During all tests, the screw located on the rear of the relay must be grounded. A test voltage is applied between each group and earth, while all other groups are connected to earth.

For verifying isolation, independent groups are created, and voltage is applied as follows:

RMS volts, indicated in the table, below will be applied **progressively** among all terminals in a group, short-circuited between them and the case, during one second.

RMS volts, listed in the table below, will be applied **progressively** between groups, during one second.

⚠WARNING **No communication circuit shall be tested for isolation.**

Groups to be created depend on the type of modules included in R650, selectable according to the model.

The following table shows the different groups depending on the module type:

Slot	Group	Terminals	RMS voltage
Power Supply 1	G1	H10, H18	2500
	G2	H13,H14,H15	2500
Power Supply 2	G1	H1, H9	2500
	G2	H13,H14,H15	2500
I/O Board type 1 (F1 or G1)	G1	F1...9 or G1....9 (depending in which slot, the PCBA has been installed)	2500
	G2	F10...18 or G10....18 (depending in which slot, the PCBA has been installed)	2500
	G3	F19...36 or G19....36 (depending in which slot, the PCBA has been installed)	2500

Slot	Group	Terminals	RMS voltage
I/O Board type 2 (F2)	G1	F1...4 or G1....4 (depending in which slot, the PCBA has been installed)	2500
	G2	F5...9 or G5....9 (depending in which slot, the PCBA has been installed)	2500
	G3	F10...14 or G10....14 (depending in which slot, the PCBA has been installed)	2500
	G4	F15...18 or G15....18 (depending in which slot, the PCBA has been installed)	2500
	G5	F19...30 or G19....30 (depending in which slot, the PCBA has been installed)	2500
	G6	F31...36 or G31....36 (depending in which slot, the PCBA has been installed)	2500
I/O Board type 4 (F4 or G4)	G1	F1...9 or G1....9 (depending in which slot, the PCBA has been installed)	2500
	G2	F10...18 or G10....18 (depending in which slot, the PCBA has been installed)	2500
	G3	F19...27 or G19....27 (depending in which slot, the PCBA has been installed)	2500
	G4	F28...36 or G28....36 (depending in which slot, the PCBA has been installed)	2500
I/OBoard type 5 (F5 or G5)	G1	F1...9 or G1....9 (depending in which slot, the PCBA has been installed)	2500
	G2	F10...18 or G10....18 (depending in which slot, the PCBA has been installed)	2500
I/O B4169G1 (F6)	G1	F1.....F10	2500
	G2	F19.....F36	2500
Magnetics (L)	G1 (Currents inputs)	B1....B12	2500
	G2 (Voltages VLx)	A1....A6	1500
	G3 (Voltages VBx)	A7....A12	1500

10.5 Indicators

Feed the relay and verify that when commanding a LED reset operation, all LED indicators light up and they are turned off when pressing the **ESC** key for more than 3 seconds.

10.6 Power supply testing

Feed the relay with the minimum and maximum voltage. For each voltage value, verify that the alarm relay is activated when there is voltage, and it is deactivated when there is no feed. If the power supply source incorporates AC feed, this test is also performed for VAC.

If the relay incorporates a redundant power supply, these tests shall be performed on both power supplies.

Voltage values to be applied are the ones indicated below according to the relay model:

SUPPLY	V min.	V max.
HI/HIR 110-250 Vdc 120-230 Vac	88 Vdc 96 Vac	300 Vdc 250 Vac
LO/LOR 24-48 Vdc	19.2 Vdc	57.6 Vdc

NOTE: Codes HIR and LOR correspond to a redundant power supply

10.7 Communications

Verify that available communication ports allow communication with the relay.

Ports to be checked are as follows:

Front:RS232

Rear:2 x RS485, 2 x Fiber Optic - Serial, 2 x Fiber Optic - Ethernet, 1 x RJ45 - Ethernet .

A computer with EnerVista 650 Setup software and an appropriate connector must be used.

10.8 Inputs and outputs

During all tests, the screw on the rear of the relay must be grounded.

10.8.1 Digital inputs

During this test, the user determines the activation/deactivation points for every input in the relay for the set voltage value of 30 Volts.

Verify that the error does not exceed ± 10% (+10% on activation, -10% on deactivation).

Default board settings for the input test can be modified in EnerVista 650 Setup software in:

Setpoint > Inputs/Outputs > Contact I/O > Board X

X, is substituted by the corresponding board:

F for board in first slot

G for board in second slot

H for board in first slot of CIO module

J for board in second slot of CIO module

Test settings for mixed board (type 1:16 inputs and 8 outputs):

I/O Board Type 1 (MIXED)	
Voltage Threshold A_X	30 V
Voltage Threshold B_X	40 V
Debounce Time A_X	5 ms
Debounce Time B_X	5 ms
Input Type_X_CC1 (CC1)	POSITIVE
...	...
Input Type_X_CC16 (CC16)	POSITIVE

The inputs test is completed by groups of 8 inputs, as this type of board has 2 groups of 8 inputs with the same common. For the first 8 inputs, the voltage threshold setting is determined by Voltage Threshold A. For the next 8 inputs, the setting is Voltage Threshold B. Inputs (or contact converters, CC1 – CC16) must also be set to POSITIVE.

Test settings for mixed board (type 2: 8 digital inputs, 4 blocks for supervision and 8 outputs):

I/O Board Type 2 (SUPERVISION)	
Voltage Threshold A_X	30 V
Voltage Threshold B_X	40 V
Debounce Time A_X	5 ms
Debounce Time B_X	5 ms
Input Type_X_CC1 (CC1)	POSITIVE
...	...
Input Type_X_CC8 (CC8)	POSITIVE

The inputs test is completed by groups of 4 inputs, as this type of board has 2 groups of 4 inputs with the same common. For the first 4 inputs, the voltage threshold setting is determined by Voltage Threshold A. For the next 4 inputs, the setting is Voltage Threshold B. Inputs (or contact converters, CC1 – CC8) must also be set to POSITIVE.

If the relay incorporates more input modules, these tests must also be applied to them.

10.8.2 Contact outputs, I/O boards type 1 and 2

The correct activation of every output to be verified.

For every output, activation command of a single contact must be given, and then verify that only that contact is activated. Go to EnerVista 650 Setup Software (***Setpoint > Inputs/Outputs > Force Outputs***).

For switched contacts, the change of state of both contacts shall be verified.

10.8.3 Circuit continuity supervision inputs

Supervision inputs are tested as normal inputs, revising the voltage level that is 19 Volts.

Coil 1:

Apply 19 Vdc to both 52/a (terminals F1-F2) and 52/b (terminals F3-F4)"Coil 1" circuit supervision inputs and verify that they are activated.

Apply -19 Vdc to both 52/a (terminals F1-F2) and 52/b (terminals F3-F4)"Coil 1" circuit supervision inputs and verify that they are activated.

Remove voltage from both inputs and verify that it takes them 500 ms to change state (deactivate).

Coil 2:

Apply 19 Vdc to both 52/a (terminals F15-F16) and 52/b (terminals F17-F18)"Coil 2" circuit supervision inputs and verify that they are activated.

Apply -19 Vdc to both 52/a (terminals F15-F16) and 52/b (terminals F17-F18)"Coil 2" circuit supervision inputs and verify that they are activated.

Remove voltage from both inputs and verify that it takes them 500 ms to change state (deactivate).

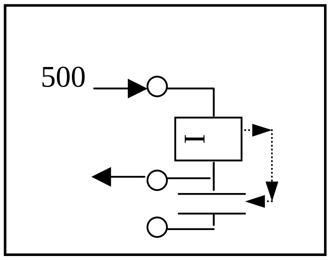
10.8.4 Latching circuits

Send a closing command to the latched contact (F31-F33).

Make circulate a current of 500 mA through the contact in series with the sensing terminal.

Send an opening command and verify that the contact does not open.

Interrupt current and check that the contact is released.



Repeat the test for the other latched contact (F34-F36).

10.9 Connections for testing measurements and protection elements

Connect current sources to the relay according to the wiring diagram. Current and voltage input terminals are as follows:

Phase	Connections
Current	
IA	B1-B2
IB	B3-B4
IC	B5-B6
IG	B9-B10
ISG	B11-B12
Voltage	
VLa	A1-A2
VLb	A3-A4
VLc	A5-A6
VSa	A7-A8
VSb	A9-A10
VSc	A11-A12

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Chapter 11: Frequently asked questions

11.1 Communications

Q1. Does the R650 support DNP and ModBus over the Ethernet port?

A1. R650 units support both protocols over both the asynchronous serial ports and the Ethernet LAN synchronous port using TCP/IP and UDP/IP layers over the Ethernet.

Q2. Does this equipment support dual IP access?

A2. Yes, it supports two independent IP addresses in aliasing mode. Those address go in the communications settings Network0 and Network1.

Q3. Can the R650 be used as a DNP master station?

A3. Not at this moment. It works as a slave IED station for all protocols.

Q4. How many communication ports are included in the R650?

A4. The equipment has 2 different boards, one for asynchronous serial ports and another for a high-speed synchronous Ethernet port. The first board has 2 comm ports, COM1 and COM2. COM2 is multiplexed with the front serial RS232 port, whereas the COM1 port is completely independent from COM2.
The synchronous LAN port is ETH_1/ETH2 or ETH_E/ETH_A/ETH_B (Depending on model.

Q5. Are there one or two Ethernet ports?

A5. The equipment has only 1 Ethernet port. For redundant fiber optic versions, redundancy is done at the physical level (fiber optic) but there is just one port.

Q6. How many different communication Ethernet sessions can be opened through the LAN port?

A6. ModBus TCP/IP:4 sockets
DNP TCP/IP:3 sessions (from version 1.72 on)

Q7. May I use the cooper 10/100 BaseTX connection included in the basic model with all protocols?

A7. Yes, it may be used with all protocols. In noisy substation environments and/or long distances, it is recommended to use fiber optic options due to much better EMC performance and immunity. For fiber optic models, it is necessary to adjust an internal jumper to use the copper port.

Q8. Remote I/O CAN bus. Does it support DeviceNet protocol?

A8. No it does not support DeviceNet.

Q9. Which functions are available in the relay web server?

A9. Currently, it includes several functions for viewing measures and retrieving information.

Q10. Q11 May I use URPC to program the relay?

A10. Only oscillography records may be viewed with URPC once downloaded to a file using the ENERVISTA 650 Setup software.

Q11. May I connect URs and R650s to the same Ethernet?

A11. Yes, either in cable as in fiber, or even mix them.

Q12. How do I connect with fiber 10-BASE-FL UR relays with 100-BASE-FX R650 relays?

A12. Take into account that an UR is never connected directly to a R650 (neither two UR nor two R650 with each other) but they are always connected through a hub or switch. The hub or switch where the URs are connected must be 10-BASE-FL and the hub or switch for the R650 must be 100-BASE-FX.

Q13. How do I connect with cable 10_BASE-T UR relays with 10/100-BASE-TX R650 relays?

A13. The answer to this question is as described before but also in this case there is an advantage added, because the hub 10-BASE-TX port is able to understand a 10-BASE-T port. This means that a hub 10-BASE-T port may be connected to an UR or a R650, and a hub 10/100-BASE-TX port may be connected either to an UR or R650.

Q14. What happens with fiber optic connectors compatibility, because the hub that I have has a different connector to the one of the R650, although both are 100-BASE-FX?

A14. Just buy fiber cables with the appropriate male connectors. For the UR and R650 side we need the same connectors, ST type, for the hub side, the correspondent ones. And in what concerns to the fiber type, it is used the same for 10 as for 100, it is the 50/125 or 62.5/125 multimode, this last one allows longer distances.

Q15. What is the difference between a hub and a switch?

A15. In a repeater type hub (shared hub), one unit talks and the rest listen. If all the units are talking at the same time there may be collisions in the messages, what may produce certain communication delays.
The switch (switched hub) has very powerful processors and a lot of memory and it is much more expensive than the hub. It directs messages to the proper destination avoiding collisions and allowing a much more efficient communication.

Q16. Why do we have 10/100 compatibility for cable but not for fiber?

A16. The cable has some advantages that the fiber does not have, and it is that the signal attenuation in short and medium distances, is worthless and this is truth for low and high frequency signals. By the contrary, the light in one fiber optic is highly attenuated, being much worse in case of high frequencies than in the low ones. The 10-BASE-FL fiber transmission is performed in a wavelength of 850nm, what allows a less expensive electronic than the 1300 nm used in 100-BASE-FX fiber transmission. Using, in both cases, the same glass multimode fiber type, the attenuation to 1300 nm is lower than the 850 nm ones, this way the greater attenuation of the 100 Mbits is compensated. There is another fiber standard, the 100-

BASE-SX, which uses 850 nm to 100 Mbits, being compatible with the 10-BASE-FL one, although it sacrifices the maximum distance to 300 m. Nowadays, this standard has not had success among Ethernet equipment manufacturers and suppliers.

11.2 Protection

Q1. Does the R650 support IRIG-B signals? Which type and accuracy? How many units may be connected to the same source?

A1. Yes, the R650 includes an IRIG-B input for all models, including the basic ones.
It uses DC level format B. Formats used are B0000, B0002 and B0003.
Actual accuracy is 1 millisecond. Internal sampling rate allows true 1 ms accuracy time tagging.
The input burden is very low. The maximum number of units that may be connected to a generator depends on its output driving capability. Up to 60 units have been successfully connected with equipments commonly used in the market.

Q2. Does the equipment work with dry inputs in both AC and DC?

A2. The equipment works only with DC inputs.
Inputs should be driven with externally generated DC current. No special 48 Vdc or other outputs are included in the equipment to drive these inputs; therefore, contacts connected to the equipment should be connected to a DC source.

Q3. Is it oscillography programmable?

A3. Yes, the sampling rate is programmable (4, 8, 16, 32 or 64 samples per input). The depth depends on the sampling rate.

Q4. Do I have to select a different model for 1 or 5 A?

A4. No. The same model is able to work with either /1 A or /5 A rated secondary currents. There are high accuracy sensing transformers that allow the use of any current input through the same terminals to reduce the spares and simplify wiring.

Q5. In my installation, several digital inputs become active when I energize the transformer. How can I reduce sensitivity?

A5. By selecting debounce time and/or voltage threshold, the relay may adapt its sensitivity to different applications. Select the maximum voltage threshold and debounce time (recommended 15 ms) to minimize AC coupling effects.

11.3 Relay configuration

Q1. Does the "Service" contact on the Power Supply board cover all possible failures or do I have to create an output on the I/O board that includes all the internal errors I can access in the logic?

A1. The power supply ready contact only monitor hardware failures in the power supply, to monitor the internal error of the unit it is necessary to configure a virtual output to and the assign it to the device desired (contact output, LED, etc.).

Q2. I set an output contact as "Latched". If I do not set a "reset" condition, will it reset from the "ESC" key?

A2. No, you have to configure the contact output reset signal (in ***Setpoint > Relay Configuration > Outputs***).

The ESC key only reset the LED indicators.

11.4 Control & HMI

Q1. What is the difference between Get/Send info from/to relay and Upload/Download info files to/from relay?

A1. Get/Send are used for settings and configuration storage that although both are in a unique file, are sent separately in two times. Upload/Download are used for project or PLC files group storage. These files are the setting_configuration file source. To operate, the R650 does not need the source files; the Upload/Download tool is destined to serve as historic file.

Q2. Can I program interlocks?

A2. Yes, via ENERVISTA 650 Setup interlocks may be programmed from very simple to advanced schemes.

Q3. Can we rotate the display 90 degrees to show feeders vertically?

A3. No. The product has been designed to view it in horizontal mode (landscape) due to the following reasons:

- It is easier to read the LCD display because it has been designed for horizontal positions.
- Compatibility between text display (4x20 characters) and LCD display (16x40 characters or 128x240 pixels).
- Refresh speed is better in horizontal than vertical format.

Q4. Do I need a laptop or handheld to program the unit?

A4. No, all main operations can easily be performed with just the incorporated HMI. Handheld or laptops may be required to download large quantities of information (such as oscillograms, etc.) but they are not mandatory for a conventional user that just needs to change settings, view measurements, states, etc.

Q5. Is there password security for protection and control?

A5. Yes, there are two passwords. An independent password for protection changes and control operations is available since version 1.44

Q6. Is it possible to have a remote HMI installed in the front of the panel with the rest of the relay in the rear side?

A6. Not in the present version.

Q7. Is it possible to program a default screen for the HMI?

A7. In graphic display versions the user may program a custom screen with the single-line diagram, measurements, etc. In text display models, there is a choice of logo, measurements, or scrolling both screens.

Q8. May I force inputs and outputs to ease commissioning and testing?

A8. Yes.

Q9. How can I disable/enable the beep sound from the HMI keypad in models with Enhanced HMI?

A9. **To disable**: Press the ESC push-button for more than 3 seconds and then press the ENTER push-button while continuing to press the ESC push button.
To enable: Press the ESC push-button for more than 3 seconds. While continuing to press the ESC push-button, press the ENTER push-button and then the Up/down key.

Q10. Why do appear strange texts on the display when switching on the relay?

A10. You have pressed any button and the HMI has entered test mode.
The display messages are updated after a few minutes, once the relay has completed the starting sequence.

R650 Recloser Controller

Chapter 12: R650 troubleshooting guide

12.1 Symptoms and recommended actions

R650 units have been designed and verified using the most advanced and reliable equipment. Mounting and testing automation ensure a high consistency of the final product. Before sending a unit back to the factory, we strongly suggest you follow the recommendations below. These actions may solve the problem, and if not they will help define the problem for quicker repair.

To send a unit back to the factory for repair, use the appropriate RETURN MATERIAL AUTHORIZATION process, and follow the shipping instructions provided by our Service Department, especially in the case of international shipments. This will lead to a faster and more efficient solution to your problem.

Category	Symptom	Possible cause	Recommended action
Protection	The relay does not trip	-Function not permitted - Function blocked - Output not assigned - The unit is not set to ready	-Set the function permission to ENABLED -Check Protection units block screen -Program the output to the desired function using ENERVISTA 650 Setup logic configuration - Verify that the general setting is set to disable and the out of service state is not active
General	When feeding the unit, no indicator is lit up	-Insufficient power supply - Wrong versions -Fuse failure - Loose fuse -Incorrect wiring	-Verify the voltage level using a multimeter in the power supply terminals, and check that it is within the model range -Check relay and ENERVISTA 650 Setup versions are the same -Remove power supply, dismount the power supply module and replace the fuse -Same as above with same fuse -Make sure that terminals labeled + and – are connected to the 9-pin connector corresponding to the power source
Comms	The relay does not communicate via the front RS232 port	-Incorrect cable -Damaged cable -Relay or PC not grounded -Incorrect baud rate, port, address, etc.	-Make sure you are using a straight cable -Replace the cable -Ensure ground connection -Test other ports, other baud rates, etc. Make sure that the communication parameters in the computer match the ones in the relay.
General	After Updating the firmware the relay does not start up and always shows the message "Os Loading...".	Check that the bootware version match with the firmware version	-If there is an incompatibility between boot and firmware version, update to the corresponding boot and after that update the firmware version -If the boot and firmware versions are correct, perform the firmware update procedure again.
Comms	Cannot see properly the web server in R650 with Windows XP. Some windows are in grey with a red cross mark.	1.- Disabled Java options in Advanced Internet Explorer properties or high level of security 2.- Nor Java Virtual Machine installed.	1.1- Go to Advanced in Internet options for Internet explorer and select the three selections in Microsoft VM (Java Virtual Machine) and deselect any other virtual machine not Microsoft, for example SUN. In case Microsoft VM is not installed in the computer, the user must install it using the Microsoft VM installation program msjavx86.exe. For internet explorer 6.0 or higher it is not included by default. 1.2.- Try to set a lower level of security in internet explorer options. 1.3.-Delete temporary internet files in "General" screen in internet explorer options. 1.4- Install either Microsoft or Sun Java Virtual Machine
Comms	Enervista 650 Setup does not retrieve osc, fault reports and Data Logger files	Bad communication in TFTP using Windows 2000	Disable and Enable the Ethernet connection on Control Panel inside Windows 2000. Try again to retrieve files from relay

Category	Symptom	Possible cause	Recommended action
Firmware and bootware upgrade			
Bootware	The relay gets stuck during the upgrading process after switching off and on the relay, giving the following error message: "ERROR Setting relay in configuration mode. Retry?	- The relay does not communicate via the front RS232 port	To perform the bootware upgrading process it is necessary to connect the unit thought the front RS232 port. check: • Serial cable correct(straightthrouhg) and undamaged. • Settings selection in Enervista 650 Setup: Communication > Computer Settings": o Com port selected must be the one that is being used to perform this procedure o Parity set to NONE o Baud rate set to 19200 o Control type: No control type o Modbus slave number: any **Note: if the bootware upgrade procedure got stuck at this point the relay will not be upgraded. After reboot the relay will continue working with the former firmware and bootware versions**.
Bootware	The relay gets stuck at "Sending file imagen_kernel..."	-The Ethernet connection does not work properly.	Serial communications work properly and the flash memory has been erased but Ethernet communication does not work properly, check: • RJ45 cable used (crossover cable for back-to-back connection and straight through Ethernet cable for hub or switch) • IP address and netmask, gateway are correct and correspond to the ones used in the computer performing the procedure. See chapter 5.2.1 Communication settings • Ethernet board parameters selection, check that: o 802.1p QOS is Enabled o Flow control is Auto o Speed & Duplex is Auto (or 10 Mb Full) • If the above points are correct but the problem persists: o Force the Speed & Duplex to 10 Mb Full o Disable and enable the Ethernet connection while the files are being sent (during the "sending file..." message **Note: if the bootware upgrade procedure is stuck at this point, the relay flash memory has been erased and the upgrade procedure must be completed to start working with the unit. If the procedure is not completed, the HMI shows the message "Os Loading..." and the relay does not start up**.
Firmware	The procedure can not start due to ethernet problems	-The Ethernet connection does not work properly.	• Check the same as in the point above for bootware. Note: if the firmware upgrade procedure is stuck at this point the relay will not be upgraded. After switching it off and on it will continue working with the former firmware and bootware versions.
Firmware	Program messages "file" do not exist in local drive	- File path is too long - File has no file attributes	• Check the path length, copy the files in a shorter path and restart the upgrade procedure. • Check the unzip process to see if the file properties are properly set to "File". **• Note: if the firmware upgrade procedure is stuck after having been started, the former firmware has been erased and the upgrade procedure must be completed to start working with the unit. If the procedure is not completed, the HMI shows the message "Os Loading..." and the relay does not start up.**

Category	Symptom	Possible cause	Recommended action
Firmware	It is not possible to to upgrade models without IEC 61850 to models with IEC 61850 automatically	- IEC 61850 upgrade from standard models is password protected.	• To upgrade from a standard model to a 6 model, ask the factory for an upgrade package, depending on the hardware the existing unit has. If it is hardware 00 a hardware and firmware change is required (password protected), if it is hardware 01 or above only a firmware change is required (password protected).
Firmware	During the upgrading procces for models with IEC 61850 sometimes it ask for password and sometimes not.	- Communication problems during the upgrade procecure. -The procedure has been not performed in a continuous way.	• EnerVista 650 Setup program does not ask for a password if the relay model is IEC61850 and the procedure is completed. • If during the process there is any problem and it has to be restarted, this second time the program will ask to confirm the IEC password. • If the EnerVista 650 Setup program is closed and started again during the bootware and firmware upgrade process, the program will ask to confirm the IEC password.
Firmware	Password for IEC61850 incorrect	- Model change - Incorrect mac or serial number	• The password is tied to the model, MAC Address and serial number, so a change in any of these requires a password change. • If the model has been modified to add or replace any boards or communication protocol, the IEC 61850 passwords needs to be updated (contact the factory).
EnerVista 650 Setup	InstallShield Setup Initialization Error 6001	A previous installation of any product using InstallShield for installation may have corrupted some of the InstallShield files used in the EnerVista 650 Setup installation	Delete (or rename) the 0701 folder located in "C:\Program Files\Common Files\InstallShield\Professional\RunTime\" and retry installation

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Appendix A: Logic Operands

A.1 Operands - R650 - model FX - GX

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
autocheck internal states (critical)		
DSP Internal States (Critical to metering and protection)	DSP COMM ERROR	DSP Communication Error: (0) Rignt communications between DSP and main processor; (1) Communication Error between DSP and main processor
	MAGNETIC MODULE ERROR	Magnetic Module Error: (0) Right Communication between DSP and magnetic module processor; (1) Communication Error between DSP and magnetic module processor
	CALIBRATION ERROR	Calibration Error: (0) Right calibration values stored; (1) The calibration values stored are out of the calibration limits.
Flash Internal States (Critical to Relay configuration and stored data)	E2PROM STATUS	E2prom status :(0) Not configured or problems during writing process ; (1) Configured and OK
IO Board States (Critical to operation and protection)	BOARD F STATUS	Board F status: (0) Inactive - There is no communication with the board (1) Active - There is communication with the board.
	BOARD G STATUS	Board G status: (0) Inactive - There is no communication with the board (1) Active - There is communication with the board.
	BOARD H STATUS	Board H status: (0) Inactive - There is no communication with the board (1) Active - There is communication with the board.
	BOARD J STATUS	Board J status: (0) Inactive - There is no communication with the board (1) Active - There is communication with the board.
IEC61850 INTERNAL STATES (NON CRITICAL)		

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
IEC61850 Internal States	ICD STATUS	UNKNOWN: when the relay has not the IEC61850 protocol in the relay model the ICD status is unknow to the unit
		ICD ERROR: There is an error in the ICD file and the relay ICD is not operative. To solve this issue it is necessary to send a correct ICD to the relay using the IEC61850 configurator tool. When the ICD error is raised the IEC 61850 will not be operative (the IEC 61850 client, reports and gooses will not work). It is advisable to include the ICD ERROR in the main error signal configured for specific applications.
		MODIFIED: The settings have been changed in the icd but they are still not written in the icd file in the relay
		IN PROGRESS: The icd setting are being written to the file in the relay
		OK WITHOUT DAIS: The relay has not got the "Use DOI &DAI" setting enabled (true) and it is working properly with the ICD file.
		OK: The relay has got the "Use DOI &DAI" setting enabled (true) and it is working properly with the ICD file. When that setting is set to true the icd setting prevails over the relay settings.
OTHER INTERNAL STATES (NON CRITICAL)		
Other internal states	USER MAP STATUS	User map status: (0) Not configured ; (1) Configured
	FACTORY CALIBRATION	Calibration status (0) Relay calibrated; (1) Not calibrated
	FLEXCURVE A STATUS	User curve A: (0) Not configured (1) Configured
	FLEXCURVE B STATUS	User curve B: (0) Not configured (1) Configured
	FLEXCURVE C STATUS	User curve C: (0) Not configured (1) Configured
	FLEXCURVE D STATUS	User curve D: (0) Not configured (1) Configured
	Green Zone	Memory internal status
	Yellow Zone	Memory internal status
	Orange Zone	Memory internal status
	Red Zone	Memory internal status
	UpTime	System Time
Autocheck Internal States (Not available)	TIMER STATUS	Real time clock autocheck (not available)
	GRAPHIC STATUS	Graphic display status (not available)
	ALARM TEXT ARRAY	Text display status (not available)

OPERANDS - R650 - MODEL FX - GX
Internal System Status

Note: It is advisable to use the critical alarms to raise an event or to light a warning LED for maintenance purposes. See the example below, the Board X Status depends on the relay model.

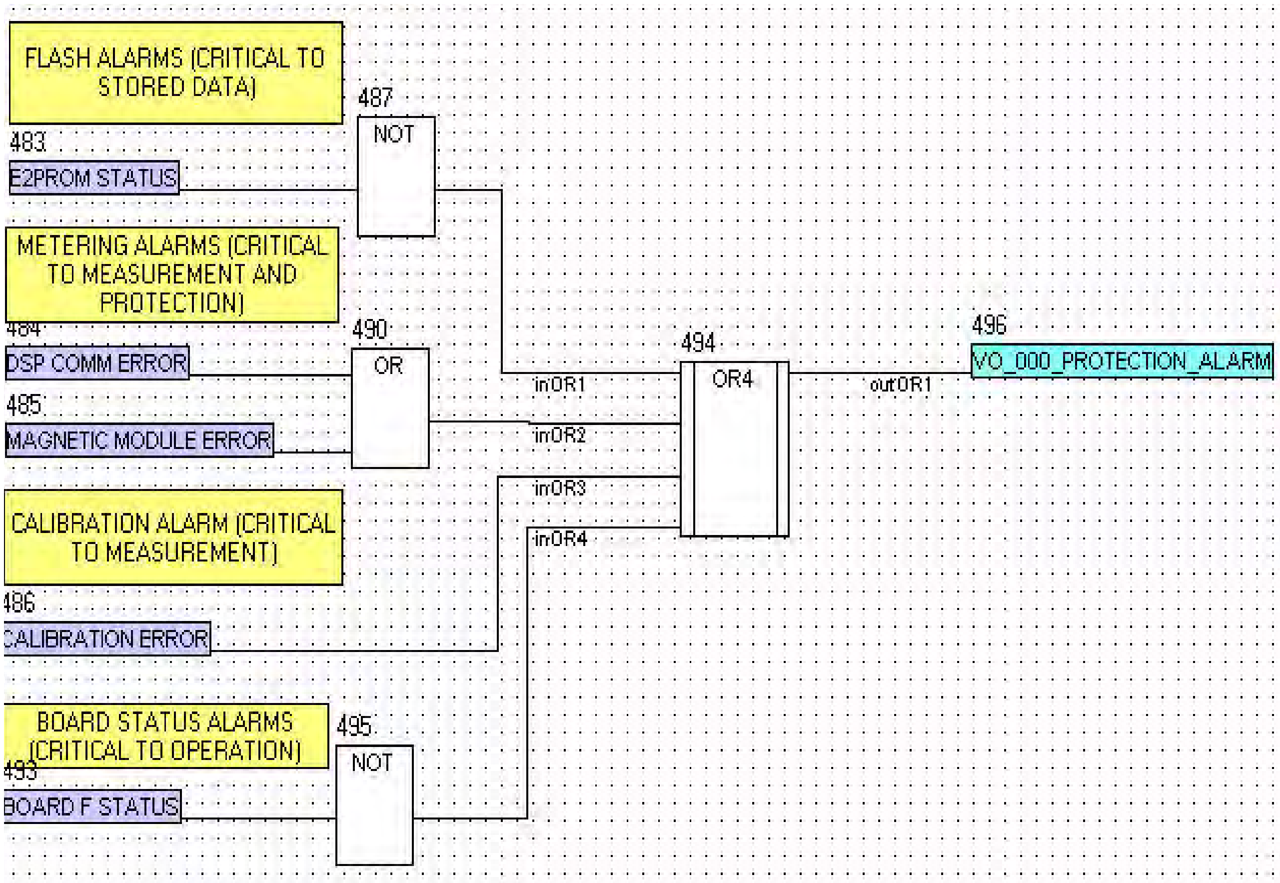


Figure A–1: Protection Alarm Signal

Configurable Logic Outputs (512 elements)	VIRTUAL OUTPUT 000	Configurable logic output 000
	VIRTUAL OUTPUT 001	Configurable logic output 001
	...	...
	VIRTUAL OUTPUT 511	Configurable logic output 511
Operation Bits (24 elements)	OPERATION BIT 1	Operation bit 001: (0) the configured time expires or when success conditions are met;(1) operation 1 is executed and interlocks are fulfilled.
	OPERATION BIT 2	Operation bit 002: (0) the configured time expires or when success conditions are met;(1) operation 2 is executed and interlocks are fulfilled.
	...	...
	OPERATION BIT 24	Operation bit 024: (0) the configured time expires or when success conditions are met;(1) operation 24 is executed and interlocks are fulfilled.

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Control Event Bits (128 elements)	CONTROL EVENT 1	Control Event 1 Activation Bit
	CONTROL EVENT 2	Control Event 2 Activation Bit
	...	...
	CONTROL EVENT 128	Control Event 128 Activation Bit
Latched Virtual Inputs (32 elements)	LATCHED VIRT IP 1	Latched virtual input 1
	LATCHED VIRT IP 2	Latched virtual input 2
	...	...
	LATCHED VIRT IP 32	Latched virtual input 32
Self Reset Virtual Inputs (32 elements)	SELF-RST VIRT IP 1	Self reset virtual input 1
	SELF-RST VIRT IP 2	Self reset virtual input 2
	...	...
	SELF-RST VIRT IP 32	Self reset virtual input 32
Contact Inputs Type 1Board	CONT IP_X_CC1	Input 1 (CC1) in Board X
	CONT IP_X_CC2	Input 2 (CC2) in Board X
	...	...
	CONT IP_X_CC16	Input 16 (CC16) in Board X
Contact Inputs Type 2 Board	CONT IP_X_CC1	Input 1 (CC1) in Board X
	CONT IP_X_CC2	Input 2 (CC2) in Board X
	...	...
	CONT IP_X_CC8	Input 8 (CC8) in Board X
	CONT IP_X_CC9 (Va_COIL1)	Contact Input 09 (Va_COIL1) for slot X. Input voltage (Va) detected, Circuit 1. Complete circuit supervised
	CONT IP_X_CC10 (Vb_COIL1)	Contact Input 10 (Vb_COIL1) for slot X. Input voltage (Vb) detected, Circuit 1. Complete circuit supervised
	CONT IP_X_CC11 (Va_COIL2)	Contact Input 11 (Va_COIL2) for slot X. Input voltage (Va) detected, Circuit 1. Complete circuit supervised
	CONT IP_X_CC12 (Vb_COIL2)	Contact Input 12 (Vb_COIL2) for slot X. Input voltage (Vb) detected, Circuit 2. Complete circuit supervised
	CONT IP_X_CC13 (O7_SEAL)	Contact Input 13 (07_SEAL) for slot X. Current detected. Contact output associated with current flow > 100 mA latched
	CONT IP_X_CC14 (O8_SEAL)	Contact Input 14 (08_SEAL) for slot X. Current detected. Contact output associated with current flow > 100 mA latched
	CONT IP_X_CC15 (SUP_COIL1)	Contact Input 15 (SUP_COIL1) for slot X. Output for circuit 1 supervision element
	CONT IP_X_CC16 (SUP_COIL2)	Contact Input 16 (SUP_COIL2) for slot X. Output for circuit 2 supervision element
Contact Inputs Type 4 Board	CONT IP_X_CC1	Input 1 (CC1) in Board X
	CONT IP_X_CC2	Input 2 (CC2) in Board X
	...	...
	CONT IP_X_CC32	Input 32 (CC32) in Board X

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Contact Inputs Type 5 Board (Digital Values)	CONT IP_X_CC1	Input 1 (CC1) in Board X
	CONT IP_X_CC2	Input 2 (CC2) in Board X
	...	...
	CONT IP_X_CC16	Input 16 (CC16) in Board X
Contact Inputs Type 5 Board (Analog Values)	ANALOG_INP_X_01	Analog Input 01 in Board X
	ANALOG_INP_X_02	Analog Input 02 in Board X
	ANALOG_INP_X_03	Analog Input 03 in Board X
	...	...
	ANALOG_INP_X_08	Analog Input 08 in Board X
Contact Outputs Type 1 & 2 Board Activation signals	CONT OP OPER_X_01	Logic signal for Output 1 activation. Board X
	CONT OP OPER_X_02	Logic signal for Output 2 activation. Board X
	...	...
	CONT OP OPER_X_08	Logic signal for Output 8 activation. Board X
Contact Outputs Type 1 & 2 Board Reset signals	CONT RESET_X_01	board X, 01 latched output reset
	CONT RESET_X_02	board X, 02 latched output reset
	...	...
	CONT RESET_X_08	board X, 08 latched output reset
Contact Outputs Type 1 & 2 Board Status	CONT OP_X_01	Contact output 1 Board X operation
	CONT OP_X_02	Contact output 2 Board X operation
	...	...
	CONT OP_X_8	Contact output 8 Board X operation
Board Status	BOARD X STATUS	Board X status: (0) Inactive - There is no communication with the board (1) Active - There is communication with the board
Switchgear status (16 elements)	SWITCH 1 A INPUT	Contact input type A to switchgear Function 1
	SWITCH 1 B INPUT	Contact input type B to switchgear Function 1
	SWITCH 2 A INPUT	Contact input type A to switchgear Function 2
	SWITCH 2 B INPUT	Contact input type B to switchgear Function 2
	...	...
	SWITCH 16 A INPUT	Contact input type A to switchgear Function 16
	SWITCH 16 B INPUT	Contact input type B to switchgear Function 16
Switchgear outputs (16 elements)	SWITCH 1 A STATUS	Contact logic output type A from switchgear Function 1
	SWITCH 1 B STATUS	Contact logic output type B from switchgear Function 1
	SWITCH 2 A STATUS	Contact logic output type A from switchgear Function 2
	SWITCH 2 B STATUS	Contact logic output type B from switchgear Function 2
	...	...
	SWITCH 16 A STATUS	Contact logic output type A from switchgear Function 16
	SWITCH 16 B STATUS	Contact logic output type B from switchgear Function 16

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Switchgear states (16 elements)	SWITCH 1 OPEN	switchgear 1 open
	SWITCH 1 CLOSED	switchgear 1 closed
	SWITCH 1 00_ERROR	Error 00 switchgear 1 (contact A = 0, contact B = 0)
	SWITCH 1 11_ERROR	Error 11 switchgear 1 (contact A = 1, contact B = 1)
	SWITCH 2 OPEN	Switchgear 2 open
	SWITCH 2 CLOSED	Switchgear 2 closed
	SWITCH 2 00_ERROR	Error 00 switchgear 2 (contact A = 0, contact B = 0)
	SWITCH 2 11_ERROR	Error 11 switchgear 2 (contact A = 1, contact B = 1)
	...	...
	SWITCH 16 OPEN	Switchgear 16 open
	SWITCH 16 CLOSED	Switchgear 16 closed
	SWITCH 16 00_ERROR	Error 00 switchgear 16 (contact A = 0, contact B = 0)
	SWITCH 16 11_ERROR	Error 11 switchgear 16 (contact A = 1, contact B = 1)
Switchgear Open-Close Initializing States	SWITCH 1 OPEN INIT	Switchgear 1 opening initiation
	SWITCH 1 CLOSE INIT	Switchgear 1 closing initiation
	SWITCH 2 OPEN INIT	Switchgear 2 opening initiation
	SWITCH 2 CLOSE INIT	Switchgear 2 closing initiation
	...	...
	SWITCH 16 OPEN INIT	Switchgear 16 opening initiation
	SWITCH 16 CLOSE INIT	Switchgear 16 closing initiation
Switchgear Fail States	SWGR 1 FAIL TO OPEN	Failure to open Switchgear 1
	SWGR 2 FAIL TO OPEN	Failure to open Switchgear 2
	...	...
	SWGR 16 FAIL TO OPEN	Failure to open Switchgear 16
	SWGR 1 FAIL TO CLOSE	Failure to close Switchgear 1
	SWGR 2 FAIL TO CLOSE	Failure to close Switchgear 2
	...	...
	SWGR 16 FAIL TO CLOSE	Failure to close Switchgear 16

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
LEDS HMI (16 Elements)	READY LED	Ready LED: (0-Red) Relay out of service, protection OUT OF ORDER (1-Green) Relay in service; protection READY
	LED 1	Programmable LED 1 status: Red colour. Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 2	Programmable LED 2 status: Red colour. Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 3	Programmable LED 3 status: Red colour. Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 4	Programmable LED 4 status: Red colour. Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 5	Programmable LED 5 status: Red colour. Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 6	Programmable LED 6 status: Orange colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 7	Programmable LED 7 status: Orange colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 8	Programmable LED 8 status: Orange colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 9	Programmable LED 9 status: Orange colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 10	Programmable LED 10 status: Orange colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 11	Programmable LED 11 status: Green colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 12	Programmable LED 12 status: Green colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 13	Programmable LED 13 status: Green colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 14	Programmable LED 14 status: Green colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 15	Programmable LED 15 status: Green colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
LEDs reset input (programmable)	LED RESET INPUT	Programmable input for remote LED reset
Programmable Keypad Status (HMI)	I Key	I key operation (Programmable signal via PLC)
	O Key	O key operation (Programmable signal via PLC)
	*/F3 Key	*/F3 key operation (Programmable signal via PLC)

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
	F1 Key	F1 key operation (Programmable signal via PLC)
	F2 Key	F2 key operation (Programmable signal via PLC)
LOCAL/REMOTE Operation status LEDs	LOCAL/REMOTE OPERATION MODE	Local/remote status for operations 1 = Local, 0 = Remote. Selectable through the front pushbutton (Hardware) and also through communications (software).
	OPERATIONS BLOCKED	Operations OFF status (1) Command execution block (operations blocked both in local and remote mode).Selectable through the front pushbutton (Hardware) and also through communications (software).
LOCAL/REMOTE/OFF Selection	CHANGE LOCAL-REMOTE	Changing local-remote status by communications
	CHANGE OP BLOCKED	Operations Block-Unblock signal
HMI Backlight	HMI BACKLIGHT ON	"Switching on backlignt" signal (the display is switched on by communications
	HMI BACKLIGHT OFF	"Switching off backlignt" signal (the display is switched off by communications
Internal System Status (cont.)		
Oscillography States	OSC DIG CHANNEL 1	Oscillography Digital channel 1 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 2	Oscillography Digital channel 2 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 3	Oscillography Digital channel 3 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 4	Oscillography Digital channel 4 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 5	Oscillography Digital channel 5 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 6	Oscillography Digital channel 6 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 7	Oscillography Digital channel 7 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 8	Oscillography Digital channel 8 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 9	Oscillography Digital channel 9 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 10	Oscillography Digital channel 10: (1) Active ; (0) Not Active
	OSC DIG CHANNEL 11	Oscillography Digital channel 11 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 12	Oscillography Digital channel 12 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 13	Oscillography Digital channel 13 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 14	Oscillography Digital channel 14 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 15	Oscillography Digital channel 15 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 16	Oscillography Digital channel 16 : (1) Active ; (0) Not Active
	OSCILLO TRIGGER	Oscillo trigger activation (1) Active ; (0) Not active
Fault Report (Fault locator)	FAULT REPORT TRIGG	Fault report trigger (1) Active ; (0) Not active
	CLEAR FAULT REPORTS	Fault report removal from HMI and ModBus (volatile memory)
Energy Counters	FREEZE ENERGY CNT	Energy counter freeze
	UNFREEZE ENERGY CNT	Energy counter unfreeze
	RESET ENERGY CNT	Energy counter reset

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Demand Inputs	DEMAND TRIGGER INP	Demand trigger (for Block interval algorithm)
	DEMAND RESET INP	Demand reset
Setting Groups	GROUP 1 ACT ON	Group 1 activation, and deactivation of groups 2 & 3
	GROUP 2 ACT ON	Group 2 activation, and deactivation of groups 1 & 3
	GROUP 3 ACT ON	Group 3 activation, and deactivation of groups 1 & 2
	SETT GROUPS BLOCK	Group change input blocked
	GROUP 1 BLOCKED	Settings Group 1 blocked
	GROUP 2 BLOCKED	Settings Group 2 blocked
	GROUP 3 BLOCKED	Settings Group 3 blocked

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Phase IOC High	PH IOC1 HIGH A BLK	Phase instantaneous overcurrent element block Group 1 phase A
	PH IOC1 HIGH B BLK	Phase instantaneous overcurrent element block Group 1 phase B
	PH IOC1 HIGH C BLK	Phase instantaneous overcurrent element block Group 1 phase C
	PH IOC1 HIGH A PKP	Phase instantaneous overcurrent element pickup high level Group 1 phase A
	PH IOC1 HIGH A OP	Phase instantaneous overcurrent element operation (trip) high level Group 1 phase A
	PH IOC1 HIGH B PKP	Phase instantaneous overcurrent element pickup high level Group 1 phase B
	PH IOC1 HIGH B OP	Phase instantaneous overcurrent element operation (trip) high level Group 1 phase B
	PH IOC1 HIGH C PKP	Phase instantaneous overcurrent element pickup high level Group 1 phase C
	PH IOC1 HIGH C OP	Phase instantaneous overcurrent element operation (trip) high level Group 1 phase C
	PH IOC1 HIGH PKP	Phase instantaneous overcurrent element pickup high level Group 1 any phase
	PH IOC1 HIGH OP	Phase instantaneous overcurrent element operation (trip) high level Group 1 any phase
	PH IOC2 HIGH A BLK	Phase instantaneous overcurrent element block Group 2 phase A
	PH IOC2 HIGH B BLK	Phase instantaneous overcurrent element block Group 2 phase B
	PH IOC2 HIGH C BLK	Phase instantaneous overcurrent element block Group 2 phase C
	PH IOC2 HIGH A PKP	Phase instantaneous overcurrent element pickup high level Group 2 phase A
	PH IOC2 HIGH A OP	Phase instantaneous overcurrent element operation (trip) high level Group 2 phase A
	PH IOC2 HIGH B PKP	Phase instantaneous overcurrent element pickup high level Group 2 phase B
	PH IOC2 HIGH B OP	Phase instantaneous overcurrent element operation (trip) high level Group 2 phase B
	PH IOC2 HIGH C PKP	Phase instantaneous overcurrent element pickup high level Group 2 phase C
	PH IOC2 HIGH C OP	Phase instantaneous overcurrent element operation (trip) high level Group 2 phase C
	PH IOC2 HIGH PKP	Phase instantaneous overcurrent element pickup high level Group 2 any phase
	PH IOC2 HIGH OP	Phase instantaneous overcurrent element operation (trip) high level Group 2 any phase
	PH IOC3 HIGH A BLK	Phase instantaneous overcurrent element block Group 3 phase A
	PH IOC3 HIGH B BLK	Phase instantaneous overcurrent element block Group 3 phase B
OPERANDS - R650 - MODEL FX - GX		

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Internal System Status (cont.)		
Phase IOC High	PH IOC3 HIGH C BLK	Phase instantaneous overcurrent element block Group 3 phase C
	PH IOC3 HIGH A PKP	Phase instantaneous overcurrent element pickup high level Group 3 phase A
	PH IOC3 HIGH A OP	Phase instantaneous overcurrent element operation (trip) high level Group 3 phase A
	PH IOC3 HIGH B PKP	Phase instantaneous overcurrent element pickup high level Group 3 phase B
	PH IOC3 HIGH B OP	Phase instantaneous overcurrent element operation (trip) high level Group 3 phase B
	PH IOC3 HIGH C PKP	Phase instantaneous overcurrent element pickup high level Group 3 phase C
	PH IOC3 HIGH C OP	Phase instantaneous overcurrent element operation (trip) high level Group 3 phase C
	PH IOC3 HIGH PKP	Phase instantaneous overcurrent element pickup high level Group 3 any phase
	PH IOC3 HIGH OP	Phase instantaneous overcurrent element operation (trip) high level Group 3 any phase

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Phase IOC Low	PH IOC1 LOW A BLK	Phase instantaneous overcurrent element block Low level Group 1 phase A
	PH IOC1 LOW B BLK	Phase instantaneous overcurrent element block Low level Group 1 phase B
	PH IOC1 LOW C BLK	Phase instantaneous overcurrent element block Low level Group 1 phase C
	PH IOC1 LOW A PKP	Phase instantaneous overcurrent element pickup low level Group 1 phase A
	PH IOC1 LOW A OP	Phase instantaneous overcurrent element operation (trip) low level Group 1 phase A
	PH IOC1 LOW B PKP	Phase instantaneous overcurrent element pickup low level Group 1 phase B
	PH IOC1 LOW B OP	Phase instantaneous overcurrent element operation (trip) low level Group 1 phase B
	PH IOC1 LOW C PKP	Phase instantaneous overcurrent element pickup low level Group 1 phase C
	PH IOC1 LOW C OP	Phase instantaneous overcurrent element operation (trip) low level Group 1 phase C
	PH IOC1 LOW PKP	Phase instantaneous overcurrent element pickup low level Group 1 any phase
	PH IOC1 LOW OP	Phase instantaneous overcurrent element operation (trip) low level Group 1 any phase
	PH IOC2 LOW A BLK	Phase instantaneous overcurrent element block Low level Group 2 phase A
	PH IOC2 LOW B BLK	Phase instantaneous overcurrent element block Low level Group 2 phase B
	PH IOC2 LOW C BLK	Phase instantaneous overcurrent element block Low level Group 2 phase C
	PH IOC2 LOW A PKP	Phase instantaneous overcurrent element pickup low level Group 2 phase A
	PH IOC2 LOW A OP	Phase instantaneous overcurrent element operation (trip) low level Group 2 phase A
	PH IOC2 LOW B PKP	Phase instantaneous overcurrent element pickup low level Group 2 phase B
	PH IOC2 LOW B OP	Phase instantaneous overcurrent element operation (trip) low level Group 2 phase B
	PH IOC2 LOW C PKP	Phase instantaneous overcurrent element pickup low level Group 2 phase C
	PH IOC2 LOW C OP	Phase instantaneous overcurrent element operation (trip) low level Group 2 phase C
	PH IOC2 LOW PKP	Phase instantaneous overcurrent element pickup low level Group 2 any phase
	PH IOC2 LOW OP	Phase instantaneous overcurrent element operation (trip) low level Group 2 any phase
	PH IOC3 LOW A BLK	Phase instantaneous overcurrent element block Low level Group 3 phase A

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Phase IOC Low	PH IOC3 LOW B BLK	Phase instantaneous overcurrent element block Low level Group 3 phase B
	PH IOC3 LOW C BLK	Phase instantaneous overcurrent element block Low level Group 3 phase C
	PH IOC3 LOW A PKP	Phase instantaneous overcurrent element pickup low level Group 3 phase A
	PH IOC3 LOW A OP	Phase instantaneous overcurrent element operation (trip) low level Group 3 phase A
	PH IOC3 LOW B PKP	Phase instantaneous overcurrent element pickup low level Group 3 phase B
	PH IOC3 LOW B OP	Phase instantaneous overcurrent element operation (trip) low level Group 3 phase B
	PH IOC3 LOW C PKP	Phase instantaneous overcurrent element pickup low level Group 3 phase C
	PH IOC3 LOW C OP	Phase instantaneous overcurrent element operation (trip) low level Group 3 phase C
	PH IOC3 LOW PKP	Phase instantaneous overcurrent element pickup low level Group 3 any phase
	PH IOC3 LOW OP	Phase instantaneous overcurrent element operation (trip) low level Group 3 any phase
Neutral IOC	NEUTRAL IOC1 BLOCK	Neutral instantaneous overcurrent element block Group 1
	NEUTRAL IOC1 PKP	Neutral instantaneous overcurrent element pickup Group 1
	NEUTRAL IOC1 OP	Neutral instantaneous overcurrent element operation (trip) Group 1
	NEUTRAL IOC2 BLOCK	Neutral instantaneous overcurrent element block Group 2
	NEUTRAL IOC2 PKP	Neutral instantaneous overcurrent element pickup Group 2
	NEUTRAL IOC2 OP	Neutral instantaneous overcurrent element operation (trip) Group 2
	NEUTRAL IOC3 BLOCK	Neutral instantaneous overcurrent element block Group 3
	NEUTRAL IOC3 PKP	Neutral instantaneous overcurrent element pickup Group 3
	NEUTRAL IOC3 OP	Neutral instantaneous overcurrent element operation (trip) Group 3

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Ground IOC	GROUND IOC1 BLOCK	Ground instantaneous overcurrent element block Group 1
	GROUND IOC1 PKP	Ground instantaneous overcurrent element pickup Group 1
	GROUND IOC1 OP	Ground instantaneous overcurrent element operation (trip) Group 1
	GROUND IOC2 BLOCK	Ground instantaneous overcurrent element block Group 2
	GROUND IOC2 PKP	Ground instantaneous overcurrent element pickup Group 2
	GROUND IOC2 OP	Ground instantaneous overcurrent element operation (trip) Group 2
	GROUND IOC3 BLOCK	Ground instantaneous overcurrent element block Group 3
	GROUND IOC3 PKP	Ground instantaneous overcurrent element pickup Group 3
	GROUND IOC3 OP	Ground instantaneous overcurrent element operation (trip) Group 3
Sensitive Ground IOC	SENS GND IOC1 BLK	Sensitive ground instantaneous overcurrent element block Group 1
	SENS GND IOC1 PKP	Sensitive ground instantaneous overcurrent element pickup Group 1
	SENS GND IOC1 OP	Sensitive ground instantaneous overcurrent element operation (trip) Group 1
	SENS GND IOC2 BLK	Sensitive ground instantaneous overcurrent element block Group 2
	SENS GND IOC2 PKP	Sensitive ground instantaneous overcurrent element pickup Group 2
	SENS GND IOC2 OP	Sensitive ground instantaneous overcurrent element operation (trip) Group 2
	SENS GND IOC3 BLK	Sensitive ground instantaneous overcurrent element block Group 3
	SENS GND IOC3 PKP	Sensitive ground instantaneous overcurrent element pickup Group 3
	SENS GND IOC3 OP	Sensitive ground instantaneous overcurrent element operation (trip) Group 3
Isolated Ground	ISOLATED GND1 BLK	Isolated ground instantaneous overcurrent element block Group 1
	ISOLATED GND1 PKP	Isolated ground instantaneous overcurrent element pickup Group 1
	ISOLATED GND1 OP	Isolated ground instantaneous overcurrent element operation (trip) Group 1
	ISOLATED GND2 BLK	Isolated ground instantaneous overcurrent element block Group 2
	ISOLATED GND2 PKP	Isolated ground instantaneous overcurrent element pickup Group 2
	ISOLATED GND2 OP	Isolated ground instantaneous overcurrent element operation (trip) Group 2
	ISOLATED GND3 BLK	Isolated ground instantaneous overcurrent element block Group 3
	ISOLATED GND3 PKP	Isolated ground instantaneous overcurrent element pickup Group 3
	ISOLATED GND3 OP	Isolated ground instantaneous overcurrent element operation (trip) Group 3

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Phase TOC High	PH TOC1 HIGH A BLK	Phase timed overcurrent element block Group 1 phase A
	PH TOC1 HIGH B BLK	Phase timed overcurrent element block Group 1 phase B
	PH TOC1 HIGH C BLK	Phase timed overcurrent element block Group 1 phase C
	PH TOC1 HIGH A PKP	Phase timed overcurrent element pickup Group 1 phase A
	PH TOC1 HIGH A OP	Phase timed overcurrent element operation (trip) Group 1 phase A
	PH TOC1 HIGH B PKP	Phase timed overcurrent element pickup Group 1 phase B
	PH TOC1 HIGH B OP	Phase timed overcurrent element operation (trip) Group 1 phase B
	PH TOC1 HIGH C PKP	Phase timed overcurrent element pickup Group 1 phase C
	PH TOC1 HIGH C OP	Phase timed overcurrent element operation (trip) Group 1 phase C
	PH TOC1 HIGH PKP	Phase timed overcurrent element pickup Group 1 any phase
	PH TOC1 HIGH OP	Phase timed overcurrent element operation (trip) Group 1 any phase
	PH TOC2 HIGH A BLK	Phase timed overcurrent element block Group 2 phase A
	PH TOC2 HIGH B BLK	Phase timed overcurrent element block Group 2 phase B
	PH TOC2 HIGH C BLK	Phase timed overcurrent element block Group 2 phase C
	PH TOC2 HIGH A PKP	Phase timed overcurrent element pickup Group 2 phase A
	PH TOC2 HIGH A OP	Phase timed overcurrent element operation (trip) Group 2 phase A
	PH TOC2 HIGH B PKP	Phase timed overcurrent element pickup Group 2 phase B
	PH TOC2 HIGH B OP	Phase timed overcurrent element operation (trip) Group 2 phase B
	PH TOC2 HIGH C PKP	Phase timed overcurrent element pickup Group 2 phase C
	PH TOC2 HIGH C OP	Phase timed overcurrent element operation (trip) Group 2 phase C
	PH TOC2 HIGH PKP	Phase timed overcurrent element pickup Group 2 any phase
	PH TOC2 HIGH OP	Phase timed overcurrent element operation (trip) Group 2 any phase
	PH TOC3 HIGH A BLK	Phase timed overcurrent element block Group 3 phase A
	PH TOC3 HIGH B BLK	Phase timed overcurrent element block Group 3 phase B
	PH TOC3 HIGH C BLK	Phase timed overcurrent element block Group 3 phase C

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Phase TOC High	PH TOC3 HIGH A PKP	Phase timed overcurrent element pickup Group 3 phase A
	PH TOC3 HIGH A OP	Phase timed overcurrent element operation (trip) Group 3 phase A
	PH TOC3 HIGH B PKP	Phase timed overcurrent element pickup Group 3 phase B
	PH TOC3 HIGH B OP	Phase timed overcurrent element operation (trip) Group 3 phase B
	PH TOC3 HIGH C PKP	Phase timed overcurrent element pickup Group 3 phase C
	PH TOC3 HIGH C OP	Phase timed overcurrent element operation (trip) Group 3 phase C
	PH TOC3 HIGH PKP	Phase timed overcurrent element pickup Group 3 any phase
	PH TOC3 HIGH OP	Phase timed overcurrent element operation (trip) Group 3 any phase
Phase TOC Low	PH TOC1 LOW A BLK	Phase timed overcurrent element block Low level Group 1 phase A
	PH TOC1 LOW B BLK	Phase timed overcurrent element block Low level Group 1 phase B
	PH TOC1 LOW C BLK	Phase timed overcurrent element block Low level Group 1 phase C
	PH TOC1 LOW A PKP	Phase timed overcurrent element pickup low level Group 1 phase A
	PH TOC1 LOW A OP	Phase timed overcurrent element operation (trip) low level Group 1 phase A
	PH TOC1 LOW B PKP	Phase timed overcurrent element pickup low level Group 1 phase B
	PH TOC1 LOW B OP	Phase timed overcurrent element operation (trip) low level Group 1 phase B
	PH TOC1 LOW C PKP	Phase timed overcurrent element pickup low level Group 1 phase C
	PH TOC1 LOW C OP	Phase timed overcurrent element operation (trip) low level Group 1 phase C
	PH TOC1 LOW PKP	Phase timed overcurrent element pickup low level Group 1 any phase
	PH TOC1 LOW OP	Phase timed overcurrent element operation (trip) low level Group 1 any phase
	PH TOC2 LOW A BLK	Phase timed overcurrent element block Low level Group 2 phase A
	PH TOC2 LOW B BLK	Phase timed overcurrent element block Low level Group 2 phase B
	PH TOC2 LOW C BLK	Phase timed overcurrent element block Low level Group 2 phase C
	PH TOC2 LOW A PKP	Phase timed overcurrent element pickup low level Group 2 phase A
	PH TOC2 LOW A OP	Phase timed overcurrent element operation (trip) low level Group 2 phase A
	PH TOC2 LOW B PKP	Phase timed overcurrent element pickup low level Group 2 phase B

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Phase TOC Low	PH TOC2 LOW B OP	Phase timed overcurrent element operation (trip) low level Group 2 phase B
	PH TOC2 LOW C PKP	Phase timed overcurrent element pickup low level Group 2 phase C
	PH TOC2 LOW C OP	Phase timed overcurrent element operation (trip) low level Group 2 phase C
	PH TOC2 LOW PKP	Phase timed overcurrent element pickup low level Group 2 any phase
	PH TOC2 LOW OP	Phase timed overcurrent element operation (trip) low level Group 2 any phase
	PH TOC3 LOW A BLK	Phase timed overcurrent element block Low level Group 3 phase A
	PH TOC3 LOW B BLK	Phase timed overcurrent element block Low level Group 3 phase B
	PH TOC3 LOW C BLK	Phase timed overcurrent element block Low level Group 3 phase C
	PH TOC3 LOW A PKP	Phase timed overcurrent element pickup low level Group 3 phase A
	PH TOC3 LOW A OP	Phase timed overcurrent element operation (trip) low level Group 3 phase A
	PH TOC3 LOW B PKP	Phase timed overcurrent element pickup low level Group 3 phase B
	PH TOC3 LOW B OP	Phase timed overcurrent element operation (trip) low level Group 3 phase B
	PH TOC3 LOW C PKP	Phase timed overcurrent element pickup low level Group 3 phase C
	PH TOC3 LOW C OP	Phase timed overcurrent element operation (trip) low level Group 3 phase C
	PH TOC3 LOW PKP	Phase timed overcurrent element pickup low level Group 3 any phase
	PH TOC3 LOW OP	Phase timed overcurrent element operation (trip) low level Group 3 any phase
Neutral TOC	NEUTRAL TOC1 BLOCK	Neutral timed overcurrent element block Group 1
	NEUTRAL TOC1 PKP	Neutral timed overcurrent element pickup Group 1
	NEUTRAL TOC1 OP	Neutral timed overcurrent element operation (trip) Group 1
	NEUTRAL TOC2 BLOCK	Neutral timed overcurrent element block Group 2
	NEUTRAL TOC2 PKP	Neutral timed overcurrent element pickup Group 2
	NEUTRAL TOC2 OP	Neutral timed overcurrent element operation (trip) Group 2
	NEUTRAL TOC3 BLOCK	Neutral timed overcurrent element block Group 3
	NEUTRAL TOC3 PKP	Neutral timed overcurrent element pickup Group 3
	NEUTRAL TOC3 OP	Neutral timed overcurrent element operation (trip) Group 3

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Ground TOC	GROUND TOC1 BLOCK	Ground timed overcurrent element block Group 1
	GROUND TOC1 PKP	Ground timed overcurrent element pickup Group 1
	GROUND TOC1 OP	Ground timed overcurrent element operation (trip) Group 1
	GROUND TOC2 BLOCK	Ground timed overcurrent element block Group 2
	GROUND TOC2 PKP	Ground timed overcurrent element pickup Group 2
	GROUND TOC2 OP	Ground timed overcurrent element operation (trip) Group 2
	GROUND TOC3 BLOCK	Ground timed overcurrent element block Group 3
	GROUND TOC3 PKP	Ground timed overcurrent element pickup Group 3
	GROUND TOC3 OP	Ground timed overcurrent element operation (trip) Group 3
Sensitive Ground TOC	SENS GND TOC1 BLOCK	Sensitive ground timed overcurrent element block Group 1
	SENS GND TOC1 PKP	Sensitive ground timed overcurrent element pickup Group 1
	SENS GND TOC1 OP	Sensitive ground timed overcurrent element operation (trip) Group 1
	SENS GND TOC2 BLOCK	Sensitive ground timed overcurrent element block Group 2
	SENS GND TOC2 PKP	Sensitive ground timed overcurrent element pickup Group 2
	SENS GND TOC2 OP	Sensitive ground timed overcurrent element operation (trip) Group 2
	SENS GND TOC3 BLOCK	Sensitive ground timed overcurrent element block Group 3
	SENS GND TOC3 PKP	Sensitive ground timed overcurrent element pickup Group 3
	SENS GND TOC3 OP	Sensitive ground timed overcurrent element operation (trip) Group 3
Negative Sequence TOC	NEG SEQ TOC1 BLOCK	Negative sequence timed overcurrent element block Group 1
	NEG SEQ TOC1 PKP	Negative sequence timed overcurrent element pickup Group 1
	NEG SEQ TOC1 OP	Negative sequence timed overcurrent element operation Group 1
	NEG SEQ TOC2 BLOCK	Negative sequence timed overcurrent element block Group 2
	NEG SEQ TOC2 PKP	Negative sequence timed overcurrent element pickup Group 2
	NEG SEQ TOC2 OP	Negative sequence timed overcurrent element operation Group 2
	NEG SEQ TOC3 BLOCK	Negative sequence timed overcurrent element block Group 3
	NEG SEQ TOC3 PKP	Negative sequence timed overcurrent element pickup Group 3
	NEG SEQ TOC3 OP	Negative sequence timed overcurrent element operation Group 3

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Thermal Image	THERMAL1 BLOCK	Thermal image block Group 1
	THERMAL1 A RST	Thermal image phase A Group 1 element reset
	THERMAL1 B RST	Thermal image phase B Group 1 element reset
	THERMAL1 C RST	Thermal image phase C Group 1 element reset
	THERMAL1 ALARM	Thermal image element alarm any phase Group 1
	THERMAL1 OP	Thermal image element operation any phase Group 1
	THERMAL1 A ALRM	Thermal image element alarm phase A Group 1
	THERMAL1 A OP	Thermal image element operation phase A Group 1
	THERMAL1 B ALRM	Thermal image element alarm phase B Group 1
	THERMAL1 B OP	Thermal image element operation phase B Group 1
	THERMAL1 C ALRM	Thermal image element alarm phase C Group 1
	THERMAL1 C OP	Thermal image element operation phase C Group 1
	THERMAL2 BLOCK	Thermal image block Group 2
	THERMAL2 A RST	Thermal image phase A Group 2 element reset
	THERMAL2 B RST	Thermal image phase B Group 2 element reset
	THERMAL2 C RST	Thermal image phase C Group 2 element reset
	THERMAL2 ALARM	Thermal image element alarm any phase Group 2
	THERMAL2 OP	Thermal image element operation any phase Group 2
	THERMAL2 A ALRM	Thermal image element alarm phase A Group 2
	THERMAL2 A OP	Thermal image element operation phase A Group 2
	THERMAL2 B ALRM	Thermal image element alarm phase B Group 2
	THERMAL2 B OP	Thermal image element operation phase B Group 2
	THERMAL2 C ALRM	Thermal image element alarm phase C Group 2
	THERMAL2 C OP	Thermal image element operation phase C Group 2
	THERMAL3 BLOCK	Thermal image block Group 3
	THERMAL3 A RST	Thermal image phase A Group 3 element reset
	THERMAL3 B RST	Thermal image phase B Group 3 element reset
	THERMAL3 C RST	Thermal image phase C Group 3 element reset
	THERMAL3 ALARM	Thermal image element alarm any phase Group 3
	THERMAL3 OP	Thermal image element operation any phase Group 3
	THERMAL3 A ALRM	Thermal image element alarm phase A Group 3
	THERMAL3 A OP	Thermal image element operation phase A Group 3
	THERMAL3 B ALRM	Thermal image element alarm phase B Group 3
	THERMAL3 B OP	Thermal image element operation phase B Group 3
	THERMAL3 C ALRM	Thermal image element alarm phase C Group 3
	THERMAL3 C OP	Thermal image element operation phase C Group 3

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Phase Directional	PHASE DIR1 BLK INP	Phase directional block Group 1
	PHASE DIR1 BLOCK A	Phase directional element block Group 1 Phase A
	PHASE DIR1 A OP	Phase directional element operation Group 1 Phase A
	PHASE DIR1 BLOCK B	Phase directional element block Group 1 Phase B
	PHASE DIR1 B OP	Phase directional element operation Group 1 Phase B
	PHASE DIR1 BLOCK C	Phase directional element block Group 1 Phase C
	PHASE DIR1 C OP	Phase directional element operation Group 1 Phase C
	PHASE DIR2 BLK INP	Phase directional block Group 2
	PHASE DIR2 BLOCK A	Phase directional element block Group 2 Phase A
	PHASE DIR2 A OP	Phase directional element operation Group 2 Phase A
	PHASE DIR2 BLOCK B	Phase directional element block Group 2 Phase B
	PHASE DIR2 B OP	Phase directional element operation Group 2 Phase B
	PHASE DIR2 BLOCK C	Phase directional element block Group 2 Phase C
	PHASE DIR2 C OP	Phase directional element operation Group 2 Phase C
	PHASE DIR3 BLK INP	Phase directional block Group 3
	PHASE DIR3 BLOCK A	Phase directional element block Group 3 Phase A
	PHASE DIR3 A OP	Phase directional element operation Group 3 Phase A
	PHASE DIR3 BLOCK B	Phase directional element block Group 3 Phase B
	PHASE DIR3 B OP	Phase directional element operation Group 3 Phase B
	PHASE DIR3 BLOCK C	Phase directional element block Group 3 Phase C
	PHASE DIR3 C OP	Phase directional element operation Group 3 Phase C
Neutral Directional	NEUTRAL DIR1 BLK INP	Neutral directional element block input signal Group 1
	NEUTRAL DIR1 BLOCK	Neutral directional element blocked Group 1
	NEUTRAL DIR1 OP	Neutral directional element operation Group 1
	NEUTRAL DIR2 BLK INP	Neutral directional element block input signal Group 2
	NEUTRAL DIR2 BLOCK	Neutral directional element blocked Group 2
	NEUTRAL DIR2 OP	Neutral directional element operation Group 2
	NEUTRAL DIR3 BLK INP	Neutral directional element block input signal Group 3
	NEUTRAL DIR3 BLOCK	Neutral directional element blocked Group 3
	NEUTRAL DIR3 OP	Neutral directional element operation Group 3
Ground Directional	GROUND DIR1 BLK INP	Ground directional element block input signal Group 1
	GROUND DIR1 BLOCK	Ground directional element blocked Group 1
	GROUND DIR1 OP	Ground directional element operation Group 1
	GROUND DIR2 BLK INP	Ground directional element block input signal Group 2
	GROUND DIR2 BLOCK	Ground directional element blocked Group 2
	GROUND DIR2 OP	Ground directional element operation Group 2
	GROUND DIR3 BLK INP	Ground directional element block input signal Group 3
	GROUND DIR3 BLOCK	Ground directional element blocked Group 3
	GROUND DIR3 OP	Ground directional element operation Group 3

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Sensitive Ground Directional	SENS GND DIR1 BLK IP	Sensitive ground directional element block input Group 1
	SENS GND DIR1 BLOCK	Sensitive Ground directional element block Group 1
	SENS GND DIR1 OP	Sensitive Ground directional element operation Group 1
	SENS GND DIR2 BLK IP	Sensitive ground directional element block input Group 2
	SENS GND DIR2 BLOCK	Sensitive Ground directional element block Group 2
	SENS GND DIR2 OP	Sensitive Ground directional element operation Group 2
	SENS GND DIR3 BLK IP	Sensitive ground directional element block input Group 3
	SENS GND DIR3 BLOCK	Sensitive Ground directional element block Group 3
	SENS GND DIR3 OP	Sensitive Ground directional element operation Group 3
Fuse failure	VT FUSE FAILURE	Fuse failure operation
Phase UV	PHASE UV1 BLOCK	Phase undervoltage element block Group 1
	PHASE UV1 A PKP	Undervoltage element pickup AG Group 1
	PHASE UV1 A OP	Undervoltage element operation AG Group 1
	PHASE UV1 B PKP	Undervoltage element pickup BG Group 1
	PHASE UV1 B OP	Undervoltage element operation BG Group 1
	PHASE UV1 C PKP	Undervoltage element pickup CG Group 1
	PHASE UV1 C OP	Undervoltage element operation CG Group 1
	PHASE UV1 AB PKP	Undervoltage element pickup AB Group 1
	PHASE UV1 AB OP	Undervoltage element operation AB Group 1
	PHASE UV1 BC PKP	Undervoltage element pickup BC Group 1
	PHASE UV1 BC OP	Undervoltage element operation BC Group 1
	PHASE UV1 CA PKP	Undervoltage element pickup CA Group 1

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Phase UV	PHASE UV1 CA OP	Undervoltage element operation CA Group 1
	PHASE UV1 PKP	Pickup of any of the above mentioned elements
	PHASE UV1 OP	Operation of any of the above mentioned elements
	PHASE UV2 BLOCK	Phase undervoltage element block Group 2
	PHASE UV2 A PKP	Undervoltage element pickup AG Group 2
	PHASE UV2 A OP	Undervoltage element operation AG Group 2
	PHASE UV2 B PKP	Undervoltage element pickup BG Group 2
	PHASE UV2 B OP	Undervoltage element operation BG Group 2
	PHASE UV2 C PKP	Undervoltage element pickup CG Group 2
	PHASE UV2 C OP	Undervoltage element operation CG Group 2
	PHASE UV2 AB PKP	Undervoltage element pickup AB Group 2
	PHASE UV2 AB OP	Undervoltage element operation AB Group 2
	PHASE UV2 BC PKP	Undervoltage element pickup BC Group 2
	PHASE UV2 BC OP	Undervoltage element operation BC Group 2
	PHASE UV2 CA PKP	Undervoltage element pickup CA Group 2
	PHASE UV2 CA OP	Undervoltage element operation CA Group 2
	PHASE UV2 PKP	Pickup of any of the above mentioned elements
	PHASE UV2 OP	Operation of any of the above mentioned elements
	PHASE UV3 BLOCK	Phase undervoltage element block Group 3
	PHASE UV3 A PKP	Undervoltage element pickup AG Group 3
	PHASE UV3 A OP	Undervoltage element operation AG Group 3
	PHASE UV3 B PKP	Undervoltage element pickup BG Group 3
	PHASE UV3 B OP	Undervoltage element operation BG Group 3
	PHASE UV3 C PKP	Undervoltage element pickup CG Group 3
	PHASE UV3 C OP	Undervoltage element operation CG Group 3
	PHASE UV3 AB PKP	Undervoltage element pickup AB Group 3
	PHASE UV3 AB OP	Undervoltage element operation AB Group 3
	PHASE UV3 BC PKP	Undervoltage element pickup BC Group 3
	PHASE UV3 BC OP	Undervoltage element operation BC Group 3
	PHASE UV3 CA PKP	Undervoltage element pickup CA Group 3
	PHASE UV3 CA OP	Undervoltage element operation CA Group 3
	PHASE UV3 PKP	Pickup of any of the above mentioned elements
	PHASE UV3 OP	Operation of any of the above mentioned elements

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Phase OV	PHASE OV1 BLOCK	Phase overvoltage element block Group 1
	PHASE OV1 AB PKP	Overvoltage element pickup AB Group 1
	PHASE OV1 AB OP	Overvoltage element operation AB Group 1
	PHASE OV1 BC PKP	Overvoltage element pickup BC Group 1
	PHASE OV1 BC OP	Overvoltage element operation BC Group 1
	PHASE OV1 CA PKP	Overvoltage element pickup CA Group 1
	PHASE OV1 CA OP	Overvoltage element operation CA Group 1
	PHASE OV1 PKP	Pickup of any of the above mentioned elements
	PHASE OV1 OP	Operation of any of the above mentioned elements
	PHASE OV2 BLOCK	Phase overvoltage element block Group 2
	PHASE OV2 AB PKP	Overvoltage element pickup AB Group 2
	PHASE OV2 AB OP	Overvoltage element operation AB Group 2
	PHASE OV2 BC PKP	Overvoltage element pickup BC Group 2
	PHASE OV2 BC OP	Overvoltage element operation BC Group 2
	PHASE OV2 CA PKP	Overvoltage element pickup CA Group 2
	PHASE OV2 CA OP	Overvoltage element operation CA Group 2
	PHASE OV2 PKP	Pickup of any of the above mentioned elements
	PHASE OV2 OP	Operation of any of the above mentioned elements
	PHASE OV3 BLOCK	Phase overvoltage element block Group 3
	PHASE OV3 AB PKP	Overvoltage element pickup AB Group 3
	PHASE OV3 AB OP	Overvoltage element operation AB Group 3
	PHASE OV3 BC PKP	Overvoltage element pickup BC Group 3
	PHASE OV3 BC OP	Overvoltage element operation BC Group 3
	PHASE OV3 CA PKP	Overvoltage element pickup CA Group 3
	PHASE OV3 CA OP	Overvoltage element operation CA Group 3
	PHASE OV3 PKP	Pickup of any of the above mentioned elements
	PHASE OV3 OP	Operation of any of the above mentioned elements
Neutral OV High	NEUTRAL OV1 HIGH BLK	Neutral overvoltage element block high level Group 1
	NEUTRAL OV1 HIGH PKP	Neutral overvoltage element pickup high level Group 1
	NEUTRAL OV1 HIGH OP	Neutral overvoltage element operation high level Group 1
	NEUTRAL OV2 HIGH BLK	Neutral overvoltage element block high level Group 2
	NEUTRAL OV2 HIGH PKP	Neutral overvoltage element pickup high level Group 2
	NEUTRAL OV2 HIGH OP	Neutral overvoltage element operation high level Group 2
	NEUTRAL OV3 HIGH BLK	Neutral overvoltage element block high level Group 3
	NEUTRAL OV3 HIGH PKP	Neutral overvoltage element pickup high level Group 3
	NEUTRAL OV3 HIGH OP	Neutral overvoltage element operation high level Group 3

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Neutral OV Low	NEUTRAL OV1 LOW BLK	Neutral overvoltage element block low level Group 1
	NEUTRAL OV1 LOW PKP	Neutral overvoltage element pickup low level Group 1
	NEUTRAL OV1 LOW OP	Neutral overvoltage element operation low level Group 1
	NEUTRAL OV2 LOW BLK	Neutral overvoltage element block low level Group 2
	NEUTRAL OV2 LOW PKP	Neutral overvoltage element pickup low level Group 2
	NEUTRAL OV2 LOW OP	Neutral overvoltage element operation low level Group 2
	NEUTRAL OV3 LOW BLK	Neutral overvoltage element block low level Group 3
	NEUTRAL OV3 LOW PKP	Neutral overvoltage element pickup low level Group 3
	NEUTRAL OV3 LOW OP	Neutral overvoltage element operation low level Group 3
Negative Sequence OV	NEG SEQ OV1 BLOCK	Negative sequence overvoltage element block Group 1
	NEG SEQ OV1 PKP	Negative sequence overvoltage element pickup Group 1
	NEG SEQ OV1 OP	Negative sequence overvoltage element operation Group 1
	NEG SEQ OV2 BLOCK	Negative sequence overvoltage element block Group 2
	NEG SEQ OV2 PKP	Negative sequence overvoltage element pickup Group 2
	NEG SEQ OV2 OP	Negative sequence overvoltage element operation Group 2
	NEG SEQ OV3 BLOCK	Negative sequence overvoltage element block Group 3
	NEG SEQ OV3 PKP	Negative sequence overvoltage element pickup Group 3
	NEG SEQ OV3 OP	Negative sequence overvoltage element operation Group 3
Overfrequency	OVERFREQ1 BLOCK	Overfrequency element block Group 1
	OVERFREQ1 PKP	Overfrequency element pickup Group 1
	OVERFREQ1 OP	Overfrequency element operation Group 1
	OVERFREQ2 BLOCK	Overfrequency element block Group 2
	OVERFREQ2 PKP	Overfrequency element pickup Group 2
	OVERFREQ2 OP	Overfrequency element operation Group 2
	OVERFREQ3 BLOCK	Overfrequency element block Group 3
	OVERFREQ3 PKP	Overfrequency element pickup Group 3
	OVERFREQ3 OP	Overfrequency element operation Group 3
Underfrequency	UNDERFREQ1 BLOCK	Underfrequency element block Group 1
	UNDERFREQ1 PKP	Underfrequency element pickup Group 1
	UNDERFREQ1 OP	Underfrequency element operation Group 1
	UNDERFREQ2 BLOCK	Underfrequency element block Group 2
	UNDERFREQ2 PKP	Underfrequency element pickup Group 2
	UNDERFREQ2 OP	Underfrequency element operation Group 2
	UNDERFREQ3 BLOCK	Underfrequency element block Group 3
	UNDERFREQ3 PKP	Underfrequency element pickup Group 3
	UNDERFREQ3 OP	Underfrequency element operation Group 3

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Broken Conductor	BROKEN CONDUCT1 BLK	Broken conductor block Group 1
	BROKEN CONDUCT1 PKP	Broken conductor element Pickup Group 1
	BROKEN CONDUCT1 OP	Broken conductor element operation Group 1
	BROKEN CONDUCT2 BLK	Broken conductor block Group 2
	BROKEN CONDUCT2 PKP	Broken conductor element Pickup Group 2
	BROKEN CONDUCT2 OP	Broken conductor element operation Group 2
	BROKEN CONDUCT3 BLK	Broken conductor block Group 3
	BROKEN CONDUCT3 PKP	Broken conductor element Pickup Group 3
	BROKEN CONDUCT3 OP	Broken conductor element operation Group 3
Forward Power (32FP)	FWD PWR1 BLOCK	Forward power element block Group 1
	FWD PWR1 STG1 PKP	Forward Power element pickup level 1 Group 1
	FWD PWR1 STG1 OP	Forward Power element operation level 1 Group 1
	FWD PWR1 STG2 PKP	Forward Power element pickup level 2 Group 1
	FWD PWR1 STG2 OP	Forward Power element operation level 2 Group 1
	FWD PWR2 BLOCK	Forward power element block Group 2
	FWD PWR2 STG1 PKP	Forward Power element pickup level 1 Group 2
	FWD PWR2 STG1 OP	Forward Power element operation level 1 Group 2
	FWD PWR2 STG2 PKP	Forward Power element pickup level 2 Group 2
	FWD PWR2 STG2 OP	Forward Power element operation level 2 Group 2
	FWD PWR3 BLOCK	Forward power element block Group 3
	FWD PWR3 STG1 PKP	Forward Power element pickup level 1 Group 3
	FWD PWR3 STG1 OP	Forward Power element operation level 1 Group 3
	FWD PWR3 STG2 PKP	Forward Power element pickup level 2 Group 3
	FWD PWR3 STG2 OP	Forward Power element operation level 2 Group 3
Breaker Maintenance	KI2t PHASE A ALARM	$K \cdot I^2t$ phase A Alarm
	KI2t PHASE B ALARM	$K \cdot I^2t$ phase B Alarm
	KI2t PHASE C ALARM	$K \cdot I^2t$ phase C Alarm
	BKR OPENINGS ALARM	Maximum Breaker openings alarm
	BKR OPEN 1 HOUR ALRM	Maximum Breaker openings in one hour alarm
	RESET KI2t COUNTERS	KI^2t Breaker ageing counter reset
	RESET BKR COUNTERS	Breaker openings and closings counters reset
Breaker Status	BREAKER OPEN	Breaker Opened
	BREAKER CLOSED	Breaker closed
	BREAKER UNDEFINED	Breaker undefined (52a and 52b have the same status)
Breaker Failure	BKR FAIL INITIATE	Breaker failure initiation
	BKR FAIL NO CURRENT	Breaker failure without current
	BKR FAIL SUPERVISION	Breaker failure 1st level (supervision – retrip)
	BKR FAIL HISET	Breaker failure 2nd level (high level)
	BKR FAIL LOWSET	Breaker failure 3rd level (low level)
	INTERNAL ARC	Internal arc
	BKR FAIL 2nd STEP	Breaker failure second step

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Synchrocheck	SYNCHROCHECK BLK INP	Synchronism element block
	SYNCHROCHECK OP	Synchronsim condition (Dv, Dj and Df are within the set range)
	SYNCHK CLOSE PERM	Closing permission for the synchronism element: (SYNCHK OP) OR (SYNCHK CON OP)
	SYNCHROCHECK COND OP	Active if when it is set, any of the three following conditions is met:
	DL-DB OPERATION	Dead line – dead bus condition
	DL-LB OPERATION	Dead line – live bus condition
	LL-DB OPERATION	Live line – dead bus condition
	SLIP CONDITION	Slip conditions are met
	BUS FREQ > LINE FREQ	Bus Frequency higher than line frequency
	BUS FREQ < LINE FREQ	Bus Frequency lower than line frequency
Autorecloser	AR LEVEL BLOCK	Recloser element block by level
	AR PULSE BLOCK	Recloser element block by pulse
	AR PULSE UNBLOCK	Recloser element unblock by pulse
	AR INITIATE	Reclose initiate
	AR CONDS INPUT	Reclose permission condition in input to Function 1 = there are conditions
	AR CLOSE BREAKER	Closing permission for the recloser
	AR OUT OF SERVICE	Recloser out of service
	AR READY	Recloser READY
	AR LOCKOUT	Recloser in LOCKOUT
	AR BLOCK	Recloser BLOCKed
	AR RCL IN PROGRESS	Recloser – Cycle in progress
	AR LCK BY ANOMALY	Recloser – LOCKOUT by anomaly (reclosing command during cycle in progress)
	AR LCK BY FAIL OPEN	Recloser – LOCKOUT by failure to open
	AR LCK BY FAIL CLOSE	Recloser – LOCKOUT by failure to close
	AR LCK BY USER	Recloser – LOCKOUT by external operation (e.g.: manual opening with cycle in progress)
	AR LCK BY CONDS	Recloser – LOCKOUT by lack of reclosing conditions
	AR LCK BY TRIPS	Recloser – LOCKOUT by number of trips
	AR LCK BY SHOTS	Recloser – LOCKOUT by number of shots
	AR BLK AFTER 1 SHOT	Recloser – Block after first shot
	AR BLK AFTER 2 SHOT	Recloser – Block after second shot
	AR BLK AFTER 3 SHOT	Recloser – Block after third shot
	AR BLK AFTER 4 SHOT	Recloser – Block after fourth shot
Autorecloser	AR BLOCK BY LEVEL	Recloser – Block by level
	AR BLOCK BY PULSE	Recloser – Block by command (pulse)
Default Channel (not used)	Default Channel	Channel not used

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Directional Power	DIR PWR1 BLOCK	Directional power element block Group 1
	DIR PWR1 STG1 PKP	Directional Power element pickup level 1 Group 1
	DIR PWR1 STG1 OP	Directional Power element operation level 1 Group 1
	DIR PWR1 STG2 PKP	Directional Power element pickup level 2 Group 1
	DIR PWR1 STG2 OP	Directional Power element operation level 2 Group 1
	DIR PWR1 STG PKP	Directional power element pickup Group 1
	DIR PWR1 STG OP	Directional Power element operation Group 1
	DIR PWR2 BLOCK	Directional power element block Group 2
	DIR PWR2 STG1 PKP	Directional Power element pickup level 1 Group 2
	DIR PWR2 STG1 OP	Directional Power element operation level 1 Group 2
	DIR PWR2 STG2 PKP	Directional Power element pickup level 2 Group 2
	DIR PWR2 STG2 OP	Directional Power element operation level 2 Group 2
	DIR PWR2 STG PKP	Directional power element pickup Group 2
	DIR PWR2 STG OP	Directional Power element operation Group 2
	DIR PWR3 BLOCK	Directional power element block Group 3
	DIR PWR3 STG1 PKP	Directional Power element pickup level 1 Group 3
	DIR PWR3 STG1 OP	Directional Power element operation level 1 Group 3
	DIR PWR3 STG2 PKP	Directional Power element pickup level 2 Group 3
	DIR PWR3 STG2 OP	Directional Power element operation level 2 Group 3
	DIR PWR3 STG PKP	Directional power element pickup Group 3
	DIR PWR3 STG OP	Directional Power element operation Group 3
Pulse Counters	PulseCntr Value 1	Pulse counter element value Group 1
	PulseCntr Value 2	Pulse counter element value Group 2
	...	...
	PulseCntr Value 8	Pulse counter element value Group 8
	PulseCntr Freeze 1	Pulse counter element freeze value Group 1
	PulseCntr Freeze 2	Pulse counter element freeze value Group 2
	...	...
	PulseCntr Freeze 8	Pulse counter element freeze value Group 8
Analog comparators	Analog Level 01	Analog comparator element level Group 1
	Analog Level 02	Analog comparator element level Group 2
	...	...
	Analog Level 20	Analog comparator element level Group 20

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
wattmetric Ground Fault (Logic Operands)	32N1 BLOCK	wattmetric Ground Fault Element Block Level Group 1
	32N1 PKP	wattmetric Ground Fault Element Global Pickup (current, voltage and power) Level Group 1
	32N1 OC PKP	wattmetric Ground Fault Element Overcurrent Pickup Level Group 1
	32N1 OP	wattmetric Ground Fault Element Operation Level Group 1
	32N2 BLOCK	wattmetric Ground Fault Element Block Level Group 2
	32N2 PKP	wattmetric Ground Fault Element Global Pickup (current, voltage and power) Level Group 2
	32N2 OC PKP	wattmetric Ground Fault Element Overcurrent Pickup Level Group 2
	32N2 OP	wattmetric Ground Fault Element Operation Level Group 2
	32N3 BLOCK	wattmetric Ground Fault Element Block Level Group 3
	32N3 PKP	wattmetric Ground Fault Element Global Pickup (current, voltage and power) Level Group 3
	32N3 OC PKP	wattmetric Ground Fault Element Overcurrent Pickup Level Group 3
	32N3 OP	wattmetric Ground Fault Element Operation Level Group 3
wattmetric Ground Fault (Power Measurements)	32N1 POWER	wattmetric Ground Fault Element Level Group 1 Power Value (watts)
	32N2 POWER	wattmetric Ground Fault Element Level Group 2 Power Value (watts)
	32N3 POWER	wattmetric Ground Fault Element Level Group 3 Power Value (watts)
Remote Outputs	DNA 1	1 output on. Remote Output DNA 1 Operation (GSSE/GOOSE)
	DNA 2	1 output on. Remote Output DNA 2 Operation (GSSE/GOOSE)
	...	...
	DNA 32	1 output on. Remote Output DNA 32 Operation (GSSE/GOOSE)
	User St 1	1 output on. Remote Output UserSt 1 Operation (GSSE/GOOSE)
	User St 2	1 output on. Remote Output UserSt 2 Operation (GSSE/GOOSE)
	...	**...**
	User St 64	1 output on. Remote Output UserSt 64 Operation (GSSE/GOOSE)
	Rem GOOSE Dig Out 1	1 output on. Remote Output GOOSE 1 Operation (GOOSE)
	Rem GOOSE Dig Out 2	1 output on. Remote Output GOOSE 2 Operation (GOOSE)
	...	...
	Rem GOOSE Dig Out 32	1 output on. Remote Output GOOSE 32 Operation (GOOSE)
Remote Inputs	Remote Input 1	Flag is set, logic =1
	Remote Input 2	Flag is set, logic =1
	...	...
	Remote Input 32	Flag is set, logic =1

OPERANDS - R650 - MODEL FX - GX		
Internal System Status		
Remote Devices	Remote Device 1	Flag is set, logic =1
	Remote Device 2	Flag is set, logic =1
	...	...
	Remote Device 16	Flag is set, logic =1
GOOSE DIG INPUTS	Rem GOOSE Dig Input 1	Flag is set, logic = 1
	Rem GOOSE Dig Input 2	Flag is set, logic =1
	...	...
	Rem GOOSE Dig Input 32	Flag is set, logic =1
GOOSE Analog Inputs (FLOAT AND INTEGER)	Rem Ana Inp FLOAT 1	Analog Input 1 (Float type)
	Rem Ana Inp FLOAT 2	Analog Input 2 (Float type)
	...	...
	Rem Ana Inp FLOAT 8	Analog Input 8 (Float type)
	Rem Ana Inp INT 1	Analog Input 1 (Integer type)
	Rem Ana Inp INT 2	Analog Input 2 (Integer type)
	...	...
	Rem Ana Inp INT 8	Analog Input 8 (Integer type)

R650 Recloser Controller

Appendix B: MODBUS protocol

B.1 Introduction

This section describes the MODBUS memory map and how to read and write data from and to the R650 relay using MODBUS protocol. The MODBUS protocol is an industrial communications protocol based on a master/slave architecture (RTU-Serial) or a client/server architecture (TCP/IP). Refer to http://www.modbus.org/ for more information about this protocol.

A generic memory map has been created, **compatible between versions**, with all possible items that an R650 may have, independent of type or configuration to prevent an existing integration from being affected by version changes. This memory map describes each item including the data type, length, memory position, object version, etc. Moreover, the memory map groups the different objects into subgroups, such as status and settings groups.

Each object has a **unique** memory position for the whole family. Only after reading the objects of a particular relay model, it is possible to elaborate its own MODBUS memory map. This map is only valid for that particular relay and memory version. From one version to another the memory positions of existing objects remain fixed, and new objects are assigned new addresses, which again remain the same for following versions.

View the Memory Map using **EnerVista 650 Setup software**, menu: **View > MODBUS Memory map**

B.2 MODBUS R650

B.2.1 Implemented MODBUS functionality

The implemented protocol is standard MODBUS, so any SCADA or PLC can easily communicate with R650 units.

The R650 unit always works as a slave/server, and thus never initiates communication; it is always the master/client (Enervista 650 Software or PLC, i.e.) that initiates communication.

Only two MODBUS codes are implemented in all firmware versions:

- **Read function 3 (03h) and 4 (04h)**
- **Write function 16 (10h)**

Two custom MODBUS functions have also been implemented:

- **Read function 66 (42h)**
- **Write function 67 (43h)**

The two new custom function codes allow the master/server to read/write settings of protection functions affected by the setting groups. If these MODBUS function codes are used, the master/server has access to read/write protection element settings that belong to any setting group. In contrast, if read function 3 or Write function 4 is used, only protection elements settings in the **active setting group** can be accessed/modified.

B.2.2 Physical layer

MODBUS protocol is independent of hardware. The physical layer may be in different hardware configurations: USB, RS232, RS485, fiber optic or Ethernet.

R650 units incorporate a front USB or RS232 port, and can mount two rear RS485 or fiber optic ports, and a 1mixture of 10/100Base TX and 10/100Base FX ports, depending on the specific order code of each R650 unit. The data flow in any of these configurations is “half-duplex”.

B.2.2.1 Serial layer

The port baud rate and the parity are independent and programmable for each communication port. Any port may be programmed to baud rates of: 1200, 2400, 4800, 9600, 19200, 38400, 57600 or 115200. Parity may be even, odd, or none.

The master must know the slave address with which it is going to communicate. No unit operates after a master request if the message address is not its own, unless the address is 0, which is the broadcast address. In this case the relay operates, but won’t send a reply.

B.2.2.2 B.2.2.2 TCP/IP layer

The rear ethernet or fiber optic ports are used for this connection layer.

The settings for this type of connection are gathered from the Ethernet and MODBUS protocol setpoint menus, where the IP addresses and TCP port are configured, among other settings.

B.2.3 Data link layer

Communication is performed in strings, with data groups sent asynchronously. The master/client transmits a string to the slave/server and the slave/server responds with another string (except for the case of broadcast communication). For the MODBUS serial connection, a timeout or a pause in communication marks the end of a string. The length of this timeout is equal to 3 characters, thus it varies depending on the baud rate.

The following table shows the generic string format, valid for transmission and reception. However, each function has its own particularities, as described later in this manual.

MODBUS FORMAT		
CLIENT ADDRESS [A]	1 byte	Each device in a communications bus must have a unique address to prevent two units from responding at the same time to the same request. All relay ports use this address, which can be programmed to any value between 1 and 254. When the master transmits a string with the slave address 0, this indicates that it is a Broadcast. Every slave in the communication bus performs the requested action, but none of them responds to the master. Broadcast is only accepted for writing since no unit responds.
FUNCTION CODE [B]	1 byte	This is one of the function codes supported by the equipment. The generic function codes are 3 and 4 for reading and 16 for writing. Special read function 66 and write function 67 are also available. When the slave responds with an exception to any of these strings, it places to 1 the most important bit of the corresponding function. For example, an exception to function 3 is indicated with an 83 as function code, and an exception to function 16 or 0x10 in hexadecimal, is indicated with a 0x90.
SETTING GROUP SELECTED [B1]	1byte	This part of string format only applies to read function 66 and write function 67. This byte indicates the setting group being read or written. Values should are as follow: 0 [Decimal]→ Setting Group 1 1 [Decimal]→ Setting Group 2 ... 5 [Decimal]→ Setting Group 6
DATA [C]	N bytes	This section includes a variable number of bytes, depending on the function code. It may include: addresses, data length, settings, commands or exception codes sent by the client.
CRC [D]	2 bytes	Two-byte control code. ModBus/RTU includes a 16-bit CRC in each string for error detection. If the slave detects a string with errors, based on an incorrect CRC, it neither performs an action, nor responds to the master. The CRC order is LSB-MSB.
TIME OUT	Required time to transmit 3.5 Bytes	A string is finished when nothing is received during a period of 3.5 bytes, with the actual time varying depending on baud rate: 15 ms at 2400 bps 2 ms at 19200 bps 300 µs at 115200 bps etc.

B.2.4 Generic reading

MASTER/CLIENT SLAVE/SERVER

Request

Reading function 3 or 4:

+[A]+ +[B]+ +[C]--------------+ +[D]--+

01 04 01 09 00 01 XX XX

Data addr. Regs.

Reading function 66:

+[A]+ +[B]+ +[B1]++[C]--------------+ +[D]--+

01 42 00 01 09 00 01 XX XX

SG Data addr. Regs.

OK Response

Reading function 3 or 4:

+[A]+ +[B]+ +[C]-----------------------+ +[D]--+

01 04 02 00 08 XX XX

Bytes...Data .....

Reading function 66:

+[A]+ +[B]+ +[C]-----------------------+ +[D]--+

01 42 02 00 08 XX XX

Bytes...Data ....

Error Response

R
e

ading function 3 or 4:

+[A]+ +[B]+ +[C]-----------------------+ +[D]--+

01 84 03 XX XX

Error code..........

Reading function 66:

+[A]+ +[B]+ +[C]------------------------+ +[D]--+

01 C2 03 XX XX

B.2.5 Generic writing

MASTER/CLIENT SLAVE/SERVER

Request

Writting function 16:

+[A]+ +[B]+ +[C]--------------------------------+ +[D]--+

01 10 00 87 00 02 04 00 0A 01 02 XX XX

Data addr. Regs. Bytes ....Data.......

Writing function 67:

+[A]+ +[B]+ +[B1]++[C]--------------+ +[D]--+

01 43 00 09 C1 00 01 02 00 03 XX XX

SG Data addr. Regs. Bytes Data

OK Response

Writting function 16:

+[A]+ +[B]+ +[C]-----------------------------+ +[D]--+

01 10 00 87 00 02 XX XX

Data Addr.......Regs .....

Writting function 67:

+[A]+ +[B]+ +[C]--------------------------------+ +[D]--+

01 43 09 C1 00 01 XX XX

Data Addr.......Regs .....

Error Response

Writting function 16:

+[A]+ +[B]+ +[C]------------------------+ +[D]--+

01 90 07 XX XX

Error code...........

Writting function 67:

+[A]+ +[B]+ +[C]------------------------+ -+ +[D]--+

01 C3 03 XX XX

B.2.6 Function codes

CODE		MODBUS NAME	R650 DEFINITION	COMMENT
HEX	DEC			
03	3	Read Holding Registers	Reading of any value	These functions allow the master to read one or more consecutive relay addresses. Registers are always 16-bits long, with the most important byte first. The maximum number of registers that can be read in a single package is 125, equivalent to 250 bytes.
04	4	Read Input Registers	Reading of any value	
42	66	Setting Group Read	Reading of values affected by setting groups	This function allows the master to read any setting/actual value that belongs to any setting groups, active or not, in one or more consecutive relay addresses. Registers are always 16-bits long, with the most important byte first. The maximum number of registers that can be read in a single package is 125, equivalent to 250 bytes.
10	16	Preset Multiple Registers	Writing	This function allows the master to write one or more registers, representing one or more settings. Registers are 2-byte long values, transmitted with the most important byte first. The maximum number of registers that can be written in a single package is 125, equivalent to 250 bytes.
43	67	Setting Group Write	Writtig of values affected by sseting	This function allows the master to write any setting that belongs to any setting group, active or not, in one or more consecutive relay addresses. Registers are always 16-bits long, with the most important byte first. The maximum number of registers that can be written in a single package is 125, equivalent to 250 bytes.

B.2.7 Exception and error responses

The following table shows error codes defined in ModBus protocol:

01	ILLEGAL FUNCTION	Slave does not support the function code received.
02	ILLEGAL DATA ADDRESS	Master is using an incorrect address.
03	ILLEGAL DATA VALUE	Slave has detected an invalid value.
04	ILLEGAL RESPONSE LENGTH	Response to the master's request exceeds the maximum size for that function code.
05	ACKNOWLEDGE	Generic acknowledgement.
06	SLAVE DEVICE BUSY	Slave is busy and cannot perform the requested operation.
07	NEGATIVE ACKNOWLEDGE	Negative acknowledgement.

B.3 Data type

TYPE	LENGTH	DESCRIPTIÓN
F1	1	Boolean data type. As it is a bit, for evaluating it we need a memory address and a bit. For example: Value *0x1A41-0001101001000001b* Bit 15 0 Bit 14 0 Bit 13 0 Bit 12 1 Bit 11 1 Bit 10 0 Bit 09 1 Bit 08 0 Bit 07 0 Bit 06 1 Bit 05 0 Bit 04 0 Bit 03 0 Bit 02 0 Bit 01 0 Bit 00 1
F2	2	Integer with 4 bytes sign. Must be scaled, by multiplying the sent value by 1000, or dividing the received value by 1000. For example, if a value of 34509 is received, the converted value is 34.509. To write the value 334, the value 334000 is sent. This prevents the loss of accuracy involved in using float values. Example: 12312d=0x00003018. Real Value = 12312/1000=12.312
F3	2	4-byte Floating Example: 1240.556 = 0x449B11CB
F4	1	Integer with 2 bytes sign. Example: 123 = 0x007B
F5	2	Integer without 4 bytes sign. Example: 12312 = 0x00003018
F6	4	8 bytes Float Example: 123.324 = 0x405ED4BC6A7EF9DB
F7	1	Characters without sign. As it needs to be sent in a register, i.e. in two bytes, the character goes below. *Example: ‘β = 0x00E1*
F8	1	Characters with sign As it needs to be sent in a register, i.e. in two bytes, the character goes below. Example: ‘A’ = 0x0041
F9	16	String. Chain of characters with a fixed length (32 bytes). The end of the string is marked with “\0”. Example: “ABC” = 0x41x42x43x00....
F10	1	This is a 16-bit integer without sign. Each value that can be taken by this integer has a correspondence in the database Auxiliary Table. In this table we can find the corresponding chain, which must be shown for each value. In memory, only an integer value is received. Example: 0, 1Correspond to CLOSE, OPEN
F11	3	Milliseconds passed since January/1/2000 at 00:00:00.000.
F12	1	Unsigned int 16 bit (enumerated), example: In MODBUS address Ox0EBE is the FAULT TYPE 0=GROUND 1=PHASE 2=3 PH 3=AG 4=ABG 5=AB 6=BG 7=BCG 8=BC 9=CG 10=CAG 11=CA 12=NAF

B.4 MODBUS data

B.4.1 Data management

The data managed in ModBus differs in size and functionality. Depending on the functionality and importance of certain data, the use of ModBus is optimized in time for real time processes, as in the case of events.

Although some configuration settings, such as GRAPHIC, PLC equations, TEXTS, and ALARM and LED configuration can be read and written using ModBus protocol, formats are not shown because they are subject to change. Use the EnerVista 650 Setup program to manage and format configuration settings.

B.4.2 Writing settings

The process for changing protection functionality usually involves the modification of a group of settings that belong to a particular protection function. This guarantees protection functionality and offers versatility for possible legacy programs.

Writing settings must be performed in two consecutive steps: Writing and Confirmation.

In order to perform this process, the MODBUS master must write the selected settings and then confirm the operation by writing a register in the last position of this group. For safety reasons, there is a set time window within which the confirm settings modification must be completed. The time window between the last settings being written to confirmation cannot exceed 15 seconds.

B.4.3 Snapshot events

In the R650, the NEW EVENTS concept has been extended, providing additional functionality. These are the events created after the last request.

Firmware version 1.60 adds a new way of reading snapshot events in binary format. Before this version, the relay sent information only in ASCII format. The snapshot event retrieval is similar to the ASCII.

SNAPSHOT EVENT READING IN ASCII FORMAT

1. **Write a message to the '0xfe00' address,** including the file name to open:

   "EVE .TXT": to read all events.

   "NEW_EVE.TXT": to read events created from the last request of this same file.

   "EVE0234 .TXT ": to read events starting, for example, from event number 234.

2. **Subsequent messages read the 0xff00 address**, in blocks of 250 bytes (4 bytes that indicate the point value to the file, 2 bytes that indicate the number of data bytes sent, and 244 data bytes). If the number of data bytes sent is lower than 244, this indicates that it is the last message.

   If during this process there is an error response, the request can be repeated in address 0xff02 reading 246 bytes (2 bytes that indicate the number of bytes sent, and 244 data bytes).

   In the second step, many BUSY responses may be produced, because an ASCII file is being created internally.

SNAPSHOT EVENT READING IN BINARY FORMAT:

1. **Write a message to the '0xfe00' address,** including the file name to open:

   "EVE .BIN": to read all events.

   "NEW_EVE.BIN": to read events created from the last request of this same file.

   "EVE0234 .BIN ": to read events starting, for example, from event number 234.

2. **Subsequent messages read the 0xff00 address**, in blocks of 250 bytes (4 bytes that indicate the point value to the file, 2 bytes that indicate the number of data bytes sent, and 244 data bytes). If the number of data bytes sent is lower than 244, this indicates that it is the last message.

If during this process there is an error response, the request can be repeated in address 0xff02 reading 246 bytes (2 bytes that indicate the number of bytes sent, and 244 data bytes).

Each Snapshot event includes:

1st byte: event format code.

N bytes: Event information structured depending on the code

There is only one format type with code 0. Its structure is as follows:

- UINT16: event handle.
- 8 bytes: event date and time.
- 29 bytes: event cause. (string end in null).
- UINT32: Phasor Ia (scaled to 1000).
- UINT32: Phasor Ib (scaled to 1000).
- UINT32: Phasor Ic (scaled to 1000).
- UINT32: Line Frequency (scaled to 1000).
- UINT32: Phasor Ig (scaled to 1000).
- UINT32: Phasor Isg (scaled to 1000).
- UINT32: Zero seq I0 (scaled to 1000).
- UINT32: Positive seq I1 (scaled to 1000).
- UINT32: Negative seq I2 (scaled to 1000).
- UINT32: Phasor Van (scaled to 1000).
- UINT32: Phasor Vbn (scaled to 1000).
- UINT32: Phasor Vcn (scaled to 1000).
- UINT32: Positive Seq V1 (scaled to 1000).
- UINT32: Negative Seq V2 (scaled to 1000).
- UINT32: Zero Seq V0 (scaled to 1000).
- UINT32: 3 Phase Power Factor (scaled to 1000).

Example:

1st step:

[0xFE 0x10 0xFE 0x00 0x00 0x06 0x0C 0x4E 0x45 0x57 0x5F 0x45 0x56 0x45 0x2E 0x54 0x58 0x54 0x00 0x16 0xB0] **---------> RELAY**

PC <--------- [0xFE 0x10 0xFE 0x00 0x00 0x06 0x65 0xEC]

2nd step:

[0xFE 0x03 0xFF 0x00 0x00 0x7D 0xA1 0xF0] **--------> RELAY**

The relay responds with "SLAVE DEVICE BUSY":

PC <--------- 0xFE 0x83 0x06 0xF1 0x02]

The request is repeated:

[0xFE 0x03 0xFF 0x00 0x00 0x7D 0xA1 0xF0] **--------> RELAY**

Now the relay sends the events format:

[A] Position within file (Unsigned 32 bits)

[B] Block size (Unsigned 16 bits)

PC ←--------- [0xFE 0x03 0xFA 0x00 0x00 0x00 0x00 0x00 0xF4 0x46 0x4F 0x52 0x4D 0x41

.............[A].............. .....[B]...... F O R M A

0x54 0x2C 0x45 0x56 0x45 0x4E 0x54 0x5F 0x46 0x36 0x35 0x30 0x5F 0x56 0x30

T , E V E N T _ F 6 5 0 _ V 0

0x30 0x2C 0x45 0x76 0x65 0x6E 0x74 0x20 0x4E 0x75 0x6D 0x2C 0x44 0x61 0x74

0 , E v e n t N u m , D a t

0x65 0x2F 0x54 0x69 0x6D 0x65 0x3C 0x48 0x65 0x78 0x3E 0x2C 0x43 0x61 0x75

e / T i m e . . . etc . . .

0x73 0x65 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x49 0x61 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x49 0x62 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x49 0x63 0x2C 0x4C 0x69 0x6E 0x65 0x20 0x46 0x72 0x65 0x71 0x75 0x65 0x6E 0x63 0x79 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x49 0x67 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x49 0x73 0x67 0x2C 0x5A 0x65 0x72 0x6F 0x20 0x73 0x65 0x71 0x20 0x49 0x30 0x2C 0x50 0x6F 0x73 0x69 0x74 0x69 0x76 0x65 0x20 0x53 0x65 0x71 0x20 0x49 0x31 0x2C 0x4E 0x65 0x67 0x61 0x74 0x69 0x76 0x65 0x20 0x53 0x65 0x71 0x20 0x49 0x32 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x56 0x61 0x6E 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x56 0x62 0x6E 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x56 0x63 0x6E 0x2C 0x50 0x6F 0x73 0x69 0x74 0x69 0x76 0x65 0x20 0x53 0x65 0x71 0x20 0x56 0x31 0x2C 0x4E 0x65 0x67 0x61 0x74 0x69 0x76 0x65 0x20 0x53 0x65 0x71 0x20 0x56 0x32 0x2C 0x5A 0x65 0x72 0x6F 0x20 0x53 0x65 0x71 0x20 0x56 0x30 0x2C 0x33 0x20 0x50 0x68 0x4C 0xF3]

[0xFE 0x03 0xFF 0x00 0x00 0x7D 0xA1 0xF0] **---------> RELAY**

PC <--------- [0xFE 0x03 0xFA 0x00 0x00 0x00 0xF4 0x00 0xF4 0x61 0x73 0x65 0x20 0x50 0x6F

0x77 0x65 0x72 0x20 0x46 0x61 0x63 0x74 0x6F 0x72 0x0D 0x0A

CR LF (here the format ends)

0x45 0x56 0x45 0x4E 0x54 0x5F 0x46 0x36 0x35 0x30 0x5F 0x56 0x30 0x30 0x2C 0x35 0x36 0x35

E V E N T _ F 6 5 0 _ V 0 0 , 5 6 5

0 x37 0x2C 0x30 0x30 0x30 0x30 0x30 0x30 0x31 0x36 0x66 0x63 0x39 0x38 0x66

7 , 0 0 0 0 0 0 1 6 f 3 9 8 f

0x34 0x33 0x39 0x2C 0x4C 0x6F 0x63 0x61 0x6C 0x20 0x6D 0x6F 0x64 0x65 0x2C

4 3 9 , l o c a l m o d e ,

0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30

....

0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x32 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x32 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x31 0x2E 0x30 0x30 0x30 0x0D 0x0A

CR LF (a line ends)

0x45 0x56 0x45 0x4E 0x54 0x5F 0x46 0x36 0x35 0x30 0x5F 0x56 0x30 0x30 0x2C 0x35 0x36 0x35 0x38 0x2C 0x30 0x30 0x30 0x30 0x30 0x30 0x31 0x36 0x66 0x63 0x39 0x38 0x66 0x34 0x33 0x39 0x2C 0x28 0x31 0x29 0x56 0x69 0x72 0x74 0x75 0x61 0x6C 0x20 0x4F 0x75 0x74 0x38 0x39 0x36 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x34 0x24]

[0xFE 0x03 0xFF 0x00 0x00 0x7D 0xA1 0xF0] **---------> RELAY**

PC <---------[0xFE 0x03 0xFA 0x00 0x00 0x01 0xE8 0x00 0x47 0x30 0x0047 **=> last string**

0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x32 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x32 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x31 0x2E 0x30 0x30 0x30 0x0D 0x0A

CR LF (a line ends)

0x00 0x00 0x30 0x0D 0x0A 0x45 0x56 0x45 0x4E 0x54 0x5F 0x46 0x36 0x35 0x30 0x5F 0x56 0x30 0x30 0x2C 0x33 0x30 0x39 0x38 0x2C 0x30 0x30 0x30 0x30 0x30 0x30 0x31 0x36 0x65 0x62 0x61 0x33 0x33 0x62 0x62 0x38 0x2C 0x43 0x6F 0x6E 0x74 0x61 0x63 0x74 0x20 0x4F 0x75 0x74 0x70 0x75 0x74 0x5F 0x30 0x30 0x5F 0x30 0x30 0x20 0x4F 0x4E 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x32 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x31 0x2E 0x30 0x30 0x30 0x0D 0x0A 0x45 0x56 0x45 0x4E 0x54 0x5F 0x46 0x36 0x35 0x30 0xDB 0xB4]

B.4.4 Operations

To execute an operation, write the bit corresponding to that operation. For this purpose, there are two memory records with bits representing operations. These records are 0xAFFE and 0xAFFF.

Each operation is assigned one bit in the register:

Operation 1: bit 0 'Oxaffe'

Operation 2: bit 1'0xaffe'

...

Operation 16: bit 15'0xaffe'

Operation 17: bit 0'0xafff'

...

Operation 24: bit 7'0xafff'

The register format is Big Endian; this means that the first byte arriving is the one with more weight. Operations commands are affected depending on the physical communication channel they use: serial port, ethernet ports, mmi, etc.

Refer to section 4.2.3.2 Command push button on page 4–33.

The operations channels are:

0 - MMI

1 - OPER REMOTE

2 - COM 1- COMMUNICATION

3 - COM 2- COMMUNICATION

4 - RED 1- COMMUNICATION

5 - RED 2- COMMUNICATION

6 - RED 3- COMMUNICATION

7 - RED 4- COMMUNICATION

Example, operation 1 is going to perform:

[0xFE 0x10 0xAF 0xFE 0x00 0x01 0x02 0x00 0x01 0x68 0xB0] **---------> RELAY**

PC <--------- [0xFE 0x10 0xAF 0xFE 0x00 0x01 0x55 0x22] **(ACK (acknowledge) the operation)**

B.4.5 Force outputs of IO boards

To ease and test IO boards' outputs physical wiring, each IO boards' contact outputs can be forced to actuate with this MODBUS command. Proceed as with a file access (open, write, and close).

For example, to write to a mixed board (16 inputs and 8 outputs):

1 - OPEN OUTPUT FILE: write to 0xFE20, 3 registers with the name **OUTPUT**

2 - WRITE TO FILE: write to 0xFF20, 5 REGISTERS, the first one is the board slot (F=0, G=1, H=2, J=3 and so on) and the restraint ones are the bytes of bits (bits are grouped byte to byte).

3 - CLOSE OUTPUT FILE: write msg to 0xFE 28 of 3 registers with the name **OUTPUT**

Example, activate the two lower relays to board '0':

1 Open:

[0xFE 0x10 0xFE 0x20 0x00 0x03 0x06 0x4F 0x55 0x54 0x50 0x55 0x54 0xA8 0x42] **---------> RELAY**

O U T P U T

PC <---------[0xFE 0x10 0xFE 0x20 0x00 0x03 0xA4 0x25]

2 Write:

[0xFE 0x10 0xFF 0x20 0x00 0x05 0x0A 0x00 0x00 0x03 0x00 0x00 0x00 0x00 0x00 0x00 0x00

0x0000 0x03

0xAE 0x8D] **---------> RELAY**

PC <--------- [0xFE 0x10 0xFF 0x20 0x00 0x05 0x25 0xDB]

3 Close:

[0xFE 0x10 0xFE 0x28 0x00 0x03 0x06 0x4F 0x55 0x54 0x50 0x55 0x54 0x29 0xA8] ---------> RELAY

PC <--------- [0xFE 0x10 0xFE 0x28 0x00 0x03 0x25 0xE7]

B.4.6 Control events

This section explains control events, not to be confused with the snapshot events. A control event is the value change from 0 to 1 or from 1 to 0 of one bit, and is associated with a time label showing when the change occurred.

In the R650, any status or combination of status may generate an event. The R650 has **192 control events** available. The first **128 control events** are user-configurable through a table from the EnerVista 650 Setup menu: **Setpoint > Relay configuration**. The remaining **64 control events** are associated with the 16 possible switchgear, each one generating 4 status bits:

- Open (52B ON, 52A OFF)

- Close (52A ON, 52B OFF)

- Error 00 (52A&52B OFF)

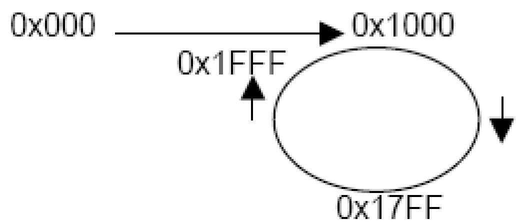
- Error 11 (52A&52B ON)

Internally the events buffer is a circular FIFO of 255 events. The addresses for managing this FIFO are:

- 0x03FF:	Number of the next event
- 0xFCFF:	Access to the oldest event
- 0xFD00 to 0xFDFF:	Access to any stored event (circular queue)

The address **0x03FF** stores the number of the next event. For example, if the number 7677 is stored, the last event stored is number 7676. This value is initially 0, and it is increases from 0 to 2^12 + 1 carry bit as events are generated.

The carry bit indicates whether the R650 has been started, since when the relay starts, whether due to lack of power supply or a configuration change, the carry bit is set to 0. When events are generated, the event number is increased up to a maximum value of 0x1FFF; in the next event the number is 0x1000, thus the carry bit is always 1, until the R650 is restarted. This is shown in the following figure:



B.4.6.1 Event structure

Each event has 14 bytes, with the following format:

- Short (2 bytes): event number (0 - 2^12 + carry bit)
- Short (2 bytes): event bit number (from 0 to 191).
- Short (2 bytes): the 0 bit indicates the event value (0 or 1) and the 15 bit indicates whether this is a valid event (all events are initially set to 0)
- Double unsigned (8 bytes): milliseconds from 1 January 2000

The 0xFCFF address is useful when reading all the available events in the R650, as is done following a master start up.

WARNING! Unlike a standard ModBus address, these addresses consist of 14 bytes each one, instead of the 2 used in ModBus. This way, each event, which has a structure of 14 bytes, is contained in one address, as shown on the table below:

0xFD00	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte
…………														
0xFDFF	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte

For example, the events buffer could contain the following information:

Event Number	7424	7425	……….	7675	7676	7421	7422	7423
Address	0xFD00	0xFD01		0xFDFB	0xFDFC	0xFDFD	0xFDFE	0xFDFF

105 registers: 15 events * 7 registers.

NOTE: In this example the 0x03FF address has event number 7677 because 7676 was the last event number used.

B.4.6.2 Event collection process

ALL EVENTS

Whe n reading all events, there are two possible approaches:

First option: start from the oldest event, in address 0xFCFF, and read the events 15 by 15. The initial request frame sent to the relay is as follows:

Within this frame the buffer pointer is set to the oldest event, or number 7421 in the example. 15 events are returned, ending with number 7435.

In order to read the following 15 events, numbered from 7436 to 7450, calculate the initial address and send another request frame:

Hex(7436)=	0x1D0C
0x1D0C AND 0x00FF=	0xOC
0xFD00+0x0C=	0xFD0C: **initial address**

[0xFE 0x03 **0xFD 0x0C** 0x00 0x69 0x60 0x44] **---------> RELAY**

Either continue until the relay responds with a 0 event, or stop at the last recorded event by reading the number of the next upcoming event from address 0x03FF and comparing against the last event read.

Second option: read the circular event queue directly, from address 0xFD00 to 0xFDFF, and then rearrange the retrieved events by event number.

Once all events have been read, subsequent queries should only request new events.

NEW EVENTS

The 0x03FF address contains the number of the next event to be written. Based on this, the number of events recorded since the last query can be determined.For example, if the relay indicates that the next event to be generated is number 7677 and events up to number 7674 have already been read, there are two new events. A frame must be sent to read the two new events, 7675 and 7676, and the corresponding 28 bytes.

Circular queue

Event Number	7424	7425	....	7675	7676	7421	7422	7423
Address	0xFD00	0xFD01		0xFDFB	0xFDFC	0xFDFD	0xFDFE	0xFDFF

NOTE: In this example the 0x03FF address has event number 7677 because 7676 was the last event number used.

Hex(7675)=0x1DFB

0x1DFB AND 0xFF=0xFB

0xFD00+0xFB=0xFDFB: **reading address (*)**

[0xFE 0x03 **0xFD 0xFB 0x00 0x0E** 0x90 0x5C] **---------> RELAY**

B.4.6.3 Control events from the command line

Starting EnerVista 650 Setup from the command line allows the transfer of control events to a file. For this purpose, we need to indicate the event number from which event controls are to be retrieved, and the file where they are to be stored.

Communication can be established via serial communication by specifying the port and access baud rate, or via Ethernet through the IP address and communication port. The relay number from which events are to be retrieved must also be indicated.

For executing this Operation, 6 parameters must be written, for both cases, serial communication or Ethernet.

SERIAL COMUNICATION

EnerVista 650 Setup –e event number " File name" –com port: baud_rate relay_number

E.g.: EnerVista 650 Setup –e 6 "C:\GE Power Management\EnerVista 650 Setup\files\Events\eventos.txt" –com 1:19200 254

ETHERNET COMMUNICATION

EnerVista 650 Setup –e event number " File name" –ip "IP address": port relay_number

E.g.: EnerVista 650 Setup –e 6 "C:\GE Power Management\EnerVista 650 Setup\files\Events \eventos.txt" –ip 192.168.37.240:502 254

The created file format looks as follows:

#Event Number, Event Id,Event Text,Event Data Time,Event Value(0,1)#

6,1,Local,09-Sep-2003 17:42:40.782,1

7,1,Local,09-Sep-2003 17:42:43.236,0

8,2,Remote,09-Sep-2003 17:42:43.236,1

B.4.6.4 Event status request (alarms)

To retrieve events that have been configured as alarms, see the following addresses:

0xF000: 24 registers, the first 12 indicate the status active/inactive and the last 12 indicate the status of acknowledged/not acknowledged.

0xF018: 12 event alarm status (active - not active, acknowledged – not acknowledged) registers.

0xF024: date and hour of the event bits starts (groups of 16 dates and hour must be asked for).

To obtain an instantaneous snapshot of all events and alarms states, do the following:

1. Read the head of events FIFO (0x03FF).
2. Read the addresses above.
3. Finally, read the head again to confirm that it has not changed. If it had changed, restart the procedure.

NOTE: The message must request the address and the quantity of bytes indicated in each zone. If another quantity is needed, it will not respond with the requested data.

B.4.6.5 Acknowledging alarms

For acknowledging the alarms we must simply write message to the 0xf324 address with 12 data registers. Each bit means an event, if we want to acknowledge an alarm, its corresponding bit must be set to '1' (in order within the 192 bits).

NOTE: it must be borne in mind the independence of the acknowledgement condition, for its reading and its change, depending on the communication channel

There are 6 channels:

LOCAL: by MMI or COM-2 (front and rear accessible).

REMOTE: by COM-1

NET 1: nowadays by any net communication

NET 2: (it does not exist in version 1.4x and lower)

NET 3: (it does not exist in version 1.4x and lower)

NET 4: (it does not exist in version 1.4x and lower)

B.4.7 Write virtual inputs

For forcing Virtual Inputs, a message with 4 indivisible records must be written at address 0xF430, so that each bit corresponds to a Virtual Input. Values are not correct if the first 4 records are not written in the same message. The first 32 are LATCHED (internally stored in flash memory), and the last 32 are SELF-RST (activated to 1 and deactivated in the next pass by the PLC).

For reading the status of Virtual Inputs, it is necessary to start with address 0x0083(bit 0x004) up to 0x0087 (bit 0x0200).

B.4.8 User map

R650 units incorporate a powerful feature called ModBus User Map, that allows to read 256 non-consecutive data records (settings and statuses). It is often required for a master computer to interrogate repeatedly several connected slave relays. If those values are dispersed along the memory map, reading them may require several petitions, and this may cause a communications overload. The User Map can be programmed to get several memory addresses together in a block of consecutive addresses of the User Map, so that they can be accessible with a single reading operation.

The User Map has two sections:

A record index area (addresses 0x3384 to 0x3483), containing 256 statuses and/or setting record addresses.

A record area (addresses 0xF330 to 0xF42F), containing the values for addresses indicated in the index area.

Data records that are separated in the rest of the memory map can be remapped to an address of an adjacent record in the User Map area. For programming the map this way, addresses for the required records must be written in the index area. This avoids the need for several reading operations, thus improving data transmission yield.

For instance, if Contact Outputs from Board F (address 0x008B) and Board G (address 0x00B0) values are required, these addresses must be mapped as follows:

In address 0x3384, write 0x008B.

In address 0x3385 XXX write 0x00B0.

The reading of records 0xF330 and 0xF331, applying the corresponding bit masks, provides the required information about the two boards Contact Outputs.

NOTE: Only single data can be set in the map, i.e. data that are in the memory map and can be read. This feature is not valid for events, waveform records, etc. that are not located in a map address.

B.4.9 Time synchronization

Time synchronization consists of setting the relay date and time.

This is similar to other settings group entries, with some unique characteristics:

- The data type is specific to time.

- Once the data is changed, varies with time, it is a changing setting that can be read.
- It shares the time change with IRIG-B (this has more priority) and with a possible modification from MMI or another protocols.
- When the relay is disconnected from its auxiliary power supply for extended periods (days) the time remains in a chip, fed by a capacitor (it does not need maintenance).
- And last, there are synchronism between the real time chip and the microprocessor time.

Time synchronization is made by a reading message over 0xfff0 address, either with the address of a single relay, if a writing confirmation is desired, or in broadcast, to synchronize several relays simultaneously.

Date/time format is stored in 4 MODBUS registers (8 bytes, Big Endian format), which indicates elapsed milliseconds from the 1st of January 2000 at 00:00:00.000.

Reading example:

[0xFE 0x03 0xFF 0xF0 0x00 0x04 0x60 0x21] **---------> RELAY**

PC <---------- [0xFE 0x03 0x08 0x00 0x00 0x00 0x17 0x05 0xFA 0xD5 0xBA 0x2D 0x1D]

Synchronism example:

[0xFE 0x10 0xFF 0xF0 0x00 0x04 0x08 0x00 0x00 0x00 0x17 0x9B 0x53 0x3F 0x60 0xA4 0x2B] **---------> RELAY**

PC <---------- [0xFE 0x10 0xFF 0xF0 0x00 0x04 0xE5 0xE2]

B.4.10 Queueing messages

In ModBus protocol, as in other protocols, exists an internal procedure in message reception and transmission.

When a relay gets a string, determined by a silence of 3 or 4 characters, it is queued in a FIFO queue, for a later processing in its own protocol. When the protocol is free of execution, it searches in the queue for strings to respond of the FIFO. If there is such string, it processes it and then it is responded.

Several criteria have been adopted for real time operation:

- Each reading or writing is answered as soon as possible.
- This implies that when settings are changed and answered, a writing request recognition is indicated and then, the modification of internal settings is performed, and finally, after confirmation is sent, settings are stored in a non-volatile memory device.

NOTE: As the relay is internally a modular system, it is possible that the response of some processes is slower than what is expected by the external program, considering the message as missed and sending again another request. If so, there will be 2 queued messages and therefore, 2 message responses. For this reason, response message 'ACK' must be verified with its request, and special attention must be paid to setting confirmation writings, especially with reference to time-out. EnerVista 650 Setup software is recommended to do the configuration modifications, as this software takes into account all these details.

B.4.11 Traces and troubleshooting

The tracer is a debugging tool to view the strings in any writing or reading process in ModBus. This tracer is activated in the menu from EnerVista 650 Setup: **View, Traces**.

With this option enabled, request and response strings are shown. If, for instance, the request and response strings view is desired, between R650 and the relay, do the following:

1 - Activate traces, from **View > Traces**, and a new window opens at the bottom of the main window.

2 - Open the general settings menu: **Setpoint > System Setup > General Settings**

The screen displays the group settings, and on the left side bottom the relay read request is shown:

<0001><06/18/03 12:14:15>[0xFE 0x03 0x21 0x8A 0x00 0x16 0xFB 0xDD]

On the right the settings response is shown:

0001><06/18/03 12:14:15>[0xFE 0x03 0x2C 0x3F 0x80 0x00 0x00 0x3F 0x80 0x00 0x00 0x3F 0x80 0x00 0x00 0x3F 0x80 0x00 0x00 0x00 0x00 0x42 0xC8 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x01 0x00 0xFE 0x00 0xFE 0x00 0x06 0x00 0x06 0x00 0x00 0x01 0xF6 0xAC 0xB5]

This way, any request or mechanism to obtain information from the relay can be viewed string by string.

There is another tool for tracing the relay memory: in the EnerVista 650 Setup menu: **Communication > Troubleshooting**, any read of any address can be requested, and the PC forms the request string together with the check-sum register.

B.4.12 MODBUS CRC generation function

This section describes the C programming language implementation to calculate the CRC of the message string check in ModBus, in a Big-Endian format.

The implemented function in the R650 called here fn_035c_cr16 returns an unsigned 16 bit type (2 bytes) with the CRC of the message defined in the function parameters as:

p = pointer to the MODBUS message string to calculate the CRC

us = length in bytes of the MODBUS message (header + data) minus 2 bytes (the CRC of the message itself)

USHORT fn_035c_cr16(UCHAR *p, UNSIGNED us)

```
{
const UCHAR hi[] = {
0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,
0X80,0X41,0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,
0X0,0Xc1,0X81,0X40,0X0,0Xc1,0X81,0X40,0X1,0Xc0,
0X80,0X41,0X1,0Xc0,0X80,0X41,0X0,0Xc1,0X81,0X40,
0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X0,0Xc1,
0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,0X80,0X41,
0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X0,0Xc1,
0X81,0X40,0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,
0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,
0X80,0X41,0X0,0Xc1,0X81,0X40,0X0,0Xc1,0X81,0X40,
0X1,0Xc0,0X80,0X41,0X1,0Xc0,0X80,0X41,0X0,0Xc1,
```

```
0X81,0X40,0X1,0Xc0,0X80,0X41,0X0,0Xc1,0X81,0X40,
0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,
0X80,0X41,0X0,0Xc1,0X81,0X40,0X0,0Xc1,0X81,0X40,
0X1,0Xc0,0X80,0X41,0X0,0Xc1,0X81,0X40,0X1,0Xc0,
0X80,0X41,0X1,0Xc0,0X80,0X41,0X0,0Xc1,0X81,0X40,
0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,
0X80,0X41,0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,
0X0,0Xc1,0X81,0X40,0X0,0Xc1,0X81,0X40,0X1,0Xc0,
0X80,0X41,0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,
0X1,0Xc0,0X80,0X41,0X0,0Xc1,0X81,0X40,0X1,0Xc0,
0X80,0X41,0X0,0Xc1,0X81,0X40,0X0,0Xc1,0X81,0X40,
0X1,0Xc0,0X80,0X41,0X1,0Xc0,0X80,0X41,0X0,0Xc1,
0X81,0X40,0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,
0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,
0X80,0X41,0X0,0Xc1,0X81,0X40};

const UCHAR lo[] = {
0X0,0Xc0,0Xc1,0X1,0Xc3,0X3,0X2,0Xc2,0Xc6,0X6,
0X7,0Xc7,0X5,0Xc5,0Xc4,0X4,0Xcc,0Xc,0Xd,0Xcd,
0Xf,0Xcf,0Xce,0Xe,0Xa,0Xca,0Xcb,0Xb,0Xc9,0X9,
0X8,0Xc8,0Xd8,0X18,0X19,0Xd9,0X1b,0Xdb,0Xda,0X1a,
0X1e,0Xde,0Xdf,0X1f,0Xdd,0X1d,0X1c,0Xdc,0X14,0Xd4,
0Xd5,0X15,0Xd7,0X17,0X16,0Xd6,0Xd2,0X12,0X13,0Xd3,
0X11,0Xd1,0Xd0,0X10,0Xf0,0X30,0X31,0Xf1,0X33,0Xf3,
0Xf2,0X32,0X36,0Xf6,0Xf7,0X37,0Xf5,0X35,0X34,0Xf4,
0X3c,0Xfc,0Xfd,0X3d,0Xff,0X3f,0X3e,0Xfe,0Xfa,0X3a,
0X3b,0Xfb,0X39,0Xf9,0Xf8,0X38,0X28,0Xe8,0Xe9,0X29,
0Xeb,0X2b,0X2a,0Xea,0Xee,0X2e,0X2f,0Xef,0X2d,0Xed,
0Xec,0X2c,0Xe4,0X24,0X25,0Xe5,0X27,0Xe7,0Xe6,0X26,
0X22,0Xe2,0Xe3,0X23,0Xe1,0X21,0X20,0Xe0,0Xa0,0X60,
0X61,0Xa1,0X63,0Xa3,0Xa2,0X62,0X66,0Xa6,0Xa7,0X67,
0Xa5,0X65,0X64,0Xa4,0X6c,0Xac,0Xad,0X6d,0Xaf,0X6f,
0X6e,0Xae,0Xaa,0X6a,0X6b,0Xab,0X69,0Xa9,0Xa8,0X68,
0X78,0Xb8,0Xb9,0X79,0Xbb,0X7b,0X7a,0Xba,0Xbe,0X7e,
0X7f,0Xbf,0X7d,0Xbd,0Xbc,0X7c,0Xb4,0X74,0X75,0Xb5,
0X77,0Xb7,0Xb6,0X76,0X72,0Xb2,0Xb3,0X73,0Xb1,0X71,
0X70,0Xb0,0X50,0X90,0X91,0X51,0X93,0X53,0X52,0X92,
0X96,0X56,0X57,0X97,0X55,0X95,0X94,0X54,0X9c,0X5c,
0X5d,0X9d,0X5f,0X9f,0X9e,0X5e,0X5a,0X9a,0X9b,0X5b,
0X99,0X59,0X58,0X98,0X88,0X48,0X49,0X89,0X4b,0X8b,
0X8a,0X4a,0X4e,0X8e,0X8f,0X4f,0X8d,0X4d,0X4c,0X8c,
0X44,0X84,0X85,0X45,0X87,0X47,0X46,0X86,0X82,0X42,
```

```
0X43,0X83,0X41,0X81,0X80,0X40 };

    UCHAR chi;
    UCHAR clo;
    USHORT ui;

    chi = 0xff;
    clo = 0xff;
    while(us--)
    {   ui = chi ^ *p++;
    chi = clo ^ hi[ui];
    clo = lo[ui];
    }
    ui = chi;
    ui = ui << 8;
    ui = ui | clo;      // Big-Endian format

    return(ui);
}
```

If it is Little-Endian format the returned bytes must be interchanged: each unsigned 16 bit type's bytes need to be swapped.

B.5 Memory map

The Memory map can be obtained from EnerVista 650 Setup software, menu:

View > ModBus Memory map

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0003	0x0100	34	TIMER STATUS	F001		R	1	
0x0003	0x0200	11707	Self-Test Memory OK	F001		R	1	
0x0005	0x0400	100	VIRTUAL OUTPUT 000	F001		R	1	
0x0005	0x0800	101	VIRTUAL OUTPUT 001	F001		R	1	
0x0005	0x1000	102	VIRTUAL OUTPUT 002	F001		R	1	
0x0005	0x2000	103	VIRTUAL OUTPUT 003	F001		R	1	
0x0005	0x4000	104	VIRTUAL OUTPUT 004	F001		R	1	
0x0005	0x8000	105	VIRTUAL OUTPUT 005	F001		R	1	
0x0005	0x0001	106	VIRTUAL OUTPUT 006	F001		R	1	
0x0005	0x0002	107	VIRTUAL OUTPUT 007	F001		R	1	
0x0005	0x0004	108	VIRTUAL OUTPUT 008	F001		R	1	
0x0005	0x0008	109	VIRTUAL OUTPUT 009	F001		R	1	
0x0005	0x0010	110	VIRTUAL OUTPUT 010	F001		R	1	
0x0005	0x0020	111	VIRTUAL OUTPUT 011	F001		R	1	
0x0005	0x0040	112	VIRTUAL OUTPUT 012	F001		R	1	
0x0005	0x0080	113	VIRTUAL OUTPUT 013	F001		R	1	
0x0006	0x0100	114	VIRTUAL OUTPUT 014	F001		R	1	
0x0006	0x0200	115	VIRTUAL OUTPUT 015	F001		R	1	
0x0006	0x0400	116	VIRTUAL OUTPUT 016	F001		R	1	
0x0006	0x0800	117	VIRTUAL OUTPUT 017	F001		R	1	
0x0006	0x1000	118	VIRTUAL OUTPUT 018	F001		R	1	
0x0006	0x2000	119	VIRTUAL OUTPUT 019	F001		R	1	
0x0006	0x4000	120	VIRTUAL OUTPUT 020	F001		R	1	
0x0006	0x8000	121	VIRTUAL OUTPUT 021	F001		R	1	
0x0006	0x0001	122	VIRTUAL OUTPUT 022	F001		R	1	
0x0006	0x0002	123	VIRTUAL OUTPUT 023	F001		R	1	
0x0006	0x0004	124	VIRTUAL OUTPUT 024	F001		R	1	
0x0006	0x0008	125	VIRTUAL OUTPUT 025	F001		R	1	
0x0006	0x0010	126	VIRTUAL OUTPUT 026	F001		R	1	
0x0006	0x0020	127	VIRTUAL OUTPUT 027	F001		R	1	
0x0006	0x0040	128	VIRTUAL OUTPUT 028	F001		R	1	
0x0006	0x0080	129	VIRTUAL OUTPUT 029	F001		R	1	
0x0007	0x0100	130	VIRTUAL OUTPUT 030	F001		R	1	
0x0007	0x0200	131	VIRTUAL OUTPUT 031	F001		R	1	
0x0007	0x0400	132	VIRTUAL OUTPUT 032	F001		R	1	
0x0007	0x0800	133	VIRTUAL OUTPUT 033	F001		R	1	
0x0007	0x1000	134	VIRTUAL OUTPUT 034	F001		R	1	
0x0007	0x2000	135	VIRTUAL OUTPUT 035	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0007	0x4000	136	VIRTUAL OUTPUT 036	F001		R	1	
0x0007	0x8000	137	VIRTUAL OUTPUT 037	F001		R	1	
0x0007	0x0001	138	VIRTUAL OUTPUT 038	F001		R	1	
0x0007	0x0002	139	VIRTUAL OUTPUT 039	F001		R	1	
0x0007	0x0004	140	VIRTUAL OUTPUT 040	F001		R	1	
0x0007	0x0008	141	VIRTUAL OUTPUT 041	F001		R	1	
0x0007	0x0010	142	VIRTUAL OUTPUT 042	F001		R	1	
0x0007	0x0020	143	VIRTUAL OUTPUT 043	F001		R	1	
0x0007	0x0040	144	VIRTUAL OUTPUT 044	F001		R	1	
0x0007	0x0080	145	VIRTUAL OUTPUT 045	F001		R	1	
0x0008	0x0100	146	VIRTUAL OUTPUT 046	F001		R	1	
0x0008	0x0200	147	VIRTUAL OUTPUT 047	F001		R	1	
0x0008	0x0400	148	VIRTUAL OUTPUT 048	F001		R	1	
0x0008	0x0800	149	VIRTUAL OUTPUT 049	F001		R	1	
0x0008	0x1000	150	VIRTUAL OUTPUT 050	F001		R	1	
0x0008	0x2000	151	VIRTUAL OUTPUT 051	F001		R	1	
0x0008	0x4000	152	VIRTUAL OUTPUT 052	F001		R	1	
0x0008	0x8000	153	VIRTUAL OUTPUT 053	F001		R	1	
0x0008	0x0001	154	VIRTUAL OUTPUT 054	F001		R	1	
0x0008	0x0002	155	VIRTUAL OUTPUT 055	F001		R	1	
0x0008	0x0004	156	VIRTUAL OUTPUT 056	F001		R	1	
0x0008	0x0008	157	VIRTUAL OUTPUT 057	F001		R	1	
0x0008	0x0010	158	VIRTUAL OUTPUT 058	F001		R	1	
0x0008	0x0020	159	VIRTUAL OUTPUT 059	F001		R	1	
0x0008	0x0040	160	VIRTUAL OUTPUT 060	F001		R	1	
0x0008	0x0080	161	VIRTUAL OUTPUT 061	F001		R	1	
0x0009	0x0100	162	VIRTUAL OUTPUT 062	F001		R	1	
0x0009	0x0200	163	VIRTUAL OUTPUT 063	F001		R	1	
0x0009	0x0400	164	VIRTUAL OUTPUT 064	F001		R	1	
0x0009	0x0800	165	VIRTUAL OUTPUT 065	F001		R	1	
0x0009	0x1000	166	VIRTUAL OUTPUT 066	F001		R	1	
0x0009	0x2000	167	VIRTUAL OUTPUT 067	F001		R	1	
0x0009	0x4000	168	VIRTUAL OUTPUT 068	F001		R	1	
0x0009	0x8000	169	VIRTUAL OUTPUT 069	F001		R	1	
0x0009	0x0001	170	VIRTUAL OUTPUT 070	F001		R	1	
0x0009	0x0002	171	VIRTUAL OUTPUT 071	F001		R	1	
0x0009	0x0004	172	VIRTUAL OUTPUT 072	F001		R	1	
0x0009	0x0008	173	VIRTUAL OUTPUT 073	F001		R	1	
0x0009	0x0010	174	VIRTUAL OUTPUT 074	F001		R	1	
0x0009	0x0020	175	VIRTUAL OUTPUT 075	F001		R	1	
0x0009	0x0040	176	VIRTUAL OUTPUT 076	F001		R	1	
0x0009	0x0080	177	VIRTUAL OUTPUT 077	F001		R	1	
0x000A	0x0100	178	VIRTUAL OUTPUT 078	F001		R	1	
0x000A	0x0200	179	VIRTUAL OUTPUT 079	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x000A	0x0400	180	VIRTUAL OUTPUT 080	F001		R	1	
0x000A	0x0800	181	VIRTUAL OUTPUT 081	F001		R	1	
0x000A	0x1000	182	VIRTUAL OUTPUT 082	F001		R	1	
0x000A	0x2000	183	VIRTUAL OUTPUT 083	F001		R	1	
0x000A	0x4000	184	VIRTUAL OUTPUT 084	F001		R	1	
0x000A	0x8000	185	VIRTUAL OUTPUT 085	F001		R	1	
0x000A	0x0001	186	VIRTUAL OUTPUT 086	F001		R	1	
0x000A	0x0002	187	VIRTUAL OUTPUT 087	F001		R	1	
0x000A	0x0004	188	VIRTUAL OUTPUT 088	F001		R	1	
0x000A	0x0008	189	VIRTUAL OUTPUT 089	F001		R	1	
0x000A	0x0010	190	VIRTUAL OUTPUT 090	F001		R	1	
0x000A	0x0020	191	VIRTUAL OUTPUT 091	F001		R	1	
0x000A	0x0040	192	VIRTUAL OUTPUT 092	F001		R	1	
0x000A	0x0080	193	VIRTUAL OUTPUT 093	F001		R	1	
0x000B	0x0100	194	VIRTUAL OUTPUT 094	F001		R	1	
0x000B	0x0200	195	VIRTUAL OUTPUT 095	F001		R	1	
0x000B	0x0400	196	VIRTUAL OUTPUT 096	F001		R	1	
0x000B	0x0800	197	VIRTUAL OUTPUT 097	F001		R	1	
0x000B	0x1000	198	VIRTUAL OUTPUT 098	F001		R	1	
0x000B	0x2000	199	VIRTUAL OUTPUT 099	F001		R	1	
0x000B	0x4000	200	VIRTUAL OUTPUT 100	F001		R	1	
0x000B	0x8000	201	VIRTUAL OUTPUT 101	F001		R	1	
0x000B	0x0001	202	VIRTUAL OUTPUT 102	F001		R	1	
0x000B	0x0002	203	VIRTUAL OUTPUT 103	F001		R	1	
0x000B	0x0004	204	VIRTUAL OUTPUT 104	F001		R	1	
0x000B	0x0008	205	VIRTUAL OUTPUT 105	F001		R	1	
0x000B	0x0010	206	VIRTUAL OUTPUT 106	F001		R	1	
0x000B	0x0020	207	VIRTUAL OUTPUT 107	F001		R	1	
0x000B	0x0040	208	VIRTUAL OUTPUT 108	F001		R	1	
0x000B	0x0080	209	VIRTUAL OUTPUT 109	F001		R	1	
0x000C	0x0100	210	VIRTUAL OUTPUT 110	F001		R	1	
0x000C	0x0200	211	VIRTUAL OUTPUT 111	F001		R	1	
0x000C	0x0400	212	VIRTUAL OUTPUT 112	F001		R	1	
0x000C	0x0800	213	VIRTUAL OUTPUT 113	F001		R	1	
0x000C	0x1000	214	VIRTUAL OUTPUT 114	F001		R	1	
0x000C	0x2000	215	VIRTUAL OUTPUT 115	F001		R	1	
0x000C	0x4000	216	VIRTUAL OUTPUT 116	F001		R	1	
0x000C	0x8000	217	VIRTUAL OUTPUT 117	F001		R	1	
0x000C	0x0001	218	VIRTUAL OUTPUT 118	F001		R	1	
0x000C	0x0002	219	VIRTUAL OUTPUT 119	F001		R	1	
0x000C	0x0004	220	VIRTUAL OUTPUT 120	F001		R	1	
0x000C	0x0008	221	VIRTUAL OUTPUT 121	F001		R	1	
0x000C	0x0010	222	VIRTUAL OUTPUT 122	F001		R	1	
0x000C	0x0020	223	VIRTUAL OUTPUT 123	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x000C	0x0040	224	VIRTUAL OUTPUT 124	F001		R	1	
0x000C	0x0080	225	VIRTUAL OUTPUT 125	F001		R	1	
0x000D	0x0100	226	VIRTUAL OUTPUT 126	F001		R	1	
0x000D	0x0200	227	VIRTUAL OUTPUT 127	F001		R	1	
0x000D	0x0400	228	VIRTUAL OUTPUT 128	F001		R	1	
0x000D	0x0800	229	VIRTUAL OUTPUT 129	F001		R	1	
0x000D	0x1000	230	VIRTUAL OUTPUT 130	F001		R	1	
0x000D	0x2000	231	VIRTUAL OUTPUT 131	F001		R	1	
0x000D	0x4000	232	VIRTUAL OUTPUT 132	F001		R	1	
0x000D	0x8000	233	VIRTUAL OUTPUT 133	F001		R	1	
0x000D	0x0001	234	VIRTUAL OUTPUT 134	F001		R	1	
0x000D	0x0002	235	VIRTUAL OUTPUT 135	F001		R	1	
0x000D	0x0004	236	VIRTUAL OUTPUT 136	F001		R	1	
0x000D	0x0008	237	VIRTUAL OUTPUT 137	F001		R	1	
0x000D	0x0010	238	VIRTUAL OUTPUT 138	F001		R	1	
0x000D	0x0020	239	VIRTUAL OUTPUT 139	F001		R	1	
0x000D	0x0040	240	VIRTUAL OUTPUT 140	F001		R	1	
0x000D	0x0080	241	VIRTUAL OUTPUT 141	F001		R	1	
0x000E	0x0100	242	VIRTUAL OUTPUT 142	F001		R	1	
0x000E	0x0200	243	VIRTUAL OUTPUT 143	F001		R	1	
0x000E	0x0400	244	VIRTUAL OUTPUT 144	F001		R	1	
0x000E	0x0800	245	VIRTUAL OUTPUT 145	F001		R	1	
0x000E	0x1000	246	VIRTUAL OUTPUT 146	F001		R	1	
0x000E	0x2000	247	VIRTUAL OUTPUT 147	F001		R	1	
0x000E	0x4000	248	VIRTUAL OUTPUT 148	F001		R	1	
0x000E	0x8000	249	VIRTUAL OUTPUT 149	F001		R	1	
0x000E	0x0001	250	VIRTUAL OUTPUT 150	F001		R	1	
0x000E	0x0002	251	VIRTUAL OUTPUT 151	F001		R	1	
0x000E	0x0004	252	VIRTUAL OUTPUT 152	F001		R	1	
0x000E	0x0008	253	VIRTUAL OUTPUT 153	F001		R	1	
0x000E	0x0010	254	VIRTUAL OUTPUT 154	F001		R	1	
0x000E	0x0020	255	VIRTUAL OUTPUT 155	F001		R	1	
0x000E	0x0040	256	VIRTUAL OUTPUT 156	F001		R	1	
0x000E	0x0080	257	VIRTUAL OUTPUT 157	F001		R	1	
0x000F	0x0100	258	VIRTUAL OUTPUT 158	F001		R	1	
0x000F	0x0200	259	VIRTUAL OUTPUT 159	F001		R	1	
0x000F	0x0400	260	VIRTUAL OUTPUT 160	F001		R	1	
0x000F	0x0800	261	VIRTUAL OUTPUT 161	F001		R	1	
0x000F	0x1000	262	VIRTUAL OUTPUT 162	F001		R	1	
0x000F	0x2000	263	VIRTUAL OUTPUT 163	F001		R	1	
0x000F	0x4000	264	VIRTUAL OUTPUT 164	F001		R	1	
0x000F	0x8000	265	VIRTUAL OUTPUT 165	F001		R	1	
0x000F	0x0001	266	VIRTUAL OUTPUT 166	F001		R	1	
0x000F	0x0002	267	VIRTUAL OUTPUT 167	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x000F	0x0004	268	VIRTUAL OUTPUT 168	F001		R	1	
0x000F	0x0008	269	VIRTUAL OUTPUT 169	F001		R	1	
0x000F	0x0010	270	VIRTUAL OUTPUT 170	F001		R	1	
0x000F	0x0020	271	VIRTUAL OUTPUT 171	F001		R	1	
0x000F	0x0040	272	VIRTUAL OUTPUT 172	F001		R	1	
0x000F	0x0080	273	VIRTUAL OUTPUT 173	F001		R	1	
0x0010	0x0100	274	VIRTUAL OUTPUT 174	F001		R	1	
0x0010	0x0200	275	VIRTUAL OUTPUT 175	F001		R	1	
0x0010	0x0400	276	VIRTUAL OUTPUT 176	F001		R	1	
0x0010	0x0800	277	VIRTUAL OUTPUT 177	F001		R	1	
0x0010	0x1000	278	VIRTUAL OUTPUT 178	F001		R	1	
0x0010	0x2000	279	VIRTUAL OUTPUT 179	F001		R	1	
0x0010	0x4000	280	VIRTUAL OUTPUT 180	F001		R	1	
0x0010	0x8000	281	VIRTUAL OUTPUT 181	F001		R	1	
0x0010	0x0001	282	VIRTUAL OUTPUT 182	F001		R	1	
0x0010	0x0002	283	VIRTUAL OUTPUT 183	F001		R	1	
0x0010	0x0004	284	VIRTUAL OUTPUT 184	F001		R	1	
0x0010	0x0008	285	VIRTUAL OUTPUT 185	F001		R	1	
0x0010	0x0010	286	VIRTUAL OUTPUT 186	F001		R	1	
0x0010	0x0020	287	VIRTUAL OUTPUT 187	F001		R	1	
0x0010	0x0040	288	VIRTUAL OUTPUT 188	F001		R	1	
0x0010	0x0080	289	VIRTUAL OUTPUT 189	F001		R	1	
0x0011	0x0100	290	VIRTUAL OUTPUT 190	F001		R	1	
0x0011	0x0200	291	VIRTUAL OUTPUT 191	F001		R	1	
0x0011	0x0400	292	VIRTUAL OUTPUT 192	F001		R	1	
0x0011	0x0800	293	VIRTUAL OUTPUT 193	F001		R	1	
0x0011	0x1000	294	VIRTUAL OUTPUT 194	F001		R	1	
0x0011	0x2000	295	VIRTUAL OUTPUT 195	F001		R	1	
0x0011	0x4000	296	VIRTUAL OUTPUT 196	F001		R	1	
0x0011	0x8000	297	VIRTUAL OUTPUT 197	F001		R	1	
0x0011	0x0001	298	VIRTUAL OUTPUT 198	F001		R	1	
0x0011	0x0002	299	VIRTUAL OUTPUT 199	F001		R	1	
0x0011	0x0004	300	VIRTUAL OUTPUT 200	F001		R	1	
0x0011	0x0008	301	VIRTUAL OUTPUT 201	F001		R	1	
0x0011	0x0010	302	VIRTUAL OUTPUT 202	F001		R	1	
0x0011	0x0020	303	VIRTUAL OUTPUT 203	F001		R	1	
0x0011	0x0040	304	VIRTUAL OUTPUT 204	F001		R	1	
0x0011	0x0080	305	VIRTUAL OUTPUT 205	F001		R	1	
0x0012	0x0100	306	VIRTUAL OUTPUT 206	F001		R	1	
0x0012	0x0200	307	VIRTUAL OUTPUT 207	F001		R	1	
0x0012	0x0400	308	VIRTUAL OUTPUT 208	F001		R	1	
0x0012	0x0800	309	VIRTUAL OUTPUT 209	F001		R	1	
0x0012	0x1000	310	VIRTUAL OUTPUT 210	F001		R	1	
0x0012	0x2000	311	VIRTUAL OUTPUT 211	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0012	0x4000	312	VIRTUAL OUTPUT 212	F001		R	1	
0x0012	0x8000	313	VIRTUAL OUTPUT 213	F001		R	1	
0x0012	0x0001	314	VIRTUAL OUTPUT 214	F001		R	1	
0x0012	0x0002	315	VIRTUAL OUTPUT 215	F001		R	1	
0x0012	0x0004	316	VIRTUAL OUTPUT 216	F001		R	1	
0x0012	0x0008	317	VIRTUAL OUTPUT 217	F001		R	1	
0x0012	0x0010	318	VIRTUAL OUTPUT 218	F001		R	1	
0x0012	0x0020	319	VIRTUAL OUTPUT 219	F001		R	1	
0x0012	0x0040	320	VIRTUAL OUTPUT 220	F001		R	1	
0x0012	0x0080	321	VIRTUAL OUTPUT 221	F001		R	1	
0x0013	0x0100	322	VIRTUAL OUTPUT 222	F001		R	1	
0x0013	0x0200	323	VIRTUAL OUTPUT 223	F001		R	1	
0x0013	0x0400	324	VIRTUAL OUTPUT 224	F001		R	1	
0x0013	0x0800	325	VIRTUAL OUTPUT 225	F001		R	1	
0x0013	0x1000	326	VIRTUAL OUTPUT 226	F001		R	1	
0x0013	0x2000	327	VIRTUAL OUTPUT 227	F001		R	1	
0x0013	0x4000	328	VIRTUAL OUTPUT 228	F001		R	1	
0x0013	0x8000	329	VIRTUAL OUTPUT 229	F001		R	1	
0x0013	0x0001	330	VIRTUAL OUTPUT 230	F001		R	1	
0x0013	0x0002	331	VIRTUAL OUTPUT 231	F001		R	1	
0x0013	0x0004	332	VIRTUAL OUTPUT 232	F001		R	1	
0x0013	0x0008	333	VIRTUAL OUTPUT 233	F001		R	1	
0x0013	0x0010	334	VIRTUAL OUTPUT 234	F001		R	1	
0x0013	0x0020	335	VIRTUAL OUTPUT 235	F001		R	1	
0x0013	0x0040	336	VIRTUAL OUTPUT 236	F001		R	1	
0x0013	0x0080	337	VIRTUAL OUTPUT 237	F001		R	1	
0x0014	0x0100	338	VIRTUAL OUTPUT 238	F001		R	1	
0x0014	0x0200	339	VIRTUAL OUTPUT 239	F001		R	1	
0x0014	0x0400	340	VIRTUAL OUTPUT 240	F001		R	1	
0x0014	0x0800	341	VIRTUAL OUTPUT 241	F001		R	1	
0x0014	0x1000	342	VIRTUAL OUTPUT 242	F001		R	1	
0x0014	0x2000	343	VIRTUAL OUTPUT 243	F001		R	1	
0x0014	0x4000	344	VIRTUAL OUTPUT 244	F001		R	1	
0x0014	0x8000	345	VIRTUAL OUTPUT 245	F001		R	1	
0x0014	0x0001	346	VIRTUAL OUTPUT 246	F001		R	1	
0x0014	0x0002	347	VIRTUAL OUTPUT 247	F001		R	1	
0x0014	0x0004	348	VIRTUAL OUTPUT 248	F001		R	1	
0x0014	0x0008	349	VIRTUAL OUTPUT 249	F001		R	1	
0x0014	0x0010	350	VIRTUAL OUTPUT 250	F001		R	1	
0x0014	0x0020	351	VIRTUAL OUTPUT 251	F001		R	1	
0x0014	0x0040	352	VIRTUAL OUTPUT 252	F001		R	1	
0x0014	0x0080	353	VIRTUAL OUTPUT 253	F001		R	1	
0x0015	0x0100	354	VIRTUAL OUTPUT 254	F001		R	1	
0x0015	0x0200	355	VIRTUAL OUTPUT 255	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0015	0x0400	356	VIRTUAL OUTPUT 256	F001		R	1	
0x0015	0x0800	357	VIRTUAL OUTPUT 257	F001		R	1	
0x0015	0x1000	358	VIRTUAL OUTPUT 258	F001		R	1	
0x0015	0x2000	359	VIRTUAL OUTPUT 259	F001		R	1	
0x0015	0x4000	360	VIRTUAL OUTPUT 260	F001		R	1	
0x0015	0x8000	361	VIRTUAL OUTPUT 261	F001		R	1	
0x0015	0x0001	362	VIRTUAL OUTPUT 262	F001		R	1	
0x0015	0x0002	363	VIRTUAL OUTPUT 263	F001		R	1	
0x0015	0x0004	364	VIRTUAL OUTPUT 264	F001		R	1	
0x0015	0x0008	365	VIRTUAL OUTPUT 265	F001		R	1	
0x0015	0x0010	366	VIRTUAL OUTPUT 266	F001		R	1	
0x0015	0x0020	367	VIRTUAL OUTPUT 267	F001		R	1	
0x0015	0x0040	368	VIRTUAL OUTPUT 268	F001		R	1	
0x0015	0x0080	369	VIRTUAL OUTPUT 269	F001		R	1	
0x0016	0x0100	370	VIRTUAL OUTPUT 270	F001		R	1	
0x0016	0x0200	371	VIRTUAL OUTPUT 271	F001		R	1	
0x0016	0x0400	372	VIRTUAL OUTPUT 272	F001		R	1	
0x0016	0x0800	373	VIRTUAL OUTPUT 273	F001		R	1	
0x0016	0x1000	374	VIRTUAL OUTPUT 274	F001		R	1	
0x0016	0x2000	375	VIRTUAL OUTPUT 275	F001		R	1	
0x0016	0x4000	376	VIRTUAL OUTPUT 276	F001		R	1	
0x0016	0x8000	377	VIRTUAL OUTPUT 277	F001		R	1	
0x0016	0x0001	378	VIRTUAL OUTPUT 278	F001		R	1	
0x0016	0x0002	379	VIRTUAL OUTPUT 279	F001		R	1	
0x0016	0x0004	380	VIRTUAL OUTPUT 280	F001		R	1	
0x0016	0x0008	381	VIRTUAL OUTPUT 281	F001		R	1	
0x0016	0x0010	382	VIRTUAL OUTPUT 282	F001		R	1	
0x0016	0x0020	383	VIRTUAL OUTPUT 283	F001		R	1	
0x0016	0x0040	384	VIRTUAL OUTPUT 284	F001		R	1	
0x0016	0x0080	385	VIRTUAL OUTPUT 285	F001		R	1	
0x0017	0x0100	386	VIRTUAL OUTPUT 286	F001		R	1	
0x0017	0x0200	387	VIRTUAL OUTPUT 287	F001		R	1	
0x0017	0x0400	388	VIRTUAL OUTPUT 288	F001		R	1	
0x0017	0x0800	389	VIRTUAL OUTPUT 289	F001		R	1	
0x0017	0x1000	390	VIRTUAL OUTPUT 290	F001		R	1	
0x0017	0x2000	391	VIRTUAL OUTPUT 291	F001		R	1	
0x0017	0x4000	392	VIRTUAL OUTPUT 292	F001		R	1	
0x0017	0x8000	393	VIRTUAL OUTPUT 293	F001		R	1	
0x0017	0x0001	394	VIRTUAL OUTPUT 294	F001		R	1	
0x0017	0x0002	395	VIRTUAL OUTPUT 295	F001		R	1	
0x0017	0x0004	396	VIRTUAL OUTPUT 296	F001		R	1	
0x0017	0x0008	397	VIRTUAL OUTPUT 297	F001		R	1	
0x0017	0x0010	398	VIRTUAL OUTPUT 298	F001		R	1	
0x0017	0x0020	399	VIRTUAL OUTPUT 299	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0017	0x0040	400	VIRTUAL OUTPUT 300	F001		R	1	
0x0017	0x0080	401	VIRTUAL OUTPUT 301	F001		R	1	
0x0018	0x0100	402	VIRTUAL OUTPUT 302	F001		R	1	
0x0018	0x0200	403	VIRTUAL OUTPUT 303	F001		R	1	
0x0018	0x0400	404	VIRTUAL OUTPUT 304	F001		R	1	
0x0018	0x0800	405	VIRTUAL OUTPUT 305	F001		R	1	
0x0018	0x1000	406	VIRTUAL OUTPUT 306	F001		R	1	
0x0018	0x2000	407	VIRTUAL OUTPUT 307	F001		R	1	
0x0018	0x4000	408	VIRTUAL OUTPUT 308	F001		R	1	
0x0018	0x8000	409	VIRTUAL OUTPUT 309	F001		R	1	
0x0018	0x0001	410	VIRTUAL OUTPUT 310	F001		R	1	
0x0018	0x0002	411	VIRTUAL OUTPUT 311	F001		R	1	
0x0018	0x0004	412	VIRTUAL OUTPUT 312	F001		R	1	
0x0018	0x0008	413	VIRTUAL OUTPUT 313	F001		R	1	
0x0018	0x0010	414	VIRTUAL OUTPUT 314	F001		R	1	
0x0018	0x0020	415	VIRTUAL OUTPUT 315	F001		R	1	
0x0018	0x0040	416	VIRTUAL OUTPUT 316	F001		R	1	
0x0018	0x0080	417	VIRTUAL OUTPUT 317	F001		R	1	
0x0019	0x0100	418	VIRTUAL OUTPUT 318	F001		R	1	
0x0019	0x0200	419	VIRTUAL OUTPUT 319	F001		R	1	
0x0019	0x0400	420	VIRTUAL OUTPUT 320	F001		R	1	
0x0019	0x0800	421	VIRTUAL OUTPUT 321	F001		R	1	
0x0019	0x1000	422	VIRTUAL OUTPUT 322	F001		R	1	
0x0019	0x2000	423	VIRTUAL OUTPUT 323	F001		R	1	
0x0019	0x4000	424	VIRTUAL OUTPUT 324	F001		R	1	
0x0019	0x8000	425	VIRTUAL OUTPUT 325	F001		R	1	
0x0019	0x0001	426	VIRTUAL OUTPUT 326	F001		R	1	
0x0019	0x0002	427	VIRTUAL OUTPUT 327	F001		R	1	
0x0019	0x0004	428	VIRTUAL OUTPUT 328	F001		R	1	
0x0019	0x0008	429	VIRTUAL OUTPUT 329	F001		R	1	
0x0019	0x0010	430	VIRTUAL OUTPUT 330	F001		R	1	
0x0019	0x0020	431	VIRTUAL OUTPUT 331	F001		R	1	
0x0019	0x0040	432	VIRTUAL OUTPUT 332	F001		R	1	
0x0019	0x0080	433	VIRTUAL OUTPUT 333	F001		R	1	
0x001A	0x0100	434	VIRTUAL OUTPUT 334	F001		R	1	
0x001A	0x0200	435	VIRTUAL OUTPUT 335	F001		R	1	
0x001A	0x0400	436	VIRTUAL OUTPUT 336	F001		R	1	
0x001A	0x0800	437	VIRTUAL OUTPUT 337	F001		R	1	
0x001A	0x1000	438	VIRTUAL OUTPUT 338	F001		R	1	
0x001A	0x2000	439	VIRTUAL OUTPUT 339	F001		R	1	
0x001A	0x4000	440	VIRTUAL OUTPUT 340	F001		R	1	
0x001A	0x8000	441	VIRTUAL OUTPUT 341	F001		R	1	
0x001A	0x0001	442	VIRTUAL OUTPUT 342	F001		R	1	
0x001A	0x0002	443	VIRTUAL OUTPUT 343	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x001A	0x0004	444	VIRTUAL OUTPUT 344	F001		R	1	
0x001A	0x0008	445	VIRTUAL OUTPUT 345	F001		R	1	
0x001A	0x0010	446	VIRTUAL OUTPUT 346	F001		R	1	
0x001A	0x0020	447	VIRTUAL OUTPUT 347	F001		R	1	
0x001A	0x0040	448	VIRTUAL OUTPUT 348	F001		R	1	
0x001A	0x0080	449	VIRTUAL OUTPUT 349	F001		R	1	
0x001B	0x0100	450	VIRTUAL OUTPUT 350	F001		R	1	
0x001B	0x0200	451	VIRTUAL OUTPUT 351	F001		R	1	
0x001B	0x0400	452	VIRTUAL OUTPUT 352	F001		R	1	
0x001B	0x0800	453	VIRTUAL OUTPUT 353	F001		R	1	
0x001B	0x1000	454	VIRTUAL OUTPUT 354	F001		R	1	
0x001B	0x2000	455	VIRTUAL OUTPUT 355	F001		R	1	
0x001B	0x4000	456	VIRTUAL OUTPUT 356	F001		R	1	
0x001B	0x8000	457	VIRTUAL OUTPUT 357	F001		R	1	
0x001B	0x0001	458	VIRTUAL OUTPUT 358	F001		R	1	
0x001B	0x0002	459	VIRTUAL OUTPUT 359	F001		R	1	
0x001B	0x0004	460	VIRTUAL OUTPUT 360	F001		R	1	
0x001B	0x0008	461	VIRTUAL OUTPUT 361	F001		R	1	
0x001B	0x0010	462	VIRTUAL OUTPUT 362	F001		R	1	
0x001B	0x0020	463	VIRTUAL OUTPUT 363	F001		R	1	
0x001B	0x0040	464	VIRTUAL OUTPUT 364	F001		R	1	
0x001B	0x0080	465	VIRTUAL OUTPUT 365	F001		R	1	
0x001C	0x0100	466	VIRTUAL OUTPUT 366	F001		R	1	
0x001C	0x0200	467	VIRTUAL OUTPUT 367	F001		R	1	
0x001C	0x0400	468	VIRTUAL OUTPUT 368	F001		R	1	
0x001C	0x0800	469	VIRTUAL OUTPUT 369	F001		R	1	
0x001C	0x1000	470	VIRTUAL OUTPUT 370	F001		R	1	
0x001C	0x2000	471	VIRTUAL OUTPUT 371	F001		R	1	
0x001C	0x4000	472	VIRTUAL OUTPUT 372	F001		R	1	
0x001C	0x8000	473	VIRTUAL OUTPUT 373	F001		R	1	
0x001C	0x0001	474	VIRTUAL OUTPUT 374	F001		R	1	
0x001C	0x0002	475	VIRTUAL OUTPUT 375	F001		R	1	
0x001C	0x0004	476	VIRTUAL OUTPUT 376	F001		R	1	
0x001C	0x0008	477	VIRTUAL OUTPUT 377	F001		R	1	
0x001C	0x0010	478	VIRTUAL OUTPUT 378	F001		R	1	
0x001C	0x0020	479	VIRTUAL OUTPUT 379	F001		R	1	
0x001C	0x0040	480	VIRTUAL OUTPUT 380	F001		R	1	
0x001C	0x0080	481	VIRTUAL OUTPUT 381	F001		R	1	
0x001D	0x0100	482	VIRTUAL OUTPUT 382	F001		R	1	
0x001D	0x0200	483	VIRTUAL OUTPUT 383	F001		R	1	
0x001D	0x0400	484	VIRTUAL OUTPUT 384	F001		R	1	
0x001D	0x0800	485	VIRTUAL OUTPUT 385	F001		R	1	
0x001D	0x1000	486	VIRTUAL OUTPUT 386	F001		R	1	
0x001D	0x2000	487	VIRTUAL OUTPUT 387	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x001D	0x4000	488	VIRTUAL OUTPUT 388	F001		R	1	
0x001D	0x8000	489	VIRTUAL OUTPUT 389	F001		R	1	
0x001D	0x0001	490	VIRTUAL OUTPUT 390	F001		R	1	
0x001D	0x0002	491	VIRTUAL OUTPUT 391	F001		R	1	
0x001D	0x0004	492	VIRTUAL OUTPUT 392	F001		R	1	
0x001D	0x0008	493	VIRTUAL OUTPUT 393	F001		R	1	
0x001D	0x0010	494	VIRTUAL OUTPUT 394	F001		R	1	
0x001D	0x0020	495	VIRTUAL OUTPUT 395	F001		R	1	
0x001D	0x0040	496	VIRTUAL OUTPUT 396	F001		R	1	
0x001D	0x0080	497	VIRTUAL OUTPUT 397	F001		R	1	
0x001E	0x0100	498	VIRTUAL OUTPUT 398	F001		R	1	
0x001E	0x0200	499	VIRTUAL OUTPUT 399	F001		R	1	
0x001E	0x0400	500	VIRTUAL OUTPUT 400	F001		R	1	
0x001E	0x0800	501	VIRTUAL OUTPUT 401	F001		R	1	
0x001E	0x1000	502	VIRTUAL OUTPUT 402	F001		R	1	
0x001E	0x2000	503	VIRTUAL OUTPUT 403	F001		R	1	
0x001E	0x4000	504	VIRTUAL OUTPUT 404	F001		R	1	
0x001E	0x8000	505	VIRTUAL OUTPUT 405	F001		R	1	
0x001E	0x0001	506	VIRTUAL OUTPUT 406	F001		R	1	
0x001E	0x0002	507	VIRTUAL OUTPUT 407	F001		R	1	
0x001E	0x0004	508	VIRTUAL OUTPUT 408	F001		R	1	
0x001E	0x0008	509	VIRTUAL OUTPUT 409	F001		R	1	
0x001E	0x0010	510	VIRTUAL OUTPUT 410	F001		R	1	
0x001E	0x0020	511	VIRTUAL OUTPUT 411	F001		R	1	
0x001E	0x0040	512	VIRTUAL OUTPUT 412	F001		R	1	
0x001E	0x0080	513	VIRTUAL OUTPUT 413	F001		R	1	
0x001F	0x0100	514	VIRTUAL OUTPUT 414	F001		R	1	
0x001F	0x0200	515	VIRTUAL OUTPUT 415	F001		R	1	
0x001F	0x0400	516	VIRTUAL OUTPUT 416	F001		R	1	
0x001F	0x0800	517	VIRTUAL OUTPUT 417	F001		R	1	
0x001F	0x1000	518	VIRTUAL OUTPUT 418	F001		R	1	
0x001F	0x2000	519	VIRTUAL OUTPUT 419	F001		R	1	
0x001F	0x4000	520	VIRTUAL OUTPUT 420	F001		R	1	
0x001F	0x8000	521	VIRTUAL OUTPUT 421	F001		R	1	
0x001F	0x0001	522	VIRTUAL OUTPUT 422	F001		R	1	
0x001F	0x0002	523	VIRTUAL OUTPUT 423	F001		R	1	
0x001F	0x0004	524	VIRTUAL OUTPUT 424	F001		R	1	
0x001F	0x0008	525	VIRTUAL OUTPUT 425	F001		R	1	
0x001F	0x0010	526	VIRTUAL OUTPUT 426	F001		R	1	
0x001F	0x0020	527	VIRTUAL OUTPUT 427	F001		R	1	
0x001F	0x0040	528	VIRTUAL OUTPUT 428	F001		R	1	
0x001F	0x0080	529	VIRTUAL OUTPUT 429	F001		R	1	
0x0020	0x0100	530	VIRTUAL OUTPUT 430	F001		R	1	
0x0020	0x0200	531	VIRTUAL OUTPUT 431	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0020	0x0400	532	VIRTUAL OUTPUT 432	F001		R	1	
0x0020	0x0800	533	VIRTUAL OUTPUT 433	F001		R	1	
0x0020	0x1000	534	VIRTUAL OUTPUT 434	F001		R	1	
0x0020	0x2000	535	VIRTUAL OUTPUT 435	F001		R	1	
0x0020	0x4000	536	VIRTUAL OUTPUT 436	F001		R	1	
0x0020	0x8000	537	VIRTUAL OUTPUT 437	F001		R	1	
0x0020	0x0001	538	VIRTUAL OUTPUT 438	F001		R	1	
0x0020	0x0002	539	VIRTUAL OUTPUT 439	F001		R	1	
0x0020	0x0004	540	VIRTUAL OUTPUT 440	F001		R	1	
0x0020	0x0008	541	VIRTUAL OUTPUT 441	F001		R	1	
0x0020	0x0010	542	VIRTUAL OUTPUT 442	F001		R	1	
0x0020	0x0020	543	VIRTUAL OUTPUT 443	F001		R	1	
0x0020	0x0040	544	VIRTUAL OUTPUT 444	F001		R	1	
0x0020	0x0080	545	VIRTUAL OUTPUT 445	F001		R	1	
0x0021	0x0100	546	VIRTUAL OUTPUT 446	F001		R	1	
0x0021	0x0200	547	VIRTUAL OUTPUT 447	F001		R	1	
0x0021	0x0400	548	VIRTUAL OUTPUT 448	F001		R	1	
0x0021	0x0800	549	VIRTUAL OUTPUT 449	F001		R	1	
0x0021	0x1000	550	VIRTUAL OUTPUT 450	F001		R	1	
0x0021	0x2000	551	VIRTUAL OUTPUT 451	F001		R	1	
0x0021	0x4000	552	VIRTUAL OUTPUT 452	F001		R	1	
0x0021	0x8000	553	VIRTUAL OUTPUT 453	F001		R	1	
0x0021	0x0001	554	VIRTUAL OUTPUT 454	F001		R	1	
0x0021	0x0002	555	VIRTUAL OUTPUT 455	F001		R	1	
0x0021	0x0004	556	VIRTUAL OUTPUT 456	F001		R	1	
0x0021	0x0008	557	VIRTUAL OUTPUT 457	F001		R	1	
0x0021	0x0010	558	VIRTUAL OUTPUT 458	F001		R	1	
0x0021	0x0020	559	VIRTUAL OUTPUT 459	F001		R	1	
0x0021	0x0040	560	VIRTUAL OUTPUT 460	F001		R	1	
0x0021	0x0080	561	VIRTUAL OUTPUT 461	F001		R	1	
0x0022	0x0100	562	VIRTUAL OUTPUT 462	F001		R	1	
0x0022	0x0200	563	VIRTUAL OUTPUT 463	F001		R	1	
0x0022	0x0400	564	VIRTUAL OUTPUT 464	F001		R	1	
0x0022	0x0800	565	VIRTUAL OUTPUT 465	F001		R	1	
0x0022	0x1000	566	VIRTUAL OUTPUT 466	F001		R	1	
0x0022	0x2000	567	VIRTUAL OUTPUT 467	F001		R	1	
0x0022	0x4000	568	VIRTUAL OUTPUT 468	F001		R	1	
0x0022	0x8000	569	VIRTUAL OUTPUT 469	F001		R	1	
0x0022	0x0001	570	VIRTUAL OUTPUT 470	F001		R	1	
0x0022	0x0002	571	VIRTUAL OUTPUT 471	F001		R	1	
0x0022	0x0004	572	VIRTUAL OUTPUT 472	F001		R	1	
0x0022	0x0008	573	VIRTUAL OUTPUT 473	F001		R	1	
0x0022	0x0010	574	VIRTUAL OUTPUT 474	F001		R	1	
0x0022	0x0020	575	VIRTUAL OUTPUT 475	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0022	0x0040	576	VIRTUAL OUTPUT 476	F001		R	1	
0x0022	0x0080	577	VIRTUAL OUTPUT 477	F001		R	1	
0x0023	0x0100	578	VIRTUAL OUTPUT 478	F001		R	1	
0x0023	0x0200	579	VIRTUAL OUTPUT 479	F001		R	1	
0x0023	0x0400	580	VIRTUAL OUTPUT 480	F001		R	1	
0x0023	0x0800	581	VIRTUAL OUTPUT 481	F001		R	1	
0x0023	0x1000	582	VIRTUAL OUTPUT 482	F001		R	1	
0x0023	0x2000	583	VIRTUAL OUTPUT 483	F001		R	1	
0x0023	0x4000	584	VIRTUAL OUTPUT 484	F001		R	1	
0x0023	0x8000	585	VIRTUAL OUTPUT 485	F001		R	1	
0x0023	0x0001	586	VIRTUAL OUTPUT 486	F001		R	1	
0x0023	0x0002	587	VIRTUAL OUTPUT 487	F001		R	1	
0x0023	0x0004	588	VIRTUAL OUTPUT 488	F001		R	1	
0x0023	0x0008	589	VIRTUAL OUTPUT 489	F001		R	1	
0x0023	0x0010	590	VIRTUAL OUTPUT 490	F001		R	1	
0x0023	0x0020	591	VIRTUAL OUTPUT 491	F001		R	1	
0x0023	0x0040	592	VIRTUAL OUTPUT 492	F001		R	1	
0x0023	0x0080	593	VIRTUAL OUTPUT 493	F001		R	1	
0x0024	0x0100	594	VIRTUAL OUTPUT 494	F001		R	1	
0x0024	0x0200	595	VIRTUAL OUTPUT 495	F001		R	1	
0x0024	0x0400	596	VIRTUAL OUTPUT 496	F001		R	1	
0x0024	0x0800	597	VIRTUAL OUTPUT 497	F001		R	1	
0x0024	0x1000	598	VIRTUAL OUTPUT 498	F001		R	1	
0x0024	0x2000	599	VIRTUAL OUTPUT 499	F001		R	1	
0x0024	0x4000	600	VIRTUAL OUTPUT 500	F001		R	1	
0x0024	0x8000	601	VIRTUAL OUTPUT 501	F001		R	1	
0x0024	0x0001	602	VIRTUAL OUTPUT 502	F001		R	1	
0x0024	0x0002	603	VIRTUAL OUTPUT 503	F001		R	1	
0x0024	0x0004	604	VIRTUAL OUTPUT 504	F001		R	1	
0x0024	0x0008	605	VIRTUAL OUTPUT 505	F001		R	1	
0x0024	0x0010	606	VIRTUAL OUTPUT 506	F001		R	1	
0x0024	0x0020	607	VIRTUAL OUTPUT 507	F001		R	1	
0x0024	0x0040	608	VIRTUAL OUTPUT 508	F001		R	1	
0x0024	0x0080	609	VIRTUAL OUTPUT 509	F001		R	1	
0x0025	0x0100	610	VIRTUAL OUTPUT 510	F001		R	1	
0x0025	0x0200	611	VIRTUAL OUTPUT 511	F001		R	1	
0x0025	0x0400	612	OPERATION BIT 1	F001		R	1	
0x0025	0x0800	613	OPERATION BIT 2	F001		R	1	
0x0025	0x1000	614	OPERATION BIT 3	F001		R	1	
0x0025	0x2000	615	OPERATION BIT 4	F001		R	1	
0x0025	0x4000	616	OPERATION BIT 5	F001		R	1	
0x0025	0x8000	617	OPERATION BIT 6	F001		R	1	
0x0025	0x0001	618	OPERATION BIT 7	F001		R	1	
0x0025	0x0002	619	OPERATION BIT 8	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0025	0x0004	620	OPERATION BIT 9	F001		R	1	
0x0025	0x0008	621	OPERATION BIT 10	F001		R	1	
0x0025	0x0010	622	OPERATION BIT 11	F001		R	1	
0x0025	0x0020	623	OPERATION BIT 12	F001		R	1	
0x0025	0x0040	624	OPERATION BIT 13	F001		R	1	
0x0025	0x0080	625	OPERATION BIT 14	F001		R	1	
0x0026	0x0100	626	OPERATION BIT 15	F001		R	1	
0x0026	0x0200	627	OPERATION BIT 16	F001		R	1	
0x0026	0x0400	628	OPERATION BIT 17	F001		R	1	
0x0026	0x0800	629	OPERATION BIT 18	F001		R	1	
0x0026	0x1000	630	OPERATION BIT 19	F001		R	1	
0x0026	0x2000	631	OPERATION BIT 20	F001		R	1	
0x0026	0x4000	632	OPERATION BIT 21	F001		R	1	
0x0026	0x8000	633	OPERATION BIT 22	F001		R	1	
0x0026	0x0001	634	OPERATION BIT 23	F001		R	1	
0x0026	0x0002	635	OPERATION BIT 24	F001		R	1	
0x003C	0x0004	988	OPERATION BIT 25	F001		R	1	
0x003C	0x0008	989	OPERATION BIT 26	F001		R	1	
0x003C	0x0010	990	OPERATION BIT 27	F001		R	1	
0x003C	0x0020	991	OPERATION BIT 28	F001		R	1	
0x003C	0x0040	992	OPERATION BIT 29	F001		R	1	
0x003C	0x0080	993	OPERATION BIT 30	F001		R	1	
0x003D	0x0100	994	OPERATION BIT 31	F001		R	1	
0x003D	0x0200	995	OPERATION BIT 32	F001		R	1	
0x003D	0x0400	996	CONTROL EVENT 1	F001		R	1	
0x003D	0x0800	997	CONTROL EVENT 2	F001		R	1	
0x003D	0x1000	998	CONTROL EVENT 3	F001		R	1	
0x003D	0x2000	999	CONTROL EVENT 4	F001		R	1	
0x003D	0x4000	1000	CONTROL EVENT 5	F001		R	1	
0x003D	0x8000	1001	CONTROL EVENT 6	F001		R	1	
0x003D	0x0001	1002	CONTROL EVENT 7	F001		R	1	
0x003D	0x0002	1003	CONTROL EVENT 8	F001		R	1	
0x003D	0x0004	1004	CONTROL EVENT 9	F001		R	1	
0x003D	0x0008	1005	CONTROL EVENT 10	F001		R	1	
0x003D	0x0010	1006	CONTROL EVENT 11	F001		R	1	
0x003D	0x0020	1007	CONTROL EVENT 12	F001		R	1	
0x003D	0x0040	1008	CONTROL EVENT 13	F001		R	1	
0x003D	0x0080	1009	CONTROL EVENT 14	F001		R	1	
0x003E	0x0100	1010	CONTROL EVENT 15	F001		R	1	
0x003E	0x0200	1011	CONTROL EVENT 16	F001		R	1	
0x003E	0x0400	1012	CONTROL EVENT 17	F001		R	1	
0x003E	0x0800	1013	CONTROL EVENT 18	F001		R	1	
0x003E	0x1000	1014	CONTROL EVENT 19	F001		R	1	
0x003E	0x2000	1015	CONTROL EVENT 20	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x003E	0x4000	1016	CONTROL EVENT 21	F001		R	1	
0x003E	0x8000	1017	CONTROL EVENT 22	F001		R	1	
0x003E	0x0001	1018	CONTROL EVENT 23	F001		R	1	
0x003E	0x0002	1019	CONTROL EVENT 24	F001		R	1	
0x003E	0x0004	1020	CONTROL EVENT 25	F001		R	1	
0x003E	0x0008	1021	CONTROL EVENT 26	F001		R	1	
0x003E	0x0010	1022	CONTROL EVENT 27	F001		R	1	
0x003E	0x0020	1023	CONTROL EVENT 28	F001		R	1	
0x003E	0x0040	1024	CONTROL EVENT 29	F001		R	1	
0x003E	0x0080	1025	CONTROL EVENT 30	F001		R	1	
0x003F	0x0100	1026	CONTROL EVENT 31	F001		R	1	
0x003F	0x0200	1027	CONTROL EVENT 32	F001		R	1	
0x003F	0x0400	1028	CONTROL EVENT 33	F001		R	1	
0x003F	0x0800	1029	CONTROL EVENT 34	F001		R	1	
0x003F	0x1000	1030	CONTROL EVENT 35	F001		R	1	
0x003F	0x2000	1031	CONTROL EVENT 36	F001		R	1	
0x003F	0x4000	1032	CONTROL EVENT 37	F001		R	1	
0x003F	0x8000	1033	CONTROL EVENT 38	F001		R	1	
0x003F	0x0001	1034	CONTROL EVENT 39	F001		R	1	
0x003F	0x0002	1035	CONTROL EVENT 40	F001		R	1	
0x003F	0x0004	1036	CONTROL EVENT 41	F001		R	1	
0x003F	0x0008	1037	CONTROL EVENT 42	F001		R	1	
0x003F	0x0010	1038	CONTROL EVENT 43	F001		R	1	
0x003F	0x0020	1039	CONTROL EVENT 44	F001		R	1	
0x003F	0x0040	1040	CONTROL EVENT 45	F001		R	1	
0x003F	0x0080	1041	CONTROL EVENT 46	F001		R	1	
0x0040	0x0100	1042	CONTROL EVENT 47	F001		R	1	
0x0040	0x0200	1043	CONTROL EVENT 48	F001		R	1	
0x0040	0x0400	1044	CONTROL EVENT 49	F001		R	1	
0x0040	0x0800	1045	CONTROL EVENT 50	F001		R	1	
0x0040	0x1000	1046	CONTROL EVENT 51	F001		R	1	
0x0040	0x2000	1047	CONTROL EVENT 52	F001		R	1	
0x0040	0x4000	1048	CONTROL EVENT 53	F001		R	1	
0x0040	0x8000	1049	CONTROL EVENT 54	F001		R	1	
0x0040	0x0001	1050	CONTROL EVENT 55	F001		R	1	
0x0040	0x0002	1051	CONTROL EVENT 56	F001		R	1	
0x0040	0x0004	1052	CONTROL EVENT 57	F001		R	1	
0x0040	0x0008	1053	CONTROL EVENT 58	F001		R	1	
0x0040	0x0010	1054	CONTROL EVENT 59	F001		R	1	
0x0040	0x0020	1055	CONTROL EVENT 60	F001		R	1	
0x0040	0x0040	1056	CONTROL EVENT 61	F001		R	1	
0x0040	0x0080	1057	CONTROL EVENT 62	F001		R	1	
0x0041	0x0100	1058	CONTROL EVENT 63	F001		R	1	
0x0041	0x0200	1059	CONTROL EVENT 64	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0041	0x0400	1060	CONTROL EVENT 65	F001		R	1	
0x0041	0x0800	1061	CONTROL EVENT 66	F001		R	1	
0x0041	0x1000	1062	CONTROL EVENT 67	F001		R	1	
0x0041	0x2000	1063	CONTROL EVENT 68	F001		R	1	
0x0041	0x4000	1064	CONTROL EVENT 69	F001		R	1	
0x0041	0x8000	1065	CONTROL EVENT 70	F001		R	1	
0x0041	0x0001	1066	CONTROL EVENT 71	F001		R	1	
0x0041	0x0002	1067	CONTROL EVENT 72	F001		R	1	
0x0041	0x0004	1068	CONTROL EVENT 73	F001		R	1	
0x0041	0x0008	1069	CONTROL EVENT 74	F001		R	1	
0x0041	0x0010	1070	CONTROL EVENT 75	F001		R	1	
0x0041	0x0020	1071	CONTROL EVENT 76	F001		R	1	
0x0041	0x0040	1072	CONTROL EVENT 77	F001		R	1	
0x0041	0x0080	1073	CONTROL EVENT 78	F001		R	1	
0x0042	0x0100	1074	CONTROL EVENT 79	F001		R	1	
0x0042	0x0200	1075	CONTROL EVENT 80	F001		R	1	
0x0042	0x0400	1076	CONTROL EVENT 81	F001		R	1	
0x0042	0x0800	1077	CONTROL EVENT 82	F001		R	1	
0x0042	0x1000	1078	CONTROL EVENT 83	F001		R	1	
0x0042	0x2000	1079	CONTROL EVENT 84	F001		R	1	
0x0042	0x4000	1080	CONTROL EVENT 85	F001		R	1	
0x0042	0x8000	1081	CONTROL EVENT 86	F001		R	1	
0x0042	0x0001	1082	CONTROL EVENT 87	F001		R	1	
0x0042	0x0002	1083	CONTROL EVENT 88	F001		R	1	
0x0042	0x0004	1084	CONTROL EVENT 89	F001		R	1	
0x0042	0x0008	1085	CONTROL EVENT 90	F001		R	1	
0x0042	0x0010	1086	CONTROL EVENT 91	F001		R	1	
0x0042	0x0020	1087	CONTROL EVENT 92	F001		R	1	
0x0042	0x0040	1088	CONTROL EVENT 93	F001		R	1	
0x0042	0x0080	1089	CONTROL EVENT 94	F001		R	1	
0x0043	0x0100	1090	CONTROL EVENT 95	F001		R	1	
0x0043	0x0200	1091	CONTROL EVENT 96	F001		R	1	
0x0043	0x0400	1092	CONTROL EVENT 97	F001		R	1	
0x0043	0x0800	1093	CONTROL EVENT 98	F001		R	1	
0x0043	0x1000	1094	CONTROL EVENT 99	F001		R	1	
0x0043	0x2000	1095	CONTROL EVENT 100	F001		R	1	
0x0043	0x4000	1096	CONTROL EVENT 101	F001		R	1	
0x0043	0x8000	1097	CONTROL EVENT 102	F001		R	1	
0x0043	0x0001	1098	CONTROL EVENT 103	F001		R	1	
0x0043	0x0002	1099	CONTROL EVENT 104	F001		R	1	
0x0043	0x0004	1100	CONTROL EVENT 105	F001		R	1	
0x0043	0x0008	1101	CONTROL EVENT 106	F001		R	1	
0x0043	0x0010	1102	CONTROL EVENT 107	F001		R	1	
0x0043	0x0020	1103	CONTROL EVENT 108	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0043	0x0040	1104	CONTROL EVENT 109	F001		R	1	
0x0043	0x0080	1105	CONTROL EVENT 110	F001		R	1	
0x0044	0x0100	1106	CONTROL EVENT 111	F001		R	1	
0x0044	0x0200	1107	CONTROL EVENT 112	F001		R	1	
0x0044	0x0400	1108	CONTROL EVENT 113	F001		R	1	
0x0044	0x0800	1109	CONTROL EVENT 114	F001		R	1	
0x0044	0x1000	1110	CONTROL EVENT 115	F001		R	1	
0x0044	0x2000	1111	CONTROL EVENT 116	F001		R	1	
0x0044	0x4000	1112	CONTROL EVENT 117	F001		R	1	
0x0044	0x8000	1113	CONTROL EVENT 118	F001		R	1	
0x0044	0x0001	1114	CONTROL EVENT 119	F001		R	1	
0x0044	0x0002	1115	CONTROL EVENT 120	F001		R	1	
0x0044	0x0004	1116	CONTROL EVENT 121	F001		R	1	
0x0044	0x0008	1117	CONTROL EVENT 122	F001		R	1	
0x0044	0x0010	1118	CONTROL EVENT 123	F001		R	1	
0x0044	0x0020	1119	CONTROL EVENT 124	F001		R	1	
0x0044	0x0040	1120	CONTROL EVENT 125	F001		R	1	
0x0044	0x0080	1121	CONTROL EVENT 126	F001		R	1	
0x0045	0x0100	1122	CONTROL EVENT 127	F001		R	1	
0x0045	0x0200	1123	CONTROL EVENT 128	F001		R	1	
0x0045	0x0400	9341	V.O. Latched 1	F001		R	1	
0x0045	0x0800	9342	V.O. Latched 2	F001		R	1	
0x0045	0x1000	9343	V.O. Latched 3	F001		R	1	
0x0045	0x2000	9344	V.O. Latched 4	F001		R	1	
0x0045	0x4000	9345	V.O. Latched 5	F001		R	1	
0x0045	0x8000	9346	V.O. Latched 6	F001		R	1	
0x0045	0x0001	9347	V.O. Latched 7	F001		R	1	
0x0045	0x0002	9348	V.O. Latched 8	F001		R	1	
0x0045	0x0004	9349	V.O. Latched 9	F001		R	1	
0x0045	0x0008	9350	V.O. Latched 10	F001		R	1	
0x0045	0x0010	9351	V.O. Latched 11	F001		R	1	
0x0045	0x0020	9352	V.O. Latched 12	F001		R	1	
0x0045	0x0040	9353	V.O. Latched 13	F001		R	1	
0x0045	0x0080	9354	V.O. Latched 14	F001		R	1	
0x0046	0x0100	9355	V.O. Latched 15	F001		R	1	
0x0046	0x0200	9356	V.O. Latched 16	F001		R	1	
0x0046	0x0400	9357	Reset V.O. Latched	F001		R	1	
0x0046	0x0800	10655	PLC BOOL ON	F001		R	1	
0x0046	0x1000	10656	PLC BOOL OFF	F001		R	1	
0x0046	0x2000	11505	CH HMI	F001		R	1	
0x0046	0x4000	11506	CH COM1 REMOTE	F001		R	1	
0x0046	0x8000	11507	CH COM2 LOCAL	F001		R	1	
0x0046	0x0001	11508	CH ETHERNET	F001		R	1	
0x0083	0x0400	3396	LATCHED VIRT IP 1	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0083	0x0800	3397	LATCHED VIRT IP 2	F001		R	1	
0x0083	0x1000	3398	LATCHED VIRT IP 3	F001		R	1	
0x0083	0x2000	3399	LATCHED VIRT IP 4	F001		R	1	
0x0083	0x4000	3400	LATCHED VIRT IP 5	F001		R	1	
0x0083	0x8000	3401	LATCHED VIRT IP 6	F001		R	1	
0x0083	0x0001	3402	LATCHED VIRT IP 7	F001		R	1	
0x0083	0x0002	3403	LATCHED VIRT IP 8	F001		R	1	
0x0083	0x0004	3404	LATCHED VIRT IP 9	F001		R	1	
0x0083	0x0008	3405	LATCHED VIRT IP 10	F001		R	1	
0x0083	0x0010	3406	LATCHED VIRT IP 11	F001		R	1	
0x0083	0x0020	3407	LATCHED VIRT IP 12	F001		R	1	
0x0083	0x0040	3408	LATCHED VIRT IP 13	F001		R	1	
0x0083	0x0080	3409	LATCHED VIRT IP 14	F001		R	1	
0x0084	0x0100	3410	LATCHED VIRT IP 15	F001		R	1	
0x0084	0x0200	3411	LATCHED VIRT IP 16	F001		R	1	
0x0084	0x0400	3412	LATCHED VIRT IP 17	F001		R	1	
0x0084	0x0800	3413	LATCHED VIRT IP 18	F001		R	1	
0x0084	0x1000	3414	LATCHED VIRT IP 19	F001		R	1	
0x0084	0x2000	3415	LATCHED VIRT IP 20	F001		R	1	
0x0084	0x4000	3416	LATCHED VIRT IP 21	F001		R	1	
0x0084	0x8000	3417	LATCHED VIRT IP 22	F001		R	1	
0x0084	0x0001	3418	LATCHED VIRT IP 23	F001		R	1	
0x0084	0x0002	3419	LATCHED VIRT IP 24	F001		R	1	
0x0084	0x0004	3420	LATCHED VIRT IP 25	F001		R	1	
0x0084	0x0008	3421	LATCHED VIRT IP 26	F001		R	1	
0x0084	0x0010	3422	LATCHED VIRT IP 27	F001		R	1	
0x0084	0x0020	3423	LATCHED VIRT IP 28	F001		R	1	
0x0084	0x0040	3424	LATCHED VIRT IP 29	F001		R	1	
0x0084	0x0080	3425	LATCHED VIRT IP 30	F001		R	1	
0x0085	0x0100	3426	LATCHED VIRT IP 31	F001		R	1	
0x0085	0x0200	3427	LATCHED VIRT IP 32	F001		R	1	
0x0085	0x0400	3428	SELF-RST VIRT IP 1	F001		R	1	
0x0085	0x0800	3429	SELF-RST VIRT IP 2	F001		R	1	
0x0085	0x1000	3430	SELF-RST VIRT IP 3	F001		R	1	
0x0085	0x2000	3431	SELF-RST VIRT IP 4	F001		R	1	
0x0085	0x4000	3432	SELF-RST VIRT IP 5	F001		R	1	
0x0085	0x8000	3433	SELF-RST VIRT IP 6	F001		R	1	
0x0085	0x0001	3434	SELF-RST VIRT IP 7	F001		R	1	
0x0085	0x0002	3435	SELF-RST VIRT IP 8	F001		R	1	
0x0085	0x0004	3436	SELF-RST VIRT IP 9	F001		R	1	
0x0085	0x0008	3437	SELF-RST VIRT IP 10	F001		R	1	
0x0085	0x0010	3438	SELF-RST VIRT IP 11	F001		R	1	
0x0085	0x0020	3439	SELF-RST VIRT IP 12	F001		R	1	
0x0085	0x0040	3440	SELF-RST VIRT IP 13	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0085	0x0080	3441	SELF-RST VIRT IP 14	F001		R	1	
0x0086	0x0100	3442	SELF-RST VIRT IP 15	F001		R	1	
0x0086	0x0200	3443	SELF-RST VIRT IP 16	F001		R	1	
0x0086	0x0400	3444	SELF-RST VIRT IP 17	F001		R	1	
0x0086	0x0800	3445	SELF-RST VIRT IP 18	F001		R	1	
0x0086	0x1000	3446	SELF-RST VIRT IP 19	F001		R	1	
0x0086	0x2000	3447	SELF-RST VIRT IP 20	F001		R	1	
0x0086	0x4000	3448	SELF-RST VIRT IP 21	F001		R	1	
0x0086	0x8000	3449	SELF-RST VIRT IP 22	F001		R	1	
0x0086	0x0001	3450	SELF-RST VIRT IP 23	F001		R	1	
0x0086	0x0002	3451	SELF-RST VIRT IP 24	F001		R	1	
0x0086	0x0004	3452	SELF-RST VIRT IP 25	F001		R	1	
0x0086	0x0008	3453	SELF-RST VIRT IP 26	F001		R	1	
0x0086	0x0010	3454	SELF-RST VIRT IP 27	F001		R	1	
0x0086	0x0020	3455	SELF-RST VIRT IP 28	F001		R	1	
0x0086	0x0040	3456	SELF-RST VIRT IP 29	F001		R	1	
0x0086	0x0080	3457	SELF-RST VIRT IP 30	F001		R	1	
0x0087	0x0100	3458	SELF-RST VIRT IP 31	F001		R	1	
0x0087	0x0200	3459	SELF-RST VIRT IP 32	F001		R	1	
0x0087	0x0400	3460	GRAPHIC STATUS	F001		R	1	
0x0087	0x0800	3461	ALARM TEXT ARRAY	F001		R	1	
0x0087	0x1000	3579	CONT IP_F_CC1	F001		R	1	
0x0087	0x2000	3580	CONT IP_F_CC2	F001		R	1	
0x0087	0x4000	3581	CONT IP_F_CC3	F001		R	1	
0x0087	0x8000	3582	CONT IP_F_CC4	F001		R	1	
0x0087	0x0001	3583	CONT IP_F_CC5	F001		R	1	
0x0087	0x0002	3584	CONT IP_F_CC6	F001		R	1	
0x0087	0x0004	3585	CONT IP_F_CC7	F001		R	1	
0x0087	0x0008	3586	CONT IP_F_CC8	F001		R	1	
0x0087	0x0010	3587	CONT IP_F_CC9	F001		R	1	
0x0087	0x0020	3588	CONT IP_F_CC10	F001		R	1	
0x0087	0x0040	3589	CONT IP_F_CC11	F001		R	1	
0x0087	0x0080	3590	CONT IP_F_CC12	F001		R	1	
0x0088	0x0100	3591	CONT IP_F_CC13	F001		R	1	
0x0088	0x0200	3592	CONT IP_F_CC14	F001		R	1	
0x0088	0x0400	3593	CONT IP_F_CC15	F001		R	1	
0x0088	0x0800	3594	CONT IP_F_CC16	F001		R	1	
0x0088	0x1000	3595	CONT IP_F_CC17	F001		R	1	
0x0088	0x2000	3596	CONT IP_F_CC18	F001		R	1	
0x0088	0x4000	3597	CONT IP_F_CC19	F001		R	1	
0x0088	0x8000	3598	CONT IP_F_CC20	F001		R	1	
0x0088	0x0001	3599	CONT IP_F_CC21	F001		R	1	
0x0088	0x0002	3600	CONT IP_F_CC22	F001		R	1	
0x0088	0x0004	3601	CONT IP_F_CC23	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0088	0x0008	3602	CONT IP_F_CC24	F001		R	1	
0x0088	0x0010	3603	CONT IP_F_CC25	F001		R	1	
0x0088	0x0020	3604	CONT IP_F_CC26	F001		R	1	
0x0088	0x0040	3605	CONT IP_F_CC27	F001		R	1	
0x0088	0x0080	3606	CONT IP_F_CC28	F001		R	1	
0x0089	0x0100	3607	CONT IP_F_CC29	F001		R	1	
0x0089	0x0200	3608	CONT IP_F_CC30	F001		R	1	
0x0089	0x0400	3609	CONT IP_F_CC31	F001		R	1	
0x0089	0x0800	3610	CONT IP_F_CC32	F001		R	1	
0x0089	0x1000	3611	CONT OP OPER_F_01	F001		R	1	
0x0089	0x2000	3612	CONT OP OPER_F_02	F001		R	1	
0x0089	0x4000	3613	CONT OP OPER_F_03	F001		R	1	
0x0089	0x8000	3614	CONT OP OPER_F_04	F001		R	1	
0x0089	0x0001	3615	CONT OP OPER_F_05	F001		R	1	
0x0089	0x0002	3616	CONT OP OPER_F_06	F001		R	1	
0x0089	0x0004	3617	CONT OP OPER_F_07	F001		R	1	
0x0089	0x0008	3618	CONT OP OPER_F_08	F001		R	1	
0x0089	0x0010	3619	CONT OP OPER_F_09	F001		R	1	
0x0089	0x0020	3620	CONT OP OPER_F_10	F001		R	1	
0x0089	0x0040	3621	CONT OP OPER_F_11	F001		R	1	
0x0089	0x0080	3622	CONT OP OPER_F_12	F001		R	1	
0x008A	0x0100	3623	CONT OP OPER_F_13	F001		R	1	
0x008A	0x0200	3624	CONT OP OPER_F_14	F001		R	1	
0x008A	0x0400	3625	CONT OP OPER_F_15	F001		R	1	
0x008A	0x0800	3626	CONT OP OPER_F_16	F001		R	1	
0x008A	0x1000	3627	CONT OP RESET_F_01	F001		R	1	
0x008A	0x2000	3628	CONT OP RESET_F_02	F001		R	1	
0x008A	0x4000	3629	CONT OP RESET_F_03	F001		R	1	
0x008A	0x8000	3630	CONT OP RESET_F_04	F001		R	1	
0x008A	0x0001	3631	CONT OP RESET_F_05	F001		R	1	
0x008A	0x0002	3632	CONT OP RESET_F_06	F001		R	1	
0x008A	0x0004	3633	CONT OP RESET_F_07	F001		R	1	
0x008A	0x0008	3634	CONT OP RESET_F_08	F001		R	1	
0x008A	0x0010	3635	CONT OP RESET_F_09	F001		R	1	
0x008A	0x0020	3636	CONT OP RESET_F_10	F001		R	1	
0x008A	0x0040	3637	CONT OP RESET_F_11	F001		R	1	
0x008A	0x0080	3638	CONT OP RESET_F_12	F001		R	1	
0x008B	0x0100	3639	CONT OP RESET_F_13	F001		R	1	
0x008B	0x0200	3640	CONT OP RESET_F_14	F001		R	1	
0x008B	0x0400	3641	CONT OP RESET_F_15	F001		R	1	
0x008B	0x0800	3642	CONT OP RESET_F_16	F001		R	1	
0x008B	0x1000	3643	CONT OP_F_01	F001		R	1	
0x008B	0x2000	3644	CONT OP_F_02	F001		R	1	
0x008B	0x4000	3645	CONT OP_F_03	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x008B	0x8000	3646	CONT OP_F_04	F001		R	1	
0x008B	0x0001	3647	CONT OP_F_05	F001		R	1	
0x008B	0x0002	3648	CONT OP_F_06	F001		R	1	
0x008B	0x0004	3649	CONT OP_F_07	F001		R	1	
0x008B	0x0008	3650	CONT OP_F_08	F001		R	1	
0x008B	0x0010	3651	CONT OP_F_09	F001		R	1	
0x008B	0x0020	3652	CONT OP_F_10	F001		R	1	
0x008B	0x0040	3653	CONT OP_F_11	F001		R	1	
0x008B	0x0080	3654	CONT OP_F_12	F001		R	1	
0x008C	0x0100	3655	CONT OP_F_13	F001		R	1	
0x008C	0x0200	3656	CONT OP_F_14	F001		R	1	
0x008C	0x0400	3657	CONT OP_F_15	F001		R	1	
0x008C	0x0800	3658	CONT OP_F_16	F001		R	1	
0x008C	0x1000	3659	BOARD F STATUS	F001		R	1	
0x008C	0x2000	11275	COIL A OPEN ST	F001		R	1	
0x008C	0x4000	11276	COIL A CLOSE ST	F001		R	1	
0x008C	0x8000	11277	COIL B OPEN ST	F001		R	1	
0x008C	0x0001	11278	COIL B CLOSE ST	F001		R	1	
0x008C	0x0002	11279	COIL C OPEN ST	F001		R	1	
0x008C	0x0004	11280	COIL C CLOSE ST	F001		R	1	
0x008C	0x0008	11281	COIL A OPEN OP	F001		R	1	
0x008C	0x0010	11282	COIL A CLOSE OP	F001		R	1	
0x008C	0x0020	11283	COIL B OPEN OP	F001		R	1	
0x008C	0x0040	11284	COIL B CLOSE OP	F001		R	1	
0x008C	0x0080	11285	COIL C OPEN OP	F001		R	1	
0x008D	0x0100	11286	COIL C CLOSE OP	F001		R	1	
0x00AC	0x2000	3777	CONT IP_G_CC1	F001		R	1	
0x00AC	0x4000	3778	CONT IP_G_CC2	F001		R	1	
0x00AC	0x8000	3779	CONT IP_G_CC3	F001		R	1	
0x00AC	0x0001	3780	CONT IP_G_CC4	F001		R	1	
0x00AC	0x0002	3781	CONT IP_G_CC5	F001		R	1	
0x00AC	0x0004	3782	CONT IP_G_CC6	F001		R	1	
0x00AC	0x0008	3783	CONT IP_G_CC7	F001		R	1	
0x00AC	0x0010	3784	CONT IP_G_CC8	F001		R	1	
0x00AC	0x0020	3785	CONT IP_G_CC9	F001		R	1	
0x00AC	0x0040	3786	CONT IP_G_CC10	F001		R	1	
0x00AC	0x0080	3787	CONT IP_G_CC11	F001		R	1	
0x00AD	0x0100	3788	CONT IP_G_CC12	F001		R	1	
0x00AD	0x0200	3789	CONT IP_G_CC13	F001		R	1	
0x00AD	0x0400	3790	CONT IP_G_CC14	F001		R	1	
0x00AD	0x0800	3791	CONT IP_G_CC15	F001		R	1	
0x00AD	0x1000	3792	CONT IP_G_CC16	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x00AD	0x2000	3793	CONT IP_G_CC17	F001		R	1	
0x00AD	0x4000	3794	CONT IP_G_CC18	F001		R	1	
0x00AD	0x8000	3795	CONT IP_G_CC19	F001		R	1	
0x00AD	0x0001	3796	CONT IP_G_CC20	F001		R	1	
0x00AD	0x0002	3797	CONT IP_G_CC21	F001		R	1	
0x00AD	0x0004	3798	CONT IP_G_CC22	F001		R	1	
0x00AD	0x0008	3799	CONT IP_G_CC23	F001		R	1	
0x00AD	0x0010	3800	CONT IP_G_CC24	F001		R	1	
0x00AD	0x0020	3801	CONT IP_G_CC25	F001		R	1	
0x00AD	0x0040	3802	CONT IP_G_CC26	F001		R	1	
0x00AD	0x0080	3803	CONT IP_G_CC27	F001		R	1	
0x00AE	0x0100	3804	CONT IP_G_CC28	F001		R	1	
0x00AE	0x0200	3805	CONT IP_G_CC29	F001		R	1	
0x00AE	0x0400	3806	CONT IP_G_CC30	F001		R	1	
0x00AE	0x0800	3807	CONT IP_G_CC31	F001		R	1	
0x00AE	0x1000	3808	CONT IP_G_CC32	F001		R	1	
0x00AE	0x2000	3809	CONT OP OPER_G_01	F001		R	1	
0x00AE	0x4000	3810	CONT OP OPER_G_02	F001		R	1	
0x00AE	0x8000	3811	CONT OP OPER_G_03	F001		R	1	
0x00AE	0x0001	3812	CONT OP OPER_G_04	F001		R	1	
0x00AE	0x0002	3813	CONT OP OPER_G_05	F001		R	1	
0x00AE	0x0004	3814	CONT OP OPER_G_06	F001		R	1	
0x00AE	0x0008	3815	CONT OP OPER_G_07	F001		R	1	
0x00AE	0x0010	3816	CONT OP OPER_G_08	F001		R	1	
0x00AE	0x0020	3817	CONT OP OPER_G_09	F001		R	1	
0x00AE	0x0040	3818	CONT OP OPER_G_10	F001		R	1	
0x00AE	0x0080	3819	CONT OP OPER_G_11	F001		R	1	
0x00AF	0x0100	3820	CONT OP OPER_G_12	F001		R	1	
0x00AF	0x0200	3821	CONT OP OPER_G_13	F001		R	1	
0x00AF	0x0400	3822	CONT OP OPER_G_14	F001		R	1	
0x00AF	0x0800	3823	CONT OP OPER_G_15	F001		R	1	
0x00AF	0x1000	3824	CONT OP OPER_G_16	F001		R	1	
0x00AF	0x2000	3825	CONT OP RESET_G_01	F001		R	1	
0x00AF	0x4000	3826	CONT OP RESET_G_02	F001		R	1	
0x00AF	0x8000	3827	CONT OP RESET_G_03	F001		R	1	
0x00AF	0x0001	3828	CONT OP RESET_G_04	F001		R	1	
0x00AF	0x0002	3829	CONT OP RESET_G_05	F001		R	1	
0x00AF	0x0004	3830	CONT OP RESET_G_06	F001		R	1	
0x00AF	0x0008	3831	CONT OP RESET_G_07	F001		R	1	
0x00AF	0x0010	3832	CONT OP RESET_G_08	F001		R	1	
0x00AF	0x0020	3833	CONT OP RESET_G_09	F001		R	1	
0x00AF	0x0040	3834	CONT OP RESET_G_10	F001		R	1	
0x00AF	0x0080	3835	CONT OP RESET_G_11	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x00B0	0x0100	3836	CONT OP RESET_G_12	F001		R	1	
0x00B0	0x0200	3837	CONT OP RESET_G_13	F001		R	1	
0x00B0	0x0400	3838	CONT OP RESET_G_14	F001		R	1	
0x00B0	0x0800	3839	CONT OP RESET_G_15	F001		R	1	
0x00B0	0x1000	3840	CONT OP RESET_G_16	F001		R	1	
0x00B0	0x2000	3841	CONT OP_G_01	F001		R	1	
0x00B0	0x4000	3842	CONT OP_G_02	F001		R	1	
0x00B0	0x8000	3843	CONT OP_G_03	F001		R	1	
0x00B0	0x0001	3844	CONT OP_G_04	F001		R	1	
0x00B0	0x0002	3845	CONT OP_G_05	F001		R	1	
0x00B0	0x0004	3846	CONT OP_G_06	F001		R	1	
0x00B0	0x0008	3847	CONT OP_G_07	F001		R	1	
0x00B0	0x0010	3848	CONT OP_G_08	F001		R	1	
0x00B0	0x0020	3849	CONT OP_G_09	F001		R	1	
0x00B0	0x0040	3850	CONT OP_G_10	F001		R	1	
0x00B0	0x0080	3851	CONT OP_G_11	F001		R	1	
0x00B1	0x0100	3852	CONT OP_G_12	F001		R	1	
0x00B1	0x0200	3853	CONT OP_G_13	F001		R	1	
0x00B1	0x0400	3854	CONT OP_G_14	F001		R	1	
0x00B1	0x0800	3855	CONT OP_G_15	F001		R	1	
0x00B1	0x1000	3856	CONT OP_G_16	F001		R	1	
0x00B1	0x2000	3857	BOARD G STATUS	F001		R	1	
0x00D1	0x4000	3874	READY LED	F001		R	1	
0x00D1	0x8000	3875	LED 1	F001		R	1	
0x00D1	0x0001	3876	LED 2	F001		R	1	
0x00D1	0x0002	3877	LED 3	F001		R	1	
0x00D1	0x0004	3878	LED 4	F001		R	1	
0x00D1	0x0008	3879	LED 5	F001		R	1	
0x00D1	0x0010	3880	LED 6	F001		R	1	
0x00D1	0x0020	3881	LED 7	F001		R	1	
0x00D1	0x0040	3882	LED 8	F001		R	1	
0x00D1	0x0080	3883	LED 9	F001		R	1	
0x00D2	0x0100	3884	LED 10	F001		R	1	
0x00D2	0x0200	3885	LED 11	F001		R	1	
0x00D2	0x0400	3886	LED 12	F001		R	1	
0x00D2	0x0800	3887	LED 13	F001		R	1	
0x00D2	0x1000	3888	LED 14	F001		R	1	
0x00D2	0x2000	3889	LED 15	F001		R	1	
0x00D2	0x4000	3890	I Key	F001		R	1	
0x00D2	0x8000	3891	O Key	F001		R	1	
0x00D2	0x0001	3892	* Key	F001		R	1	
0x00D2	0x0002	3893	F1 Key	F001		R	1	
0x00D2	0x0004	3894	F2 Key	F001		R	1	
0x00D2	0x0008	3895	LOCAL OPERATION MODE	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x00D2	0x0010	3896	OPERATIONS BLOCKED	F001		R	1	
0x00D2	0x0020	11708	Self-Test DSP Fault	F001		R	1	
0x00D2	0x0040	11709	Magnetics Fault	F001		R	1	
0x00D2	0x0080	6839	LED RESET INPUT	F001		R	1	
0x00D3	0x0100	7784	CHANGE LOCAL-REMOTE	F001		R	1	
0x00D3	0x0200	7785	CHANGE OP BLOCKED	F001		R	1	
0x00D3	0x1000	7997	HMI BACKLIGHT ON	F001		R	1	
0x00D3	0x2000	7998	HMI BACKLIGHT OFF	F001		R	1	
0x00D4	0x4000	9333	OUT OF SERVICE	F001		R	1	
0x00D4	0x8000	11710	Logics Fault	F001		R	1	
0x00D4	0x0001	10456	General Trip	F001		R	1	
0x00D4	0x0002	11711	Network Fault	F001		R	1	
0x00D4	0x0004	10480	ST HMI BACKLIGHT	F001		R	1	
0x00D4	0x0008	11712	Order Code Fault	F001		R	1	
0x00D4	0x0010	11715	Link Status Port E	F001		R	1	
0x00D4	0x0020	11716	Link Status Port A	F001		R	1	
0x00D4	0x0040	11717	Link Status Port B	F001		R	1	
0x00F2	0x0080	3994	PH IOC1 HIGH A BLK	F001		R	1	
0x00F3	0x0100	3995	PH IOC1 HIGH B BLK	F001		R	1	
0x00F3	0x0200	3996	PH IOC1 HIGH C BLK	F001		R	1	
0x00F3	0x0400	3997	PH IOC1 HIGH A PKP	F001		R	1	
0x00F3	0x0800	3998	PH IOC1 HIGH A OP	F001		R	1	
0x00F3	0x1000	3999	PH IOC1 HIGH B PKP	F001		R	1	
0x00F3	0x2000	4000	PH IOC1 HIGH B OP	F001		R	1	
0x00F3	0x4000	4001	PH IOC1 HIGH C PKP	F001		R	1	
0x00F3	0x8000	4002	PH IOC1 HIGH C OP	F001		R	1	
0x00F3	0x0001	4003	PH IOC1 HIGH PKP	F001		R	1	
0x00F3	0x0002	4004	PH IOC1 HIGH OP	F001		R	1	
0x00F8	0x0004	4010	PH IOC2 HIGH A BLK	F001		R	1	
0x00F8	0x0008	4011	PH IOC2 HIGH B BLK	F001		R	1	
0x00F8	0x0010	4012	PH IOC2 HIGH C BLK	F001		R	1	
0x00F8	0x0020	4013	PH IOC2 HIGH A PKP	F001		R	1	
0x00F8	0x0040	4014	PH IOC2 HIGH A OP	F001		R	1	
0x00F8	0x0080	4015	PH IOC2 HIGH B PKP	F001		R	1	
0x00F9	0x0100	4016	PH IOC2 HIGH B OP	F001		R	1	
0x00F9	0x0200	4017	PH IOC2 HIGH C PKP	F001		R	1	
0x00F9	0x0400	4018	PH IOC2 HIGH C OP	F001		R	1	
0x00F9	0x0800	4019	PH IOC2 HIGH PKP	F001		R	1	
0x00F9	0x1000	4020	PH IOC2 HIGH OP	F001		R	1	
0x00FE	0x2000	4026	PH IOC3 HIGH A BLK	F001		R	1	
0x00FE	0x4000	4027	PH IOC3 HIGH B BLK	F001		R	1	
0x00FE	0x8000	4028	PH IOC3 HIGH C BLK	F001		R	1	
0x00FE	0x0001	4029	PH IOC3 HIGH A PKP	F001		R	1	
0x00FE	0x0002	4030	PH IOC3 HIGH A OP	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x00FE	0x0004	4031	PH IOC3 HIGH B PKP	F001		R	1	
0x00FE	0x0008	4032	PH IOC3 HIGH B OP	F001		R	1	
0x00FE	0x0010	4033	PH IOC3 HIGH C PKP	F001		R	1	
0x00FE	0x0020	4034	PH IOC3 HIGH C OP	F001		R	1	
0x00FE	0x0040	4035	PH IOC3 HIGH PKP	F001		R	1	
0x00FE	0x0080	4036	PH IOC3 HIGH OP	F001		R	1	
0x0104	0x0100	4042	PH IOC1 LOW A BLK	F001		R	1	
0x0104	0x0200	4043	PH IOC1 LOW B BLK	F001		R	1	
0x0104	0x0400	4044	PH IOC1 LOW C BLK	F001		R	1	
0x0104	0x0800	4045	PH IOC1 LOW A PKP	F001		R	1	
0x0104	0x1000	4046	PH IOC1 LOW A OP	F001		R	1	
0x0104	0x2000	4047	PH IOC1 LOW B PKP	F001		R	1	
0x0104	0x4000	4048	PH IOC1 LOW B OP	F001		R	1	
0x0104	0x8000	4049	PH IOC1 LOW C PKP	F001		R	1	
0x0104	0x0001	4050	PH IOC1 LOW C OP	F001		R	1	
0x0104	0x0002	4051	PH IOC1 LOW PKP	F001		R	1	
0x0104	0x0004	4052	PH IOC1 LOW OP	F001		R	1	
0x0109	0x0008	4058	PH IOC2 LOW A BLK	F001		R	1	
0x0109	0x0010	4059	PH IOC2 LOW B BLK	F001		R	1	
0x0109	0x0020	4060	PH IOC2 LOW C BLK	F001		R	1	
0x0109	0x0040	4061	PH IOC2 LOW A PKP	F001		R	1	
0x0109	0x0080	4062	PH IOC2 LOW A OP	F001		R	1	
0x010A	0x0100	4063	PH IOC2 LOW B PKP	F001		R	1	
0x010A	0x0200	4064	PH IOC2 LOW B OP	F001		R	1	
0x010A	0x0400	4065	PH IOC2 LOW C PKP	F001		R	1	
0x010A	0x0800	4066	PH IOC2 LOW C OP	F001		R	1	
0x010A	0x1000	4067	PH IOC2 LOW PKP	F001		R	1	
0x010A	0x2000	4068	PH IOC2 LOW OP	F001		R	1	
0x010F	0x4000	4074	PH IOC3 LOW A BLK	F001		R	1	
0x010F	0x8000	4075	PH IOC3 LOW B BLK	F001		R	1	
0x010F	0x0001	4076	PH IOC3 LOW C BLK	F001		R	1	
0x010F	0x0002	4077	PH IOC3 LOW A PKP	F001		R	1	
0x010F	0x0004	4078	PH IOC3 LOW A OP	F001		R	1	
0x010F	0x0008	4079	PH IOC3 LOW B PKP	F001		R	1	
0x010F	0x0010	4080	PH IOC3 LOW B OP	F001		R	1	
0x010F	0x0020	4081	PH IOC3 LOW C PKP	F001		R	1	
0x010F	0x0040	4082	PH IOC3 LOW C OP	F001		R	1	
0x010F	0x0080	4083	PH IOC3 LOW PKP	F001		R	1	
0x0110	0x0100	4084	PH IOC3 LOW OP	F001		R	1	
0x0115	0x0200	4089	NEUTRAL IOC1 BLOCK	F001		R	1	
0x0115	0x0400	4090	NEUTRAL IOC1 PKP	F001		R	1	
0x0115	0x0800	4091	NEUTRAL IOC1 OP	F001		R	1	
0x011A	0x1000	4096	NEUTRAL IOC2 BLOCK	F001		R	1	
0x011A	0x2000	4097	NEUTRAL IOC2 PKP	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x011A	0x4000	4098	NEUTRAL IOC2 OP	F001		R	1	
0x011F	0x8000	4103	NEUTRAL IOC3 BLOCK	F001		R	1	
0x011F	0x0001	4104	NEUTRAL IOC3 PKP	F001		R	1	
0x011F	0x0002	4105	NEUTRAL IOC3 OP	F001		R	1	
0x0124	0x0004	4111	GROUND IOC1 BLOCK	F001		R	1	
0x0124	0x0008	4112	GROUND IOC1 PKP	F001		R	1	
0x0124	0x0010	4113	GROUND IOC1 OP	F001		R	1	
0x0129	0x0020	4119	GROUND IOC2 BLOCK	F001		R	1	
0x0129	0x0040	4120	GROUND IOC2 PKP	F001		R	1	
0x0129	0x0080	4121	GROUND IOC2 OP	F001		R	1	
0x012F	0x0100	4127	GROUND IOC3 BLOCK	F001		R	1	
0x012F	0x0200	4128	GROUND IOC3 PKP	F001		R	1	
0x012F	0x0400	4129	GROUND IOC3 OP	F001		R	1	
0x0134	0x0800	4135	SENS GND IOC1 BLK	F001		R	1	
0x0134	0x1000	4136	SENS GND IOC1 PKP	F001		R	1	
0x0134	0x2000	4137	SENS GND IOC1 OP	F001		R	1	
0x0139	0x4000	4143	SENS GND IOC2 BLK	F001		R	1	
0x0139	0x8000	4144	SENS GND IOC2 PKP	F001		R	1	
0x0139	0x0001	4145	SENS GND IOC2 OP	F001		R	1	
0x013E	0x0002	4151	SENS GND IOC3 BLK	F001		R	1	
0x013E	0x0004	4152	SENS GND IOC3 PKP	F001		R	1	
0x013E	0x0008	4153	SENS GND IOC3 OP	F001		R	1	
0x0143	0x0010	4161	PH TOC1 HIGH A BLK	F001		R	1	
0x0143	0x0020	4162	PH TOC1 HIGH B BLK	F001		R	1	
0x0143	0x0040	4163	PH TOC1 HIGH C BLK	F001		R	1	
0x0143	0x0080	4164	PH TOC1 HIGH A PKP	F001		R	1	
0x0144	0x0100	4165	PH TOC1 HIGH A OP	F001		R	1	
0x0144	0x0200	4166	PH TOC1 HIGH B PKP	F001		R	1	
0x0144	0x0400	4167	PH TOC1 HIGH B OP	F001		R	1	
0x0144	0x0800	4168	PH TOC1 HIGH C PKP	F001		R	1	
0x0144	0x1000	4169	PH TOC1 HIGH C OP	F001		R	1	
0x0144	0x2000	4170	PH TOC1 HIGH PKP	F001		R	1	
0x0144	0x4000	4171	PH TOC1 HIGH OP	F001		R	1	
0x0149	0x8000	4179	PH TOC2 HIGH A BLK	F001		R	1	
0x0149	0x0001	4180	PH TOC2 HIGH B BLK	F001		R	1	
0x0149	0x0002	4181	PH TOC2 HIGH C BLK	F001		R	1	
0x0149	0x0004	4182	PH TOC2 HIGH A PKP	F001		R	1	
0x0149	0x0008	4183	PH TOC2 HIGH A OP	F001		R	1	
0x0149	0x0010	4184	PH TOC2 HIGH B PKP	F001		R	1	
0x0149	0x0020	4185	PH TOC2 HIGH B OP	F001		R	1	
0x0149	0x0040	4186	PH TOC2 HIGH C PKP	F001		R	1	
0x0149	0x0080	4187	PH TOC2 HIGH C OP	F001		R	1	
0x014A	0x0100	4188	PH TOC2 HIGH PKP	F001		R	1	
0x014A	0x0200	4189	PH TOC2 HIGH OP	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x014F	0x0400	4197	PH TOC3 HIGH A BLK	F001		R	1	
0x014F	0x0800	4198	PH TOC3 HIGH B BLK	F001		R	1	
0x014F	0x1000	4199	PH TOC3 HIGH C BLK	F001		R	1	
0x014F	0x2000	4200	PH TOC3 HIGH A PKP	F001		R	1	
0x014F	0x4000	4201	PH TOC3 HIGH A OP	F001		R	1	
0x014F	0x8000	4202	PH TOC3 HIGH B PKP	F001		R	1	
0x014F	0x0001	4203	PH TOC3 HIGH B OP	F001		R	1	
0x014F	0x0002	4204	PH TOC3 HIGH C PKP	F001		R	1	
0x014F	0x0004	4205	PH TOC3 HIGH C OP	F001		R	1	
0x014F	0x0008	4206	PH TOC3 HIGH PKP	F001		R	1	
0x014F	0x0010	4207	PH TOC3 HIGH OP	F001		R	1	
0x0154	0x0020	4213	NEUTRAL TOC1 BLOCK	F001		R	1	
0x0154	0x0040	4214	NEUTRAL TOC1 PKP	F001		R	1	
0x0154	0x0080	4215	NEUTRAL TOC1 OP	F001		R	1	
0x015A	0x0100	4221	NEUTRAL TOC2 BLOCK	F001		R	1	
0x015A	0x0200	4222	NEUTRAL TOC2 PKP	F001		R	1	
0x015A	0x0400	4223	NEUTRAL TOC2 OP	F001		R	1	
0x015F	0x0800	4229	NEUTRAL TOC3 BLOCK	F001		R	1	
0x015F	0x1000	4230	NEUTRAL TOC3 PKP	F001		R	1	
0x015F	0x2000	4231	NEUTRAL TOC3 OP	F001		R	1	
0x0164	0x4000	4238	GROUND TOC1 BLOCK	F001		R	1	
0x0164	0x8000	4239	GROUND TOC1 PKP	F001		R	1	
0x0164	0x0001	4240	GROUND TOC1 OP	F001		R	1	
0x0169	0x0002	4247	GROUND TOC2 BLOCK	F001		R	1	
0x0169	0x0004	4248	GROUND TOC2 PKP	F001		R	1	
0x0169	0x0008	4249	GROUND TOC2 OP	F001		R	1	
0x016E	0x0010	4256	GROUND TOC3 BLOCK	F001		R	1	
0x016E	0x0020	4257	GROUND TOC3 PKP	F001		R	1	
0x016E	0x0040	4258	GROUND TOC3 OP	F001		R	1	
0x0173	0x0080	4265	SENS GND TOC1 BLOCK	F001		R	1	
0x0174	0x0100	4266	SENS GND TOC1 PKP	F001		R	1	
0x0174	0x0200	4267	SENS GND TOC1 OP	F001		R	1	
0x0179	0x0400	4274	SENS GND TOC2 BLOCK	F001		R	1	
0x0179	0x0800	4275	SENS GND TOC2 PKP	F001		R	1	
0x0179	0x1000	4276	SENS GND TOC2 OP	F001		R	1	
0x017E	0x2000	4283	SENS GND TOC3 BLOCK	F001		R	1	
0x017E	0x4000	4284	SENS GND TOC3 PKP	F001		R	1	
0x017E	0x8000	4285	SENS GND TOC3 OP	F001		R	1	
0x0183	0x0001	4294	LOAD PHASE UV1 BLK	F001		R	1	
0x0183	0x0002	4295	LOAD PHASE UV1 A PKP	F001		R	1	
0x0183	0x0004	4296	LOAD PHASE UV1 A OP	F001		R	1	
0x0183	0x0008	4297	LOAD PHASE UV1 B PKP	F001		R	1	
0x0183	0x0010	4298	LOAD PHASE UV1 B OP	F001		R	1	
0x0183	0x0020	4299	LOAD PHASE UV1 C PKP	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0183	0x0040	4300	LOAD PHASE UV1 C OP	F001		R	1	
0x0183	0x0080	4301	LOAD PHASE UV1 AB PKP	F001		R	1	
0x0184	0x0100	4302	LOAD PHASE UV1 AB OP	F001		R	1	
0x0184	0x0200	4303	LOAD PHASE UV1 BC PKP	F001		R	1	
0x0184	0x0400	4304	LOAD PHASE UV1 BC OP	F001		R	1	
0x0184	0x0800	4305	LOAD PHASE UV1 CA PKP	F001		R	1	
0x0184	0x1000	4306	LOAD PHASE UV1 CA OP	F001		R	1	
0x0184	0x2000	4307	LOAD PHASE UV1 PKP	F001		R	1	
0x0184	0x4000	4308	LOAD PHASE UV1 OP	F001		R	1	
0x0189	0x8000	4317	LOAD PHASE UV2 BLK	F001		R	1	
0x0189	0x0001	4318	LOAD PHASE UV2 A PKP	F001		R	1	
0x0189	0x0002	4319	LOAD PHASE UV2 A OP	F001		R	1	
0x0189	0x0004	4320	LOAD PHASE UV2 B PKP	F001		R	1	
0x0189	0x0008	4321	LOAD PHASE UV2 B OP	F001		R	1	
0x0189	0x0010	4322	LOAD PHASE UV2 C PKP	F001		R	1	
0x0189	0x0020	4323	LOAD PHASE UV2 C OP	F001		R	1	
0x0189	0x0040	4324	LOAD PHASE UV2 AB PKP	F001		R	1	
0x0189	0x0080	4325	LOAD PHASE UV2 AB OP	F001		R	1	
0x018A	0x0100	4326	LOAD PHASE UV2 BC PKP	F001		R	1	
0x018A	0x0200	4327	LOAD PHASE UV2 BC OP	F001		R	1	
0x018A	0x0400	4328	LOAD PHASE UV2 CA PKP	F001		R	1	
0x018A	0x0800	4329	LOAD PHASE UV2 CA OP	F001		R	1	
0x018A	0x1000	4330	LOAD PHASE UV2 PKP	F001		R	1	
0x018A	0x2000	4331	LOAD PHASE UV2 OP	F001		R	1	
0x018F	0x4000	4340	LOAD PHASE UV3 BLK	F001		R	1	
0x018F	0x8000	4341	LOAD PHASE UV3 A PKP	F001		R	1	
0x018F	0x0001	4342	LOAD PHASE UV3 A OP	F001		R	1	
0x018F	0x0002	4343	LOAD PHASE UV3 B PKP	F001		R	1	
0x018F	0x0004	4344	LOAD PHASE UV3 B OP	F001		R	1	
0x018F	0x0008	4345	LOAD PHASE UV3 C PKP	F001		R	1	
0x018F	0x0010	4346	LOAD PHASE UV3 C OP	F001		R	1	
0x018F	0x0020	4347	LOAD PHASE UV3 AB PKP	F001		R	1	
0x018F	0x0040	4348	LOAD PHASE UV3 AB OP	F001		R	1	
0x018F	0x0080	4349	LOAD PHASE UV3 BC PKP	F001		R	1	
0x0190	0x0100	4350	LOAD PHASE UV3 BC OP	F001		R	1	
0x0190	0x0200	4351	LOAD PHASE UV3 CA PKP	F001		R	1	
0x0190	0x0400	4352	LOAD PHASE UV3 CA OP	F001		R	1	
0x0190	0x0800	4353	LOAD PHASE UV3 PKP	F001		R	1	
0x0190	0x1000	4354	LOAD PHASE UV3 OP	F001		R	1	
0x0195	0x2000	4359	LOAD NEG SEQ OV1 BLK	F001		R	1	
0x0195	0x4000	4360	LOAD NEG SEQ OV1 PKP	F001		R	1	
0x0195	0x8000	4361	LOAD NEG SEQ OV1 OP	F001		R	1	
0x019A	0x0001	4366	LOAD NEG SEQ OV2 BLK	F001		R	1	
0x019A	0x0002	4367	LOAD NEG SEQ OV2 PKP	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x019A	0x0004	4368	LOAD NEG SEQ OV2 OP	F001		R	1	
0x019F	0x0008	4373	LOAD NEG SEQ OV3 BLK	F001		R	1	
0x019F	0x0010	4374	LOAD NEG SEQ OV3 PKP	F001		R	1	
0x019F	0x0020	4375	LOAD NEG SEQ OV3 OP	F001		R	1	
0x01A4	0x0040	4381	THERMAL1 BLOCK	F001		R	1	
0x01A4	0x0080	4382	THERMAL1 A RST	F001		R	1	
0x01A5	0x0100	4383	THERMAL1 B RST	F001		R	1	
0x01A5	0x0200	4384	THERMAL1 C RST	F001		R	1	
0x01A5	0x0400	4385	THERMAL1 ALARM	F001		R	1	
0x01A5	0x0800	4386	THERMAL1 OP	F001		R	1	
0x01A5	0x1000	4387	THERMAL1 A ALRM	F001		R	1	
0x01A5	0x2000	4388	THERMAL1 A OP	F001		R	1	
0x01A5	0x4000	4389	THERMAL1 B ALRM	F001		R	1	
0x01A5	0x8000	4390	THERMAL1 B OP	F001		R	1	
0x01A5	0x0001	4391	THERMAL1 C ALRM	F001		R	1	
0x01A5	0x0002	4392	THERMAL1 C OP	F001		R	1	
0x01AA	0x0004	4401	THERMAL2 BLOCK	F001		R	1	
0x01AA	0x0008	4402	THERMAL2 A RST	F001		R	1	
0x01AA	0x0010	4403	THERMAL2 B RST	F001		R	1	
0x01AA	0x0020	4404	THERMAL2 C RST	F001		R	1	
0x01AA	0x0040	4405	THERMAL2 ALARM	F001		R	1	
0x01AA	0x0080	4406	THERMAL2 OP	F001		R	1	
0x01AB	0x0100	4407	THERMAL2 A ALRM	F001		R	1	
0x01AB	0x0200	4408	THERMAL2 A OP	F001		R	1	
0x01AB	0x0400	4409	THERMAL2 B ALRM	F001		R	1	
0x01AB	0x0800	4410	THERMAL2 B OP	F001		R	1	
0x01AB	0x1000	4411	THERMAL2 C ALRM	F001		R	1	
0x01AB	0x2000	4412	THERMAL2 C OP	F001		R	1	
0x01B0	0x4000	4421	THERMAL3 BLOCK	F001		R	1	
0x01B0	0x8000	4422	THERMAL3 A RST	F001		R	1	
0x01B0	0x0001	4423	THERMAL3 B RST	F001		R	1	
0x01B0	0x0002	4424	THERMAL3 C RST	F001		R	1	
0x01B0	0x0004	4425	THERMAL3 ALARM	F001		R	1	
0x01B0	0x0008	4426	THERMAL3 OP	F001		R	1	
0x01B0	0x0010	4427	THERMAL3 A ALRM	F001		R	1	
0x01B0	0x0020	4428	THERMAL3 A OP	F001		R	1	
0x01B0	0x0040	4429	THERMAL3 B ALRM	F001		R	1	
0x01B0	0x0080	4430	THERMAL3 B OP	F001		R	1	
0x01B1	0x0100	4431	THERMAL3 C ALRM	F001		R	1	
0x01B1	0x0200	4432	THERMAL3 C OP	F001		R	1	
0x01B6	0x0400	4441	PHASE DIR1 BLK INP	F001		R	1	
0x01B6	0x0800	4442	PHASE DIR1 BLOCK A	F001		R	1	
0x01B6	0x1000	4443	PHASE DIR1 A OP	F001		R	1	
0x01B6	0x2000	4444	PHASE DIR1 BLOCK B	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x01B6	0x4000	4445	PHASE DIR1 B OP	F001		R	1	
0x01B6	0x8000	4446	PHASE DIR1 BLOCK C	F001		R	1	
0x01B6	0x0001	4447	PHASE DIR1 C OP	F001		R	1	
0x01BB	0x0002	4453	PHASE DIR2 BLK INP	F001		R	1	
0x01BB	0x0004	4454	PHASE DIR2 BLOCK A	F001		R	1	
0x01BB	0x0008	4455	PHASE DIR2 A OP	F001		R	1	
0x01BB	0x0010	4456	PHASE DIR2 BLOCK B	F001		R	1	
0x01BB	0x0020	4457	PHASE DIR2 B OP	F001		R	1	
0x01BB	0x0040	4458	PHASE DIR2 BLOCK C	F001		R	1	
0x01BB	0x0080	4459	PHASE DIR2 C OP	F001		R	1	
0x01C1	0x0100	4465	PHASE DIR3 BLK INP	F001		R	1	
0x01C1	0x0200	4466	PHASE DIR3 BLOCK A	F001		R	1	
0x01C1	0x0400	4467	PHASE DIR3 A OP	F001		R	1	
0x01C1	0x0800	4468	PHASE DIR3 BLOCK B	F001		R	1	
0x01C1	0x1000	4469	PHASE DIR3 B OP	F001		R	1	
0x01C1	0x2000	4470	PHASE DIR3 BLOCK C	F001		R	1	
0x01C1	0x4000	4471	PHASE DIR3 C OP	F001		R	1	
0x01C6	0x8000	4478	NEUTRAL DIR1 BLK INP	F001		R	1	
0x01C6	0x0001	4479	NEUTRAL DIR1 BLOCK	F001		R	1	
0x01C6	0x0002	4480	NEUTRAL DIR1 OP	F001		R	1	
0x01CB	0x0004	4487	NEUTRAL DIR2 BLK INP	F001		R	1	
0x01CB	0x0008	4488	NEUTRAL DIR2 BLOCK	F001		R	1	
0x01CB	0x0010	4489	NEUTRAL DIR2 OP	F001		R	1	
0x01D0	0x0020	4496	NEUTRAL DIR3 BLK INP	F001		R	1	
0x01D0	0x0040	4497	NEUTRAL DIR3 BLOCK	F001		R	1	
0x01D0	0x0080	4498	NEUTRAL DIR3 OP	F001		R	1	
0x01D6	0x0100	4505	GROUND DIR1 BLK INP	F001		R	1	
0x01D6	0x0200	4506	GROUND DIR1 BLOCK	F001		R	1	
0x01D6	0x0400	4507	GROUND DIR1 OP	F001		R	1	
0x01DB	0x0800	4514	GROUND DIR2 BLK INP	F001		R	1	
0x01DB	0x1000	4515	GROUND DIR2 BLOCK	F001		R	1	
0x01DB	0x2000	4516	GROUND DIR2 OP	F001		R	1	
0x01E0	0x4000	4523	GROUND DIR3 BLK INP	F001		R	1	
0x01E0	0x8000	4524	GROUND DIR3 BLOCK	F001		R	1	
0x01E0	0x0001	4525	GROUND DIR3 OP	F001		R	1	
0x01EB	0x0100	4545	VT FUSE FAILURE	F001		R	1	
0x01F0	0x0200	4558	SYNCROCHECK BLK INP	F001		R	1	
0x01F0	0x0400	4559	SYNCROCHECK OP	F001		R	1	
0x01F0	0x0800	4560	SYNCHK CLOSE PERM	F001		R	1	
0x01F0	0x1000	4561	SYNCROCHECK COND OP	F001		R	1	
0x01F0	0x2000	4562	DEAD LOAD - DEAD SRC	F001		R	1	
0x01F0	0x4000	4563	DEAD LOAD - LIVE SRC	F001		R	1	
0x01F0	0x8000	4564	LIVE LOAD - DEAD SRC	F001		R	1	
0x01F0	0x0001	4565	SLIP CONDITION	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x01F0	0x0002	4566	SRC FREQ > LOAD FREQ	F001		R	1	
0x01F0	0x0004	4567	SRC FREQ < LOAD FREQ	F001		R	1	
0x01F0	0x0008	11682	FORCE SYNC TRAD	F001		R	1	
0x01F0	0x0010	11683	MAX FREQ DIFFERENCE	F001		R	1	
0x01F0	0x0020	11684	MAX ROC OF SLIP	F001		R	1	
0x01FC	0x1000	4612	LOAD NEUTRAL OV1 BLK	F001		R	1	
0x01FC	0x2000	4613	LOAD NEUTRAL OV1 PKP	F001		R	1	
0x01FC	0x4000	4614	LOAD NEUTRAL OV1 OP	F001		R	1	
0x0201	0x8000	4619	LOAD NEUTRAL OV2 BLK	F001		R	1	
0x0201	0x0001	4620	LOAD NEUTRAL OV2 PKP	F001		R	1	
0x0201	0x0002	4621	LOAD NEUTRAL OV2 OP	F001		R	1	
0x0206	0x0004	4626	LOAD NEUTRAL OV3 BLK	F001		R	1	
0x0206	0x0008	4627	LOAD NEUTRAL OV3 PKP	F001		R	1	
0x0206	0x0010	4628	LOAD NEUTRAL OV3 OP	F001		R	1	
0x020B	0x0020	4633	SRC NEUTRAL OV1 BLK	F001		R	1	
0x020B	0x0040	4634	SRC NEUTRAL OV1 PKP	F001		R	1	
0x020B	0x0080	4635	SRC NEUTRAL OV1 OP	F001		R	1	
0x0211	0x0100	4640	SRC NEUTRAL OV2 BLK	F001		R	1	
0x0211	0x0200	4641	SRC NEUTRAL OV2 PKP	F001		R	1	
0x0211	0x0400	4642	SRC NEUTRAL OV2 OP	F001		R	1	
0x0216	0x0800	4647	SRC NEUTRAL OV3 BLK	F001		R	1	
0x0216	0x1000	4648	SRC NEUTRAL OV3 PKP	F001		R	1	
0x0216	0x2000	4649	SRC NEUTRAL OV3 OP	F001		R	1	
0x022A	0x0080	4676	LOAD PHASE OV1 BLK	F001		R	1	
0x022B	0x0100	4677	LOAD PHASE OV1 AB PKP	F001		R	1	
0x022B	0x0200	4678	LOAD PHASE OV1 AB OP	F001		R	1	
0x022B	0x0400	4679	LOAD PHASE OV1 BC PKP	F001		R	1	
0x022B	0x0800	4680	LOAD PHASE OV1 BC OP	F001		R	1	
0x022B	0x1000	4681	LOAD PHASE OV1 CA PKP	F001		R	1	
0x022B	0x2000	4682	LOAD PHASE OV1 CA OP	F001		R	1	
0x022B	0x4000	4683	LOAD PHASE OV1 PKP	F001		R	1	
0x022B	0x8000	4684	LOAD PHASE OV1 OP	F001		R	1	
0x0230	0x0001	4690	LOAD PHASE OV2 BLK	F001		R	1	
0x0230	0x0002	4691	LOAD PHASE OV2 AB PKP	F001		R	1	
0x0230	0x0004	4692	LOAD PHASE OV2 AB OP	F001		R	1	
0x0230	0x0008	4693	LOAD PHASE OV2 BC PKP	F001		R	1	
0x0230	0x0010	4694	LOAD PHASE OV2 BC OP	F001		R	1	
0x0230	0x0020	4695	LOAD PHASE OV2 CA PKP	F001		R	1	
0x0230	0x0040	4696	LOAD PHASE OV2 CA OP	F001		R	1	
0x0230	0x0080	4697	LOAD PHASE OV2 PKP	F001		R	1	
0x0231	0x0100	4698	LOAD PHASE OV2 OP	F001		R	1	
0x0236	0x0200	4704	LOAD PHASE OV3 BLK	F001		R	1	
0x0236	0x0400	4705	LOAD PHASE OV3 AB PKP	F001		R	1	
0x0236	0x0800	4706	LOAD PHASE OV3 AB OP	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0236	0x1000	4707	LOAD PHASE OV3 BC PKP	F001		R	1	
0x0236	0x2000	4708	LOAD PHASE OV3 BC OP	F001		R	1	
0x0236	0x4000	4709	LOAD PHASE OV3 CA PKP	F001		R	1	
0x0236	0x8000	4710	LOAD PHASE OV3 CA OP	F001		R	1	
0x0236	0x0001	4711	LOAD PHASE OV3 PKP	F001		R	1	
0x0236	0x0002	4712	LOAD PHASE OV3 CA OP	F001		R	1	
0x024B	0x0800	4739	NEG SEQ TOC1 BLOCK	F001		R	1	
0x024B	0x1000	4740	NEG SEQ TOC1 PKP	F001		R	1	
0x024B	0x2000	4741	NEG SEQ TOC1 OP	F001		R	1	
0x0250	0x4000	4747	NEG SEQ TOC2 BLOCK	F001		R	1	
0x0250	0x8000	4748	NEG SEQ TOC2 PKP	F001		R	1	
0x0250	0x0001	4749	NEG SEQ TOC2 OP	F001		R	1	
0x0255	0x0002	4755	NEG SEQ TOC3 BLOCK	F001		R	1	
0x0255	0x0004	4756	NEG SEQ TOC3 PKP	F001		R	1	
0x0255	0x0008	4757	NEG SEQ TOC3 OP	F001		R	1	
0x025A	0x0010	4763	OVERFREQ1 BLOCK	F001		R	1	
0x025A	0x0020	10860	OVERFREQ1 PKP	F001		R	1	
0x025A	0x0040	10861	OVERFREQ1 OP	F001		R	1	
0x025F	0x0080	4771	OVERFREQ2 BLOCK	F001		R	1	
0x0260	0x0100	10862	OVERFREQ2 PKP	F001		R	1	
0x0260	0x0200	10863	OVERFREQ2 OP	F001		R	1	
0x0265	0x0400	4779	OVERFREQ3 BLOCK	F001		R	1	
0x0265	0x0800	10864	OVERFREQ3 PKP	F001		R	1	
0x0265	0x1000	10865	OVERFREQ3 OP	F001		R	1	
0x026A	0x2000	4787	UNDERFREQ1 BLOCK	F001		R	1	
0x026A	0x4000	10866	UNDERFREQ1 PKP	F001		R	1	
0x026A	0x8000	10867	UNDERFREQ1 OP	F001		R	1	
0x026F	0x0001	4795	UNDERFREQ2 BLOCK	F001		R	1	
0x026F	0x0002	10868	UNDERFREQ2 PKP	F001		R	1	
0x026F	0x0004	10869	UNDERFREQ2 OP	F001		R	1	
0x0274	0x0008	4803	UNDERFREQ3 BLOCK	F001		R	1	
0x0274	0x0010	10870	UNDERFREQ3 PKP	F001		R	1	
0x0274	0x0020	10871	UNDERFREQ3 OP	F001		R	1	
0x0279	0x0040	11713	Device Not Calibrated	F001		R	1	
0x0279	0x0080	11714	Calibration Error	F001		R	1	
0x027A	0x0100	4847	OSC DIG CHANNEL 1	F001		R	1	
0x027A	0x0200	4848	OSC DIG CHANNEL 2	F001		R	1	
0x027A	0x0400	4849	OSC DIG CHANNEL 3	F001		R	1	
0x027A	0x0800	4850	OSC DIG CHANNEL 4	F001		R	1	
0x027A	0x1000	4851	OSC DIG CHANNEL 5	F001		R	1	
0x027A	0x2000	4852	OSC DIG CHANNEL 6	F001		R	1	
0x027A	0x4000	4853	OSC DIG CHANNEL 7	F001		R	1	
0x027A	0x8000	4854	OSC DIG CHANNEL 8	F001		R	1	
0x027A	0x0001	4855	OSC DIG CHANNEL 9	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x027A	0x0002	4856	OSC DIG CHANNEL 10	F001		R	1	
0x027A	0x0004	4857	OSC DIG CHANNEL 11	F001		R	1	
0x027A	0x0008	4858	OSC DIG CHANNEL 12	F001		R	1	
0x027A	0x0010	4859	OSC DIG CHANNEL 13	F001		R	1	
0x027A	0x0020	4860	OSC DIG CHANNEL 14	F001		R	1	
0x027A	0x0040	4861	OSC DIG CHANNEL 15	F001		R	1	
0x027A	0x0080	4862	OSC DIG CHANNEL 16	F001		R	1	
0x027B	0x0100	4863	OSCILLO TRIGGER	F001		R	1	
0x0280	0x0200	4870	FAULT REPORT TRIGG	F001		R	1	
0x0280	0x0400	6847	CLEAR FAULT REPORTS	F001		R	1	
0x028F	0x0400	4875	GROUP 1 ACT ON	F001		R	1	
0x028F	0x0800	4876	GROUP 2 ACT ON	F001		R	1	
0x028F	0x1000	4877	GROUP 3 ACT ON	F001		R	1	
0x028F	0x2000	4878	SETT GROUPS BLOCK	F001		R	1	
0x028F	0x0002	10830	GROUP 4 ACT ON	F001		R	1	
0x028F	0x0004	10831	GROUP 5 ACT ON	F001		R	1	
0x028F	0x0008	10832	GROUP 6 ACT ON	F001		R	1	
0x0294	0x0002	4898	Default Channel	F001		R	1	
0x0294	0x0004	4902	BROKEN CONDUCT1 BLK	F001		R	1	
0x0294	0x0008	10890	BROKEN CONDUCT1 PKP	F001		R	1	
0x0294	0x0010	10891	BROKEN CONDUCT1 OP	F001		R	1	
0x0299	0x0020	4908	BROKEN CONDUCT2 BLK	F001		R	1	
0x0299	0x0040	10892	BROKEN CONDUCT2 PKP	F001		R	1	
0x0299	0x0080	10893	BROKEN CONDUCT2 OP	F001		R	1	
0x029F	0x0100	4914	BROKEN CONDUCT3 BLK	F001		R	1	
0x029F	0x0200	10894	BROKEN CONDUCT3 PKP	F001		R	1	
0x029F	0x0400	10895	BROKEN CONDUCT3 OP	F001		R	1	
0x02A4	0x0800	5060	FREEZE ENERGY CNT	F001		R	1	
0x02A4	0x1000	5061	UNFREEZE ENERGY CNT	F001		R	1	
0x02A4	0x2000	5062	RESET ENERGY CNT	F001		R	1	
0x02B8	0x4000	5123	ISOLATED GND1 BLK	F001		R	1	
0x02B8	0x8000	5124	ISOLATED GND1 PKP	F001		R	1	
0x02B8	0x0001	5125	ISOLATED GND1 OP	F001		R	1	
0x02C7	0x0002	5133	ISOLATED GND2 BLK	F001		R	1	
0x02C7	0x0004	5134	ISOLATED GND2 PKP	F001		R	1	
0x02C7	0x0008	5135	ISOLATED GND2 OP	F001		R	1	
0x02D6	0x0010	5143	ISOLATED GND3 BLK	F001		R	1	
0x02D6	0x0020	5144	ISOLATED GND3 PKP	F001		R	1	
0x02D6	0x0040	5145	ISOLATED GND3 OP	F001		R	1	
0x02E5	0x0080	5151	SENS GND DIR1 BLK IP	F001		R	1	
0x02E6	0x0100	5152	SENS GND DIR1 BLOCK	F001		R	1	
0x02E6	0x0200	5153	SENS GND DIR1 OP	F001		R	1	
0x02EB	0x0400	5159	SENS GND DIR2 BLK IP	F001		R	1	
0x02EB	0x0800	5160	SENS GND DIR2 BLOCK	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x02EB	0x1000	5161	SENS GND DIR2 OP	F001		R	1	
0x02F0	0x2000	5167	SENS GND DIR3 BLK IP	F001		R	1	
0x02F0	0x4000	5168	SENS GND DIR3 BLOCK	F001		R	1	
0x02F0	0x8000	5169	SENS GND DIR3 OP	F001		R	1	
0x02F5	0x0001	5176	FWD PWR1 BLOCK	F001		R	1	
0x02F5	0x0002	5177	FWD PWR1 STG1 PKP	F001		R	1	
0x02F5	0x0004	5178	FWD PWR1 STG1 OP	F001		R	1	
0x02F5	0x0008	5179	FWD PWR1 STG2 PKP	F001		R	1	
0x02F5	0x0010	5180	FWD PWR1 STG2 OP	F001		R	1	
0x02FA	0x0020	5187	FWD PWR2 BLOCK	F001		R	1	
0x02FA	0x0040	5188	FWD PWR2 STG1 PKP	F001		R	1	
0x02FA	0x0080	5189	FWD PWR2 STG1 OP	F001		R	1	
0x02FB	0x0100	5190	FWD PWR2 STG2 PKP	F001		R	1	
0x02FB	0x0200	5191	FWD PWR2 STG2 OP	F001		R	1	
0x0300	0x0400	5198	FWD PWR3 BLOCK	F001		R	1	
0x0300	0x0800	5199	FWD PWR3 STG1 PKP	F001		R	1	
0x0300	0x1000	5200	FWD PWR3 STG1 OP	F001		R	1	
0x0300	0x2000	5201	FWD PWR3 STG2 PKP	F001		R	1	
0x0300	0x4000	5202	FWD PWR3 STG2 OP	F001		R	1	
0x0305	0x8000	5208	DEMAND TRIGGER INP	F001		R	1	
0x0305	0x0001	5209	DEMAND RESET INP	F001		R	1	
0x0319	0x0002	5359	CONT IP_H_CC1	F001		R	1	
0x0319	0x0004	5360	CONT IP_H_CC2	F001		R	1	
0x0319	0x0008	5361	CONT IP_H_CC3	F001		R	1	
0x0319	0x0010	5362	CONT IP_H_CC4	F001		R	1	
0x0319	0x0020	5363	CONT IP_H_CC5	F001		R	1	
0x0319	0x0040	5364	CONT IP_H_CC6	F001		R	1	
0x0319	0x0080	5365	CONT IP_H_CC7	F001		R	1	
0x031A	0x0100	5366	CONT IP_H_CC8	F001		R	1	
0x031A	0x0200	5367	CONT IP_H_CC9	F001		R	1	
0x031A	0x0400	5368	CONT IP_H_CC10	F001		R	1	
0x031A	0x0800	5369	CONT IP_H_CC11	F001		R	1	
0x031A	0x1000	5370	CONT IP_H_CC12	F001		R	1	
0x031A	0x2000	5371	CONT IP_H_CC13	F001		R	1	
0x031A	0x4000	5372	CONT IP_H_CC14	F001		R	1	
0x031A	0x8000	5373	CONT IP_H_CC15	F001		R	1	
0x031A	0x0001	5374	CONT IP_H_CC16	F001		R	1	
0x031A	0x0002	5375	CONT IP_H_CC17	F001		R	1	
0x031A	0x0004	5376	CONT IP_H_CC18	F001		R	1	
0x031A	0x0008	5377	CONT IP_H_CC19	F001		R	1	
0x031A	0x0010	5378	CONT IP_H_CC20	F001		R	1	
0x031A	0x0020	5379	CONT IP_H_CC21	F001		R	1	
0x031A	0x0040	5380	CONT IP_H_CC22	F001		R	1	
0x031A	0x0080	5381	CONT IP_H_CC23	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x031B	0x0100	5382	CONT IP_H_CC24	F001		R	1	
0x031B	0x0200	5383	CONT IP_H_CC25	F001		R	1	
0x031B	0x0400	5384	CONT IP_H_CC26	F001		R	1	
0x031B	0x0800	5385	CONT IP_H_CC27	F001		R	1	
0x031B	0x1000	5386	CONT IP_H_CC28	F001		R	1	
0x031B	0x2000	5387	CONT IP_H_CC29	F001		R	1	
0x031B	0x4000	5388	CONT IP_H_CC30	F001		R	1	
0x031B	0x8000	5389	CONT IP_H_CC31	F001		R	1	
0x031B	0x0001	5390	CONT IP_H_CC32	F001		R	1	
0x031B	0x0002	5391	CONT OP OPER_H_01	F001		R	1	
0x031B	0x0004	5392	CONT OP OPER_H_02	F001		R	1	
0x031B	0x0008	5393	CONT OP OPER_H_03	F001		R	1	
0x031B	0x0010	5394	CONT OP OPER_H_04	F001		R	1	
0x031B	0x0020	5395	CONT OP OPER_H_05	F001		R	1	
0x031B	0x0040	5396	CONT OP OPER_H_06	F001		R	1	
0x031B	0x0080	5397	CONT OP OPER_H_07	F001		R	1	
0x031C	0x0100	5398	CONT OP OPER_H_08	F001		R	1	
0x031C	0x0200	5399	CONT OP OPER_H_09	F001		R	1	
0x031C	0x0400	5400	CONT OP OPER_H_10	F001		R	1	
0x031C	0x0800	5401	CONT OP OPER_H_11	F001		R	1	
0x031C	0x1000	5402	CONT OP OPER_H_12	F001		R	1	
0x031C	0x2000	5403	CONT OP OPER_H_13	F001		R	1	
0x031C	0x4000	5404	CONT OP OPER_H_14	F001		R	1	
0x031C	0x8000	5405	CONT OP OPER_H_15	F001		R	1	
0x031C	0x0001	5406	CONT OP OPER_H_16	F001		R	1	
0x031C	0x0002	5407	CONT OP RESET_H_01	F001		R	1	
0x031C	0x0004	5408	CONT OP RESET_H_02	F001		R	1	
0x031C	0x0008	5409	CONT OP RESET_H_03	F001		R	1	
0x031C	0x0010	5410	CONT OP RESET_H_04	F001		R	1	
0x031C	0x0020	5411	CONT OP RESET_H_05	F001		R	1	
0x031C	0x0040	5412	CONT OP RESET_H_06	F001		R	1	
0x031C	0x0080	5413	CONT OP RESET_H_07	F001		R	1	
0x031D	0x0100	5414	CONT OP RESET_H_08	F001		R	1	
0x031D	0x0200	5415	CONT OP RESET_H_09	F001		R	1	
0x031D	0x0400	5416	CONT OP RESET_H_10	F001		R	1	
0x031D	0x0800	5417	CONT OP RESET_H_11	F001		R	1	
0x031D	0x1000	5418	CONT OP RESET_H_12	F001		R	1	
0x031D	0x2000	5419	CONT OP RESET_H_13	F001		R	1	
0x031D	0x4000	5420	CONT OP RESET_H_14	F001		R	1	
0x031D	0x8000	5421	CONT OP RESET_H_15	F001		R	1	
0x031D	0x0001	5422	CONT OP RESET_H_16	F001		R	1	
0x031D	0x0002	5423	CONT OP_H_01	F001		R	1	
0x031D	0x0004	5424	CONT OP_H_02	F001		R	1	
0x031D	0x0008	5425	CONT OP_H_03	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x031D	0x0010	5426	CONT OP_H_04	F001		R	1	
0x031D	0x0020	5427	CONT OP_H_05	F001		R	1	
0x031D	0x0040	5428	CONT OP_H_06	F001		R	1	
0x031D	0x0080	5429	CONT OP_H_07	F001		R	1	
0x031E	0x0100	5430	CONT OP_H_08	F001		R	1	
0x031E	0x0200	5431	CONT OP_H_09	F001		R	1	
0x031E	0x0400	5432	CONT OP_H_10	F001		R	1	
0x031E	0x0800	5433	CONT OP_H_11	F001		R	1	
0x031E	0x1000	5434	CONT OP_H_12	F001		R	1	
0x031E	0x2000	5435	CONT OP_H_13	F001		R	1	
0x031E	0x4000	5436	CONT OP_H_14	F001		R	1	
0x031E	0x8000	5437	CONT OP_H_15	F001		R	1	
0x031E	0x0001	5438	CONT OP_H_16	F001		R	1	
0x031E	0x0002	5439	BOARD H STATUS	F001		R	1	
0x033E	0x0004	5557	CONT IP_J_CC1	F001		R	1	
0x033E	0x0008	5558	CONT IP_J_CC2	F001		R	1	
0x033E	0x0010	5559	CONT IP_J_CC3	F001		R	1	
0x033E	0x0020	5560	CONT IP_J_CC4	F001		R	1	
0x033E	0x0040	5561	CONT IP_J_CC5	F001		R	1	
0x033E	0x0080	5562	CONT IP_J_CC6	F001		R	1	
0x033F	0x0100	5563	CONT IP_J_CC7	F001		R	1	
0x033F	0x0200	5564	CONT IP_J_CC8	F001		R	1	
0x033F	0x0400	5565	CONT IP_J_CC9	F001		R	1	
0x033F	0x0800	5566	CONT IP_J_CC10	F001		R	1	
0x033F	0x1000	5567	CONT IP_J_CC11	F001		R	1	
0x033F	0x2000	5568	CONT IP_J_CC12	F001		R	1	
0x033F	0x4000	5569	CONT IP_J_CC13	F001		R	1	
0x033F	0x8000	5570	CONT IP_J_CC14	F001		R	1	
0x033F	0x0001	5571	CONT IP_J_CC15	F001		R	1	
0x033F	0x0002	5572	CONT IP_J_CC16	F001		R	1	
0x033F	0x0004	5573	CONT IP_J_CC17	F001		R	1	
0x033F	0x0008	5574	CONT IP_J_CC18	F001		R	1	
0x033F	0x0010	5575	CONT IP_J_CC19	F001		R	1	
0x033F	0x0020	5576	CONT IP_J_CC20	F001		R	1	
0x033F	0x0040	5577	CONT IP_J_CC21	F001		R	1	
0x033F	0x0080	5578	CONT IP_J_CC22	F001		R	1	
0x0340	0x0100	5579	CONT IP_J_CC23	F001		R	1	
0x0340	0x0200	5580	CONT IP_J_CC24	F001		R	1	
0x0340	0x0400	5581	CONT IP_J_CC25	F001		R	1	
0x0340	0x0800	5582	CONT IP_J_CC26	F001		R	1	
0x0340	0x1000	5583	CONT IP_J_CC27	F001		R	1	
0x0340	0x2000	5584	CONT IP_J_CC28	F001		R	1	
0x0340	0x4000	5585	CONT IP_J_CC29	F001		R	1	
0x0340	0x8000	5586	CONT IP_J_CC30	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0340	0x0001	5587	CONT IP_J_CC31	F001		R	1	
0x0340	0x0002	5588	CONT IP_J_CC32	F001		R	1	
0x0340	0x0004	5589	CONT OP OPER_J_01	F001		R	1	
0x0340	0x0008	5590	CONT OP OPER_J_02	F001		R	1	
0x0340	0x0010	5591	CONT OP OPER_J_03	F001		R	1	
0x0340	0x0020	5592	CONT OP OPER_J_04	F001		R	1	
0x0340	0x0040	5593	CONT OP OPER_J_05	F001		R	1	
0x0340	0x0080	5594	CONT OP OPER_J_06	F001		R	1	
0x0341	0x0100	5595	CONT OP OPER_J_07	F001		R	1	
0x0341	0x0200	5596	CONT OP OPER_J_08	F001		R	1	
0x0341	0x0400	5597	CONT OP OPER_J_09	F001		R	1	
0x0341	0x0800	5598	CONT OP OPER_J_10	F001		R	1	
0x0341	0x1000	5599	CONT OP OPER_J_11	F001		R	1	
0x0341	0x2000	5600	CONT OP OPER_J_12	F001		R	1	
0x0341	0x4000	5601	CONT OP OPER_J_13	F001		R	1	
0x0341	0x8000	5602	CONT OP OPER_J_14	F001		R	1	
0x0341	0x0001	5603	CONT OP OPER_J_15	F001		R	1	
0x0341	0x0002	5604	CONT OP OPER_J_16	F001		R	1	
0x0341	0x0004	5605	CONT OP RESET_J_01	F001		R	1	
0x0341	0x0008	5606	CONT OP RESET_J_02	F001		R	1	
0x0341	0x0010	5607	CONT OP RESET_J_03	F001		R	1	
0x0341	0x0020	5608	CONT OP RESET_J_04	F001		R	1	
0x0341	0x0040	5609	CONT OP RESET_J_05	F001		R	1	
0x0341	0x0080	5610	CONT OP RESET_J_06	F001		R	1	
0x0342	0x0100	5611	CONT OP RESET_J_07	F001		R	1	
0x0342	0x0200	5612	CONT OP RESET_J_08	F001		R	1	
0x0342	0x0400	5613	CONT OP RESET_J_09	F001		R	1	
0x0342	0x0800	5614	CONT OP RESET_J_10	F001		R	1	
0x0342	0x1000	5615	CONT OP RESET_J_11	F001		R	1	
0x0342	0x2000	5616	CONT OP RESET_J_12	F001		R	1	
0x0342	0x4000	5617	CONT OP RESET_J_13	F001		R	1	
0x0342	0x8000	5618	CONT OP RESET_J_14	F001		R	1	
0x0342	0x0001	5619	CONT OP RESET_J_15	F001		R	1	
0x0342	0x0002	5620	CONT OP RESET_J_16	F001		R	1	
0x0342	0x0004	5621	CONT OP_J_01	F001		R	1	
0x0342	0x0008	5622	CONT OP_J_02	F001		R	1	
0x0342	0x0010	5623	CONT OP_J_03	F001		R	1	
0x0342	0x0020	5624	CONT OP_J_04	F001		R	1	
0x0342	0x0040	5625	CONT OP_J_05	F001		R	1	
0x0342	0x0080	5626	CONT OP_J_06	F001		R	1	
0x0343	0x0100	5627	CONT OP_J_07	F001		R	1	
0x0343	0x0200	5628	CONT OP_J_08	F001		R	1	
0x0343	0x0400	5629	CONT OP_J_09	F001		R	1	
0x0343	0x0800	5630	CONT OP_J_10	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0343	0x1000	5631	CONT OP_J_11	F001		R	1	
0x0343	0x2000	5632	CONT OP_J_12	F001		R	1	
0x0343	0x4000	5633	CONT OP_J_13	F001		R	1	
0x0343	0x8000	5634	CONT OP_J_14	F001		R	1	
0x0343	0x0001	5635	CONT OP_J_15	F001		R	1	
0x0343	0x0002	5636	CONT OP_J_16	F001		R	1	
0x0343	0x0004	5637	BOARD J STATUS	F001		R	1	
0x0363	0x0008	5648	PH TOC1 LOW A BLK	F001		R	1	
0x0363	0x0010	5649	PH TOC1 LOW B BLK	F001		R	1	
0x0363	0x0020	5650	PH TOC1 LOW C BLK	F001		R	1	
0x0363	0x0040	5651	PH TOC1 LOW A PKP	F001		R	1	
0x0363	0x0080	5652	PH TOC1 LOW A OP	F001		R	1	
0x0364	0x0100	5653	PH TOC1 LOW B PKP	F001		R	1	
0x0364	0x0200	5654	PH TOC1 LOW B OP	F001		R	1	
0x0364	0x0400	5655	PH TOC1 LOW C PKP	F001		R	1	
0x0364	0x0800	5656	PH TOC1 LOW C OP	F001		R	1	
0x0364	0x1000	5657	PH TOC1 LOW PKP	F001		R	1	
0x0364	0x2000	5658	PH TOC1 LOW OP	F001		R	1	
0x0369	0x4000	5666	PH TOC2 LOW A BLK	F001		R	1	
0x0369	0x8000	5667	PH TOC2 LOW B BLK	F001		R	1	
0x0369	0x0001	5668	PH TOC2 LOW C BLK	F001		R	1	
0x0369	0x0002	5669	PH TOC2 LOW A PKP	F001		R	1	
0x0369	0x0004	5670	PH TOC2 LOW A OP	F001		R	1	
0x0369	0x0008	5671	PH TOC2 LOW B PKP	F001		R	1	
0x0369	0x0010	5672	PH TOC2 LOW B OP	F001		R	1	
0x0369	0x0020	5673	PH TOC2 LOW C PKP	F001		R	1	
0x0369	0x0040	5674	PH TOC2 LOW C OP	F001		R	1	
0x0369	0x0080	5675	PH TOC2 LOW PKP	F001		R	1	
0x036A	0x0100	5676	PH TOC2 LOW OP	F001		R	1	
0x036F	0x0200	5684	PH TOC3 LOW A BLK	F001		R	1	
0x036F	0x0400	5685	PH TOC3 LOW B BLK	F001		R	1	
0x036F	0x0800	5686	PH TOC3 LOW C BLK	F001		R	1	
0x036F	0x1000	5687	PH TOC3 LOW A PKP	F001		R	1	
0x036F	0x2000	5688	PH TOC3 LOW A OP	F001		R	1	
0x036F	0x4000	5689	PH TOC3 LOW B PKP	F001		R	1	
0x036F	0x8000	5690	PH TOC3 LOW B OP	F001		R	1	
0x036F	0x0001	5691	PH TOC3 LOW C PKP	F001		R	1	
0x036F	0x0002	5692	PH TOC3 LOW C OP	F001		R	1	
0x036F	0x0004	5693	PH TOC3 LOW PKP	F001		R	1	
0x036F	0x0008	5694	PH TOC3 LOW OP	F001		R	1	
0x0374	0x0010	5743	SWITCH 1 A INPUT	F001		R	1	
0x0374	0x0020	5744	SWITCH 1 B INPUT	F001		R	1	
0x0374	0x0040	5745	SWITCH 2 A INPUT	F001		R	1	
0x0374	0x0080	5746	SWITCH 2 B INPUT	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0375	0x0100	5747	SWITCH 3 A INPUT	F001		R	1	
0x0375	0x0200	5748	SWITCH 3 B INPUT	F001		R	1	
0x0375	0x0400	5749	SWITCH 4 A INPUT	F001		R	1	
0x0375	0x0800	5750	SWITCH 4 B INPUT	F001		R	1	
0x0375	0x1000	5751	SWITCH 5 A INPUT	F001		R	1	
0x0375	0x2000	5752	SWITCH 5 B INPUT	F001		R	1	
0x0375	0x4000	5753	SWITCH 6 A INPUT	F001		R	1	
0x0375	0x8000	5754	SWITCH 6 B INPUT	F001		R	1	
0x0375	0x0001	5755	SWITCH 7 A INPUT	F001		R	1	
0x0375	0x0002	5756	SWITCH 7 B INPUT	F001		R	1	
0x0375	0x0004	5757	SWITCH 8 A INPUT	F001		R	1	
0x0375	0x0008	5758	SWITCH 8 B INPUT	F001		R	1	
0x0375	0x0010	5759	SWITCH 9 A INPUT	F001		R	1	
0x0375	0x0020	5760	SWITCH 9 B INPUT	F001		R	1	
0x0375	0x0040	5761	SWITCH 10 A INPUT	F001		R	1	
0x0375	0x0080	5762	SWITCH 10 B INPUT	F001		R	1	
0x0376	0x0100	5763	SWITCH 11 A INPUT	F001		R	1	
0x0376	0x0200	5764	SWITCH 11 B INPUT	F001		R	1	
0x0376	0x0400	5765	SWITCH 12 A INPUT	F001		R	1	
0x0376	0x0800	5766	SWITCH 12 B INPUT	F001		R	1	
0x0376	0x1000	5767	SWITCH 13 A INPUT	F001		R	1	
0x0376	0x2000	5768	SWITCH 13 B INPUT	F001		R	1	
0x0376	0x4000	5769	SWITCH 14 A INPUT	F001		R	1	
0x0376	0x8000	5770	SWITCH 14 B INPUT	F001		R	1	
0x0376	0x0001	5771	SWITCH 15 A INPUT	F001		R	1	
0x0376	0x0002	5772	SWITCH 15 B INPUT	F001		R	1	
0x0376	0x0004	5773	SWITCH 16 A INPUT	F001		R	1	
0x0376	0x0008	5774	SWITCH 16 B INPUT	F001		R	1	
0x0376	0x0010	5775	SWITCH 1 A STATUS	F001		R	1	
0x0376	0x0020	5776	SWITCH 1 B STATUS	F001		R	1	
0x0376	0x0040	5777	SWITCH 2 A STATUS	F001		R	1	
0x0376	0x0080	5778	SWITCH 2 B STATUS	F001		R	1	
0x0377	0x0100	5779	SWITCH 3 A STATUS	F001		R	1	
0x0377	0x0200	5780	SWITCH 3 B STATUS	F001		R	1	
0x0377	0x0400	5781	SWITCH 4 A STATUS	F001		R	1	
0x0377	0x0800	5782	SWITCH 4 B STATUS	F001		R	1	
0x0377	0x1000	5783	SWITCH 5 A STATUS	F001		R	1	
0x0377	0x2000	5784	SWITCH 5 B STATUS	F001		R	1	
0x0377	0x4000	5785	SWITCH 6 A STATUS	F001		R	1	
0x0377	0x8000	5786	SWITCH 6 B STATUS	F001		R	1	
0x0377	0x0001	5787	SWITCH 7 A STATUS	F001		R	1	
0x0377	0x0002	5788	SWITCH 7 B STATUS	F001		R	1	
0x0377	0x0004	5789	SWITCH 8 A STATUS	F001		R	1	
0x0377	0x0008	5790	SWITCH 8 B STATUS	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0377	0x0010	5791	SWITCH 9 A STATUS	F001		R	1	
0x0377	0x0020	5792	SWITCH 9 B STATUS	F001		R	1	
0x0377	0x0040	5793	SWITCH 10 A STATUS	F001		R	1	
0x0377	0x0080	5794	SWITCH 10 B STATUS	F001		R	1	
0x0378	0x0100	5795	SWITCH 11 A STATUS	F001		R	1	
0x0378	0x0200	5796	SWITCH 11 B STATUS	F001		R	1	
0x0378	0x0400	5797	SWITCH 12 A STATUS	F001		R	1	
0x0378	0x0800	5798	SWITCH 12 B STATUS	F001		R	1	
0x0378	0x1000	5799	SWITCH 13 A STATUS	F001		R	1	
0x0378	0x2000	5800	SWITCH 13 B STATUS	F001		R	1	
0x0378	0x4000	5801	SWITCH 14 A STATUS	F001		R	1	
0x0378	0x8000	5802	SWITCH 14 B STATUS	F001		R	1	
0x0378	0x0001	5803	SWITCH 15 A STATUS	F001		R	1	
0x0378	0x0002	5804	SWITCH 15 B STATUS	F001		R	1	
0x0378	0x0004	5805	SWITCH 16 A STATUS	F001		R	1	
0x0378	0x0008	5806	SWITCH 16 B STATUS	F001		R	1	
0x0378	0x0010	5807	SWITCH 1 OPEN	F001		R	1	
0x0378	0x0020	5808	SWITCH 1 CLOSED	F001		R	1	
0x0378	0x0040	5809	SWITCH 1 00_ERROR	F001		R	1	
0x0378	0x0080	5810	SWITCH 1 11_ERROR	F001		R	1	
0x0379	0x0100	5811	SWITCH 2 OPEN	F001		R	1	
0x0379	0x0200	5812	SWITCH 2 CLOSED	F001		R	1	
0x0379	0x0400	5813	SWITCH 2 00_ERROR	F001		R	1	
0x0379	0x0800	5814	SWITCH 2 11_ERROR	F001		R	1	
0x0379	0x1000	5815	SWITCH 3 OPEN	F001		R	1	
0x0379	0x2000	5816	SWITCH 3 CLOSED	F001		R	1	
0x0379	0x4000	5817	SWITCH 3 00_ERROR	F001		R	1	
0x0379	0x8000	5818	SWITCH 3 11_ERROR	F001		R	1	
0x0379	0x0001	5819	SWITCH 4 OPEN	F001		R	1	
0x0379	0x0002	5820	SWITCH 4 CLOSED	F001		R	1	
0x0379	0x0004	5821	SWITCH 4 00_ERROR	F001		R	1	
0x0379	0x0008	5822	SWITCH 4 11_ERROR	F001		R	1	
0x0379	0x0010	5823	SWITCH 5 OPEN	F001		R	1	
0x0379	0x0020	5824	SWITCH 5 CLOSED	F001		R	1	
0x0379	0x0040	5825	SWITCH 5 00_ERROR	F001		R	1	
0x0379	0x0080	5826	SWITCH 5 11_ERROR	F001		R	1	
0x037A	0x0100	5827	SWITCH 6 OPEN	F001		R	1	
0x037A	0x0200	5828	SWITCH 6 CLOSED	F001		R	1	
0x037A	0x0400	5829	SWITCH 6 00_ERROR	F001		R	1	
0x037A	0x0800	5830	SWITCH 6 11_ERROR	F001		R	1	
0x037A	0x1000	5831	SWITCH 7 OPEN	F001		R	1	
0x037A	0x2000	5832	SWITCH 7 CLOSED	F001		R	1	
0x037A	0x4000	5833	SWITCH 7 00_ERROR	F001		R	1	
0x037A	0x8000	5834	SWITCH 7 11_ERROR	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x037A	0x0001	5835	SWITCH 8 OPEN	F001		R	1	
0x037A	0x0002	5836	SWITCH 8 CLOSED	F001		R	1	
0x037A	0x0004	5837	SWITCH 8 00_ERROR	F001		R	1	
0x037A	0x0008	5838	SWITCH 8 11_ERROR	F001		R	1	
0x037A	0x0010	5839	SWITCH 9 OPEN	F001		R	1	
0x037A	0x0020	5840	SWITCH 9 CLOSED	F001		R	1	
0x037A	0x0040	5841	SWITCH 9 00_ERROR	F001		R	1	
0x037A	0x0080	5842	SWITCH 9 11_ERROR	F001		R	1	
0x037B	0x0100	5843	SWITCH 10 OPEN	F001		R	1	
0x037B	0x0200	5844	SWITCH 10 CLOSED	F001		R	1	
0x037B	0x0400	5845	SWITCH 10 00_ERROR	F001		R	1	
0x037B	0x0800	5846	SWITCH 10 11_ERROR	F001		R	1	
0x037B	0x1000	5847	SWITCH 11 OPEN	F001		R	1	
0x037B	0x2000	5848	SWITCH 11 CLOSED	F001		R	1	
0x037B	0x4000	5849	SWITCH 11 00_ERROR	F001		R	1	
0x037B	0x8000	5850	SWITCH 11 11_ERROR	F001		R	1	
0x037B	0x0001	5851	SWITCH 12 OPEN	F001		R	1	
0x037B	0x0002	5852	SWITCH 12 CLOSED	F001		R	1	
0x037B	0x0004	5853	SWITCH 12 00_ERROR	F001		R	1	
0x037B	0x0008	5854	SWITCH 12 11_ERROR	F001		R	1	
0x037B	0x0010	5855	SWITCH 13 OPEN	F001		R	1	
0x037B	0x0020	5856	SWITCH 13 CLOSED	F001		R	1	
0x037B	0x0040	5857	SWITCH 13 00_ERROR	F001		R	1	
0x037B	0x0080	5858	SWITCH 13 11_ERROR	F001		R	1	
0x037C	0x0100	5859	SWITCH 14 OPEN	F001		R	1	
0x037C	0x0200	5860	SWITCH 14 CLOSED	F001		R	1	
0x037C	0x0400	5861	SWITCH 14 00_ERROR	F001		R	1	
0x037C	0x0800	5862	SWITCH 14 11_ERROR	F001		R	1	
0x037C	0x1000	5863	SWITCH 15 OPEN	F001		R	1	
0x037C	0x2000	5864	SWITCH 15 CLOSED	F001		R	1	
0x037C	0x4000	5865	SWITCH 15 00_ERROR	F001		R	1	
0x037C	0x8000	5866	SWITCH 15 11_ERROR	F001		R	1	
0x037C	0x0001	5867	SWITCH 16 OPEN	F001		R	1	
0x037C	0x0002	5868	SWITCH 16 CLOSED	F001		R	1	
0x037C	0x0004	5869	SWITCH 16 00_ERROR	F001		R	1	
0x037C	0x0008	5870	SWITCH 16 11_ERROR	F001		R	1	
0x037C	0x0010	5871	SWITCH 1 OPEN INIT	F001		R	1	
0x037C	0x0020	5872	SWITCH 1 CLOSE INIT	F001		R	1	
0x037C	0x0040	5873	SWITCH 2 OPEN INIT	F001		R	1	
0x037C	0x0080	5874	SWITCH 2 CLOSE INIT	F001		R	1	
0x037D	0x0100	5875	SWITCH 3 OPEN INIT	F001		R	1	
0x037D	0x0200	5876	SWITCH 3 CLOSE INIT	F001		R	1	
0x037D	0x0400	5877	SWITCH 4 OPEN INIT	F001		R	1	
0x037D	0x0800	5878	SWITCH 4 CLOSE INIT	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x037D	0x1000	5879	SWITCH 5 OPEN INIT	F001		R	1	
0x037D	0x2000	5880	SWITCH 5 CLOSE INIT	F001		R	1	
0x037D	0x4000	5881	SWITCH 6 OPEN INIT	F001		R	1	
0x037D	0x8000	5882	SWITCH 6 CLOSE INIT	F001		R	1	
0x037D	0x0001	5883	SWITCH 7 OPEN INIT	F001		R	1	
0x037D	0x0002	5884	SWITCH 7 CLOSE INIT	F001		R	1	
0x037D	0x0004	5885	SWITCH 8 OPEN INIT	F001		R	1	
0x037D	0x0008	5886	SWITCH 8 CLOSE INIT	F001		R	1	
0x037D	0x0010	5887	SWITCH 9 OPEN INIT	F001		R	1	
0x037D	0x0020	5888	SWITCH 9 CLOSE INIT	F001		R	1	
0x037D	0x0040	5889	SWITCH 10 OPEN INIT	F001		R	1	
0x037D	0x0080	5890	SWITCH 10 CLOSE INIT	F001		R	1	
0x037E	0x0100	5891	SWITCH 11 OPEN INIT	F001		R	1	
0x037E	0x0200	5892	SWITCH 11 CLOSE INIT	F001		R	1	
0x037E	0x0400	5893	SWITCH 12 OPEN INIT	F001		R	1	
0x037E	0x0800	5894	SWITCH 12 CLOSE INIT	F001		R	1	
0x037E	0x1000	5895	SWITCH 13 OPEN INIT	F001		R	1	
0x037E	0x2000	5896	SWITCH 13 CLOSE INIT	F001		R	1	
0x037E	0x4000	5897	SWITCH 14 OPEN INIT	F001		R	1	
0x037E	0x8000	5898	SWITCH 14 CLOSE INIT	F001		R	1	
0x037E	0x0001	5899	SWITCH 15 OPEN INIT	F001		R	1	
0x037E	0x0002	5900	SWITCH 15 CLOSE INIT	F001		R	1	
0x037E	0x0004	5901	SWITCH 16 OPEN INIT	F001		R	1	
0x037E	0x0008	5902	SWITCH 16 CLOSE INIT	F001		R	1	
0x037E	0x0010	5903	SWGR 1 FAIL TO OPEN	F001		R	1	
0x037E	0x0020	5904	SWGR 2 FAIL TO OPEN	F001		R	1	
0x037E	0x0040	5905	SWGR 3 FAIL TO OPEN	F001		R	1	
0x037E	0x0080	5906	SWGR 4 FAIL TO OPEN	F001		R	1	
0x037F	0x0100	5907	SWGR 5 FAIL TO OPEN	F001		R	1	
0x037F	0x0200	5908	SWGR 6 FAIL TO OPEN	F001		R	1	
0x037F	0x0400	5909	SWGR 7 FAIL TO OPEN	F001		R	1	
0x037F	0x0800	5910	SWGR 8 FAIL TO OPEN	F001		R	1	
0x037F	0x1000	5911	SWGR 9 FAIL TO OPEN	F001		R	1	
0x037F	0x2000	5912	SWGR 10 FAIL TO OPEN	F001		R	1	
0x037F	0x4000	5913	SWGR 11 FAIL TO OPEN	F001		R	1	
0x037F	0x8000	5914	SWGR 12 FAIL TO OPEN	F001		R	1	
0x037F	0x0001	5915	SWGR 13 FAIL TO OPEN	F001		R	1	
0x037F	0x0002	5916	SWGR 14 FAIL TO OPEN	F001		R	1	
0x037F	0x0004	5917	SWGR 15 FAIL TO OPEN	F001		R	1	
0x037F	0x0008	5918	SWGR 16 FAIL TO OPEN	F001		R	1	
0x037F	0x0010	5919	SWGR 1 FAIL TO CLOSE	F001		R	1	
0x037F	0x0020	5920	SWGR 2 FAIL TO CLOSE	F001		R	1	
0x037F	0x0040	5921	SWGR 3 FAIL TO CLOSE	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x037F	0x0080	5922	SWGR 4 FAIL TO CLOSE	F001		R	1	
0x0380	0x0100	5923	SWGR 5 FAIL TO CLOSE	F001		R	1	
0x0380	0x0200	5924	SWGR 6 FAIL TO CLOSE	F001		R	1	
0x0380	0x0400	5925	SWGR 7 FAIL TO CLOSE	F001		R	1	
0x0380	0x0800	5926	SWGR 8 FAIL TO CLOSE	F001		R	1	
0x0380	0x1000	5927	SWGR 9 FAIL TO CLOSE	F001		R	1	
0x0380	0x2000	5928	SWGR 10 FAIL TO CLOSE	F001		R	1	
0x0380	0x4000	5929	SWGR 11 FAIL TO CLOSE	F001		R	1	
0x0380	0x8000	5930	SWGR 12 FAIL TO CLOSE	F001		R	1	
0x0380	0x0001	5931	SWGR 13 FAIL TO CLOSE	F001		R	1	
0x0380	0x0002	5932	SWGR 14 FAIL TO CLOSE	F001		R	1	
0x0380	0x0004	5933	SWGR 15 FAIL TO CLOSE	F001		R	1	
0x0380	0x0008	5934	SWGR 16 FAIL TO CLOSE	F001		R	1	
0x0380	0x0010	10048	SWGR 1 BLOCK OPENING	F001		R	1	
0x0380	0x0020	10049	SWGR 2 BLOCK OPENING	F001		R	1	
0x0380	0x0040	10050	SWGR 3 BLOCK OPENING	F001		R	1	
0x0380	0x0080	10051	SWGR 4 BLOCK OPENING	F001		R	1	
0x0381	0x0100	10052	SWGR 5 BLOCK OPENING	F001		R	1	
0x0381	0x0200	10053	SWGR 6 BLOCK OPENING	F001		R	1	
0x0381	0x0400	10054	SWGR 7 BLOCK OPENING	F001		R	1	
0x0381	0x0800	10055	SWGR 8 BLOCK OPENING	F001		R	1	
0x0381	0x1000	10056	SWGR 9 BLOCK OPENING	F001		R	1	
0x0381	0x2000	10057	SWGR 10 BLOCK OPENING	F001		R	1	
0x0381	0x4000	10058	SWGR 11 BLOCK OPENING	F001		R	1	
0x0381	0x8000	10059	SWGR 12 BLOCK OPENING	F001		R	1	
0x0381	0x0001	10060	SWGR 13 BLOCK OPENING	F001		R	1	
0x0381	0x0002	10061	SWGR 14 BLOCK OPENING	F001		R	1	
0x0381	0x0004	10062	SWGR 15 BLOCK OPENING	F001		R	1	
0x0381	0x0008	10063	SWGR 16 BLOCK OPENING	F001		R	1	
0x0381	0x0010	10064	SWGR 1 BLOCK CLOSING	F001		R	1	
0x0381	0x0020	10065	SWGR 2 BLOCK CLOSING	F001		R	1	
0x0381	0x0040	10066	SWGR 3 BLOCK CLOSING	F001		R	1	
0x0381	0x0080	10067	SWGR 4 BLOCK CLOSING	F001		R	1	
0x0382	0x0100	10068	SWGR 5 BLOCK CLOSING	F001		R	1	
0x0382	0x0200	10069	SWGR 6 BLOCK CLOSING	F001		R	1	
0x0382	0x0400	10070	SWGR 7 BLOCK CLOSING	F001		R	1	
0x0382	0x0800	10071	SWGR 8 BLOCK CLOSING	F001		R	1	
0x0382	0x1000	10072	SWGR 9 BLOCK CLOSING	F001		R	1	
0x0382	0x2000	10073	SWGR 10 BLOCK CLOSING	F001		R	1	
0x0382	0x4000	10074	SWGR 11 BLOCK CLOSING	F001		R	1	
0x0382	0x8000	10075	SWGR 12 BLOCK CLOSING	F001		R	1	
0x0382	0x0001	10076	SWGR 13 BLOCK CLOSING	F001		R	1	
0x0382	0x0002	10077	SWGR 14 BLOCK CLOSING	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0382	0x0004	10078	SWGR 15 BLOCK CLOSING	F001		R	1	
0x0382	0x0008	10079	SWGR 16 BLOCK CLOSING	F001		R	1	
0x039B	0x4000	6219	USER MAP STATUS	F001		R	1	
0x039B	0x8000	6340	FLEXCURVE A STATUS	F001		R	1	
0x03A0	0x0001	6461	FLEXCURVE B STATUS	F001		R	1	
0x03A5	0x0002	6582	FLEXCURVE C STATUS	F001		R	1	
0x03AA	0x0004	6703	FLEXCURVE D STATUS	F001		R	1	
0x03B2	0x8000	7017	DIR PWR1 BLOCK	F001		R	1	
0x03B2	0x0001	7018	DIR PWR1 STG1 PKP	F001		R	1	
0x03B2	0x0002	7019	DIR PWR1 STG1 OP	F001		R	1	
0x03B2	0x0004	7020	DIR PWR1 STG2 PKP	F001		R	1	
0x03B2	0x0008	7021	DIR PWR1 STG2 OP	F001		R	1	
0x03B2	0x0010	7022	DIR PWR1 STG PKP	F001		R	1	
0x03B2	0x0020	7023	DIR PWR1 STG OP	F001		R	1	
0x03B7	0x0040	7033	DIR PWR2 BLOCK	F001		R	1	
0x03B7	0x0080	7034	DIR PWR2 STG1 PKP	F001		R	1	
0x03B8	0x0100	7035	DIR PWR2 STG1 OP	F001		R	1	
0x03B8	0x0200	7036	DIR PWR2 STG2 PKP	F001		R	1	
0x03B8	0x0400	7037	DIR PWR2 STG2 OP	F001		R	1	
0x03B8	0x0800	7038	DIR PWR2 STG PKP	F001		R	1	
0x03B8	0x1000	7039	DIR PWR2 STG OP	F001		R	1	
0x03BD	0x2000	7049	DIR PWR3 BLOCK	F001		R	1	
0x03BD	0x4000	7050	DIR PWR3 STG1 PKP	F001		R	1	
0x03BD	0x8000	7051	DIR PWR3 STG1 OP	F001		R	1	
0x03BD	0x0001	7052	DIR PWR3 STG2 PKP	F001		R	1	
0x03BD	0x0002	7053	DIR PWR3 STG2 OP	F001		R	1	
0x03BD	0x0004	7054	DIR PWR3 STG PKP	F001		R	1	
0x03BD	0x0008	7055	DIR PWR3 STG OP	F001		R	1	
0x03C6	0x2000	7100	SRC PHASE OV1 BLK	F001		R	1	
0x03C6	0x4000	7101	SRC PHASE OV1 AB PKP	F001		R	1	
0x03C6	0x8000	7102	SRC PHASE OV1 AB OP	F001		R	1	
0x03C6	0x0001	7103	SRC PHASE OV1 BC PKP	F001		R	1	
0x03C6	0x0002	7104	SRC PHASE OV1 BC OP	F001		R	1	
0x03C6	0x0004	7105	SRC PHASE OV1 CA PKP	F001		R	1	
0x03C6	0x0008	7106	SRC PHASE OV1 CA OP	F001		R	1	
0x03C6	0x0010	7107	SRC PHASE OV1 PKP	F001		R	1	
0x03C6	0x0020	7108	SRC PHASE OV1 OP	F001		R	1	
0x03CB	0x0040	7118	SRC PHASE UV1 BLK	F001		R	1	
0x03CB	0x0080	7119	SRC PHASE UV1 A PKP	F001		R	1	
0x03CC	0x0100	7120	SRC PHASE UV1 A OP	F001		R	1	
0x03CC	0x0200	7121	SRC PHASE UV1 B PKP	F001		R	1	
0x03CC	0x0400	7122	SRC PHASE UV1 B OP	F001		R	1	
0x03CC	0x0800	7123	SRC PHASE UV1 C PKP	F001		R	1	
0x03CC	0x1000	7124	SRC PHASE UV1 C OP	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x03CC	0x2000	7125	SRC PHASE UV1 AB PKP	F001		R	1	
0x03CC	0x4000	7126	SRC PHASE UV1 AB OP	F001		R	1	
0x03CC	0x8000	7127	SRC PHASE UV1 BC PKP	F001		R	1	
0x03CC	0x0001	7128	SRC PHASE UV1 BC OP	F001		R	1	
0x03CC	0x0002	7129	SRC PHASE UV1 CA PKP	F001		R	1	
0x03CC	0x0004	7130	SRC PHASE UV1 CA OP	F001		R	1	
0x03CC	0x0008	7131	SRC PHASE UV1 PKP	F001		R	1	
0x03CC	0x0010	7132	SRC PHASE UV1 OP	F001		R	1	
0x03E5	0x0004	11510	ALL REM DEV ONLINE	F001		R	1	
0x03E5	0x0008	7632	DNA 1	F001		R	1	
0x03E5	0x0010	7633	DNA 2	F001		R	1	
0x03E5	0x0020	7634	DNA 3	F001		R	1	
0x03E5	0x0040	7635	DNA 4	F001		R	1	
0x03E5	0x0080	7636	DNA 5	F001		R	1	
0x03E6	0x0100	7637	DNA 6	F001		R	1	
0x03E6	0x0200	7638	DNA 7	F001		R	1	
0x03E6	0x0400	7639	DNA 8	F001		R	1	
0x03E6	0x0800	7640	DNA 9	F001		R	1	
0x03E6	0x1000	7641	DNA 10	F001		R	1	
0x03E6	0x2000	7642	DNA 11	F001		R	1	
0x03E6	0x4000	7643	DNA 12	F001		R	1	
0x03E6	0x8000	7644	DNA 13	F001		R	1	
0x03E6	0x0001	7645	DNA 14	F001		R	1	
0x03E6	0x0002	7646	DNA 15	F001		R	1	
0x03E6	0x0004	7647	DNA 16	F001		R	1	
0x03E6	0x0008	7648	DNA 17	F001		R	1	
0x03E6	0x0010	7649	DNA 18	F001		R	1	
0x03E6	0x0020	7650	DNA 19	F001		R	1	
0x03E6	0x0040	7651	DNA 20	F001		R	1	
0x03E6	0x0080	7652	DNA 21	F001		R	1	
0x03E7	0x0100	7653	DNA 22	F001		R	1	
0x03E7	0x0200	7654	DNA 23	F001		R	1	
0x03E7	0x0400	7655	DNA 24	F001		R	1	
0x03E7	0x0800	7656	DNA 25	F001		R	1	
0x03E7	0x1000	7657	DNA 26	F001		R	1	
0x03E7	0x2000	7658	DNA 27	F001		R	1	
0x03E7	0x4000	7659	DNA 28	F001		R	1	
0x03E7	0x8000	7660	DNA 29	F001		R	1	
0x03E7	0x0001	7661	DNA 30	F001		R	1	
0x03E7	0x0002	7662	DNA 31	F001		R	1	
0x03E7	0x0004	7663	DNA 32	F001		R	1	
0x03E7	0x0008	7664	UserSt 1	F001		R	1	
0x03E7	0x0010	7665	UserSt 2	F001		R	1	
0x03E7	0x0020	7666	UserSt 3	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x03E7	0x0040	7667	UserSt 4	F001		R	1	
0x03E7	0x0080	7668	UserSt 5	F001		R	1	
0x03E8	0x0100	7669	UserSt 6	F001		R	1	
0x03E8	0x0200	7670	UserSt 7	F001		R	1	
0x03E8	0x0400	7671	UserSt 8	F001		R	1	
0x03E8	0x0800	7672	UserSt 9	F001		R	1	
0x03E8	0x1000	7673	UserSt 10	F001		R	1	
0x03E8	0x2000	7674	UserSt 11	F001		R	1	
0x03E8	0x4000	7675	UserSt 12	F001		R	1	
0x03E8	0x8000	7676	UserSt 13	F001		R	1	
0x03E8	0x0001	7677	UserSt 14	F001		R	1	
0x03E8	0x0002	7678	UserSt 15	F001		R	1	
0x03E8	0x0004	7679	UserSt 16	F001		R	1	
0x03E8	0x0008	7680	UserSt 17	F001		R	1	
0x03E8	0x0010	7681	UserSt 18	F001		R	1	
0x03E8	0x0020	7682	UserSt 19	F001		R	1	
0x03E8	0x0040	7683	UserSt 20	F001		R	1	
0x03E8	0x0080	7684	UserSt 21	F001		R	1	
0x03E9	0x0100	7685	UserSt 22	F001		R	1	
0x03E9	0x0200	7686	UserSt 23	F001		R	1	
0x03E9	0x0400	7687	UserSt 24	F001		R	1	
0x03E9	0x0800	7688	UserSt 25	F001		R	1	
0x03E9	0x1000	7689	UserSt 26	F001		R	1	
0x03E9	0x2000	7690	UserSt 27	F001		R	1	
0x03E9	0x4000	7691	UserSt 28	F001		R	1	
0x03E9	0x8000	7692	UserSt 29	F001		R	1	
0x03E9	0x0001	7693	UserSt 30	F001		R	1	
0x03E9	0x0002	7694	UserSt 31	F001		R	1	
0x03E9	0x0004	7695	UserSt 32	F001		R	1	
0x03E9	0x0008	7696	UserSt 33	F001		R	1	
0x03E9	0x0010	7697	UserSt 34	F001		R	1	
0x03E9	0x0020	7698	UserSt 35	F001		R	1	
0x03E9	0x0040	7699	UserSt 36	F001		R	1	
0x03E9	0x0080	7700	UserSt 37	F001		R	1	
0x03EA	0x0100	7701	UserSt 38	F001		R	1	
0x03EA	0x0200	7702	UserSt 39	F001		R	1	
0x03EA	0x0400	7703	UserSt 40	F001		R	1	
0x03EA	0x0800	7704	UserSt 41	F001		R	1	
0x03EA	0x1000	7705	UserSt 42	F001		R	1	
0x03EA	0x2000	7706	UserSt 43	F001		R	1	
0x03EA	0x4000	7707	UserSt 44	F001		R	1	
0x03EA	0x8000	7708	UserSt 45	F001		R	1	
0x03EA	0x0001	7709	UserSt 46	F001		R	1	
0x03EA	0x0002	7710	UserSt 47	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x03EA	0x0004	7711	UserSt 48	F001		R	1	
0x03EA	0x0008	7712	UserSt 49	F001		R	1	
0x03EA	0x0010	7713	UserSt 50	F001		R	1	
0x03EA	0x0020	7714	UserSt 51	F001		R	1	
0x03EA	0x0040	7715	UserSt 52	F001		R	1	
0x03EA	0x0080	7716	UserSt 53	F001		R	1	
0x03EB	0x0100	7717	UserSt 54	F001		R	1	
0x03EB	0x0200	7718	UserSt 55	F001		R	1	
0x03EB	0x0400	7719	UserSt 56	F001		R	1	
0x03EB	0x0800	7720	UserSt 57	F001		R	1	
0x03EB	0x1000	7721	UserSt 58	F001		R	1	
0x03EB	0x2000	7722	UserSt 59	F001		R	1	
0x03EB	0x4000	7723	UserSt 60	F001		R	1	
0x03EB	0x8000	7724	UserSt 61	F001		R	1	
0x03EB	0x0001	7725	UserSt 62	F001		R	1	
0x03EB	0x0002	7726	UserSt 63	F001		R	1	
0x03EB	0x0004	7727	UserSt 64	F001		R	1	
0x03EB	0x0008	7728	Remote Input 1	F001		R	1	
0x03EB	0x0010	7729	Remote Input 2	F001		R	1	
0x03EB	0x0020	7730	Remote Input 3	F001		R	1	
0x03EB	0x0040	7731	Remote Input 4	F001		R	1	
0x03EB	0x0080	7732	Remote Input 5	F001		R	1	
0x03EC	0x0100	7733	Remote Input 6	F001		R	1	
0x03EC	0x0200	7734	Remote Input 7	F001		R	1	
0x03EC	0x0400	7735	Remote Input 8	F001		R	1	
0x03EC	0x0800	7736	Remote Input 9	F001		R	1	
0x03EC	0x1000	7737	Remote Input 10	F001		R	1	
0x03EC	0x2000	7738	Remote Input 11	F001		R	1	
0x03EC	0x4000	7739	Remote Input 12	F001		R	1	
0x03EC	0x8000	7740	Remote Input 13	F001		R	1	
0x03EC	0x0001	7741	Remote Input 14	F001		R	1	
0x03EC	0x0002	7742	Remote Input 15	F001		R	1	
0x03EC	0x0004	7743	Remote Input 16	F001		R	1	
0x03EC	0x0008	7744	Remote Input 17	F001		R	1	
0x03EC	0x0010	7745	Remote Input 18	F001		R	1	
0x03EC	0x0020	7746	Remote Input 19	F001		R	1	
0x03EC	0x0040	7747	Remote Input 20	F001		R	1	
0x03EC	0x0080	7748	Remote Input 21	F001		R	1	
0x03ED	0x0100	7749	Remote Input 22	F001		R	1	
0x03ED	0x0200	7750	Remote Input 23	F001		R	1	
0x03ED	0x0400	7751	Remote Input 24	F001		R	1	
0x03ED	0x0800	7752	Remote Input 25	F001		R	1	
0x03ED	0x1000	7753	Remote Input 26	F001		R	1	
0x03ED	0x2000	7754	Remote Input 27	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x03ED	0x4000	7755	Remote Input 28	F001		R	1	
0x03ED	0x8000	7756	Remote Input 29	F001		R	1	
0x03ED	0x0001	7757	Remote Input 30	F001		R	1	
0x03ED	0x0002	7758	Remote Input 31	F001		R	1	
0x03ED	0x0004	7759	Remote Input 32	F001		R	1	
0x03ED	0x0008	7760	Remote Device 1	F001		R	1	
0x03ED	0x0010	7761	Remote Device 2	F001		R	1	
0x03ED	0x0020	7762	Remote Device 3	F001		R	1	
0x03ED	0x0040	7763	Remote Device 4	F001		R	1	
0x03ED	0x0080	7764	Remote Device 5	F001		R	1	
0x03EE	0x0100	7765	Remote Device 6	F001		R	1	
0x03EE	0x0200	7766	Remote Device 7	F001		R	1	
0x03EE	0x0400	7767	Remote Device 8	F001		R	1	
0x03EE	0x0800	7768	Remote Device 9	F001		R	1	
0x03EE	0x1000	7769	Remote Device 10	F001		R	1	
0x03EE	0x2000	7770	Remote Device 11	F001		R	1	
0x03EE	0x4000	7771	Remote Device 12	F001		R	1	
0x03EE	0x8000	7772	Remote Device 13	F001		R	1	
0x03EE	0x0001	7773	Remote Device 14	F001		R	1	
0x03EE	0x0002	7774	Remote Device 15	F001		R	1	
0x03EE	0x0004	7775	Remote Device 16	F001		R	1	
0x03EE	0x0008	8704	Remote Device 17	F001		R	1	
0x03EE	0x0010	8705	Remote Device 18	F001		R	1	
0x03EE	0x0020	8706	Remote Device 19	F001		R	1	
0x03EE	0x0040	8707	Remote Device 20	F001		R	1	
0x03EE	0x0080	8708	Remote Device 21	F001		R	1	
0x03EF	0x0100	8709	Remote Device 22	F001		R	1	
0x03EF	0x0200	8710	Remote Device 23	F001		R	1	
0x03EF	0x0400	8711	Remote Device 24	F001		R	1	
0x03F2	0x0008	7782	SNTP FAILURE	F001		R	1	
0x03F2	0x0010	7783	IRIGB FAILURE	F001		R	1	
0x03F3	0x0001	10464	CNT PULSES FREEZE	F001		R	1	
0x03F3	0x0002	10465	CNT PULSES UNFREEZE	F001		R	1	
0x03F3	0x0004	10466	CNT PULSES RESET	F001		R	1	
0x03F8	0x0020	7976	Analog Level 01	F001		R	1	
0x03F8	0x0040	7977	Analog Level 02	F001		R	1	
0x03F8	0x0080	7978	Analog Level 03	F001		R	1	
0x03F9	0x0100	7979	Analog Level 04	F001		R	1	
0x03F9	0x0200	7980	Analog Level 05	F001		R	1	
0x03F9	0x0400	7981	Analog Level 06	F001		R	1	
0x03F9	0x0800	7982	Analog Level 07	F001		R	1	
0x03F9	0x1000	7983	Analog Level 08	F001		R	1	
0x03F9	0x2000	7984	Analog Level 09	F001		R	1	
0x03F9	0x4000	7985	Analog Level 10	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x03F9	0x8000	7986	Analog Level 11	F001		R	1	
0x03F9	0x0001	7987	Analog Level 12	F001		R	1	
0x03F9	0x0002	7988	Analog Level 13	F001		R	1	
0x03F9	0x0004	7989	Analog Level 14	F001		R	1	
0x03F9	0x0008	7990	Analog Level 15	F001		R	1	
0x03F9	0x0010	7991	Analog Level 16	F001		R	1	
0x03F9	0x0020	7992	Analog Level 17	F001		R	1	
0x03F9	0x0040	7993	Analog Level 18	F001		R	1	
0x03F9	0x0080	7994	Analog Level 19	F001		R	1	
0x03FA	0x0100	7995	Analog Level 20	F001		R	1	
0x0421	0x2000	8082	Rem GOOSE Dig Inp 1	F001		R	1	
0x0421	0x4000	8083	Rem GOOSE Dig Inp 2	F001		R	1	
0x0421	0x8000	8084	Rem GOOSE Dig Inp 3	F001		R	1	
0x0421	0x0001	8085	Rem GOOSE Dig Inp 4	F001		R	1	
0x0421	0x0002	8086	Rem GOOSE Dig Inp 5	F001		R	1	
0x0421	0x0004	8087	Rem GOOSE Dig Inp 6	F001		R	1	
0x0421	0x0008	8088	Rem GOOSE Dig Inp 7	F001		R	1	
0x0421	0x0010	8089	Rem GOOSE Dig Inp 8	F001		R	1	
0x0421	0x0020	8090	Rem GOOSE Dig Inp 9	F001		R	1	
0x0421	0x0040	8091	Rem GOOSE Dig Inp 10	F001		R	1	
0x0421	0x0080	8092	Rem GOOSE Dig Inp 11	F001		R	1	
0x0422	0x0100	8093	Rem GOOSE Dig Inp 12	F001		R	1	
0x0422	0x0200	8094	Rem GOOSE Dig Inp 13	F001		R	1	
0x0422	0x0400	8095	Rem GOOSE Dig Inp 14	F001		R	1	
0x0422	0x0800	8096	Rem GOOSE Dig Inp 15	F001		R	1	
0x0422	0x1000	8097	Rem GOOSE Dig Inp 16	F001		R	1	
0x0422	0x2000	8098	Rem GOOSE Dig Inp 17	F001		R	1	
0x0422	0x4000	8099	Rem GOOSE Dig Inp 18	F001		R	1	
0x0422	0x8000	8100	Rem GOOSE Dig Inp 19	F001		R	1	
0x0422	0x0001	8101	Rem GOOSE Dig Inp 20	F001		R	1	
0x0422	0x0002	8102	Rem GOOSE Dig Inp 21	F001		R	1	
0x0422	0x0004	8103	Rem GOOSE Dig Inp 22	F001		R	1	
0x0422	0x0008	8104	Rem GOOSE Dig Inp 23	F001		R	1	
0x0422	0x0010	8105	Rem GOOSE Dig Inp 24	F001		R	1	
0x0422	0x0020	8106	Rem GOOSE Dig Inp 25	F001		R	1	
0x0422	0x0040	8107	Rem GOOSE Dig Inp 26	F001		R	1	
0x0422	0x0080	8108	Rem GOOSE Dig Inp 27	F001		R	1	
0x0423	0x0100	8109	Rem GOOSE Dig Inp 28	F001		R	1	
0x0423	0x0200	8110	Rem GOOSE Dig Inp 29	F001		R	1	
0x0423	0x0400	8111	Rem GOOSE Dig Inp 30	F001		R	1	
0x0423	0x0800	8112	Rem GOOSE Dig Inp 31	F001		R	1	
0x0423	0x1000	8113	Rem GOOSE Dig Inp 32	F001		R	1	
0x0423	0x2000	8114	Rem GOOSE Dig Out 1	F001		R	1	
0x0423	0x4000	8115	Rem GOOSE Dig Out 2	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0423	0x8000	8116	Rem GOOSE Dig Out 3	F001		R	1	
0x0423	0x0001	8117	Rem GOOSE Dig Out 4	F001		R	1	
0x0423	0x0002	8118	Rem GOOSE Dig Out 5	F001		R	1	
0x0423	0x0004	8119	Rem GOOSE Dig Out 6	F001		R	1	
0x0423	0x0008	8120	Rem GOOSE Dig Out 7	F001		R	1	
0x0423	0x0010	8121	Rem GOOSE Dig Out 8	F001		R	1	
0x0423	0x0020	8122	Rem GOOSE Dig Out 9	F001		R	1	
0x0423	0x0040	8123	Rem GOOSE Dig Out 10	F001		R	1	
0x0423	0x0080	8124	Rem GOOSE Dig Out 11	F001		R	1	
0x0424	0x0100	8125	Rem GOOSE Dig Out 12	F001		R	1	
0x0424	0x0200	8126	Rem GOOSE Dig Out 13	F001		R	1	
0x0424	0x0400	8127	Rem GOOSE Dig Out 14	F001		R	1	
0x0424	0x0800	8128	Rem GOOSE Dig Out 15	F001		R	1	
0x0424	0x1000	8129	Rem GOOSE Dig Out 16	F001		R	1	
0x0424	0x2000	8130	Rem GOOSE Dig Out 17	F001		R	1	
0x0424	0x4000	8131	Rem GOOSE Dig Out 18	F001		R	1	
0x0424	0x8000	8132	Rem GOOSE Dig Out 19	F001		R	1	
0x0424	0x0001	8133	Rem GOOSE Dig Out 20	F001		R	1	
0x0424	0x0002	8134	Rem GOOSE Dig Out 21	F001		R	1	
0x0424	0x0004	8135	Rem GOOSE Dig Out 22	F001		R	1	
0x0424	0x0008	8136	Rem GOOSE Dig Out 23	F001		R	1	
0x0424	0x0010	8137	Rem GOOSE Dig Out 24	F001		R	1	
0x0424	0x0020	8138	Rem GOOSE Dig Out 25	F001		R	1	
0x0424	0x0040	8139	Rem GOOSE Dig Out 26	F001		R	1	
0x0424	0x0080	8140	Rem GOOSE Dig Out 27	F001		R	1	
0x0425	0x0100	8141	Rem GOOSE Dig Out 28	F001		R	1	
0x0425	0x0200	8142	Rem GOOSE Dig Out 29	F001		R	1	
0x0425	0x0400	8143	Rem GOOSE Dig Out 30	F001		R	1	
0x0425	0x0800	8144	Rem GOOSE Dig Out 31	F001		R	1	
0x0425	0x1000	8145	Rem GOOSE Dig Out 32	F001		R	1	
0x0450	0x0080	8585	32N1 BLOCK	F001		R	1	
0x0451	0x0100	8586	32N1 PKP	F001		R	1	
0x0451	0x0200	8587	32N1 OC PKP	F001		R	1	
0x0451	0x0400	8588	32N1 OP	F001		R	1	
0x0452	0x0800	8601	32N2 BLOCK	F001		R	1	
0x0452	0x1000	8602	32N2 PKP	F001		R	1	
0x0452	0x2000	8603	32N2 OC PKP	F001		R	1	
0x0452	0x4000	8604	32N2 OP	F001		R	1	
0x0453	0x8000	8617	32N3 BLOCK	F001		R	1	
0x0453	0x0001	8618	32N3 PKP	F001		R	1	
0x0453	0x0002	8619	32N3 OC PKP	F001		R	1	
0x0453	0x0004	8620	32N3 OP	F001		R	1	
0x04A4	0x0002	9944	DIGCNT 1 BLOCK	F001		R	1	
0x04A4	0x0004	9945	DIGCNT 2 BLOCK	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x04A4	0x0008	9946	DIGCNT 3 BLOCK	F001		R	1	
0x04A4	0x0010	9947	DIGCNT 4 BLOCK	F001		R	1	
0x04A4	0x0020	9948	DIGCNT 5 BLOCK	F001		R	1	
0x04A4	0x0040	9949	DIGCNT 6 BLOCK	F001		R	1	
0x04A4	0x0080	9950	DIGCNT 7 BLOCK	F001		R	1	
0x04A5	0x0100	9951	DIGCNT 8 BLOCK	F001		R	1	
0x04A5	0x0200	9976	DIGCNT 1 HI	F001		R	1	
0x04A5	0x0400	9977	DIGCNT 2 HI	F001		R	1	
0x04A5	0x0800	9978	DIGCNT 3 HI	F001		R	1	
0x04A5	0x1000	9979	DIGCNT 4 HI	F001		R	1	
0x04A5	0x2000	9980	DIGCNT 5 HI	F001		R	1	
0x04A5	0x4000	9981	DIGCNT 6 HI	F001		R	1	
0x04A5	0x8000	9982	DIGCNT 7 HI	F001		R	1	
0x04A5	0x0001	9983	DIGCNT 8 HI	F001		R	1	
0x04A5	0x0002	9984	DIGCNT 1 EQ	F001		R	1	
0x04A5	0x0004	9985	DIGCNT 2 EQ	F001		R	1	
0x04A5	0x0008	9986	DIGCNT 3 EQ	F001		R	1	
0x04A5	0x0010	9987	DIGCNT 4 EQ	F001		R	1	
0x04A5	0x0020	9988	DIGCNT 5 EQ	F001		R	1	
0x04A5	0x0040	9989	DIGCNT 6 EQ	F001		R	1	
0x04A5	0x0080	9990	DIGCNT 7 EQ	F001		R	1	
0x04A6	0x0100	9991	DIGCNT 8 EQ	F001		R	1	
0x04A6	0x0200	9992	DIGCNT 1 LO	F001		R	1	
0x04A6	0x0400	9993	DIGCNT 2 LO	F001		R	1	
0x04A6	0x0800	9994	DIGCNT 3 LO	F001		R	1	
0x04A6	0x1000	9995	DIGCNT 4 LO	F001		R	1	
0x04A6	0x2000	9996	DIGCNT 5 LO	F001		R	1	
0x04A6	0x4000	9997	DIGCNT 6 LO	F001		R	1	
0x04A6	0x8000	9998	DIGCNT 7 LO	F001		R	1	
0x04A6	0x0001	9999	DIGCNT 8 LO	F001		R	1	
0x04A6	0x0002	10000	DIGCNT 1 UP	F001		R	1	
0x04A6	0x0004	10001	DIGCNT 2 UP	F001		R	1	
0x04A6	0x0008	10002	DIGCNT 3 UP	F001		R	1	
0x04A6	0x0010	10003	DIGCNT 4 UP	F001		R	1	
0x04A6	0x0020	10004	DIGCNT 5 UP	F001		R	1	
0x04A6	0x0040	10005	DIGCNT 6 UP	F001		R	1	
0x04A6	0x0080	10006	DIGCNT 7 UP	F001		R	1	
0x04A7	0x0100	10007	DIGCNT 8 UP	F001		R	1	
0x04A7	0x0200	10008	DIGCNT 1 DOWN	F001		R	1	
0x04A7	0x0400	10009	DIGCNT 2 DOWN	F001		R	1	
0x04A7	0x0800	10010	DIGCNT 3 DOWN	F001		R	1	
0x04A7	0x1000	10011	DIGCNT 4 DOWN	F001		R	1	
0x04A7	0x2000	10012	DIGCNT 5 DOWN	F001		R	1	
0x04A7	0x4000	10013	DIGCNT 6 DOWN	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x04A7	0x8000	10014	DIGCNT 7 DOWN	F001		R	1	
0x04A7	0x0001	10015	DIGCNT 8 DOWN	F001		R	1	
0x04A7	0x0002	10016	DIGCNT 1 SETPRESET	F001		R	1	
0x04A7	0x0004	10017	DIGCNT 2 SETPRESET	F001		R	1	
0x04A7	0x0008	10018	DIGCNT 3 SETPRESET	F001		R	1	
0x04A7	0x0010	10019	DIGCNT 4 SETPRESET	F001		R	1	
0x04A7	0x0020	10020	DIGCNT 5 SETPRESET	F001		R	1	
0x04A7	0x0040	10021	DIGCNT 6 SETPRESET	F001		R	1	
0x04A7	0x0080	10022	DIGCNT 7 SETPRESET	F001		R	1	
0x04A8	0x0100	10023	DIGCNT 8 SETPRESET	F001		R	1	
0x04A8	0x0200	10024	DIGCNT 1 RESET	F001		R	1	
0x04A8	0x0400	10025	DIGCNT 2 RESET	F001		R	1	
0x04A8	0x0800	10026	DIGCNT 3 RESET	F001		R	1	
0x04A8	0x1000	10027	DIGCNT 4 RESET	F001		R	1	
0x04A8	0x2000	10028	DIGCNT 5 RESET	F001		R	1	
0x04A8	0x4000	10029	DIGCNT 6 RESET	F001		R	1	
0x04A8	0x8000	10030	DIGCNT 7 RESET	F001		R	1	
0x04A8	0x0001	10031	DIGCNT 8 RESET	F001		R	1	
0x04A8	0x0002	10032	DIGCNT 1 FREEZERESET	F001		R	1	
0x04A8	0x0004	10033	DIGCNT 2 FREEZERESET	F001		R	1	
0x04A8	0x0008	10034	DIGCNT 3 FREEZERESET	F001		R	1	
0x04A8	0x0010	10035	DIGCNT 4 FREEZERESET	F001		R	1	
0x04A8	0x0020	10036	DIGCNT 5 FREEZERESET	F001		R	1	
0x04A8	0x0040	10037	DIGCNT 6 FREEZERESET	F001		R	1	
0x04A8	0x0080	10038	DIGCNT 7 FREEZERESET	F001		R	1	
0x04A9	0x0100	10039	DIGCNT 8 FREEZERESET	F001		R	1	
0x04A9	0x0200	10040	DIGCNT 1 FREEZECOUNT	F001		R	1	
0x04A9	0x0400	10041	DIGCNT 2 FREEZECOUNT	F001		R	1	
0x04A9	0x0800	10042	DIGCNT 3 FREEZECOUNT	F001		R	1	
0x04A9	0x1000	10043	DIGCNT 4 FREEZECOUNT	F001		R	1	
0x04A9	0x2000	10044	DIGCNT 5 FREEZECOUNT	F001		R	1	
0x04A9	0x4000	10045	DIGCNT 6 FREEZECOUNT	F001		R	1	
0x04A9	0x8000	10046	DIGCNT 7 FREEZECOUNT	F001		R	1	
0x04A9	0x0001	10047	DIGCNT 8 FREEZECOUNT	F001		R	1	
0x04D8	0x0002	10457	Cold Load PKP	F001		R	1	
0x04D8	0x0004	10458	Cold Load OP	F001		R	1	
0x04DD	0x0002	10835	CT Failure PKP	F001		R	1	
0x04DD	0x0004	10836	CT Failure OP	F001		R	1	
0x04DD	0x0008	10837	CT Failure BLOCK	F001		R	1	
0x04DE	0x0002	10844	2nd HRMC PKP	F001		R	1	
0x04DE	0x0004	10845	2nd HRMC OP	F001		R	1	
0x04DE	0x0008	10846	2nd HRMC BLOCK	F001		R	1	
0x04E2	0x0001	11162	SRC PHASE OV2 BLK	F001		R	1	
0x04E2	0x0002	11163	SRC PHASE OV2 AB PKP	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x04E2	0x0004	11164	SRC PHASE OV2 AB OP	F001		R	1	
0x04E2	0x0008	11165	SRC PHASE OV2 BC PKP	F001		R	1	
0x04E2	0x0010	11166	SRC PHASE OV2 BC OP	F001		R	1	
0x04E2	0x0020	11167	SRC PHASE OV2 CA PKP	F001		R	1	
0x04E2	0x0040	11168	SRC PHASE OV2 CA OP	F001		R	1	
0x04E2	0x0080	11169	SRC PHASE OV2 PKP	F001		R	1	
0x04E3	0x0100	11170	SRC PHASE OV2 OP	F001		R	1	
0x04E4	0x0100	11177	SRC PHASE OV3 BLK	F001		R	1	
0x04E4	0x0200	11178	SRC PHASE OV3 AB PKP	F001		R	1	
0x04E4	0x0400	11179	SRC PHASE OV3 AB OP	F001		R	1	
0x04E4	0x0800	11180	SRC PHASE OV3 BC PKP	F001		R	1	
0x04E4	0x1000	11181	SRC PHASE OV3 BC OP	F001		R	1	
0x04E4	0x2000	11182	SRC PHASE OV3 CA PKP	F001		R	1	
0x04E4	0x4000	11183	SRC PHASE OV3 CA OP	F001		R	1	
0x04E4	0x8000	11184	SRC PHASE OV3 PKP	F001		R	1	
0x04E4	0x0001	11185	SRC PHASE OV3 OP	F001		R	1	
0x04E5	0x0001	11197	SRC PHASE UV2 BLK	F001		R	1	
0x04E5	0x0002	11198	SRC PHASE UV2 A PKP	F001		R	1	
0x04E5	0x0004	11199	SRC PHASE UV2 A OP	F001		R	1	
0x04E5	0x0008	11200	SRC PHASE UV2 B PKP	F001		R	1	
0x04E5	0x0010	11201	SRC PHASE UV2 B OP	F001		R	1	
0x04E5	0x0020	11202	SRC PHASE UV2 C PKP	F001		R	1	
0x04E5	0x0040	11203	SRC PHASE UV2 C OP	F001		R	1	
0x04E5	0x0080	11204	SRC PHASE UV2 AB PKP	F001		R	1	
0x04E6	0x0100	11205	SRC PHASE UV2 AB OP	F001		R	1	
0x04E6	0x0200	11206	SRC PHASE UV2 BC PKP	F001		R	1	
0x04E6	0x0400	11207	SRC PHASE UV2 BC OP	F001		R	1	
0x04E6	0x0800	11208	SRC PHASE UV2 CA PKP	F001		R	1	
0x04E6	0x1000	11209	SRC PHASE UV2 CA OP	F001		R	1	
0x04E6	0x2000	11210	SRC PHASE UV2 PKP	F001		R	1	
0x04E6	0x4000	11211	SRC PHASE UV2 OP	F001		R	1	
0x04E7	0x0100	11221	SRC PHASE UV3 BLK	F001		R	1	
0x04E7	0x0200	11222	SRC PHASE UV3 A PKP	F001		R	1	
0x04E7	0x0400	11223	SRC PHASE UV3 A OP	F001		R	1	
0x04E7	0x0800	11224	SRC PHASE UV3 B PKP	F001		R	1	
0x04E7	0x1000	11225	SRC PHASE UV3 B OP	F001		R	1	
0x04E7	0x2000	11226	SRC PHASE UV3 C PKP	F001		R	1	
0x04E7	0x4000	11227	SRC PHASE UV3 C OP	F001		R	1	
0x04E7	0x8000	11228	SRC PHASE UV3 AB PKP	F001		R	1	
0x04E7	0x0001	11229	SRC PHASE UV3 AB OP	F001		R	1	
0x04E7	0x0002	11230	SRC PHASE UV3 BC PKP	F001		R	1	
0x04E7	0x0004	11231	SRC PHASE UV3 BC OP	F001		R	1	
0x04E7	0x0008	11232	SRC PHASE UV3 CA PKP	F001		R	1	
0x04E7	0x0010	11233	SRC PHASE UV3 CA OP	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x04E7	0x0020	11234	SRC PHASE UV3 PKP	F001		R	1	
0x04E7	0x0040	11235	SRC PHASE UV3 OP	F001		R	1	
0x04E8	0x0001	11241	SRC NEG SEQ OV1 BLK	F001		R	1	
0x04E8	0x0002	11242	SRC NEG SEQ OV1 PKP	F001		R	1	
0x04E8	0x0004	11243	SRC NEG SEQ OV1 OP	F001		R	1	
0x04E9	0x0100	11249	SRC NEG SEQ OV2 BLK	F001		R	1	
0x04E9	0x0200	11250	SRC NEG SEQ OV2 PKP	F001		R	1	
0x04E9	0x0400	11251	SRC NEG SEQ OV2 OP	F001		R	1	
0x04E9	0x0001	11257	SRC NEG SEQ OV3 BLK	F001		R	1	
0x04E9	0x0002	11258	SRC NEG SEQ OV3 PKP	F001		R	1	
0x04E9	0x0004	11259	SRC NEG SEQ OV3 OP	F001		R	1	
0x04EA	0x0100	11302	LOCKOUT PHA RESET	F001		R	1	
0x04EA	0x0200	11303	LOCKOUT PHB RESET	F001		R	1	
0x04EA	0x0400	11304	LOCKOUT PHC RESET	F001		R	1	
0x04EA	0x0800	11305	LOCKOUT 3P RESET	F001		R	1	
0x04EA	0x1000	11306	AR BLOCK INPUT	F001		R	1	
0x04EA	0x2000	11307	AR BLOCK PULSE	F001		R	1	
0x04EA	0x4000	11308	AR UNBLOCK PULSE	F001		R	1	
0x04EA	0x8000	11309	AR HALT INPUT	F001		R	1	
0x04EA	0x0001	11310	AR FORCE 3P MODE	F001		R	1	
0x04EA	0x0002	11311	AR PHASE A RI	F001		R	1	
0x04EA	0x0004	11312	AR PHASE B RI	F001		R	1	
0x04EA	0x0008	11313	AR PHASE C RI	F001		R	1	
0x04EA	0x0010	11314	AR 3P RI	F001		R	1	
0x04EA	0x0020	11315	AR DTL PHA	F001		R	1	
0x04EA	0x0040	11316	AR DTL PHB	F001		R	1	
0x04EA	0x0080	11317	AR DTL PHC	F001		R	1	
0x04EB	0x0100	11318	AR DTL PH3P	F001		R	1	
0x04EB	0x0200	11319	AR PHA COORD	F001		R	1	
0x04EB	0x0400	11320	AR PHB COORD	F001		R	1	
0x04EB	0x0800	11321	AR PHC COORD	F001		R	1	
0x04EB	0x1000	11322	AR PH 3P COORD	F001		R	1	
0x04EB	0x2000	11323	AR PHA CLS COND	F001		R	1	
0x04EB	0x4000	11324	AR PHB CLS COND	F001		R	1	
0x04EB	0x8000	11325	AR PHC CLS COND	F001		R	1	
0x04EB	0x0001	11326	AR PH 3P CLS COND	F001		R	1	
0x04EB	0x0002	11327	AR PHA SKIP SHOT	F001		R	1	
0x04EB	0x0004	11328	AR PHB SKIP SHOT	F001		R	1	
0x04EB	0x0008	11329	AR PHC SKIP SHOT	F001		R	1	
0x04EB	0x0010	11330	AR PH 3P SKIP SHOT	F001		R	1	
0x04EB	0x0020	11331	AR CLOSE PHA	F001		R	1	
0x04EB	0x0040	11332	AR CLOSE PHB	F001		R	1	
0x04EB	0x0080	11333	AR CLOSE PHC	F001		R	1	
0x04EC	0x0100	11334	AR CLOSE 3P	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x04EC	0x0200	11335	AR PHA LOCKOUT	F001		R	1	
0x04EC	0x0400	11336	AR PHB LOCKOUT	F001		R	1	
0x04EC	0x0800	11337	AR PHC LOCKOUT	F001		R	1	
0x04EC	0x1000	11338	AR 3P LOCKOUT	F001		R	1	
0x04EC	0x2000	11339	AR PHA IN PROGRESS	F001		R	1	
0x04EC	0x4000	11340	AR PHB IN PROGRESS	F001		R	1	
0x04EC	0x8000	11341	AR PHC IN PROGRESS	F001		R	1	
0x04EC	0x0001	11342	AR 3P IN PROGRESS	F001		R	1	
0x04EC	0x0002	11343	AR PHA READY	F001		R	1	
0x04EC	0x0004	11344	AR PHB READY	F001		R	1	
0x04EC	0x0008	11345	AR PHC READY	F001		R	1	
0x04EC	0x0010	11346	AR 3P READY	F001		R	1	
0x04EC	0x0020	11347	AR PHA BLOCK	F001		R	1	
0x04EC	0x0040	11348	AR PHB BLOCK	F001		R	1	
0x04EC	0x0080	11349	AR PHC BLOCK	F001		R	1	
0x04ED	0x0100	11350	AR 3P BLOCK	F001		R	1	
0x04ED	0x0200	11351	AR PHA SHOT 0	F001		R	1	
0x04ED	0x0400	11352	AR PHB SHOT 0	F001		R	1	
0x04ED	0x0800	11353	AR PHC SHOT 0	F001		R	1	
0x04ED	0x1000	11354	AR 3P SHOT 0	F001		R	1	
0x04ED	0x2000	11355	AR PHA SHOT 1	F001		R	1	
0x04ED	0x4000	11356	AR PHB SHOT 1	F001		R	1	
0x04ED	0x8000	11357	AR PHC SHOT 1	F001		R	1	
0x04ED	0x0001	11358	AR 3P SHOT 1	F001		R	1	
0x04ED	0x0002	11359	AR PHA SHOT 2	F001		R	1	
0x04ED	0x0004	11360	AR PHB SHOT 2	F001		R	1	
0x04ED	0x0008	11361	AR PHC SHOT 2	F001		R	1	
0x04ED	0x0010	11362	AR 3P SHOT 2	F001		R	1	
0x04ED	0x0020	11363	AR PHA SHOT 3	F001		R	1	
0x04ED	0x0040	11364	AR PHB SHOT 3	F001		R	1	
0x04ED	0x0080	11365	AR PHC SHOT 3	F001		R	1	
0x04EE	0x0100	11366	AR 3P SHOT 3	F001		R	1	
0x04EE	0x0200	11367	AR PHA SHOT 4	F001		R	1	
0x04EE	0x0400	11368	AR PHB SHOT 4	F001		R	1	
0x04EE	0x0800	11369	AR PHC SHOT 4	F001		R	1	
0x04EE	0x1000	11370	AR 3P SHOT 4	F001		R	1	
0x04EE	0x2000	11371	AR PHA LAST SHOT	F001		R	1	
0x04EE	0x4000	11372	AR PHB LAST SHOT	F001		R	1	
0x04EE	0x8000	11373	AR PHC LAST SHOT	F001		R	1	
0x04EE	0x0001	11374	AR 3P LAST SHOT	F001		R	1	
0x04EE	0x0002	11387	AR DEAD TIME PHA	F001		R	1	
0x04EE	0x0004	11388	AR DEAD TIME PHB	F001		R	1	
0x04EE	0x0008	11389	AR DEAD TIME PHC	F001		R	1	
0x04EE	0x0010	11390	AR DEAD TIME 3P	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x04EE	0x0020	11391	AR RECLAIM TIME PHA	F001		R	1	
0x04EE	0x0040	11392	AR RECLAIM TIME PHB	F001		R	1	
0x04EE	0x0080	11393	AR RECLAIM TIME PHC	F001		R	1	
0x04EF	0x0100	11394	AR RECLAIM TIME 3P	F001		R	1	
0x04EF	0x0200	11395	AR RESET TIME PHA	F001		R	1	
0x04EF	0x0400	11396	AR RESET TIME PHB	F001		R	1	
0x04EF	0x0800	11397	AR RESET TIME PHC	F001		R	1	
0x04EF	0x1000	11398	AR RESET TIME 3P	F001		R	1	
0x04F1	0x0100	11416	RCL WEAR PHA ALARM	F001		R	1	
0x04F1	0x0200	11417	RCL WEAR PHB ALARM	F001		R	1	
0x04F1	0x0400	11418	RCL WEAR PHC ALARM	F001		R	1	
0x04F1	0x0800	11419	RCL WEAR 3P ALARM	F001		R	1	
0x04F1	0x1000	11420	RCL PHA 1HOUR ALARM	F001		R	1	
0x04F1	0x2000	11421	RCL PHB 1HOUR ALARM	F001		R	1	
0x04F1	0x4000	11422	RCL PHC 1HOUR ALARM	F001		R	1	
0x04F1	0x8000	11423	RCL 3P 1HOUR ALARM	F001		R	1	
0x04F1	0x0001	11424	RCL PHA OPENED	F001		R	1	
0x04F1	0x0002	11425	RCL PHB OPENED	F001		R	1	
0x04F1	0x0004	11426	RCL PHC OPENED	F001		R	1	
0x04F1	0x0008	11427	RCL 3P OPENED	F001		R	1	
0x04F1	0x0010	11428	RCL PHA CLOSED	F001		R	1	
0x04F1	0x0020	11429	RCL PHB CLOSED	F001		R	1	
0x04F1	0x0040	11430	RCL PHC CLOSED	F001		R	1	
0x04F1	0x0080	11431	RCL 3P CLOSED	F001		R	1	
0x04F2	0x0100	11432	RCL PHA UNDEFINED	F001		R	1	
0x04F2	0x0200	11433	RCL PHB UNDEFINED	F001		R	1	
0x04F2	0x0400	11434	RCL PHC UNDEFINED	F001		R	1	
0x04F2	0x0800	11435	RCL 3P UNDEFINED	F001		R	1	
0x04F2	0x1000	11436	RESET CNT WEAR PHA	F001		R	1	
0x04F2	0x2000	11437	RESET CNT WEAR PHB	F001		R	1	
0x04F2	0x4000	11438	RESET CNT WEAR PHC	F001		R	1	
0x04F2	0x8000	11439	RESET CNT WEAR 3P	F001		R	1	
0x04F2	0x0001	11440	RESET CNT RCLS PHA	F001		R	1	
0x04F2	0x0002	11441	RESET CNT RCLS PHB	F001		R	1	
0x04F2	0x0004	11442	RESET CNT RCLS PHC	F001		R	1	
0x04F2	0x0008	11443	RESET CNT RCLS 3P	F001		R	1	
0x04F2	0x0010	11444	RCL PHA FAIL TO OPEN	F001		R	1	
0x04F2	0x0020	11445	RCL PHB FAIL TO OPEN	F001		R	1	
0x04F2	0x0040	11446	RCL PHC FAIL TO OPEN	F001		R	1	
0x04F2	0x0080	11447	RCL 3P FAIL TO OPEN	F001		R	1	
0x04F3	0x0100	11448	RCL PHA FAIL TOCLOSE	F001		R	1	
0x04F3	0x0200	11449	RCL PHB FAIL TOCLOSE	F001		R	1	
0x04F3	0x0400	11450	RCL PHC FAIL TOCLOSE	F001		R	1	
0x04F3	0x0800	11451	RCL 3P FAIL TOCLOSE	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x04F3	0x1000	11698	RCL PHA ERROR	F001		R	1	
0x04F3	0x2000	11699	RCL PHB ERROR	F001		R	1	
0x04F3	0x4000	11700	RCL PHC ERROR	F001		R	1	
0x04F3	0x8000	11701	RCL 3P ERROR	F001		R	1	
0x04F4	0x0100	11469	SP PHA OPEN	F001		R	1	
0x04F4	0x0200	11470	SP PHB OPEN	F001		R	1	
0x04F4	0x0400	11471	SP PHC OPEN	F001		R	1	
0x04F4	0x0800	11472	SINGLE POLE OPEN	F001		R	1	
0x04F4	0x1000	11473	3 POLE OPEN	F001		R	1	
0x04F4	0x2000	11474	ANY PHASE OPEN	F001		R	1	
0x04F4	0x4000	11475	TRIP PHA INPUT	F001		R	1	
0x04F4	0x8000	11476	TRIP PHB INPUT	F001		R	1	
0x04F4	0x0001	11477	TRIP PHC INPUT	F001		R	1	
0x04F4	0x0002	11478	TRIP 3 PHASE INPUT	F001		R	1	
0x04F4	0x0004	11479	BLK TRIP PHA	F001		R	1	
0x04F4	0x0008	11480	BLK TRIP PHB	F001		R	1	
0x04F4	0x0010	11481	BLK TRIP PHC	F001		R	1	
0x04F4	0x0020	11482	BLK 3P TRIP	F001		R	1	
0x04F4	0x0040	11483	OPEN PHA INPUT	F001		R	1	
0x04F4	0x0080	11484	OPEN PHB INPUT	F001		R	1	
0x04F5	0x0100	11485	OPEN PHC INPUT	F001		R	1	
0x04F5	0x0200	11486	OPEN 3 PHASE INPUT	F001		R	1	
0x04F5	0x0400	11487	YELLOW HANDLE INPUT	F001		R	1	
0x04F5	0x0800	11604	HOT LINE TAG INPUT	F001		R	1	
0x04F5	0x1000	11605	HOT LINE TAG OP	F001		R	1	
0x04F5	0x2000	11644	HOT LINE TAG PULSE	F001		R	1	
0x04F5	0x4000	11606	CLOSE PHA	F001		R	1	
0x04F5	0x8000	11607	CLOSE PHB	F001		R	1	
0x04F5	0x0001	11608	CLOSE PHC	F001		R	1	
0x04F5	0x0002	11609	CLOSE 3P	F001		R	1	
0x04F5	0x0004	11610	CLOSE PHA INPUT	F001		R	1	
0x04F5	0x0008	11611	CLOSE PHB INPUT	F001		R	1	
0x04F5	0x0010	11612	CLOSE PHC INPUT	F001		R	1	
0x04F5	0x0020	11613	CLOSE 3P INPUT	F001		R	1	
0x04F5	0x0040	11614	BLK CLOSE PHA	F001		R	1	
0x04F5	0x0080	11615	BLK CLOSE PHB	F001		R	1	
0x04F6	0x0100	11616	BLK CLOSE PHC	F001		R	1	
0x04F6	0x0200	11617	BLK CLOSE 3P	F001		R	1	
0x04F6	0x0400	11618	1 POLE PHA TRIP	F001		R	1	
0x04F6	0x0800	11619	1 POLE PHB TRIP	F001		R	1	
0x04F6	0x1000	11620	1 POLE PHC TRIP	F001		R	1	
0x04F6	0x2000	11621	3 POLE TRIP	F001		R	1	
0x04F7	0x0001	11267	COIL A SUPERVISION	F001		R	1	
0x04F7	0x0002	11268	COIL B SUPERVISION	F001		R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x04F7	0x0004	11269	COIL C SUPERVISION	F001		R	1	
0x04F7	0x0008	11270	PHA COIL SUP OP	F001		R	1	
0x04F7	0x0010	11271	PHB COIL SUP OP	F001		R	1	
0x04F7	0x0020	11272	PHC COIL SUP OP	F001		R	1	
0x04F7	0x0040	11273	COIL SUPERV OP	F001		R	1	
0x04F7	0x0080	11274	VOLT CAP SUPERVISION	F001		R	1	
0x04F8	0x0100	11503	COIL SUPV BLOCK	F001		R	1	
0x04F8	0x0001	11645	50BF BLOCK INPUT	F001		R	1	
0x04F8	0x0002	11646	50BF PHA INITIATE	F001		R	1	
0x04F8	0x0004	11647	50BF PHB INITIATE	F001		R	1	
0x04F8	0x0008	11648	50BF PHC INITIATE	F001		R	1	
0x04F8	0x0010	11649	50BF 3P INITIATE	F001		R	1	
0x04F8	0x0020	11650	50BF PHA RETRIP	F001		R	1	
0x04F8	0x0040	11651	50BF PHB RETRIP	F001		R	1	
0x04F8	0x0080	11652	50BF PHC RETRIP	F001		R	1	
0x04F9	0x0100	11653	50BF 3P RETRIP	F001		R	1	
0x04F9	0x0200	11654	50BF PHA INT ARC	F001		R	1	
0x04F9	0x0400	11655	50BF PHB INT ARC	F001		R	1	
0x04F9	0x0800	11656	50BF PHC INT ARC	F001		R	1	
0x04F9	0x1000	11657	50BF WO CURRENT	F001		R	1	
0x04F9	0x2000	11658	50BF PHA HISET TRIP	F001		R	1	
0x04F9	0x4000	11659	50BF PHB HISET TRIP	F001		R	1	
0x04F9	0x8000	11660	50BF PHC HISET TRIP	F001		R	1	
0x04F9	0x0001	11661	50BF 3P HISET TRIP	F001		R	1	
0x04F9	0x0002	11662	50BF PHA LOSET TRIP	F001		R	1	
0x04F9	0x0004	11663	50BF PHB LOSET TRIP	F001		R	1	
0x04F9	0x0008	11664	50BF PHC LOSET TRIP	F001		R	1	
0x04F9	0x0010	11665	50BF 3P LOSET TRIP	F001		R	1	
0x04F9	0x0020	11666	50BF PHA 2NDST TRIP	F001		R	1	
0x04F9	0x0040	11667	50BF PHB 2NDST TRIP	F001		R	1	
0x04F9	0x0080	11668	50BF PHC 2NDST TRIP	F001		R	1	
0x04FA	0x0100	11669	50BF 3P 2NDST TRIP	F001		R	1	
0x07D0		10501	INT32_000	F005	1,000	R	2	
0x07D2		10502	INT32_001	F005	1,000	R	2	
0x07D4		10503	INT32_002	F005	1,000	R	2	
0x07D6		10504	INT32_003	F005	1,000	R	2	
0x07D8		10505	INT32_004	F005	1,000	R	2	
0x07DA		10506	INT32_005	F005	1,000	R	2	
0x07DC		10507	INT32_006	F005	1,000	R	2	
0x07DE		10508	INT32_007	F005	1,000	R	2	
0x07E0		10509	INT32_008	F005	1,000	R	2	
0x07E2		10510	INT32_009	F005	1,000	R	2	
0x07E4		10511	INT32_010	F005	1,000	R	2	
0x07E6		10512	INT32_011	F005	1,000	R	2	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x07E8		10513	INT32_012	F005	1,000	R	2	
0x07EA		10514	INT32_013	F005	1,000	R	2	
0x07EC		10515	INT32_014	F005	1,000	R	2	
0x07EE		10516	INT32_015	F005	1,000	R	2	
0x07F0		10517	INT32_016	F005	1,000	R	2	
0x07F2		10518	INT32_017	F005	1,000	R	2	
0x07F4		10519	INT32_018	F005	1,000	R	2	
0x07F6		10520	INT32_019	F005	1,000	R	2	
0x07F8		10521	INT32_020	F005	1,000	R	2	
0x07FA		10522	INT32_021	F005	1,000	R	2	
0x07FC		10523	INT32_022	F005	1,000	R	2	
0x07FE		10524	INT32_023	F005	1,000	R	2	
0x0800		10525	INT32_024	F005	1,000	R	2	
0x0802		10526	INT32_025	F005	1,000	R	2	
0x0804		10527	INT32_026	F005	1,000	R	2	
0x0806		10528	INT32_027	F005	1,000	R	2	
0x0808		10529	INT32_028	F005	1,000	R	2	
0x080A		10530	INT32_029	F005	1,000	R	2	
0x080C		10531	INT32_030	F005	1,000	R	2	
0x080E		10532	INT32_031	F005	1,000	R	2	
0x0810		10533	INT32_032	F005	1,000	R	2	
0x0812		10534	INT32_033	F005	1,000	R	2	
0x0814		10535	INT32_034	F005	1,000	R	2	
0x0816		10536	INT32_035	F005	1,000	R	2	
0x0818		10537	INT32_036	F005	1,000	R	2	
0x081A		10538	INT32_037	F005	1,000	R	2	
0x081C		10539	INT32_038	F005	1,000	R	2	
0x081E		10540	INT32_039	F005	1,000	R	2	
0x0820		10541	INT32_040	F005	1,000	R	2	
0x0822		10542	INT32_041	F005	1,000	R	2	
0x0824		10543	INT32_042	F005	1,000	R	2	
0x0826		10544	INT32_043	F005	1,000	R	2	
0x0828		10545	INT32_044	F005	1,000	R	2	
0x082A		10546	INT32_045	F005	1,000	R	2	
0x082C		10547	INT32_046	F005	1,000	R	2	
0x082E		10548	INT32_047	F005	1,000	R	2	
0x0830		10549	INT32_048	F005	1,000	R	2	
0x0832		10550	INT32_049	F005	1,000	R	2	
0x0834		10551	FLT32_000	F003	1,000	R	2	
0x0836		10552	FLT32_001	F003	1,000	R	2	
0x0838		10553	FLT32_002	F003	1,000	R	2	
0x083A		10554	FLT32_003	F003	1,000	R	2	
0x083C		10555	FLT32_004	F003	1,000	R	2	
0x083E		10556	FLT32_005	F003	1,000	R	2	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0840		10557	FLT32_006	F003	1,000	R	2	
0x0842		10558	FLT32_007	F003	1,000	R	2	
0x0844		10559	FLT32_008	F003	1,000	R	2	
0x0846		10560	FLT32_009	F003	1,000	R	2	
0x0848		10561	FLT32_010	F003	1,000	R	2	
0x084A		10562	FLT32_011	F003	1,000	R	2	
0x084C		10563	FLT32_012	F003	1,000	R	2	
0x084E		10564	FLT32_013	F003	1,000	R	2	
0x0850		10565	FLT32_014	F003	1,000	R	2	
0x0852		10566	FLT32_015	F003	1,000	R	2	
0x0854		10567	FLT32_016	F003	1,000	R	2	
0x0856		10568	FLT32_017	F003	1,000	R	2	
0x0858		10569	FLT32_018	F003	1,000	R	2	
0x085A		10570	FLT32_019	F003	1,000	R	2	
0x085C		10571	FLT32_020	F003	1,000	R	2	
0x085E		10572	FLT32_021	F003	1,000	R	2	
0x0860		10573	FLT32_022	F003	1,000	R	2	
0x0862		10574	FLT32_023	F003	1,000	R	2	
0x0864		10575	FLT32_024	F003	1,000	R	2	
0x0866		10576	FLT32_025	F003	1,000	R	2	
0x0868		10577	FLT32_026	F003	1,000	R	2	
0x086A		10578	FLT32_027	F003	1,000	R	2	
0x086C		10579	FLT32_028	F003	1,000	R	2	
0x086E		10580	FLT32_029	F003	1,000	R	2	
0x0870		10581	FLT32_030	F003	1,000	R	2	
0x0872		10582	FLT32_031	F003	1,000	R	2	
0x0874		10583	FLT32_032	F003	1,000	R	2	
0x0876		10584	FLT32_033	F003	1,000	R	2	
0x0878		10585	FLT32_034	F003	1,000	R	2	
0x087A		10586	FLT32_035	F003	1,000	R	2	
0x087C		10587	FLT32_036	F003	1,000	R	2	
0x087E		10588	FLT32_037	F003	1,000	R	2	
0x0880		10589	FLT32_038	F003	1,000	R	2	
0x0882		10590	FLT32_039	F003	1,000	R	2	
0x0884		10591	FLT32_040	F003	1,000	R	2	
0x0886		10592	FLT32_041	F003	1,000	R	2	
0x0888		10593	FLT32_042	F003	1,000	R	2	
0x088A		10594	FLT32_043	F003	1,000	R	2	
0x088C		10595	FLT32_044	F003	1,000	R	2	
0x088E		10596	FLT32_045	F003	1,000	R	2	
0x0890		10597	FLT32_046	F003	1,000	R	2	
0x0892		10598	FLT32_047	F003	1,000	R	2	
0x0894		10599	FLT32_048	F003	1,000	R	2	
0x0896		10600	FLT32_049	F003	1,000	R	2	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0898		11509	CMD Info	F012	1,000	R	1	0=In Progress
								1=OK
								2=Error Remote
								3=Error Interlock
								4=Error Descargo
								5=Error Key
								6=Timeout
								7=Error Disable
0x0960		11062	Current THD Phase A	F002	1,000,000	R	2	
0x0962		11063	Current THD Phase B	F002	1,000,000	R	2	
0x0964		11064	Current THD Phase C	F002	1,000,000	R	2	
0x0966		11065	Current 2nd HMC PhA	F002	1,000,000	R	2	
0x0968		11066	Current 2nd HMC PhB	F002	1,000,000	R	2	
0x096A		11067	Current 2nd HMC PhC	F002	1,000,000	R	2	
0x096C		11068	Current 3rd HMC PhA	F002	1,000,000	R	2	
0x096E		11069	Current 3rd HMC PhB	F002	1,000,000	R	2	
0x0970		11070	Current 3rd HMC PhC	F002	1,000,000	R	2	
0x0972		11071	Current 4th HMC PhA	F002	1,000,000	R	2	
0x0974		11072	Current 4th HMC PhB	F002	1,000,000	R	2	
0x0976		11073	Current 4th HMC PhC	F002	1,000,000	R	2	
0x0978		11074	Current 5th HMC PhA	F002	1,000,000	R	2	
0x097A		11075	Current 5th HMC PhB	F002	1,000,000	R	2	
0x097C		11076	Current 5th HMC PhC	F002	1,000,000	R	2	
0x097E		11077	Current 6th HMC PhA	F002	1,000,000	R	2	
0x0980		11078	Current 6th HMC PhB	F002	1,000,000	R	2	
0x0982		11769	Current 6th HMC PhC	F002	1,000,000	R	2	
0x0984		11770	Current 7th HMC PhA	F002	1,000,000	R	2	
0x0986		11771	Current 7th HMC PhB	F002	1,000,000	R	2	
0x0988		11772	Current 7th HMC PhC	F002	1,000,000	R	2	
0x098A		11773	Current 8th HMC PhA	F002	1,000,000	R	2	
0x098C		11774	Current 8th HMC PhB	F002	1,000,000	R	2	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x098E		11775	Current 8th HMC PhC	F002	1,000,000	R	2	
0x0990		11776	Current 9th HMC PhA	F002	1,000,000	R	2	
0x0992		11777	Current 9th HMC PhB	F002	1,000,000	R	2	
0x0994		11778	Current 9th HMC PhC	F002	1,000,000	R	2	
0x0996		11779	Current 10th HMC PhA	F002	1,000,000	R	2	
0x0998		11780	Current 10th HMC PhB	F002	1,000,000	R	2	
0x099A		11781	Current 10th HMC PhC	F002	1,000,000	R	2	
0x099C		11782	Current 11th HMC PhA	F002	1,000,000	R	2	
0x099E		11783	Current 11th HMC PhB	F002	1,000,000	R	2	
0x09A0		11784	Current 11th HMC PhC	F002	1,000,000	R	2	
0x09A2		11785	Current 12th HMC PhA	F002	1,000,000	R	2	
0x09A4		11786	Current 12th HMC PhB	F002	1,000,000	R	2	
0x09A6		11787	Current 12th HMC PhC	F002	1,000,000	R	2	
0x09A8		11788	Current 13th HMC PhA	F002	1,000,000	R	2	
0x09AA		11789	Current 13th HMC PhB	F002	1,000,000	R	2	
0x09AC		11790	Current 13th HMC PhC	F002	1,000,000	R	2	
0x09AE		11791	Current 14th HMC PhA	F002	1,000,000	R	2	
0x09B0		11792	Current 14th HMC PhB	F002	1,000,000	R	2	
0x09B2		11793	Current 14th HMC PhC	F002	1,000,000	R	2	
0x09B4		11794	Current 15th HMC PhA	F002	1,000,000	R	2	
0x09B6		11795	Current 15th HMC PhB	F002	1,000,000	R	2	
0x09B8		11796	Current 15th HMC PhC	F002	1,000,000	R	2	
0x09C4		11060	Load VT Ratio	F002	1,000,000	R	2	
0x09C6		11061	Load Voltage	F002	1,000,000	R	2	
0x09C8		11079	Load THD Phase A	F002	1,000,000	R	2	
0x09CA		11080	Load THD Phase B	F002	1,000,000	R	2	
0x09CC		11081	Load THD Phase C	F002	1,000,000	R	2	
0x09CE		11082	Load 2nd HMC PhaseA	F002	1,000,000	R	2	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x09D0		11083	Load 2nd HMC PhaseB	F002	1,000,000	R	2	
0x09D2		11084	Load 2nd HMC PhaseC	F002	1,000,000	R	2	
0x09D4		11085	Load 3rd HMC PhaseA	F002	1,000,000	R	2	
0x09D6		11086	Load 3rd HMC PhaseB	F002	1,000,000	R	2	
0x09D8		11087	Load 3rd HMC PhaseC	F002	1,000,000	R	2	
0x09DA		11088	Load 4th HMC PhaseA	F002	1,000,000	R	2	
0x09DC		11089	Load 4th HMC PhaseB	F002	1,000,000	R	2	
0x09DE		11090	Load 4th HMC PhaseC	F002	1,000,000	R	2	
0x09E0		11091	Load 5th HMC PhaseA	F002	1,000,000	R	2	
0x09E2		11092	Load 5th HMC PhaseB	F002	1,000,000	R	2	
0x09E4		11093	Load 5th HMC PhaseC	F002	1,000,000	R	2	
0x09E6		11094	Load 6th HMC PhaseA	F002	1,000,000	R	2	
0x09E8		11095	Load 6th HMC PhaseB	F002	1,000,000	R	2	
0x09EA		11797	Load 6th HMC PhaseC	F002	1,000,000	R	2	
0x09EC		11798	Load 7th HMC PhaseA	F002	1,000,000	R	2	
0x09EE		11799	Load 7th HMC PhaseB	F002	1,000,000	R	2	
0x09F0		11800	Load 7th HMC PhaseC	F002	1,000,000	R	2	
0x09F2		11801	Load 8th HMC PhaseA	F002	1,000,000	R	2	
0x09F4		11802	Load 8th HMC PhaseB	F002	1,000,000	R	2	
0x09F6		11803	Load 8th HMC PhaseC	F002	1,000,000	R	2	
0x09F8		11804	Load 9th HMC PhaseA	F002	1,000,000	R	2	
0x09FA		11805	Load 9th HMC PhaseB	F002	1,000,000	R	2	
0x09FC		11806	Load 9th HMC PhaseC	F002	1,000,000	R	2	
0x09FE		11807	Load 10th HMC PhaseA	F002	1,000,000	R	2	
0x0A00		11808	Load 10th HMC PhaseB	F002	1,000,000	R	2	
0x0A02		11809	Load 10th HMC PhaseC	F002	1,000,000	R	2	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0A04		11810	Load 11th HMC PhaseA	F002	1,000, 000	R	2	
0x0A06		11811	Load 11th HMC PhaseB	F002	1,000, 000	R	2	
0x0A08		11812	Load 11th HMC PhaseC	F002	1,000, 000	R	2	
0x0A0A		11813	Load 12th HMC PhaseA	F002	1,000, 000	R	2	
0x0A0C		11814	Load 12th HMC PhaseB	F002	1,000, 000	R	2	
0x0A0E		11815	Load 12th HMC PhaseC	F002	1,000, 000	R	2	
0x0A10		11816	Load 13th HMC PhaseA	F002	1,000, 000	R	2	
0x0A12		11817	Load 13th HMC PhaseB	F002	1,000, 000	R	2	
0x0A14		11818	Load 13th HMC PhaseC	F002	1,000, 000	R	2	
0x0A16		11819	Load 14th HMC PhaseA	F002	1,000, 000	R	2	
0x0A18		11820	Load 14th HMC PhaseB	F002	1,000, 000	R	2	
0x0A1A		11821	Load 14th HMC PhaseC	F002	1,000, 000	R	2	
0x0A1C		11822	Load 15th HMC PhaseA	F002	1,000, 000	R	2	
0x0A1E		11823	Load 15th HMC PhaseB	F002	1,000, 000	R	2	
0x0A20		11824	Load 15th HMC PhaseC	F002	1,000, 000	R	2	
0x0A28		11107	Source Va Angle	F002	1,000, 000	R	2	
0x0A2A		11108	Source Vb Angle	F002	1,000, 000	R	2	
0x0A2C		11109	Source Vc Angle	F002	1,000, 000	R	2	
0x0A2E		11110	Source Vn Angle	F002	1,000, 000	R	2	
0x0A30		11111	Source Vab Angle	F002	1,000, 000	R	2	
0x0A32		11112	Source Vbc Angle	F002	1,000, 000	R	2	
0x0A34		11113	Source Vca Angle	F002	1,000, 000	R	2	
0x0A36		11114	Source Va Primary	F002	1,000, 000	R	2	
0x0A38		11115	Source Vb Primary	F002	1,000, 000	R	2	
0x0A3A		11116	Source Vc Primary	F002	1,000, 000	R	2	
0x0A3C		11117	Source Vn Primary	F002	1,000, 000	R	2	
0x0A3E		11118	Source Vab Primary	F002	1,000, 000	R	2	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0A40		11119	Source Vbc Primary	F002	1,000,000	R	2	
0x0A42		11120	Source Vca Primary	F002	1,000,000	R	2	
0x0A44		11121	Source V0 Primary	F002	1,000,000	R	2	
0x0A46		11122	Source V1 Primary	F002	1,000,000	R	2	
0x0A48		11123	Source V2 Primary	F002	1,000,000	R	2	
0x0A4A		11124	Source VT Ratio	F002	1,000,000	R	2	
0x0A4C		11125	Source Voltage	F002	1,000,000	R	2	
0x0A4E		11126	Source Phasor Vab	F002	1,000,000	R	2	
0x0A50		11127	Source Phasor Vbc	F002	1,000,000	R	2	
0x0A52		11128	Source Phasor Vca	F002	1,000,000	R	2	
0x0A54		11129	Source Phasor Van	F002	1,000,000	R	2	
0x0A56		11130	Source Phasor Vbn	F002	1,000,000	R	2	
0x0A58		11131	Source Phasor Vcn	F002	1,000,000	R	2	
0x0A5A		11132	Source Phasor Vn	F002	1,000,000	R	2	
0x0A5C		11133	Source Pos Seq V1	F002	1,000,000	R	2	
0x0A5E		11134	Source Neg Seq V2	F002	1,000,000	R	2	
0x0A60		11135	Source Zero Seq V0	F002	1,000,000	R	2	
0x0A62		11136	Source Nominal Volt	F002	1,000,000	R	2	
0x0A64		11137	Source Voltage	F002	1,000,000	R	2	
0x0A66		11676	Source V0 Angle	F002	1,000,000	R	2	
0x0A68		11677	Source V1 Angle	F002	1,000,000	R	2	
0x0A6A		11678	Source V2 Angle	F002	1,000,000	R	2	
0x0A6C		11138	Source THD Phase A	F002	1,000,000	R	2	
0x0A6E		11139	Source THD Phase B	F002	1,000,000	R	2	
0x0A70		11140	Source THD Phase C	F002	1,000,000	R	2	
0x0A72		11141	Source 2nd HMC PhA	F002	1,000,000	R	2	
0x0A74		11142	Source 2nd HMC PhB	F002	1,000,000	R	2	
0x0A76		11143	Source 2nd HMC PhC	F002	1,000,000	R	2	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0A78		11144	Source 3rd HMC PhA	F002	1,000,000	R	2	
0x0A7A		11145	Source 3rd HMC PhB	F002	1,000,000	R	2	
0x0A7C		11146	Source 3rd HMC PhC	F002	1,000,000	R	2	
0x0A7E		11147	Source 4th HMC PhA	F002	1,000,000	R	2	
0x0A80		11148	Source 4th HMC PhB	F002	1,000,000	R	2	
0x0A82		11149	Source 4th HMC PhC	F002	1,000,000	R	2	
0x0A84		11150	Source 5th HMC PhA	F002	1,000,000	R	2	
0x0A86		11151	Source 5th HMC PhB	F002	1,000,000	R	2	
0x0A88		11152	Source 5th HMC PhC	F002	1,000,000	R	2	
0x0A8A		11153	Source 6th HMC PhA	F002	1,000,000	R	2	
0x0A8C		11154	Source 6th HMC PhB	F002	1,000,000	R	2	
0x0A8E		11825	Source 6th HMC PhC	F002	1,000,000	R	2	
0x0A90		11826	Source 7th HMC PhA	F002	1,000,000	R	2	
0x0A92		11827	Source 7th HMC PhB	F002	1,000,000	R	2	
0x0A94		11828	Source 7th HMC PhC	F002	1,000,000	R	2	
0x0A96		11829	Source 8th HMC PhA	F002	1,000,000	R	2	
0x0A98		11830	Source 8th HMC PhB	F002	1,000,000	R	2	
0x0A9A		11831	Source 8th HMC PhC	F002	1,000,000	R	2	
0x0A9C		11832	Source 9th HMC PhA	F002	1,000,000	R	2	
0x0A9E		11833	Source 9th HMC PhB	F002	1,000,000	R	2	
0x0AA0		11834	Source 9th HMC PhC	F002	1,000,000	R	2	
0x0AA2		11835	Source 10th HMC PhA	F002	1,000,000	R	2	
0x0AA4		11836	Source 10th HMC PhB	F002	1,000,000	R	2	
0x0AA6		11837	Source 10th HMC PhC	F002	1,000,000	R	2	
0x0AA8		11838	Source 11th HMC PhA	F002	1,000,000	R	2	
0x0AAA		11839	Source 11th HMC PhB	F002	1,000,000	R	2	
0x0AAC		11840	Source 11th HMC PhC	F002	1,000,000	R	2	
0x0AAE		11841	Source 12th HMC PhA	F002	1,000,000	R	2	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0AB0		11842	Source 12th HMC PhB	F002	1,000,000	R	2	
0x0AB2		11843	Source 12th HMC PhC	F002	1,000,000	R	2	
0x0AB4		11844	Source 13th HMC PhA	F002	1,000,000	R	2	
0x0AB6		11845	Source 13th HMC PhB	F002	1,000,000	R	2	
0x0AB8		11846	Source 13th HMC PhC	F002	1,000,000	R	2	
0x0ABA		11847	Source 14th HMC PhA	F002	1,000,000	R	2	
0x0ABC		11848	Source 14th HMC PhB	F002	1,000,000	R	2	
0x0ABE		11849	Source 14th HMC PhC	F002	1,000,000	R	2	
0x0AC0		11850	Source 15th HMC PhA	F002	1,000,000	R	2	
0x0AC2		11851	Source 15th HMC PhB	F002	1,000,000	R	2	
0x0AC4		11852	Source 15th HMC PhC	F002	1,000,000	R	2	
0x0B06		7313	ANALOG_INP_F_01	F002	1,000,000	R	2	
0x0B08		7314	ANALOG_INP_F_02	F002	1,000,000	R	2	
0x0B0A		7315	ANALOG_INP_F_03	F002	1,000,000	R	2	
0x0B0C		7316	ANALOG_INP_F_04	F002	1,000,000	R	2	
0x0B0E		7317	ANALOG_INP_F_05	F002	1,000,000	R	2	
0x0B10		7318	ANALOG_INP_F_06	F002	1,000,000	R	2	
0x0B12		7319	ANALOG_INP_F_07	F002	1,000,000	R	2	
0x0B14		7320	ANALOG_INP_F_08	F002	1,000,000	R	2	
0x0B16		11535	IO Board F Boot Date	F011	1,000	R	3	
0x0B19		11536	IO Board F App Date	F011	1,000	R	3	
0x0B86		7383	ANALOG_INP_G_01	F002	1,000,000	R	2	
0x0B88		7384	ANALOG_INP_G_02	F002	1,000,000	R	2	
0x0B8A		7385	ANALOG_INP_G_03	F002	1,000,000	R	2	
0x0B8C		7386	ANALOG_INP_G_04	F002	1,000,000	R	2	
0x0B8E		7387	ANALOG_INP_G_05	F002	1,000,000	R	2	
0x0B90		7388	ANALOG_INP_G_06	F002	1,000,000	R	2	
0x0B92		7389	ANALOG_INP_G_07	F002	1,000,000	R	2	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0B94		7390	ANALOG_INP_G_08	F002	1,000,000	R	2	
0x0C00		3897	Phasor Ia	F002	1,000,000	R	2	
0x0C02		3898	RMS Ia	F002	1,000,000	R	2	
0x0C04		3899	Ia Real	F002	1,000,000	R	2	
0x0C06		3900	Ia Imag	F002	1,000,000	R	2	
0x0C08		3901	Phasor Ib	F002	1,000,000	R	2	
0x0C0A		3902	RMS Ib	F002	1,000,000	R	2	
0x0C0C		3903	Ib Real	F002	1,000,000	R	2	
0x0C0E		3904	Ib Imag	F002	1,000,000	R	2	
0x0C10		3905	Phasor Ic	F002	1,000,000	R	2	
0x0C12		3906	RMS Ic	F002	1,000,000	R	2	
0x0C14		3907	Ic Real	F002	1,000,000	R	2	
0x0C16		3908	Ic Imag	F002	1,000,000	R	2	
0x0C18		3909	Phasor In	F002	1,000,000	R	2	
0x0C1A		3910	In Real	F002	1,000,000	R	2	
0x0C1C		3911	In Imag	F002	1,000,000	R	2	
0x0C1E		3912	Phasor Ig	F002	1,000,000	R	2	
0x0C20		3913	RMS Ig	F002	1,000,000	R	2	
0x0C22		3914	Ig Real	F002	1,000,000	R	2	
0x0C24		3915	Ig Imag	F002	1,000,000	R	2	
0x0C26		3916	Phasor Isg	F002	1,000,000	R	2	
0x0C28		3917	RMS Isg	F002	1,000,000	R	2	
0x0C2A		3918	Isg Real	F002	1,000,000	R	2	
0x0C2C		3919	Isg Imag	F002	1,000,000	R	2	
0x0C2E		3920	Zero seq I0	F002	1,000,000	R	2	
0x0C30		3921	I0 Real	F002	1,000,000	R	2	
0x0C32		3922	I0 Imag	F002	1,000,000	R	2	
0x0C34		3923	Positive Seq I1	F002	1,000,000	R	2	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0C36		3924	I1 Real	F002	1,000,000	R	2	
0x0C38		3925	I1 Imag	F002	1,000,000	R	2	
0x0C3A		3926	Negative Seq I2	F002	1,000,000	R	2	
0x0C3C		3927	I2 Real	F002	1,000,000	R	2	
0x0C3E		3928	I2 Imag	F002	1,000,000	R	2	
0x0C40		3929	Load Phasor Vab	F002	1,000,000	R	2	
0x0C42		3930	Load Vab Real	F002	1,000,000	R	2	
0x0C44		3931	Load Vab Imag	F002	1,000,000	R	2	
0x0C46		3932	Load Phasor Vbc	F002	1,000,000	R	2	
0x0C48		3933	Load Vbc Real	F002	1,000,000	R	2	
0x0C4A		3934	Load Vbc Imag	F002	1,000,000	R	2	
0x0C4C		3935	Load Phasor Vca	F002	1,000,000	R	2	
0x0C4E		3936	Load Vca Real	F002	1,000,000	R	2	
0x0C50		3937	Load Vca Imag	F002	1,000,000	R	2	
0x0C52		3938	Load Phasor Van	F002	1,000,000	R	2	
0x0C54		3939	Load Va Real	F002	1,000,000	R	2	
0x0C56		3940	Load Va Imag	F002	1,000,000	R	2	
0x0C58		3941	Load Phasor Vbn	F002	1,000,000	R	2	
0x0C5A		3942	Load Vb Real	F002	1,000,000	R	2	
0x0C5C		3943	Load Vb Imag	F002	1,000,000	R	2	
0x0C5E		3944	Load Phasor Vcn	F002	1,000,000	R	2	
0x0C60		3945	Load Vc Real	F002	1,000,000	R	2	
0x0C62		3946	Load Vc Imag	F002	1,000,000	R	2	
0x0C64		3947	Load Phasor Vn	F002	1,000,000	R	2	
0x0C66		3948	Load Vn Real	F002	1,000,000	R	2	
0x0C68		3949	Load Vn Imag	F002	1,000,000	R	2	
0x0C6A		3950	Load Pos Seq V1	F002	1,000,000	R	2	
0x0C6C		3951	Load V1 Real	F002	1,000,000	R	2	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0C6E		3952	Load V1 Imag	F002	1,000,000	R	2	
0x0C70		3953	Load Neg Seq V2	F002	1,000,000	R	2	
0x0C72		3954	Load V2 Real	F002	1,000,000	R	2	
0x0C74		3955	Load V2 Imag	F002	1,000,000	R	2	
0x0C76		3956	Load Zero Seq V0	F002	1,000,000	R	2	
0x0C78		3957	Load V0 Real	F002	1,000,000	R	2	
0x0C7A		3958	Load V0 Imag	F002	1,000,000	R	2	
0x0C82		3962	Load Nominal Volt	F002	1,000,000	R	2	
0x0C8C		3967	Load Voltage	F002	1,000,000	R	2	
0x0C90		3969	Load Frequency	F002	1,000,000	R	2	
0x0C92		3970	Source Frequency	F002	1,000,000	R	2	
0x0CB4		5055	CT Ratio	F002	1,000,000	R	2	
0x0CB6		5056	CT Ratio Ig	F002	1,000,000	R	2	
0x0CB8		5057	CT Ratio Isg	F002	1,000,000	R	2	
0x0CBC		6825	Ia Angle	F002	1,000,000	R	2	
0x0CBE		6826	Ib Angle	F002	1,000,000	R	2	
0x0CC0		6827	Ic Angle	F002	1,000,000	R	2	
0x0CC2		6828	In Angle	F002	1,000,000	R	2	
0x0CC4		6829	Ig Angle	F002	1,000,000	R	2	
0x0CC6		6830	Isg Angle	F002	1,000,000	R	2	
0x0CC8		6831	Load Va Angle	F002	1,000,000	R	2	
0x0CCA		6832	Load Vb Angle	F002	1,000,000	R	2	
0x0CCC		6833	Load Vc Angle	F002	1,000,000	R	2	
0x0CCE		6834	Load Vn Angle	F002	1,000,000	R	2	
0x0CD2		6836	Load Vab Angle	F002	1,000,000	R	2	
0x0CD4		6837	Load Vbc Angle	F002	1,000,000	R	2	
0x0CD6		6838	Load Vca Angle	F002	1,000,000	R	2	
0x0CE2		11735	HMI Version	F004	1,000	R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0CE3		11744	DISPLAY TYPE	F004	1,000	R	1	
0x0CE4		9393	PreFault Ia Mod	F002	1,000,000	R	2	
0x0CE6		9394	PreFault Ia Ang	F003	1,000	R	2	
0x0CE8		9395	PreFault Ib Mod	F002	1,000,000	R	2	
0x0CEA		9396	PreFault Ib Ang	F003	1,000	R	2	
0x0CEC		9397	PreFault Ic Mod	F002	1,000,000	R	2	
0x0CEE		9398	PreFault Ic Ang	F003	1,000	R	2	
0x0CF0		9399	PreFault Vab Mod	F002	1,000,000	R	2	
0x0CF2		9400	PreFault Vab Ang	F003	1,000	R	2	
0x0CF4		9401	PreFault Vbc Mod	F002	1,000,000	R	2	
0x0CF6		9402	PreFault Vbc Ang	F003	1,000	R	2	
0x0CF8		9403	PreFault Vca Mod	F002	1,000,000	R	2	
0x0CFA		9404	PreFault Vca Ang	F003	1,000	R	2	
0x0CFC		9405	PreFault Ig Mod	F002	1,000,000	R	2	
0x0CFE		9406	PreFault Ig Ang	F003	1,000	R	2	
0x0D00		9407	PreFault Isg Mod	F002	1,000,000	R	2	
0x0D02		9408	PreFault Isg Ang	F003	1,000	R	2	
0x0D04		9409	PostFault Ia Mod	F002	1,000,000	R	2	
0x0D06		9410	PostFault Ia Ang	F003	1,000	R	2	
0x0D08		9411	PostFault Ib Mod	F002	1,000,000	R	2	
0x0D0A		9412	PostFault Ib Ang	F003	1,000	R	2	
0x0D0C		9413	PostFault Ic Mod	F002	1,000,000	R	2	
0x0D0E		9414	PostFault Ic Ang	F003	1,000	R	2	
0x0D10		9415	PostFault Vab Mod	F002	1,000,000	R	2	
0x0D12		9416	PostFault Vab Ang	F003	1,000	R	2	
0x0D14		9417	PostFault Vbc Mod	F002	1,000,000	R	2	
0x0D16		9418	PostFault Vbc Ang	F003	1,000	R	2	
0x0D18		9419	PostFault Vca Mod	F002	1,000,000	R	2	
0x0D1A		9420	PostFault Vca Ang	F003	1,000	R	2	
0x0D1C		9421	PostFault Ig Mod	F002	1,000,000	R	2	
0x0D1E		9422	PostFault Ig Ang	F003	1,000	R	2	
0x0D20		9423	PostFault Isg Mod	F002	1,000,000	R	2	
0x0D22		9424	PostFault Isg Ang	F003	1,000	R	2	
0x0D24		11670	I0 Angle	F002	1,000,000	R	2	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0D26		11671	I1 Angle	F002	1,000,000	R	2	
0x0D28		11672	I2 Angle	F002	1,000,000	R	2	
0x0D2A		11673	V0 Angle	F002	1,000,000	R	2	
0x0D2C		11674	V1 Angle	F002	1,000,000	R	2	
0x0D2E		11675	V2 Angle	F002	1,000,000	R	2	
0x0DD9		4393	THERMAL1 IMAGE A	F003	1,000	R	2	
0x0DDB		4394	THERMAL1 IMAGE B	F003	1,000	R	2	
0x0DDD		4395	THERMAL1 IMAGE C	F003	1,000	R	2	
0x0DE4		4413	THERMAL2 IMAGE A	F003	1,000	R	2	
0x0DE6		4414	THERMAL2 IMAGE B	F003	1,000	R	2	
0x0DE8		4415	THERMAL2 IMAGE C	F003	1,000	R	2	
0x0DEF		4433	THERMAL3 IMAGE A	F003	1,000	R	2	
0x0DF1		4434	THERMAL3 IMAGE B	F003	1,000	R	2	
0x0DF3		4435	THERMAL3 IMAGE C	F003	1,000	R	2	
0x0E31		7999	VOLTAGE DIFFERENCE	F002	1,000,000	R	2	
0x0E33		8000	FREQ. DIFFERENCE	F002	1,000,000	R	2	
0x0E35		11685	SYNC VOLT REFERENCE	F012	1,000	R	1	0=Invalid
								1=Va
								2=Vb
								3=Vc
								4=Vab
								5=Vbc
								6=Vca
0x0EB6		6814	NUMBER OF TRIGGERS	F004	1,000	R	1	
0x0EB7		6822	CYCLES PER RECORD	F004	1,000	R	1	
0x0EB8		6823	AVAILABLE RECORDS	F004	1,000	R	1	
0x0EBB		6848	FAULT DATE	F011	1,000	R	3	
0x0EBE		6849	FAULT TYPE	F012	1,000	R	1	0=GROUND
								1=PHASE
								2=TRIPHASE
								3=AG
								4=ABG
								5=AB
								6=BG
								7=BCG
								8=BC
								9=CG
								10=CAG
								11=CA
								12=NAF

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0EBF		6850	FAULT LOCATION	F003	1,000	R	2	
0x0EC1		6851	FAULT REPORT NUMBER	F005	1,000	R	2	
0x0EC3		10224	R Primary	F003	1,000	R	2	
0x0EC5		10225	R Secondary	F003	1,000	R	2	
0x0EC7		10226	X Primary	F003	1,000	R	2	
0x0EC9		10227	X Secondary	F003	1,000	R	2	
0x0ECB		10338	FAULT RESISTANCE	F003	1,000	R	2	
0x0ECD		11756	FLT AVAILABLE RECORDS	F004	1,000	R	1	
0x0ECE		10833	ACTIVE GROUP	F012	1,000	R	1	0=GROUP 1
								1=GROUP 2
								2=GROUP 3
								3=GROUP 4
								4=GROUP 5
								5=GROUP 6
0x0EE2		5063	Phasor Ia Primary	F002	1,000,000	R	2	
0x0EE4		5064	Phasor Ib Primary	F002	1,000,000	R	2	
0x0EE6		5065	Phasor Ic Primary	F002	1,000,000	R	2	
0x0EE8		5066	Phasor Ig Primary	F002	1,000,000	R	2	
0x0EEA		5067	Phasor Isg Primary	F002	1,000,000	R	2	
0x0EEC		5068	Phasor In Primary	F002	1,000,000	R	2	
0x0EEE		5069	RMS Ia Primary	F002	1,000,000	R	2	
0x0EF0		5070	RMS Ib Primary	F002	1,000,000	R	2	
0x0EF2		5071	RMS Ic Primary	F002	1,000,000	R	2	
0x0EF4		5072	RMS Ig Primary	F002	1,000,000	R	2	
0x0EF6		5073	RMS Isg Primary	F002	1,000,000	R	2	
0x0EF8		5074	I0 Primary	F002	1,000,000	R	2	
0x0EFA		5075	I1 Primary	F002	1,000,000	R	2	
0x0EFC		5076	I2 Primary	F002	1,000,000	R	2	
0x0EFE		5077	Load V0 Primary	F002	1,000,000	R	2	
0x0F00		5078	Load V1 Primary	F002	1,000,000	R	2	
0x0F02		5079	Load V2 Primary	F002	1,000,000	R	2	
0x0F04		5080	Load Vab Primary	F002	1,000,000	R	2	
0x0F06		5081	Load Vbc Primary	F002	1,000,000	R	2	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0F08		5082	Load Vca Primary	F002	1,000,000	R	2	
0x0F0A		5083	Load Va Primary	F002	1,000,000	R	2	
0x0F0C		5084	Load Vb Primary	F002	1,000,000	R	2	
0x0F0E		5085	Load Vc Primary	F002	1,000,000	R	2	
0x0F10		5086	Load Vn Primary	F002	1,000,000	R	2	
0x0F18		5090	PhA Real Pwr Pri	F002	1,000,000	R	2	
0x0F1A		5091	PhA Reactive Pwr Pri	F002	1,000,000	R	2	
0x0F1C		5092	PhA Apparent Pwr Pri	F002	1,000,000	R	2	
0x0F1E		5093	PhB Real Pwr Pri	F002	1,000,000	R	2	
0x0F20		5094	PhB Reactive Pwr Pri	F002	1,000,000	R	2	
0x0F22		5095	PhB Apparent Pwr Pri	F002	1,000,000	R	2	
0x0F24		5096	PhC Real Pwr Pri	F002	1,000,000	R	2	
0x0F26		5097	PhC Reactive Pwr Pri	F002	1,000,000	R	2	
0x0F28		5098	PhC Apparent Pwr Pri	F002	1,000,000	R	2	
0x0F2A		5099	3 Ph Real Pwr Pri	F002	1,000,000	R	2	
0x0F2C		5100	3 Ph Reactive Pwr Pri	F002	1,000,000	R	2	
0x0F2E		5101	3 Ph Apparent Pwr Pri	F002	1,000,000	R	2	
0x0F30		5102	PhA Power Factor Pri	F002	1,000,000	R	2	
0x0F32		5103	PhB Power Factor Pri	F002	1,000,000	R	2	
0x0F34		5104	PhC Power Factor Pri	F002	1,000,000	R	2	
0x0F36		5105	3 Ph Power Factor Pri	F002	1,000,000	R	2	
0x0F3C		5108	Pos MWatthour Freeze	F002	1,000,000	R	2	
0x0F3E		5109	Neg MWatthour Freeze	F002	1,000,000	R	2	
0x0F40		5110	Pos MVarhour Freeze	F002	1,000,000	R	2	
0x0F42		5111	Neg MVarhour Freeze	F002	1,000,000	R	2	
0x0F44		5112	Positive MWatthour	F002	1,000,000	R	2	
0x0F46		5113	Negative MWatthour	F002	1,000,000	R	2	
0x0F48		5114	Positive MVarhour	F002	1,000,000	R	2	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x0F4A		5115	Negative MVarhour	F002	1,000,000	R	2	
0x0F4C		8755	% of Load-To-Trip	F002	1,000,000	R	2	
0x0FAB		5210	DEMAND IA	F002	1,000,000	R	2	
0x0FAD		5211	DEMAND IA MAX	F002	1,000,000	R	2	
0x0FAF		5212	DEMAND IA DATE	F011	1,000	R	3	
0x0FB2		5213	DEMAND IB	F002	1,000,000	R	2	
0x0FB4		5214	DEMAND IB MAX	F002	1,000,000	R	2	
0x0FB6		5215	DEMAND IB DATE	F011	1,000	R	3	
0x0FB9		5216	DEMAND IC	F002	1,000,000	R	2	
0x0FBB		5217	DEMAND IC MAX	F002	1,000,000	R	2	
0x0FBD		5218	DEMAND IC DATE	F011	1,000	R	3	
0x0FC0		5219	DEMAND IG	F002	1,000,000	R	2	
0x0FC2		5220	DEMAND IG MAX	F002	1,000,000	R	2	
0x0FC4		5221	DEMAND IG DATE	F011	1,000	R	3	
0x0FC7		5222	DEMAND ISG	F002	1,000,000	R	2	
0x0FC9		5223	DEMAND ISG MAX	F002	1,000,000	R	2	
0x0FCB		5224	DEMAND ISG DATE	F011	1,000	R	3	
0x0FCE		5225	DEMAND I2	F002	1,000,000	R	2	
0x0FD0		5226	DEMAND I2 MAX	F002	1,000,000	R	2	
0x0FD2		5227	DEMAND I2 DATE	F011	1,000	R	3	
0x0FD5		5228	DEMAND W	F002	1,000,000	R	2	
0x0FD7		5229	DEMAND W MAX	F002	1,000,000	R	2	
0x0FD9		5230	DEMAND W DATE	F011	1,000	R	3	
0x0FDC		5231	DEMAND VAR PWR	F002	1,000,000	R	2	
0x0FDE		5232	DEMAND VAR MAX	F002	1,000,000	R	2	
0x0FE0		5233	DEMAND VAR DATE	F011	1,000	R	3	
0x0FE3		5234	DEMAND VA PWR	F002	1,000,000	R	2	
0x0FE5		5235	DEMAND VA MAX	F002	1,000,000	R	2	
0x0FE7		5236	DEMAND VA DATE	F011	1,000	R	3	
0x0FFE		7453	ANALOG_INP_H_01	F002	1,000,000	R	2	
0x1000		7454	ANALOG_INP_H_02	F002	1,000,000	R	2	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x1002		7455	ANALOG_INP_H_03	F002	1,000,000	R	2	
0x1004		7456	ANALOG_INP_H_04	F002	1,000,000	R	2	
0x1006		7457	ANALOG_INP_H_05	F002	1,000,000	R	2	
0x1008		7458	ANALOG_INP_H_06	F002	1,000,000	R	2	
0x100A		7459	ANALOG_INP_H_07	F002	1,000,000	R	2	
0x100C		7460	ANALOG_INP_H_08	F002	1,000,000	R	2	
0x107E		7523	ANALOG_INP_J_01	F002	1,000,000	R	2	
0x1080		7524	ANALOG_INP_J_02	F002	1,000,000	R	2	
0x1082		7525	ANALOG_INP_J_03	F002	1,000,000	R	2	
0x1084		7526	ANALOG_INP_J_04	F002	1,000,000	R	2	
0x1086		7527	ANALOG_INP_J_05	F002	1,000,000	R	2	
0x1088		7528	ANALOG_INP_J_06	F002	1,000,000	R	2	
0x108A		7529	ANALOG_INP_J_07	F002	1,000,000	R	2	
0x108C		7530	ANALOG_INP_J_08	F002	1,000,000	R	2	
0x1153		6870	OLDEST SAMPLE TIME	F011	1,000	R	3	
0x1156		6871	NEWEST SAMPLE TIME	F011	1,000	R	3	
0x1159		6872	DATA LOGGER CHANNELS	F004	1,000	R	1	
0x115A		6873	DATA LOGGER DAYS	F003	1,000	R	2	
0x116A		11741	Total RAM	F005	1,024,000	R	2	
0x116C		11742	Used DRAM	F005	1,024,000	R	2	
0x116E		11743	Free RAM	F005	1,024,000	R	2	
0x1180		11745	DSP Counter	F005	1,000	R	2	
0x1182		11747	CPU Usage	F004	1,000	R	1	
0x120E		11739	ICD FILE STATUS	F012	1,000	R	1	0=UNKNOWN
								1=ERROR PARSER CID
								2=MODIFIED
								3=IN PROGRESS
								4=OK WITHOUT DAIS
								5=OK
								6=NotValidated Empty
								7=Passed to Validated
								8=Default
								9=ERROR HEADER CID
								10=ERROR SG CID

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x120F		11740	ICD STATUS NOTVAL	F012	1,000	R	1	0=UNKNOWN
								1=ERROR PARSER CID
								2=MODIFIED
								3=IN PROGRESS
								4=OK WITHOUT DAIS
								5=OK
								6=NotValidated Empty
								7=Passed to Validated
								8=Default
								9=ERROR HEADER CID
								10=ERROR SG CID
0x121B		7838	PulseCntr Value 1	F002	1,000, 000	R	2	
0x121D		7839	PulseCntr Value 2	F002	1,000, 000	R	2	
0x121F		7840	PulseCntr Value 3	F002	1,000, 000	R	2	
0x1221		7841	PulseCntr Value 4	F002	1,000, 000	R	2	
0x1223		7842	PulseCntr Value 5	F002	1,000, 000	R	2	
0x1225		7843	PulseCntr Value 6	F002	1,000, 000	R	2	
0x1227		7844	PulseCntr Value 7	F002	1,000, 000	R	2	
0x1229		7845	PulseCntr Value 8	F002	1,000, 000	R	2	
0x122B		7846	PulseCntr Freeze 1	F002	1,000, 000	R	2	
0x122D		7847	PulseCntr Freeze 2	F002	1,000, 000	R	2	
0x122F		7848	PulseCntr Freeze 3	F002	1,000, 000	R	2	
0x1231		7849	PulseCntr Freeze 4	F002	1,000, 000	R	2	
0x1233		7850	PulseCntr Freeze 5	F002	1,000, 000	R	2	
0x1235		7851	PulseCntr Freeze 6	F002	1,000, 000	R	2	
0x1237		7852	PulseCntr Freeze 7	F002	1,000, 000	R	2	
0x1239		7853	PulseCntr Freeze 8	F002	1,000, 000	R	2	
0x126D		8146	Rem Ana Inp FLOAT 1	F003	1,000	R	2	
0x126F		8147	Rem Ana Inp FLOAT 2	F003	1,000	R	2	
0x1271		8148	Rem Ana Inp FLOAT 3	F003	1,000	R	2	
0x1273		8149	Rem Ana Inp FLOAT 4	F003	1,000	R	2	
0x1275		8150	Rem Ana Inp FLOAT 5	F003	1,000	R	2	
0x1277		8151	Rem Ana Inp FLOAT 6	F003	1,000	R	2	
0x1279		8152	Rem Ana Inp FLOAT 7	F003	1,000	R	2	
0x127B		8153	Rem Ana Inp FLOAT 8	F003	1,000	R	2	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x127D		8154	Rem Ana Inp INT 1	F005	1,000	R	2	
0x127F		8155	Rem Ana Inp INT 2	F005	1,000	R	2	
0x1281		8156	Rem Ana Inp INT 3	F005	1,000	R	2	
0x1283		8157	Rem Ana Inp INT 4	F005	1,000	R	2	
0x1285		8158	Rem Ana Inp INT 5	F005	1,000	R	2	
0x1287		8159	Rem Ana Inp INT 6	F005	1,000	R	2	
0x1289		8160	Rem Ana Inp INT 7	F005	1,000	R	2	
0x128B		8161	Rem Ana Inp INT 8	F005	1,000	R	2	
0x1349		8589	32N1 POWER	F002	1,000, 000	R	2	
0x1350		8605	32N2 POWER	F002	1,000, 000	R	2	
0x1357		8621	32N3 POWER	F002	1,000, 000	R	2	
0x147D		9952	DIGCNT 1 VALUE	F005	1,000	R	2	
0x147F		9953	DIGCNT 2 VALUE	F005	1,000	R	2	
0x1481		9954	DIGCNT 3 VALUE	F005	1,000	R	2	
0x1483		9955	DIGCNT 4 VALUE	F005	1,000	R	2	
0x1485		9956	DIGCNT 5 VALUE	F005	1,000	R	2	
0x1487		9957	DIGCNT 6 VALUE	F005	1,000	R	2	
0x1489		9958	DIGCNT 7 VALUE	F005	1,000	R	2	
0x148B		9959	DIGCNT 8 VALUE	F005	1,000	R	2	
0x148D		9960	DIGCNT 1 FROZENVALUE	F005	1,000	R	2	
0x148F		9961	DIGCNT 2 FROZENVALUE	F005	1,000	R	2	
0x1491		9962	DIGCNT 3 FROZENVALUE	F005	1,000	R	2	
0x1493		9963	DIGCNT 4 FROZENVALUE	F005	1,000	R	2	
0x1495		9964	DIGCNT 5 FROZENVALUE	F005	1,000	R	2	
0x1497		9965	DIGCNT 6 FROZENVALUE	F005	1,000	R	2	
0x1499		9966	DIGCNT 7 FROZENVALUE	F005	1,000	R	2	
0x149B		9967	DIGCNT 8 FROZENVALUE	F005	1,000	R	2	
0x149D		9968	DIGCNT 1 FROZENDATE	F011	1,000	R	3	
0x14A0		9969	DIGCNT 2 FROZENDATE	F011	1,000	R	3	
0x14A3		9970	DIGCNT 3 FROZENDATE	F011	1,000	R	3	
0x14A6		9971	DIGCNT 4 FROZENDATE	F011	1,000	R	3	
0x14A9		9972	DIGCNT 5 FROZENDATE	F011	1,000	R	3	
0x14AC		9973	DIGCNT 6 FROZENDATE	F011	1,000	R	3	
0x14AF		9974	DIGCNT 7 FROZENDATE	F011	1,000	R	3	
0x14B2		9975	DIGCNT 8 FROZENDATE	F011	1,000	R	3	
0x14E5		10169	RTC Sync Source	F012	1,000	R	1	0=INTERNAL
								1=PTP-PORT
								2=SNTP1
								3=IRIG-B
								4=SNTP2
0x14E6		10170	GrandMaster-ID LOW	F009	1,000	R	4	
0x14EA		10171	GrandMaster-ID HIGH	F009	1,000	R	4	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x14EE		10172	PTP ACCURACY	F005	1,000	R	2	
0x14F0		10173	PTP PORTA ST	F012	1,000	R	1	0=DISABLED
								1=NO SIGNAL
								2=CALIBRATING
								3=SYNCHD_NO_PDELAY
								4=SYNCHRONIZED
0x14F1		10174	PTP PORTB ST	F012	1,000	R	1	0=DISABLED
								1=NO SIGNAL
								2=CALIBRATING
								3=SYNCHD_NO_PDELAY
								4=SYNCHRONIZED
0x14F3		11725	Boot Version	F004	1,000	R	1	
0x14F4		11726	Boot Date	F009	1,000	R	10	
0x14FE		11729	CAN CPU Boot Version	F004	1,000	R	1	
0x14FF		11730	CAN CPU Boot Date	F009	1,000	R	10	
0x1509		11731	CAN CPU Load Version	F004	1,000	R	1	
0x150A		11732	CAN CPU Load Date	F009	1,000	R	10	
0x1514		11733	CAN CPU App Version	F004	1,000	R	1	
0x1515		11734	CAN CPU App Date	F009	1,000	R	10	
0x151F		11727	DSP Version	F004	1,000	R	1	
0x1520		11728	DSP Date	F009	1,000	R	16	
0x1530		11746	DSP Status	F005	1,000	R	2	
0x1532		11736	Calibration Date	F011	1,000	R	3	
0x1535		11724	Firmware Date	F009	1,000	R	10	
0x153F		11718	FPGA Version	F009	1,000	R	4	
0x1543		11748	FLASH Usage	F004	1,000	R	1	
0x1544		11749	KINETIS Status	F012	1,000	R	1	0=ERROR
								1=BOOT_MODE
								2=APP_MODE
0x1545		11750	CPU MAX Usage	F004	1,000	R	1	
0x1546		11720	PRP HSR FW Version	F009	1,000	R	4	
0x154A		11721	RSTP FW Version	F009	1,000	R	4	
0x154E		11722	LLA FW Version	F009	1,000	R	4	
0x1552		11723	Bypass FW Version	F009	1,000	R	4	
0x1556		11751	Temp Current Value	F004	1,000	R	1	
0x1557		11752	Temp Max Value	F004	1,000	R	1	
0x1558		11753	Temp Min Value	F004	1,000	R	1	
0x1559		11754	Scan Cycle Average	F004	1,000	R	1	
0x155A		11755	Scan Cycle Rate	F004	1,000	R	1	
0x155B		10468	Upload Percentage	F004	1,000	R	1	
0x155C		11737	PLC Checksum	F005	1,000	R	2	
0x155E		11738	Settings Checksum	F005	1,000	R	2	
0x1560		11719	CPU Revision	F004	1,000	R	1	
0x1561		11853	ICD Edition	F004	1,000	R	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x1562		11686	Mag Temp Value	F004	1,000	R	1	
0x1563		11687	Mag Temp Max Value	F004	1,000	R	1	
0x1564		11688	Mag Temp Min Value	F004	1,000	R	1	
0x1565		11689	Mag Vref Sup12V_H	F002	1,000, 000	R	2	
0x1567		11690	Mag Vref Sup12V_L	F002	1,000, 000	R	2	
0x1569		11691	Mag Vref Sup6V_H	F002	1,000, 000	R	2	
0x156B		11692	Mag Vref Sup6V_L	F002	1,000, 000	R	2	
0x156D		11894	MM Type	F004	1,000	R	1	
0x156E		11895	MM Revision	F004	1,000	R	1	
0x156F		11896	MM Serial Number	F009	1,000	R	4	
0x157C		10450	PRP_HSR A tx	F005	1,000	R	2	
0x157E		10451	PRP_HSR B tx	F005	1,000	R	2	
0x1580		10452	PRP_HSR A err	F005	1,000	R	2	
0x1582		10453	PRP_HSR B err	F005	1,000	R	2	
0x1584		10454	RSTP PortA St	F012	1,000	R	1	0=DISCARDING
								1=LEARNING
								2=FORWARDING
0x1585		10455	RSTP PortB St	F012	1,000	R	1	0=DISCARDING
								1=LEARNING
								2=FORWARDING
0x15A4		10853	2nd HRMC PHASE A	F002	1,000, 000	R	2	
0x15A6		10854	2nd HRMC PHASE B	F002	1,000, 000	R	2	
0x15A8		10855	2nd HRMC PHASE C	F002	1,000, 000	R	2	
0x15AE		11375	AR PHA LCK	F012	1,000	R	1	0=NONE
								1=OPEN MANUALLY
								2=FAIL TO CLOSE
								3=MAX NUM OF SHOTS
								4=FAIL BY COND
								5=FAIL BY ANOMALY
								6=FAIL TO OPEN
								7=MAX HALT TIME
								8=DIRECT TO LOCKOUT
0x15AF		11376	AR PHB LCK	F012	1,000	R	1	0=NONE
								1=OPEN MANUALLY
								2=FAIL TO CLOSE
								3=MAX NUM OF SHOTS
								4=FAIL BY COND
								5=FAIL BY ANOMALY
								6=FAIL TO OPEN
								7=MAX HALT TIME

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								8=DIRECT TO LOCKOUT
0x15B0		11377	AR PHC LCK	F012	1,000	R	1	0=NONE
								1=OPEN MANUALLY
								2=FAIL TO CLOSE
								3=MAX NUM OF SHOTS
								4=FAIL BY COND
								5=FAIL BY ANOMALY
								6=FAIL TO OPEN
								7=MAX HALT TIME
								8=DIRECT TO LOCKOUT
0x15B1		11378	AR 3P LCK	F012	1,000	R	1	0=NONE
								1=OPEN MANUALLY
								2=FAIL TO CLOSE
								3=MAX NUM OF SHOTS
								4=FAIL BY COND
								5=FAIL BY ANOMALY
								6=FAIL TO OPEN
								7=MAX HALT TIME
								8=DIRECT TO LOCKOUT
0x15B2		11379	AR PHA IN PRG	F012	1,000	R	1	0=NONE
								1=WAIT TO OPEN
								2=TIME TO CLOSE
								3=WAIT CLOSE COND
								4=TIME TO RESET
								5=HALTED
0x15B3		11380	AR PHB IN PRG	F012	1,000	R	1	0=NONE
								1=WAIT TO OPEN
								2=TIME TO CLOSE
								3=WAIT CLOSE COND
								4=TIME TO RESET
								5=HALTED
0x15B4		11381	AR PHC IN PRG	F012	1,000	R	1	0=NONE
								1=WAIT TO OPEN
								2=TIME TO CLOSE
								3=WAIT CLOSE COND
								4=TIME TO RESET
								5=HALTED
0x15B5		11382	AR 3P IN PRG	F012	1,000	R	1	0=NONE
								1=WAIT TO OPEN
								2=TIME TO CLOSE
								3=WAIT CLOSE COND
								4=TIME TO RESET
								5=HALTED
0x15B6		11460	AR PHA STATE	F012	1,000	R	1	0=OUT OF SERVICE

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								1=READY
								2=LOCKOUT
								3=BLOCK
								4=RCL IN PROGRESS
0x15B7		11461	AR PHB STATE	F012	1,000	R	1	0=OUT OF SERVICE
								1=READY
								2=LOCKOUT
								3=BLOCK
								4=RCL IN PROGRESS
0x15B8		11462	AR PHC STATE	F012	1,000	R	1	0=OUT OF SERVICE
								1=READY
								2=LOCKOUT
								3=BLOCK
								4=RCL IN PROGRESS
0x15B9		11463	AR 3P STATE	F012	1,000	R	1	0=OUT OF SERVICE
								1=READY
								2=LOCKOUT
								3=BLOCK
								4=RCL IN PROGRESS
0x15BA		11383	AR SHOT COUNTER PHA	F004	1,000	R	1	
0x15BB		11384	AR SHOT COUNTER PHB	F004	1,000	R	1	
0x15BC		11385	AR SHOT COUNTER PHC	F004	1,000	R	1	
0x15BD		11386	AR SHOT COUNTER 3P	F004	1,000	R	1	
0x15BE		11702	AutoRecSt 61850 PhA	F004	1,000	R	1	
0x15BF		11703	AutoRecSt 61850 PhB	F004	1,000	R	1	
0x15C0		11704	AutoRecSt 61850 PhC	F004	1,000	R	1	
0x15C1		11705	AutoRecSt 61850 3P	F004	1,000	R	1	
0x15C7		11488	RCL PHA WEAR MON	F003	1,000	R	2	
0x15C9		11489	RCL PHB WEAR MON	F003	1,000	R	2	
0x15CB		11490	RCL PHC WEAR MON	F003	1,000	R	2	
0x15CD		11491	RCL 3P WEAR MON	F003	1,000	R	2	
0x15CF		11568	PHA OPENING TIME	F003	1,000	R	2	
0x15D1		11569	PHB OPENING TIME	F003	1,000	R	2	
0x15D3		11570	PHC OPENING TIME	F003	1,000	R	2	
0x15D5		11571	3P OPENING TIME	F003	1,000	R	2	
0x15D7		11572	COIL A MAXOPEN CURRENT	F003	1,000	R	2	
0x15D9		11573	COIL B MAXOPEN CURRENT	F003	1,000	R	2	
0x15DB		11574	COIL C MAXOPEN CURRENT	F003	1,000	R	2	
0x15DD		11575	PHA CLOSING TIME	F003	1,000	R	2	
0x15DF		11576	PHB CLOSING TIME	F003	1,000	R	2	
0x15E1		11577	PHC CLOSING TIME	F003	1,000	R	2	
0x15E3		11578	3P CLOSING TIME	F003	1,000	R	2	
0x15E5		11579	COIL A MAXCLOSE CURRENT	F003	1,000	R	2	
0x15E7		11580	COIL B MAXCLOSE CURRENT	F003	1,000	R	2	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x15E9		11581	COIL C MAXCLOSE CURRENT	F003	1,000	R	2	
0x15EB		11582	PHA OPENING DATE	F011	1,000	R	3	
0x15EE		11583	PHB OPENING DATE	F011	1,000	R	3	
0x15F1		11584	PHC OPENING DATE	F011	1,000	R	3	
0x15F4		11585	3P OPENING DATE	F011	1,000	R	3	
0x15F7		11586	PHA CLOSING DATE	F011	1,000	R	3	
0x15FA		11587	PHB CLOSING DATE	F011	1,000	R	3	
0x15FD		11588	PHC CLOSING DATE	F011	1,000	R	3	
0x1600		11589	3P CLOSING DATE	F011	1,000	R	3	
0x1603		11590	MEAN PHA OPENING TIME	F003	1,000	R	2	
0x1605		11591	MEAN PHB OPENING TIME	F003	1,000	R	2	
0x1607		11592	MEAN PHC OPENING TIME	F003	1,000	R	2	
0x1609		11593	MEAN 3P OPENING TIME	F003	1,000	R	2	
0x160B		11594	MEAN COILA MAXOP CURRENT	F003	1,000	R	2	
0x160D		11595	MEAN COILB MAXOP CURRENT	F003	1,000	R	2	
0x160F		11596	MEAN COILC MAXOP CURRENT	F003	1,000	R	2	
0x1611		11597	MEAN PHA CLOSING TIME	F003	1,000	R	2	
0x1613		11598	MEAN PHB CLOSING TIME	F003	1,000	R	2	
0x1615		11599	MEAN PHC CLOSING TIME	F003	1,000	R	2	
0x1617		11600	MEAN 3P CLOSING TIME	F003	1,000	R	2	
0x1619		11601	MEAN COILA MAXCL CURRENT	F003	1,000	R	2	
0x161B		11602	MEAN COILB MAXCL CURRENT	F003	1,000	R	2	
0x161D		11603	MEAN COILC MAXCL CURRENT	F003	1,000	R	2	
0x161F		11757	PHA OPENING TIME	F011	1,000	R	3	
0x1622		11758	PHB OPENING TIME	F011	1,000	R	3	
0x1625		11759	PHC OPENING TIME	F011	1,000	R	3	
0x1628		11760	COIL A MAXOPEN CURRENT	F003	1,000	R	2	
0x162A		11761	COIL B MAXOPEN CURRENT	F003	1,000	R	2	
0x162C		11762	COIL C MAXOPEN CURRENT	F003	1,000	R	2	
0x162E		11763	PHA CLOSING TIME	F011	1,000	R	3	
0x1631		11764	PHB CLOSING TIME	F011	1,000	R	3	
0x1634		11765	PHC CLOSING TIME	F011	1,000	R	3	
0x1637		11766	COIL A MAXCLOSE CURRENT	F003	1,000	R	2	
0x1639		11767	COIL B MAXCLOSE CURRENT	F003	1,000	R	2	
0x163B		11768	COIL C MAXCLOSE CURRENT	F003	1,000	R	2	
0x1649		11694	Voltage Capacitor	F003	1,000	R	2	
0x1653		11882	RCL PHA OPENINGS	F005	1,000	R	2	
0x1655		11883	RCL PHB OPENINGS	F005	1,000	R	2	
0x1657		11884	RCL PHC OPENINGS	F005	1,000	R	2	
0x1659		11885	RCL 3P OPENINGS	F005	1,000	R	2	
0x165B		11886	RCL PHA CLOSINGS	F005	1,000	R	2	
0x165D		11887	RCL PHB CLOSINGS	F005	1,000	R	2	
0x165F		11888	RCL PHC CLOSINGS	F005	1,000	R	2	
0x1661		11889	RCL 3P CLOSINGS	F005	1,000	R	2	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x1663		11890	RCL PHA OPEN LASTHOUR	F004	1,000	R	1	
0x1664		11891	RCL PHB OPEN LASTHOUR	F004	1,000	R	1	
0x1665		11892	RCL PHC OPEN LASTHOUR	F004	1,000	R	1	
0x1666		11893	RCL 3P OPEN LASTHOUR	F004	1,000	R	1	
0xB000		3000	Relay Model	F009	1,000	R	8	
0xB008		3001	Firmware Version	F009	1,000	R	2	
0xB00E		3002	Board Types	F009	1,000	R	10	
0xB018		3003	Firware Year	F004	1,000	R	1	
0xB019		3004	Firware Day Month	F004	1,000	R	1	
0xB020		3005	PLC Equations	F005	1,000	R	2	
0xB022		3006	LCD Configuration	F005	1,000	R	2	
0xB024		3007	Logs Texts	F005	1,000	R	2	
0xB026		3008	Logs Number	F004	1,000	R	1	
0xB027		3009	MAC Address	F009	1,000	R	6	
0xB02D		3010	Serial Number	F009	1,000	R	4	
0xB031		3011	Manufacturing Date	F009	1,000	R	8	
0xB039		3012	Device HW Version	F004	1,000	R	1	
			Operations text					
0x1C00		36	OPERATION 1	F009	1,000	R/W	16	
0x1C10		37	OPERATION 2	F009	1,000	R/W	16	
0x1C20		38	OPERATION 3	F009	1,000	R/W	16	
0x1C30		39	OPERATION 4	F009	1,000	R/W	16	
0x1C40		40	OPERATION 5	F009	1,000	R/W	16	
0x1C50		41	OPERATION 6	F009	1,000	R/W	16	
0x1C60		42	OPERATION 7	F009	1,000	R/W	16	
0x1C70		43	OPERATION 8	F009	1,000	R/W	16	
0x1C80		44	OPERATION 9	F009	1,000	R/W	16	
0x1C90		45	OPERATION 10	F009	1,000	R/W	16	
0x1CA0		46	OPERATION 11	F009	1,000	R/W	16	
0x1CB0		47	OPERATION 12	F009	1,000	R/W	16	
0x1CC0		48	OPERATION 13	F009	1,000	R/W	16	
0x1CD0		49	OPERATION 14	F009	1,000	R/W	16	
0x1CE0		50	OPERATION 15	F009	1,000	R/W	16	
0x1CF0		51	OPERATION 16	F009	1,000	R/W	16	
0x1D00		52	OPERATION 17	F009	1,000	R/W	16	
0x1D10		53	OPERATION 18	F009	1,000	R/W	16	
0x1D20		54	OPERATION 19	F009	1,000	R/W	16	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x1D30		55	OPERATION 20	F009	1,000	R/W	16	
0x1D40		56	OPERATION 21	F009	1,000	R/W	16	
0x1D50		57	OPERATION 22	F009	1,000	R/W	16	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x1D60		58	OPERATION 23	F009	1,000	R/W	16	
0x1D70		59	OPERATION 24	F009	1,000	R/W	16	
0x1D80		60	OPERATION 25	F009	1,000	R/W	16	
0x1D90		61	OPERATION 26	F009	1,000	R/W	16	
0x1DA0		62	OPERATION 27	F009	1,000	R/W	16	
0x1DB0		63	OPERATION 28	F009	1,000	R/W	16	
0x1DC0		64	OPERATION 29	F009	1,000	R/W	16	
0x1DD0		65	OPERATION 30	F009	1,000	R/W	16	
0x1DE0		66	OPERATION 31	F009	1,000	R/W	16	
0x1DF0		10481	OPERATION 32	F009	1,000	R/W	16	
0x1E00			Confirmation address			W	1	
			PLC Timer Masks					
0x1E01		10482	TIMER MASK 01	F005	1,000	R/W	2	[0 , 86400000] ms
0x1E03		10483	TIMER MASK 02	F005	1,000	R/W	2	[0 , 86400000] ms
0x1E05		10484	TIMER MASK 03	F005	1,000	R/W	2	[0 , 86400000] ms
0x1E07		10485	TIMER MASK 04	F005	1,000	R/W	2	[0 , 86400000] ms
0x1E09		10486	TIMER MASK 05	F005	1,000	R/W	2	[0 , 86400000] ms
0x1E0B		10487	TIMER MASK 06	F005	1,000	R/W	2	[0 , 86400000] ms
0x1E0D		10488	TIMER MASK 07	F005	1,000	R/W	2	[0 , 86400000] ms
0x1E0F		10489	TIMER MASK 08	F005	1,000	R/W	2	[0 , 86400000] ms
0x1E11		10490	TIMER MASK 09	F005	1,000	R/W	2	[0 , 86400000] ms
0x1E13		10491	TIMER MASK 10	F005	1,000	R/W	2	[0 , 86400000] ms
0x1E15		10492	TIMER MASK 11	F005	1,000	R/W	2	[0 , 86400000] ms
0x1E17		10493	TIMER MASK 12	F005	1,000	R/W	2	[0 , 86400000] ms
0x1E19		10494	TIMER MASK 13	F005	1,000	R/W	2	[0 , 86400000] ms
0x1E1B		10495	TIMER MASK 14	F005	1,000	R/W	2	[0 , 86400000] ms
0x1E1D		10496	TIMER MASK 15	F005	1,000	R/W	2	[0 , 86400000] ms
0x1E1F		10497	TIMER MASK 16	F005	1,000	R/W	2	[0 , 86400000] ms
0x1E3F			Confirmation address			W	1	
0x1E41		3463	Voltage Threshold A_F	F004	1,000	R/W	1	[10 , 230] V
0x1E42		3464	Voltage Threshold B_F	F004	1,000	R/W	1	[10 , 230] V
0x1E43		3465	Debounce Time A_F	F004	1,000	R/W	1	[1 , 50] ms
0x1E44		3466	Debounce Time B_F	F004	1,000	R/W	1	[1 , 50] ms
0x1E45		3467	Input Type_F_CC1	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E46		3468	Input Type_F_CC2	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E47		3469	Input Type_F_CC3	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								3=NEGATIVE
0x1E48		3470	Input Type_F_CC4	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E49		3471	Input Type_F_CC5	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E4A		3472	Input Type_F_CC6	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E4B		3473	Input Type_F_CC7	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E4C		3474	Input Type_F_CC8	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E4D		3475	Input Type_F_CC9	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E4E		3476	Input Type_F_CC10	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E4F		3477	Input Type_F_CC11	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E50		3478	Input Type_F_CC12	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E51		3479	Input Type_F_CC13	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E52		3480	Input Type_F_CC14	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								3=NEGATIVE
0x1E53		3481	Input Type_F_CC15	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E54		3482	Input Type_F_CC16	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E55		3483	Input Type_F_CC17	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E56		3484	Input Type_F_CC18	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E57		3485	Input Type_F_CC19	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E58		3486	Input Type_F_CC20	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E59		3487	Input Type_F_CC21	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E5A		3488	Input Type_F_CC22	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E5B		3489	Input Type_F_CC23	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E5C		3490	Input Type_F_CC24	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E5D		3491	Input Type_F_CC25	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								3=NEGATIVE
0x1E5E		3492	Input Type_F_CC26	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E5F		3493	Input Type_F_CC27	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E60		3494	Input Type_F_CC28	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E61		3495	Input Type_F_CC29	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E62		3496	Input Type_F_CC30	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E63		3497	Input Type_F_CC31	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E64		3498	Input Type_F_CC32	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1E65		3499	Delay Input Time_F_CC1	F005	1,000	R/W	2	[0 , 60000] ms
0x1E67		3500	Delay Input Time_F_CC2	F005	1,000	R/W	2	[0 , 60000] ms
0x1E69		3501	Delay Input Time_F_CC3	F005	1,000	R/W	2	[0 , 60000] ms
0x1E6B		3502	Delay Input Time_F_CC4	F005	1,000	R/W	2	[0 , 60000] ms
0x1E6D		3503	Delay Input Time_F_CC5	F005	1,000	R/W	2	[0 , 60000] ms
0x1E6F		3504	Delay Input Time_F_CC6	F005	1,000	R/W	2	[0 , 60000] ms
0x1E71		3505	Delay Input Time_F_CC7	F005	1,000	R/W	2	[0 , 60000] ms
0x1E73		3506	Delay Input Time_F_CC8	F005	1,000	R/W	2	[0 , 60000] ms
0x1E75		3507	Delay Input Time_F_CC9	F005	1,000	R/W	2	[0 , 60000] ms
0x1E77		3508	Delay Input Time_F_CC10	F005	1,000	R/W	2	[0 , 60000] ms
0x1E79		3509	Delay Input Time_F_CC11	F005	1,000	R/W	2	[0 , 60000] ms
0x1E7B		3510	Delay Input Time_F_CC12	F005	1,000	R/W	2	[0 , 60000] ms
0x1E7D		3511	Delay Input Time_F_CC13	F005	1,000	R/W	2	[0 , 60000] ms
0x1E7F		3512	Delay Input Time_F_CC14	F005	1,000	R/W	2	[0 , 60000] ms
0x1E81		3513	Delay Input Time_F_CC15	F005	1,000	R/W	2	[0 , 60000] ms

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x1E83		3514	Delay Input Time_F_CC16	F005	1,000	R/W	2	[0 , 60000] ms
0x1E85		3515	Delay Input Time_F_CC17	F005	1,000	R/W	2	[0 , 60000] ms
0x1E87		3516	Delay Input Time_F_CC18	F005	1,000	R/W	2	[0 , 60000] ms
0x1E89		3517	Delay Input Time_F_CC19	F005	1,000	R/W	2	[0 , 60000] ms
0x1E8B		3518	Delay Input Time_F_CC20	F005	1,000	R/W	2	[0 , 60000] ms
0x1E8D		3519	Delay Input Time_F_CC21	F005	1,000	R/W	2	[0 , 60000] ms
0x1E8F		3520	Delay Input Time_F_CC22	F005	1,000	R/W	2	[0 , 60000] ms
0x1E91		3521	Delay Input Time_F_CC23	F005	1,000	R/W	2	[0 , 60000] ms
0x1E93		3522	Delay Input Time_F_CC24	F005	1,000	R/W	2	[0 , 60000] ms
0x1E95		3523	Delay Input Time_F_CC25	F005	1,000	R/W	2	[0 , 60000] ms
0x1E97		3524	Delay Input Time_F_CC26	F005	1,000	R/W	2	[0 , 60000] ms
0x1E99		3525	Delay Input Time_F_CC27	F005	1,000	R/W	2	[0 , 60000] ms
0x1E9B		3526	Delay Input Time_F_CC28	F005	1,000	R/W	2	[0 , 60000] ms
0x1E9D		3527	Delay Input Time_F_CC29	F005	1,000	R/W	2	[0 , 60000] ms
0x1E9F		3528	Delay Input Time_F_CC30	F005	1,000	R/W	2	[0 , 60000] ms
0x1EA1		3529	Delay Input Time_F_CC31	F005	1,000	R/W	2	[0 , 60000] ms
0x1EA3		3530	Delay Input Time_F_CC32	F005	1,000	R/W	2	[0 , 60000] ms
0x1EA5		3531	Output Logic_F_01	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x1EA6		3532	Output Logic_F_02	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x1EA7		3533	Output Logic_F_03	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x1EA8		3534	Output Logic_F_04	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x1EA9		3535	Output Logic_F_05	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x1EAA		3536	Output Logic_F_06	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x1EAB		3537	Output Logic_F_07	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x1EAC		3538	Output Logic_F_08	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x1EAD		3539	Output Logic_F_09	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x1EAE		3540	Output Logic_F_10	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x1EAF		3541	Output Logic_F_11	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x1EB0		3542	Output Logic_F_12	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x1EB1		3543	Output Logic_F_13	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x1EB2		3544	Output Logic_F_14	F012	1,000	R/W	1	0=POSITIVE

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								1=NEGATIVE
0x1EB3		3545	Output Logic_F_15	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x1EB4		3546	Output Logic_F_16	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x1EB5		3547	Output Type_F_01	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x1EB6		3548	Output Type_F_02	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x1EB7		3549	Output Type_F_03	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x1EB8		3550	Output Type_F_04	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x1EB9		3551	Output Type_F_05	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x1EBA		3552	Output Type_F_06	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x1EBB		3553	Output Type_F_07	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x1EBC		3554	Output Type_F_08	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x1EBD		3555	Output Type_F_09	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x1EBE		3556	Output Type_F_10	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x1EBF		3557	Output Type_F_11	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x1EC0		3558	Output Type_F_12	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x1EC1		3559	Output Type_F_13	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x1EC2		3560	Output Type_F_14	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x1EC3		3561	Output Type_F_15	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x1EC4		3562	Output Type_F_16	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x1EC5		3563	Pulse Output Time_F_01	F005	1,000	R/W	2	[0 , 60000] ms
0x1EC7		3564	Pulse Output Time_F_02	F005	1,000	R/W	2	[0 , 60000] ms
0x1EC9		3565	Pulse Output Time_F_03	F005	1,000	R/W	2	[0 , 60000] ms
0x1ECB		3566	Pulse Output Time_F_04	F005	1,000	R/W	2	[0 , 60000] ms
0x1ECD		3567	Pulse Output Time_F_05	F005	1,000	R/W	2	[0 , 60000] ms
0x1ECF		3568	Pulse Output Time_F_06	F005	1,000	R/W	2	[0 , 60000] ms
0x1ED1		3569	Pulse Output Time_F_07	F005	1,000	R/W	2	[0 , 60000] ms
0x1ED3		3570	Pulse Output Time_F_08	F005	1,000	R/W	2	[0 , 60000] ms
0x1ED5		3571	Pulse Output Time_F_09	F005	1,000	R/W	2	[0 , 60000] ms
0x1ED7		3572	Pulse Output Time_F_10	F005	1,000	R/W	2	[0 , 60000] ms
0x1ED9		3573	Pulse Output Time_F_11	F005	1,000	R/W	2	[0 , 60000] ms
0x1EDB		3574	Pulse Output Time_F_12	F005	1,000	R/W	2	[0 , 60000] ms
0x1EDD		3575	Pulse Output Time_F_13	F005	1,000	R/W	2	[0 , 60000] ms
0x1EDF		3576	Pulse Output Time_F_14	F005	1,000	R/W	2	[0 , 60000] ms
0x1EE1		3577	Pulse Output Time_F_15	F005	1,000	R/W	2	[0 , 60000] ms
0x1EE3		3578	Pulse Output Time_F_16	F005	1,000	R/W	2	[0 , 60000] ms
0x1EE5		6894	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x1EE6		7252	Voltage Threshold C_F	F004	1,000	R/W	1	[10 , 230] V
0x1EE7		7253	Voltage Threshold D_F	F004	1,000	R/W	1	[10 , 230] V
0x1EE8		7254	Debounce Time C_F	F004	1,000	R/W	1	[1 , 50] ms
0x1EE9		7255	Debounce Time D_F	F004	1,000	R/W	1	[1 , 50] ms
0x1EEA		7256	Range_F_01	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x1EEB		7257	Range_F_02	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x1EEC		7258	Range_F_03	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x1EED		7259	Range_F_04	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x1EEE		7260	Range_F_05	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x1EEF		7261	Range_F_06	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x1EF0		7262	Range_F_07	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x1EF1		7263	Range_F_08	F012	1,000	R/W	1	0=NONE

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x1EF2		7264	Min Value_F_01	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x1EF4		7265	Min Value_F_02	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x1EF6		7266	Min Value_F_03	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x1EF8		7267	Min Value_F_04	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x1EFA		7268	Min Value_F_05	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x1EFC		7269	Min Value_F_06	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x1EFE		7270	Min Value_F_07	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x1F00		7271	Min Value_F_08	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x1F02		7272	Max Value_F_01	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x1F04		7273	Max Value_F_02	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x1F06		7274	Max Value_F_03	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x1F08		7275	Max Value_F_04	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x1F0A		7276	Max Value_F_05	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x1F0C		7277	Max Value_F_06	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x1F0E		7278	Max Value_F_07	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x1F10		7279	Max Value_F_08	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x1F12		7280	Current A Chn Gain	F003	1,000	R/W	2	[0,950 , 1,050]
0x1F14		7281	Current B Chn Gain	F003	1,000	R/W	2	[0,950 , 1,050]
0x1F16		7282	Current C Chn Gain	F003	1,000	R/W	2	[0,950 , 1,050]
0x1F18		7283	Voltage Chn Gain	F003	1,000	R/W	2	[0,950 , 1,050]
0x1F1A		7284	Channelx1a_F_05	F003	1,000	R/W	2	[0,950 , 1,050]
0x1F1C		7285	Channelx1a_F_06	F003	1,000	R/W	2	[0,950 , 1,050]
0x1F1E		7286	Channelx1a_F_07	F003	1,000	R/W	2	[0,950 , 1,050]
0x1F20		7287	Channelx1a_F_08	F003	1,000	R/W	2	[0,950 , 1,050]
0x1F22		7288	Current A Chn Offset	F004	1,000	R/W	1	[-1000 , 1000]
0x1F23		7289	Current B Chn Offset	F004	1,000	R/W	1	[-1000 , 1000]
0x1F24		7290	Current C Chn Offset	F004	1,000	R/W	1	[-1000 , 1000]
0x1F25		7291	Voltage Chn Offset	F004	1,000	R/W	1	[-1000 , 1000]
0x1F26		7292	Channelx1b_F_05	F004	1,000	R/W	1	[-1000 , 1000]
0x1F27		7293	Channelx1b_F_06	F004	1,000	R/W	1	[-1000 , 1000]
0x1F28		7294	Channelx1b_F_07	F004	1,000	R/W	1	[-1000 , 1000]
0x1F29		7295	Channelx1b_F_08	F004	1,000	R/W	1	[-1000 , 1000]
0x1F2A		7296	Channelx10a_F_01	F003	1,000	R/W	2	[0,950 , 1,050]
0x1F2C		7297	Channelx10a_F_02	F003	1,000	R/W	2	[0,950 , 1,050]
0x1F2E		7298	Channelx10a_F_03	F003	1,000	R/W	2	[0,950 , 1,050]
0x1F30		7299	Channelx10a_F_04	F003	1,000	R/W	2	[0,950 , 1,050]
0x1F32		7300	Channelx10a_F_05	F003	1,000	R/W	2	[0,950 , 1,050]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x1F34		7301	Channelx10a_F_06	F003	1,000	R/W	2	[0,950 , 1,050]
0x1F36		7302	Channelx10a_F_07	F003	1,000	R/W	2	[0,950 , 1,050]
0x1F38		7303	Channelx10a_F_08	F003	1,000	R/W	2	[0,950 , 1,050]
0x1F3A		7304	Channelx10b_F_01	F004	1,000	R/W	1	[-1000 , 1000]
0x1F3B		7305	Channelx10b_F_02	F004	1,000	R/W	1	[-1000 , 1000]
0x1F3C		7306	Channelx10b_F_03	F004	1,000	R/W	1	[-1000 , 1000]
0x1F3D		7307	Channelx10b_F_04	F004	1,000	R/W	1	[-1000 , 1000]
0x1F3E		7308	Channelx10b_F_05	F004	1,000	R/W	1	[-1000 , 1000]
0x1F3F		7309	Channelx10b_F_06	F004	1,000	R/W	1	[-1000 , 1000]
0x1F40		7310	Channelx10b_F_07	F004	1,000	R/W	1	[-1000 , 1000]
0x1F41		7311	Channelx10b_F_08	F004	1,000	R/W	1	[-1000 , 1000]
0x1F42		7312	Calibration Type_F	F012	1,000	R/W	1	0=NONE
								1=OFFSET
								2=CALIBRATION
								3=GET CALIBRATION
			Board F					
0x1F43		11260	Ext Power Supply	F004	1,000	R/W	1	[60 , 165] V
0x1F44		11261	DI Type	F012	1,000	R/W	1	0=Wet Type
								1=Dry Type
0x1F45		11262	Close Pulse Time	F004	1,000	R/W	1	[15 , 100] ms
0x1F46		11263	Open Pulse Time	F004	1,000	R/W	1	[15 , 100] ms
0x1F47		11264	Open Pulse Delay	F004	1,000	R/W	1	[0 , 50] ms
0x1F48		11265	Open Max Current	F004	1,000	R/W	1	[5 , 30] A
0x1F49		11266	Close Max Current	F004	1,000	R/W	1	[5 , 30] A
0x1FE4			Confirmation address			W	1	
			Board G					
0x1FE6		3661	Voltage Threshold A_G	F004	1,000	R/W	1	[10 , 230] V
0x1FE7		3662	Voltage Threshold B_G	F004	1,000	R/W	1	[10 , 230] V
0x1FE8		3663	Debounce Time A_G	F004	1,000	R/W	1	[1 , 50] ms
0x1FE9		3664	Debounce Time B_G	F004	1,000	R/W	1	[1 , 50] ms
0x1FEA		3665	Input Type_G_CC1	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1FEB		3666	Input Type_G_CC2	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1FEC		3667	Input Type_G_CC3	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1FED		3668	Input Type_G_CC4	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								2=POSITIVE
								3=NEGATIVE
0x1FEE		3669	Input Type_G_CC5	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1FEF		3670	Input Type_G_CC6	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1FF0		3671	Input Type_G_CC7	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1FF1		3672	Input Type_G_CC8	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1FF2		3673	Input Type_G_CC9	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1FF3		3674	Input Type_G_CC10	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1FF4		3675	Input Type_G_CC11	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1FF5		3676	Input Type_G_CC12	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1FF6		3677	Input Type_G_CC13	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1FF7		3678	Input Type_G_CC14	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1FF8		3679	Input Type_G_CC15	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								2=POSITIVE
								3=NEGATIVE
0x1FF9		3680	Input Type_G_CC16	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1FFA		3681	Input Type_G_CC17	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1FFB		3682	Input Type_G_CC18	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1FFC		3683	Input Type_G_CC19	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1FFD		3684	Input Type_G_CC20	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1FFE		3685	Input Type_G_CC21	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x1FFF		3686	Input Type_G_CC22	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2000		3687	Input Type_G_CC23	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2001		3688	Input Type_G_CC24	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2002		3689	Input Type_G_CC25	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2003		3690	Input Type_G_CC26	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								2=POSITIVE
								3=NEGATIVE
0x2004		3691	Input Type_G_CC27	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2005		3692	Input Type_G_CC28	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2006		3693	Input Type_G_CC29	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2007		3694	Input Type_G_CC30	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2008		3695	Input Type_G_CC31	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2009		3696	Input Type_G_CC32	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x200A		3697	Delay Input Time_G_CC1	F005	1,000	R/W	2	[0 , 60000] ms
0x200C		3698	Delay Input Time_G_CC2	F005	1,000	R/W	2	[0 , 60000] ms
0x200E		3699	Delay Input Time_G_CC3	F005	1,000	R/W	2	[0 , 60000] ms
0x2010		3700	Delay Input Time_G_CC4	F005	1,000	R/W	2	[0 , 60000] ms
0x2012		3701	Delay Input Time_G_CC5	F005	1,000	R/W	2	[0 , 60000] ms
0x2014		3702	Delay Input Time_G_CC6	F005	1,000	R/W	2	[0 , 60000] ms
0x2016		3703	Delay Input Time_G_CC7	F005	1,000	R/W	2	[0 , 60000] ms
0x2018		3704	Delay Input Time_G_CC8	F005	1,000	R/W	2	[0 , 60000] ms
0x201A		3705	Delay Input Time_G_CC9	F005	1,000	R/W	2	[0 , 60000] ms
0x201C		3706	Delay Input Time_G_CC10	F005	1,000	R/W	2	[0 , 60000] ms
0x201E		3707	Delay Input Time_G_CC11	F005	1,000	R/W	2	[0 , 60000] ms
0x2020		3708	Delay Input Time_G_CC12	F005	1,000	R/W	2	[0 , 60000] ms
0x2022		3709	Delay Input Time_G_CC13	F005	1,000	R/W	2	[0 , 60000] ms
0x2024		3710	Delay Input Time_G_CC14	F005	1,000	R/W	2	[0 , 60000] ms
0x2026		3711	Delay Input Time_G_CC15	F005	1,000	R/W	2	[0 , 60000] ms
0x2028		3712	Delay Input Time_G_CC16	F005	1,000	R/W	2	[0 , 60000] ms
0x202A		3713	Delay Input Time_G_CC17	F005	1,000	R/W	2	[0 , 60000] ms
0x202C		3714	Delay Input Time_G_CC18	F005	1,000	R/W	2	[0 , 60000] ms

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x202E		3715	Delay Input Time_G_CC19	F005	1,000	R/W	2	[0 , 60000] ms
0x2030		3716	Delay Input Time_G_CC20	F005	1,000	R/W	2	[0 , 60000] ms
0x2032		3717	Delay Input Time_G_CC21	F005	1,000	R/W	2	[0 , 60000] ms
0x2034		3718	Delay Input Time_G_CC22	F005	1,000	R/W	2	[0 , 60000] ms
0x2036		3719	Delay Input Time_G_CC23	F005	1,000	R/W	2	[0 , 60000] ms
0x2038		3720	Delay Input Time_G_CC24	F005	1,000	R/W	2	[0 , 60000] ms
0x203A		3721	Delay Input Time_G_CC25	F005	1,000	R/W	2	[0 , 60000] ms
0x203C		3722	Delay Input Time_G_CC26	F005	1,000	R/W	2	[0 , 60000] ms
0x203E		3723	Delay Input Time_G_CC27	F005	1,000	R/W	2	[0 , 60000] ms
0x2040		3724	Delay Input Time_G_CC28	F005	1,000	R/W	2	[0 , 60000] ms
0x2042		3725	Delay Input Time_G_CC29	F005	1,000	R/W	2	[0 , 60000] ms
0x2044		3726	Delay Input Time_G_CC30	F005	1,000	R/W	2	[0 , 60000] ms
0x2046		3727	Delay Input Time_G_CC31	F005	1,000	R/W	2	[0 , 60000] ms
0x2048		3728	Delay Input Time_G_CC32	F005	1,000	R/W	2	[0 , 60000] ms
0x204A		3729	Output Logic_G_01	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x204B		3730	Output Logic_G_02	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x204C		3731	Output Logic_G_03	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x204D		3732	Output Logic_G_04	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x204E		3733	Output Logic_G_05	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x204F		3734	Output Logic_G_06	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2050		3735	Output Logic_G_07	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2051		3736	Output Logic_G_08	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2052		3737	Output Logic_G_09	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2053		3738	Output Logic_G_10	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2054		3739	Output Logic_G_11	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2055		3740	Output Logic_G_12	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2056		3741	Output Logic_G_13	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2057		3742	Output Logic_G_14	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2058		3743	Output Logic_G_15	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2059		3744	Output Logic_G_16	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x205A		3745	Output Type_G_01	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x205B		3746	Output Type_G_02	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x205C		3747	Output Type_G_03	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x205D		3748	Output Type_G_04	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x205E		3749	Output Type_G_05	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x205F		3750	Output Type_G_06	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2060		3751	Output Type_G_07	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2061		3752	Output Type_G_08	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2062		3753	Output Type_G_09	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2063		3754	Output Type_G_10	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2064		3755	Output Type_G_11	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2065		3756	Output Type_G_12	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2066		3757	Output Type_G_13	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2067		3758	Output Type_G_14	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2068		3759	Output Type_G_15	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2069		3760	Output Type_G_16	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x206A		3761	Pulse Output Time_G_01	F005	1,000	R/W	2	[0 , 60000] ms
0x206C		3762	Pulse Output Time_G_02	F005	1,000	R/W	2	[0 , 60000] ms
0x206E		3763	Pulse Output Time_G_03	F005	1,000	R/W	2	[0 , 60000] ms
0x2070		3764	Pulse Output Time_G_04	F005	1,000	R/W	2	[0 , 60000] ms
0x2072		3765	Pulse Output Time_G_05	F005	1,000	R/W	2	[0 , 60000] ms
0x2074		3766	Pulse Output Time_G_06	F005	1,000	R/W	2	[0 , 60000] ms
0x2076		3767	Pulse Output Time_G_07	F005	1,000	R/W	2	[0 , 60000] ms
0x2078		3768	Pulse Output Time_G_08	F005	1,000	R/W	2	[0 , 60000] ms
0x207A		3769	Pulse Output Time_G_09	F005	1,000	R/W	2	[0 , 60000] ms
0x207C		3770	Pulse Output Time_G_10	F005	1,000	R/W	2	[0 , 60000] ms
0x207E		3771	Pulse Output Time_G_11	F005	1,000	R/W	2	[0 , 60000] ms
0x2080		3772	Pulse Output Time_G_12	F005	1,000	R/W	2	[0 , 60000] ms
0x2082		3773	Pulse Output Time_G_13	F005	1,000	R/W	2	[0 , 60000] ms
0x2084		3774	Pulse Output Time_G_14	F005	1,000	R/W	2	[0 , 60000] ms
0x2086		3775	Pulse Output Time_G_15	F005	1,000	R/W	2	[0 , 60000] ms
0x2088		3776	Pulse Output Time_G_16	F005	1,000	R/W	2	[0 , 60000] ms
0x208A		6895	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x208B		7322	Voltage Threshold C_G	F004	1,000	R/W	1	[10 , 230] V
0x208C		7323	Voltage Threshold D_G	F004	1,000	R/W	1	[10 , 230] V
0x208D		7324	Debounce Time C_G	F004	1,000	R/W	1	[1 , 50] ms
0x208E		7325	Debounce Time D_G	F004	1,000	R/W	1	[1 , 50] ms
0x208F		7326	Range_G_01	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x2090		7327	Range_G_02	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2091		7328	Range_G_03	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x2092		7329	Range_G_04	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x2093		7330	Range_G_05	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x2094		7331	Range_G_06	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x2095		7332	Range_G_07	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x2096		7333	Range_G_08	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x2097		7334	Min Value_G_01	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x2099		7335	Min Value_G_02	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x209B		7336	Min Value_G_03	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x209D		7337	Min Value_G_04	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x209F		7338	Min Value_G_05	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x20A1		7339	Min Value_G_06	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x20A3		7340	Min Value_G_07	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x20A5		7341	Min Value_G_08	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x20A7		7342	Max Value_G_01	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x20A9		7343	Max Value_G_02	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x20AB		7344	Max Value_G_03	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x20AD		7345	Max Value_G_04	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x20AF		7346	Max Value_G_05	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x20B1		7347	Max Value_G_06	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x20B3		7348	Max Value_G_07	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x20B5		7349	Max Value_G_08	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x20B7		7350	Channelx1a_G_01	F003	1,000	R/W	2	[0,950 , 1,050]
0x20B9		7351	Channelx1a_G_02	F003	1,000	R/W	2	[0,950 , 1,050]
0x20BB		7352	Channelx1a_G_03	F003	1,000	R/W	2	[0,950 , 1,050]
0x20BD		7353	Channelx1a_G_04	F003	1,000	R/W	2	[0,950 , 1,050]
0x20BF		7354	Channelx1a_G_05	F003	1,000	R/W	2	[0,950 , 1,050]
0x20C1		7355	Channelx1a_G_06	F003	1,000	R/W	2	[0,950 , 1,050]
0x20C3		7356	Channelx1a_G_07	F003	1,000	R/W	2	[0,950 , 1,050]
0x20C5		7357	Channelx1a_G_08	F003	1,000	R/W	2	[0,950 , 1,050]
0x20C7		7358	Channelx1b_G_01	F004	1,000	R/W	1	[-1000 , 1000]
0x20C8		7359	Channelx1b_G_02	F004	1,000	R/W	1	[-1000 , 1000]
0x20C9		7360	Channelx1b_G_03	F004	1,000	R/W	1	[-1000 , 1000]
0x20CA		7361	Channelx1b_G_04	F004	1,000	R/W	1	[-1000 , 1000]
0x20CB		7362	Channelx1b_G_05	F004	1,000	R/W	1	[-1000 , 1000]
0x20CC		7363	Channelx1b_G_06	F004	1,000	R/W	1	[-1000 , 1000]
0x20CD		7364	Channelx1b_G_07	F004	1,000	R/W	1	[-1000 , 1000]
0x20CE		7365	Channelx1b_G_08	F004	1,000	R/W	1	[-1000 , 1000]
0x20CF		7366	Channelx10a_G_01	F003	1,000	R/W	2	[0,950 , 1,050]
0x20D1		7367	Channelx10a_G_02	F003	1,000	R/W	2	[0,950 , 1,050]
0x20D3		7368	Channelx10a_G_03	F003	1,000	R/W	2	[0,950 , 1,050]
0x20D5		7369	Channelx10a_G_04	F003	1,000	R/W	2	[0,950 , 1,050]
0x20D7		7370	Channelx10a_G_05	F003	1,000	R/W	2	[0,950 , 1,050]
0x20D9		7371	Channelx10a_G_06	F003	1,000	R/W	2	[0,950 , 1,050]
0x20DB		7372	Channelx10a_G_07	F003	1,000	R/W	2	[0,950 , 1,050]
0x20DD		7373	Channelx10a_G_08	F003	1,000	R/W	2	[0,950 , 1,050]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x20DF		7374	Channelx10b_G_01	F004	1,000	R/W	1	[-1000 , 1000]
0x20E0		7375	Channelx10b_G_02	F004	1,000	R/W	1	[-1000 , 1000]
0x20E1		7376	Channelx10b_G_03	F004	1,000	R/W	1	[-1000 , 1000]
0x20E2		7377	Channelx10b_G_04	F004	1,000	R/W	1	[-1000 , 1000]
0x20E3		7378	Channelx10b_G_05	F004	1,000	R/W	1	[-1000 , 1000]
0x20E4		7379	Channelx10b_G_06	F004	1,000	R/W	1	[-1000 , 1000]
0x20E5		7380	Channelx10b_G_07	F004	1,000	R/W	1	[-1000 , 1000]
0x20E6		7381	Channelx10b_G_08	F004	1,000	R/W	1	[-1000 , 1000]
0x20E7		7382	Calibration Type_G	F012	1,000	R/W	1	0=NONE
								1=OFFSET
								2=CALIBRATION
								3=GET CALIBRATION
0x2189			Confirmation address			W	1	
			General Settings					
0x2195		3864	Nominal Frequency	F012	1,000	R/W	1	0=50 Hz
								1=60 Hz
0x2196		3865	Phase Rotation	F012	1,000	R/W	1	0=ABC
								1=ACB
0x2197		3866	Frequency Reference	F012	1,000	R/W	1	0=VI
								1=VII
								2=VIII
0x2199		6904	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x219B		10449	Primary Meter Units	F012	1,000	R/W	1	0=KA_KV
								1=A_V
0x219C		10473	Device Name	F009	1,000	R/W	8	
0x21A4		11048	Voltage Reference	F012	1,000	R/W	1	0=Load Side (VLx)
								1=Source Side (VSx)
0x2203			Confirmation address			W	1	
			Phase IOC High 1					
0x2204		3989	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2205		3990	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS
0x2206		10908	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x2208		3992	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x220A		3993	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x220C		6953	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x221F			Confirmation address			W	1	
			Phase IOC High 2					
0x2220		4005	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2221		4006	Input	F012	1,000	R/W	1	0=PHASOR(DFT)

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								1=RMS
0x2222		10909	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x2224		4008	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2226		4009	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2228		6954	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x223B			Confirmation address			W	1	
			Phase IOC High 3					
0x223C		4021	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x223D		4022	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS
0x223E		10910	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x2240		4024	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2242		4025	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2244		6955	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2257			Confirmation address			W	1	
			Phase IOC Low 1					
0x2258		4037	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2259		4038	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS
0x225A		10911	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x225C		4040	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x225E		4041	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2260		6956	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2273			Confirmation address			W	1	
			Phase IOC Low 2					
0x2274		4053	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2275		4054	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS
0x2276		10912	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x2278		4056	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x227A		4057	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x227C		6957	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x228F			Confirmation address			W	1	
			Phase IOC Low 3					
0x2290		4069	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2291		4070	Input	F012	1,000	R/W	1	0=PHASOR(DFT)

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								1=RMS
0x2292		10913	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x2294		4072	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2296		4073	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2298		6958	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x22AB			Confirmation address			W	1	
			Neutral IOC 1					
0x22AC		4085	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x22AD		10914	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x22AF		4087	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x22B1		4088	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x22B3		6950	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x22C6			Confirmation address			W	1	
			Neutral IOC 2					
0x22C7		4092	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x22C8		10915	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x22CA		4094	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x22CC		4095	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x22CE		6951	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x22E1			Confirmation address			W	1	
			Neutral IOC 3					
0x22E2		4099	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x22E3		10916	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x22E5		4101	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x22E7		4102	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x22E9		6952	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x22FC			Confirmation address			W	1	
			Ground IOC 1					
0x22FD		4106	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x22FE		4107	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS
0x22FF		10917	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CTg
0x2301		4109	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2303		4110	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2305		6944	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2318			Confirmation address			W	1	
			Ground IOC 2					
0x2319		4114	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x231A		4115	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS
0x231B		10918	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CTg
0x231D		4117	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x231F		4118	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2321		6945	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2334			Confirmation address			W	1	
			Ground IOC 3					
0x2335		4122	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2336		4123	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS
0x2337		10919	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CTg
0x2339		4125	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x233B		4126	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x233D		6946	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2350			Confirmation address			W	1	
			Sens. Ground IOC 1					
0x2351		4130	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2352		4131	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS
0x2353		10920	Pickup Level	F003	1,000	R/W	2	[0,025 , 20,000] x CTsg
0x2355		4133	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2357		4134	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2359		6959	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x236C			Confirmation address			W	1	
			Sens. Ground IOC 2					
0x236D		4138	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x236E		4139	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS
0x236F		10921	Pickup Level	F003	1,000	R/W	2	[0,025 , 20,000] x CTsg
0x2371		4141	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2373		4142	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2375		6960	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2388			Confirmation address			W	1	
			Sens. Ground IOC 3					
0x2389		4146	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x238A		4147	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS
0x238B		10922	Pickup Level	F003	1,000	R/W	2	[0,025 , 20,000] x CTsg
0x238D		4149	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x238F		4150	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2391		6961	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x23A4			Confirmation address			W	1	
			Phase TOC High 1					
0x23A5		4154	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x23A6		4155	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS
0x23A7		10923	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x23A9		6751	Curve	F012	1,000	R/W	1	0=IEEE Ext Inv
								1=IEEE Very Inv
								2=IEEE Mod Inv
								3=IEC Curve A
								4=IEC Curve B
								5=IEC Curve C
								6=IEC Long-Time Inv
								7=IEC Short-Time Inv
								8=IAC Ext Inv
								9=IAC Very Inv
								10=IAC Mod Inv
								11=ANSI Ext Inv
								12=ANSI Very Inv
								13=ANSI Norm Inv
								14=ANSI Mod Inv
								15=I2t
								16=Definite Time
								17=Rectifier Curve
								18=User Curve A
								19=User Curve B
								20=User Curve C
								21=User Curve D
0x23AA		4158	TD Multiplier	F003	1,000	R/W	2	[0,00 , 900,00] s

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x23AC		4159	Reset	F012	1,000	R/W	1	0=INSTANTANEOUS
								1=LINEAR
0x23AD		4160	Voltage Restraint	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x23AE		6962	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x23C1			Confirmation address			W	1	
			Phase TOC High 2					
0x23C2		4172	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x23C3		4173	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS
0x23C4		10924	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x23C6		6752	Curve	F012	1,000	R/W	1	0=IEEE Ext Inv
								1=IEEE Very Inv
								2=IEEE Mod Inv
								3=IEC Curve A
								4=IEC Curve B
								5=IEC Curve C
								6=IEC Long-Time Inv
								7=IEC Short-Time Inv
								8=IAC Ext Inv
								9=IAC Very Inv
								10=IAC Mod Inv
								11=ANSI Ext Inv
								12=ANSI Very Inv
								13=ANSI Norm Inv
								14=ANSI Mod Inv
								15=I2t
								16=Definite Time
								17=Rectifier Curve
								18=User Curve A
								19=User Curve B
								20=User Curve C
								21=User Curve D
0x23C7		4176	TD Multiplier	F003	1,000	R/W	2	[0,00 , 900,00] s
0x23C9		4177	Reset	F012	1,000	R/W	1	0=INSTANTANEOUS
								1=LINEAR
0x23CA		4178	Voltage Restraint	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x23CB		6963	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x23DE			Confirmation address			W	1	
			Phase TOC High 3					

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x23DF		4190	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x23E0		4191	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS
0x23E1		10925	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x23E3		6753	Curve	F012	1,000	R/W	1	0=IEEE Ext Inv
								1=IEEE Very Inv
								2=IEEE Mod Inv
								3=IEC Curve A
								4=IEC Curve B
								5=IEC Curve C
								6=IEC Long-Time Inv
								7=IEC Short-Time Inv
								8=IAC Ext Inv
								9=IAC Very Inv
								10=IAC Mod Inv
								11=ANSI Ext Inv
								12=ANSI Very Inv
								13=ANSI Norm Inv
								14=ANSI Mod Inv
								15=I2t
								16=Definite Time
								17=Rectifier Curve
								18=User Curve A
								19=User Curve B
								20=User Curve C
								21=User Curve D
0x23E4		4194	TD Multiplier	F003	1,000	R/W	2	[0,00 , 900,00] s
0x23E6		4195	Reset	F012	1,000	R/W	1	0=INSTANTANEOUS
								1=LINEAR
0x23E7		4196	Voltage Restraint	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x23E8		6964	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x23FB			Confirmation address			W	1	
			Neutral TOC 1					
0x23FC		4208	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x23FD		10929	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x23FF		6754	Curve	F012	1,000	R/W	1	0=IEEE Ext Inv
								1=IEEE Very Inv
								2=IEEE Mod Inv
								3=IEC Curve A
								4=IEC Curve B

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								5=IEC Curve C
								6=IEC Long-Time Inv
								7=IEC Short-Time Inv
								8=IAC Ext Inv
								9=IAC Very Inv
								10=IAC Mod Inv
								11=ANSI Ext Inv
								12=ANSI Very Inv
								13=ANSI Norm Inv
								14=ANSI Mod Inv
								15=I2t
								16=Definite Time
								17=Rectifier Curve
								18=User Curve A
								19=User Curve B
								20=User Curve C
								21=User Curve D
0x2400		4211	TD Multiplier	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2402		4212	Reset	F012	1,000	R/W	1	0=INSTANTANEOUS
								1=LINEAR
0x2403		6968	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2416			Confirmation address			W	1	
			Neutral TOC 2					
0x2417		4216	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2418		10930	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x241A		6755	Curve	F012	1,000	R/W	1	0=IEEE Ext Inv
								1=IEEE Very Inv
								2=IEEE Mod Inv
								3=IEC Curve A
								4=IEC Curve B
								5=IEC Curve C
								6=IEC Long-Time Inv
								7=IEC Short-Time Inv
								8=IAC Ext Inv
								9=IAC Very Inv
								10=IAC Mod Inv
								11=ANSI Ext Inv
								12=ANSI Very Inv
								13=ANSI Norm Inv
								14=ANSI Mod Inv
								15=I2t
								16=Definite Time

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								17=Rectifier Curve
								18=User Curve A
								19=User Curve B
								20=User Curve C
								21=User Curve D
0x241B		4219	TD Multiplier	F003	1,000	R/W	2	[0,00 , 900,00] s
0x241D		4220	Reset	F012	1,000	R/W	1	0=INSTANTANEOUS
								1=LINEAR
0x241E		6969	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2431			Confirmation address			W	1	
			Neutral TOC 3					
0x2432		4224	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2433		10931	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x2435		6756	Curve	F012	1,000	R/W	1	0=IEEE Ext Inv
								1=IEEE Very Inv
								2=IEEE Mod Inv
								3=IEC Curve A
								4=IEC Curve B
								5=IEC Curve C
								6=IEC Long-Time Inv
								7=IEC Short-Time Inv
								8=IAC Ext Inv
								9=IAC Very Inv
								10=IAC Mod Inv
								11=ANSI Ext Inv
								12=ANSI Very Inv
								13=ANSI Norm Inv
								14=ANSI Mod Inv
								15=I2t
								16=Definite Time
								17=Rectifier Curve
								18=User Curve A
								19=User Curve B
								20=User Curve C
								21=User Curve D
0x2436		4227	TD Multiplier	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2438		4228	Reset	F012	1,000	R/W	1	0=INSTANTANEOUS
								1=LINEAR
0x2439		6970	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x244C			Confirmation address			W	1	
			Ground TOC 1					

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x244D		4232	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x244E		4233	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS
0x244F		10932	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CTg
0x2451		6760	Curve	F012	1,000	R/W	1	0=IEEE Ext Inv
								1=IEEE Very Inv
								2=IEEE Mod Inv
								3=IEC Curve A
								4=IEC Curve B
								5=IEC Curve C
								6=IEC Long-Time Inv
								7=IEC Short-Time Inv
								8=IAC Ext Inv
								9=IAC Very Inv
								10=IAC Mod Inv
								11=ANSI Ext Inv
								12=ANSI Very Inv
								13=ANSI Norm Inv
								14=ANSI Mod Inv
								15=I2t
								16=Definite Time
								17=Rectifier Curve
								18=User Curve A
								19=User Curve B
								20=User Curve C
								21=User Curve D
0x2452		4236	TD Multiplier	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2454		4237	Reset	F012	1,000	R/W	1	0=INSTANTANEOUS
								1=LINEAR
0x2455		6965	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2468			Confirmation address			W	1	
			Ground TOC 2					
0x2469		4241	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x246A		4242	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS
0x246B		10933	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CTg
0x246D		6761	Curve	F012	1,000	R/W	1	0=IEEE Ext Inv
								1=IEEE Very Inv
								2=IEEE Mod Inv
								3=IEC Curve A
								4=IEC Curve B

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								5=IEC Curve C
								6=IEC Long-Time Inv
								7=IEC Short-Time Inv
								8=IAC Ext Inv
								9=IAC Very Inv
								10=IAC Mod Inv
								11=ANSI Ext Inv
								12=ANSI Very Inv
								13=ANSI Norm Inv
								14=ANSI Mod Inv
								15=I2t
								16=Definite Time
								17=Rectifier Curve
								18=User Curve A
								19=User Curve B
								20=User Curve C
								21=User Curve D
0x246E		4245	TD Multiplier	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2470		4246	Reset	F012	1,000	R/W	1	0=INSTANTANEOUS
								1=LINEAR
0x2471		6966	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2484			Confirmation address			W	1	
			Ground TOC 3					
0x2485		4250	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2486		4251	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS
0x2487		10934	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CTg
0x2489		6762	Curve	F012	1,000	R/W	1	0=IEEE Ext Inv
								1=IEEE Very Inv
								2=IEEE Mod Inv
								3=IEC Curve A
								4=IEC Curve B
								5=IEC Curve C
								6=IEC Long-Time Inv
								7=IEC Short-Time Inv
								8=IAC Ext Inv
								9=IAC Very Inv
								10=IAC Mod Inv
								11=ANSI Ext Inv
								12=ANSI Very Inv
								13=ANSI Norm Inv
								14=ANSI Mod Inv

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								15=I2t
								16=Definite Time
								17=Rectifier Curve
								18=User Curve A
								19=User Curve B
								20=User Curve C
								21=User Curve D
0x248A		4254	TD Multiplier	F003	1,000	R/W	2	[0,00 , 900,00] s
0x248C		4255	Reset	F012	1,000	R/W	1	0=INSTANTANEOUS
								1=LINEAR
0x248D		6967	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x24A0			Confirmation address			W	1	
			Sens. Ground TOC 1					
0x24A1		4259	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x24A2		4260	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS
0x24A3		10935	Pickup Level	F003	1,000	R/W	2	[0,025 , 20,000] x CTsg
0x24A5		6766	Curve	F012	1,000	R/W	1	0=IEEE Ext Inv
								1=IEEE Very Inv
								2=IEEE Mod Inv
								3=IEC Curve A
								4=IEC Curve B
								5=IEC Curve C
								6=IEC Long-Time Inv
								7=IEC Short-Time Inv
								8=IAC Ext Inv
								9=IAC Very Inv
								10=IAC Mod Inv
								11=ANSI Ext Inv
								12=ANSI Very Inv
								13=ANSI Norm Inv
								14=ANSI Mod Inv
								15=I2t
								16=Definite Time
								17=Rectifier Curve
								18=User Curve A
								19=User Curve B
								20=User Curve C
								21=User Curve D
0x24A6		4263	TD Multiplier	F003	1,000	R/W	2	[0,00 , 900,00] s
0x24A8		4264	Reset	F012	1,000	R/W	1	0=INSTANTANEOUS
								1=LINEAR

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x24A9		6974	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x24BC			Confirmation address			W	1	
			Sens. Ground TOC 2					
0x24BD		4268	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x24BE		4269	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS
0x24BF		10936	Pickup Level	F003	1,000	R/W	2	[0,025 , 20,000] x CTsg
0x24C1		6767	Curve	F012	1,000	R/W	1	0=IEEE Ext Inv
								1=IEEE Very Inv
								2=IEEE Mod Inv
								3=IEC Curve A
								4=IEC Curve B
								5=IEC Curve C
								6=IEC Long-Time Inv
								7=IEC Short-Time Inv
								8=IAC Ext Inv
								9=IAC Very Inv
								10=IAC Mod Inv
								11=ANSI Ext Inv
								12=ANSI Very Inv
								13=ANSI Norm Inv
								14=ANSI Mod Inv
								15=I2t
								16=Definite Time
								17=Rectifier Curve
								18=User Curve A
								19=User Curve B
								20=User Curve C
								21=User Curve D
0x24C2		4272	TD Multiplier	F003	1,000	R/W	2	[0,00 , 900,00] s
0x24C4		4273	Reset	F012	1,000	R/W	1	0=INSTANTANEOUS
								1=LINEAR
0x24C5		6975	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x24D8			Confirmation address			W	1	
			Sens. Ground TOC 3					
0x24D9		4277	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x24DA		4278	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS
0x24DB		10937	Pickup Level	F003	1,000	R/W	2	[0,025 , 20,000] x CTsg
0x24DD		6768	Curve	F012	1,000	R/W	1	0=IEEE Ext Inv

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								1=IEEE Very Inv
								2=IEEE Mod Inv
								3=IEC Curve A
								4=IEC Curve B
								5=IEC Curve C
								6=IEC Long-Time Inv
								7=IEC Short-Time Inv
								8=IAC Ext Inv
								9=IAC Very Inv
								10=IAC Mod Inv
								11=ANSI Ext Inv
								12=ANSI Very Inv
								13=ANSI Norm Inv
								14=ANSI Mod Inv
								15=I2t
								16=Definite Time
								17=Rectifier Curve
								18=User Curve A
								19=User Curve B
								20=User Curve C
								21=User Curve D
0x24DE		4281	TD Multiplier	F003	1,000	R/W	2	[0,00 , 900,00] s
0x24E0		4282	Reset	F012	1,000	R/W	1	0=INSTANTANEOUS
								1=LINEAR
0x24E1		6976	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x24F4			Confirmation address			W	1	
			Phase UV 1					
0x24F5		4286	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x24F6		4287	Mode	F012	1,000	R/W	1	0=PHASE-PHASE
								1=PHASE-GROUND
0x24F7		10968	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x24F9		4289	Curve	F012	1,000	R/W	1	0=DEFINITE TIME
								1=INVERSE TIME
0x24FA		4290	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x24FC		10969	Minimum Voltage	F003	1,000	R/W	2	[0,00 , 1,25] x VT
0x24FE		4292	Logic	F012	1,000	R/W	1	0=ANY PHASE
								1=TWO PHASES
								2=ALL PHASES
0x24FF		4293	Supervised by 52	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2500		6925	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2513			Confirmation address			W	1	
			Phase UV 2					
0x2514		4309	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2515		4310	Mode	F012	1,000	R/W	1	0=PHASE-PHASE
								1=PHASE-GROUND
0x2516		10970	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x2518		4312	Curve	F012	1,000	R/W	1	0=DEFINITE TIME
								1=INVERSE TIME
0x2519		4313	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x251B		10971	Minimum Voltage	F003	1,000	R/W	2	[0,00 , 1,25] x VT
0x251D		4315	Logic	F012	1,000	R/W	1	0=ANY PHASE
								1=TWO PHASES
								2=ALL PHASES
0x251E		4316	Supervised by 52	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x251F		6926	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2532			Confirmation address			W	1	
			Phase UV 3					
0x2533		4332	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2534		4333	Mode	F012	1,000	R/W	1	0=PHASE-PHASE
								1=PHASE-GROUND
0x2535		10972	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x2537		4335	Curve	F012	1,000	R/W	1	0=DEFINITE TIME
								1=INVERSE TIME
0x2538		4336	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x253A		10973	Minimum Voltage	F003	1,000	R/W	2	[0,00 , 1,25] x VT
0x253C		4338	Logic	F012	1,000	R/W	1	0=ANY PHASE
								1=TWO PHASES
								2=ALL PHASES
0x253D		4339	Supervised by 52	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x253E		6927	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2551			Confirmation address			W	1	
			Negative Sequence OV 1					
0x2552		4355	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2553		10980	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x2555		4357	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2557		4358	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2559		6937	Snapshot Events	F012	1,000	R/W	1	0=DISABLED

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								1=ENABLED
0x256C			Confirmation address			W	1	
			Negative Sequence OV 2					
0x256D		4362	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x256E		10981	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x2570		4364	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2572		4365	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2574		6938	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2587			Confirmation address			W	1	
			Negative Sequence OV 3					
0x2588		4369	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2589		10982	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x258B		4371	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x258D		4372	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x258F		6939	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x25A2			Confirmation address			W	1	
			Thermal Model 1					
0x25A3		4376	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x25A4		4377	Heat Time Constant	F003	1,000	R/W	2	[3,0 , 600,0] min
0x25A6		4378	Cool Time Constant	F003	1,000	R/W	2	[1,00 , 6,00]
0x25A8		10950	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x25AA		4380	Alarm Level	F003	1,000	R/W	2	[1,0 , 110,0] %
0x25AC		6940	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x25BF			Confirmation address			W	1	
			Thermal Model 2					
0x25C0		4396	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x25C1		4397	Heat Time Constant	F003	1,000	R/W	2	[3,0 , 600,0] min
0x25C3		4398	Cool Time Constant	F003	1,000	R/W	2	[1,00 , 6,00]
0x25C5		10951	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x25C7		4400	Alarm Level	F003	1,000	R/W	2	[1,0 , 110,0] %
0x25C9		6941	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x25DC			Confirmation address			W	1	
			Thermal Model 3					
0x25DD		4416	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x25DE		4417	Heat Time Constant	F003	1,000	R/W	2	[3,0 , 600,0] min

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x25E0		4418	Cool Time Constant	F003	1,000	R/W	2	[1,00 , 6,00]
0x25E2		10952	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x25E4		4420	Alarm Level	F003	1,000	R/W	2	[1,0 , 110,0] %
0x25E6		6942	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x25F9			Confirmation address			W	1	
			Phase Directional 1					
0x25FA		4436	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x25FB		4437	MTA	F003	1,000	R/W	2	[-90 , 90] Deg
0x25FD		4438	Direction	F012	1,000	R/W	1	0=REVERSE
								1=FORWARD
0x25FE		4439	Block Logic	F012	1,000	R/W	1	0=PERMISSION
								1=BLOCK
0x25FF		10938	Pol V Threshold	F003	1,000	R/W	2	[0,00 , 1,25] x VT
0x2601		6995	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2602		10469	Voltage Memory Time	F003	1,000	R/W	2	[0,00 , 3,00] s
0x2614			Confirmation address			W	1	
			Phase Directional 2					
0x2615		4448	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2616		4449	MTA	F003	1,000	R/W	2	[-90 , 90] Deg
0x2618		4450	Direction	F012	1,000	R/W	1	0=REVERSE
								1=FORWARD
0x2619		4451	Block Logic	F012	1,000	R/W	1	0=PERMISSION
								1=BLOCK
0x261A		10939	Pol V Threshold	F003	1,000	R/W	2	[0,00 , 1,25] x VT
0x261C		6996	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x261D		10470	Voltage Memory Time	F003	1,000	R/W	2	[0,00 , 3,00] s
0x262F			Confirmation address			W	1	
			Phase Directional 3					
0x2630		4460	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2631		4461	MTA	F003	1,000	R/W	2	[-90 , 90] Deg
0x2633		4462	Direction	F012	1,000	R/W	1	0=REVERSE
								1=FORWARD
0x2634		4463	Block Logic	F012	1,000	R/W	1	0=PERMISSION
								1=BLOCK
0x2635		10940	Pol V Threshold	F003	1,000	R/W	2	[0,00 , 1,25] x VT
0x2637		6997	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2638		10471	Voltage Memory Time	F003	1,000	R/W	2	[0,00 , 3,00] s

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x264A			Confirmation address			W	1	
			Neutral Dir 1					
0x264B		4472	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x264C		4473	MTA	F003	1,000	R/W	2	[-90 , 90] Deg
0x264E		4474	Direction	F012	1,000	R/W	1	0=REVERSE
								1=FORWARD
0x264F		4475	Polarization	F012	1,000	R/W	1	0=VO
								1=IP
								2=VO + IP
								3=VO*IP
0x2650		4476	Block Logic	F012	1,000	R/W	1	0=PERMISSION
								1=BLOCK
0x2651		10941	Pol V Threshold	F003	1,000	R/W	2	[0,00 , 1,25] x VT
0x2653		6992	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2666			Confirmation address			W	1	
			Neutral Dir 2					
0x2667		4481	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2668		4482	MTA	F003	1,000	R/W	2	[-90 , 90] Deg
0x266A		4483	Direction	F012	1,000	R/W	1	0=REVERSE
								1=FORWARD
0x266B		4484	Polarization	F012	1,000	R/W	1	0=VO
								1=IP
								2=VO + IP
								3=VO*IP
0x266C		4485	Block Logic	F012	1,000	R/W	1	0=PERMISSION
								1=BLOCK
0x266D		10942	Pol V Threshold	F003	1,000	R/W	2	[0,00 , 1,25] x VT
0x266F		6993	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2682			Confirmation address			W	1	
			Neutral Dir 3					
0x2683		4490	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2684		4491	MTA	F003	1,000	R/W	2	[-90 , 90] Deg
0x2686		4492	Direction	F012	1,000	R/W	1	0=REVERSE
								1=FORWARD
0x2687		4493	Polarization	F012	1,000	R/W	1	0=VO
								1=IP
								2=VO + IP
								3=VO*IP
0x2688		4494	Block Logic	F012	1,000	R/W	1	0=PERMISSION

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								1=BLOCK
0x2689		10943	Pol V Threshold	F003	1,000	R/W	2	[0,00 , 1,25] x VT
0x268B		6994	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x269E			Confirmation address			W	1	
			Ground Dir 1					
0x269F		4499	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x26A0		4500	MTA	F003	1,000	R/W	2	[-90 , 90] Deg
0x26A2		4501	Direction	F012	1,000	R/W	1	0=REVERSE
								1=FORWARD
0x26A3		4502	Polarization	F012	1,000	R/W	1	0=VO
								1=IP
								2=VO + IP
								3=VO*IP
0x26A4		4503	Block Logic	F012	1,000	R/W	1	0=PERMISSION
								1=BLOCK
0x26A5		10944	Pol V Threshold	F003	1,000	R/W	2	[0,00 , 1,25] x VT
0x26A7		6989	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x26BA			Confirmation address			W	1	
			Ground Dir 2					
0x26BB		4508	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x26BC		4509	MTA	F003	1,000	R/W	2	[-90 , 90] Deg
0x26BE		4510	Direction	F012	1,000	R/W	1	0=REVERSE
								1=FORWARD
0x26BF		4511	Polarization	F012	1,000	R/W	1	0=VO
								1=IP
								2=VO + IP
								3=VO*IP
0x26C0		4512	Block Logic	F012	1,000	R/W	1	0=PERMISSION
								1=BLOCK
0x26C1		10945	Pol V Threshold	F003	1,000	R/W	2	[0,00 , 1,25] x VT
0x26C3		6990	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x26D6			Confirmation address			W	1	
			Ground Dir 3					
0x26D7		4517	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x26D8		4518	MTA	F003	1,000	R/W	2	[-90 , 90] Deg
0x26DA		4519	Direction	F012	1,000	R/W	1	0=REVERSE
								1=FORWARD
0x26DB		4520	Polarization	F012	1,000	R/W	1	0=VO

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								1=IP
								2=VO + IP
								3=VO*IP
0x26DC		4521	Block Logic	F012	1,000	R/W	1	0=PERMISSION
								1=BLOCK
0x26DD		10946	Pol V Threshold	F003	1,000	R/W	2	[0,00 , 1,25] x VT
0x26DF		6991	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x26F2			Confirmation address			W	1	
			VT Fuse Failure					
0x271C		4544	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x271D		6898	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2730			Confirmation address			W	1	
			Synchrocheck					
0x2731		4546	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2732		11028	Dead Src Level	F003	1,000	R/W	2	[0,00 , 1,25] x VT(S)
0x2734		11029	Live Src Level	F003	1,000	R/W	2	[0,03 , 1,25] x VT(S)
0x2736		11030	Dead Load Level	F003	1,000	R/W	2	[0,00 , 1,25] x VT(L)
0x2738		11031	Live Load Level	F003	1,000	R/W	2	[0,03 , 1,25] x VT(L)
0x273A		11032	Max Volt Difference	F003	1,000	R/W	2	[0,0 , 30000,0] V
0x273C		6816	Max Angle Difference	F003	1,000	R/W	2	[2,0 , 80,0] Deg
0x273E		6817	Max Freq Difference	F003	1,000	R/W	2	[10 , 5000] mHz
0x2742		4555	Dead Load - Dead Src	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2743		4556	Live Load - Dead Src	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2744		4557	Dead Load - Live Src	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2745		6924	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2746		11679	Min Slip Frequency	F013	1,000	R/W	1	[3 , 100] mHz
0x2747		11680	Max ROC of Slip	F013	1,000	R/W	1	[10 , 1000] mHz/s
0x2748		11681	Max Allowd CLS Angle	F003	1,000	R/W	2	[0,0 , 179,0] Deg
0x274A		11693	Sync Type	F012	1,000	R/W	1	0=TRADITIONAL
								1=PREDICTIVE
0x274B		11697	RCL Closing Time	F003	1,000	R/W	2	[0,01 , 0,30] s
0x2762			Confirmation address			W	1	
			Neutral OV 1					
0x278C		4608	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x278D		10977	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x278F		4610	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2791		4611	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2793		6980	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x27A6			Confirmation address			W	1	
			Neutral OV 2					
0x27A7		4615	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x27A8		10978	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x27AA		4617	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x27AC		4618	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x27AE		6981	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x27C1			Confirmation address			W	1	
			Neutral OV 3					
0x27C2		4622	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x27C3		10979	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x27C5		4624	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x27C7		4625	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x27C9		6982	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x27DC			Confirmation address			W	1	
			Neutral OV 1					
0x27DD		4629	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x27DE		11007	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x27E0		4631	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x27E2		4632	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x27E4		6983	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x27F7			Confirmation address			W	1	
			Neutral OV 2					
0x27F8		4636	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x27F9		11008	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x27FB		4638	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x27FD		4639	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x27FF		6984	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2812			Confirmation address			W	1	
			Neutral OV 3					
0x2813		4643	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2814		11009	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x2816		4645	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2818		4646	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x281A		6985	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x282D			Confirmation address			W	1	
			Phase OV 1					
0x287C		4671	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x287D		10974	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x287F		4673	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2881		4674	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2883		4675	Logic	F012	1,000	R/W	1	0=ANY PHASE
								1=TWO PHASES
								2=ALL PHASES
0x2884		6977	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2897			Confirmation address			W	1	
			Phase OV 2					
0x2898		4685	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2899		10975	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x289B		4687	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x289D		4688	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x289F		4689	Logic	F012	1,000	R/W	1	0=ANY PHASE
								1=TWO PHASES
								2=ALL PHASES
0x28A0		6978	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x28B3			Confirmation address			W	1	
			Phase OV 3					
0x28B4		4699	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x28B5		10976	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x28B7		4701	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x28B9		4702	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x28BB		4703	Logic	F012	1,000	R/W	1	0=ANY PHASE
								1=TWO PHASES
								2=ALL PHASES
0x28BC		6979	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x28CF			Confirmation address			W	1	
			Negative Sequence TOC 1					
0x2921		4734	Function	F012	1,000	R/W	1	0=DISABLED

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								1=ENABLED
0x2922		10965	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x2924		6757	Curve	F012	1,000	R/W	1	0=IEEE Ext Inv
								1=IEEE Very Inv
								2=IEEE Mod Inv
								3=IEC Curve A
								4=IEC Curve B
								5=IEC Curve C
								6=IEC Long-Time Inv
								7=IEC Short-Time Inv
								8=IAC Ext Inv
								9=IAC Very Inv
								10=IAC Mod Inv
								11=ANSI Ext Inv
								12=ANSI Very Inv
								13=ANSI Norm Inv
								14=ANSI Mod Inv
								15=I2t
								16=Definite Time
								17=Rectifier Curve
								18=User Curve A
								19=User Curve B
								20=User Curve C
								21=User Curve D
0x2925		4737	TD Multiplier	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2927		4738	Reset	F012	1,000	R/W	1	0=INSTANTANEOUS
								1=LINEAR
0x2928		6934	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x293B			Confirmation address			W	1	
			Negative Sequence TOC 2					
0x293C		4742	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x293D		10966	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x293F		6758	Curve	F012	1,000	R/W	1	0=IEEE Ext Inv
								1=IEEE Very Inv
								2=IEEE Mod Inv
								3=IEC Curve A
								4=IEC Curve B
								5=IEC Curve C
								6=IEC Long-Time Inv
								7=IEC Short-Time Inv
								8=IAC Ext Inv
								9=IAC Very Inv

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								10=IAC Mod Inv
								11=ANSI Ext Inv
								12=ANSI Very Inv
								13=ANSI Norm Inv
								14=ANSI Mod Inv
								15=I2t
								16=Definite Time
								17=Rectifier Curve
								18=User Curve A
								19=User Curve B
								20=User Curve C
								21=User Curve D
0x2940		4745	TD Multiplier	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2942		4746	Reset	F012	1,000	R/W	1	0=INSTANTANEOUS
								1=LINEAR
0x2943		6935	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2956			Confirmation address			W	1	
			Negative Sequence TOC 3					
0x2957		4750	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2958		10967	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x295A		6759	Curve	F012	1,000	R/W	1	0=IEEE Ext Inv
								1=IEEE Very Inv
								2=IEEE Mod Inv
								3=IEC Curve A
								4=IEC Curve B
								5=IEC Curve C
								6=IEC Long-Time Inv
								7=IEC Short-Time Inv
								8=IAC Ext Inv
								9=IAC Very Inv
								10=IAC Mod Inv
								11=ANSI Ext Inv
								12=ANSI Very Inv
								13=ANSI Norm Inv
								14=ANSI Mod Inv
								15=I2t
								16=Definite Time
								17=Rectifier Curve
								18=User Curve A

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								19=User Curve B
								20=User Curve C
								21=User Curve D
0x295B		4753	TD Multiplier	F003	1,000	R/W	2	[0,00 , 900,00] s
0x295D		4754	Reset	F012	1,000	R/W	1	0=INSTANTANEOUS
								1=LINEAR
0x295E		6936	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2971			Confirmation address			W	1	
			Overfrequency 1					
0x2972		10707	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2973		10708	Pickup Level	F003	1,000	R/W	2	[20,00 , 65,00] Hz
0x2975		10709	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2977		10710	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2979		10983	Minimum Voltage	F003	1,000	R/W	2	[0,05 , 1,25] x VT
0x297B		10712	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x297C		10713	Frequency Source	F012	1,000	R/W	1	0=LINE FRQ
								1=BUS FRQ
0x298E			Confirmation address			W	1	
			Overfrequency 2					
0x298F		10714	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2990		10715	Pickup Level	F003	1,000	R/W	2	[20,00 , 65,00] Hz
0x2992		10716	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2994		10717	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2996		10984	Minimum Voltage	F003	1,000	R/W	2	[0,05 , 1,25] x VT
0x2998		10719	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2999		10720	Frequency Source	F012	1,000	R/W	1	0=LINE FRQ
								1=BUS FRQ
0x29AB			Confirmation address			W	1	
			Overfrequency 3					
0x29AC		10721	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x29AD		10722	Pickup Level	F003	1,000	R/W	2	[20,00 , 65,00] Hz
0x29AF		10723	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x29B1		10724	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x29B3		10985	Minimum Voltage	F003	1,000	R/W	2	[0,05 , 1,25] x VT
0x29B5		10726	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x29B6		10727	Frequency Source	F012	1,000	R/W	1	0=LINE FRQ
								1=BUS FRQ

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x29C8			Confirmation address			W	1	
			UnderFrequency 1					
0x29C9		10665	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x29CA		10666	Pickup Level	F003	1,000	R/W	2	[20,00 , 65,00] Hz
0x29CC		10667	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x29CE		10668	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x29D0		10989	Minimum Voltage	F003	1,000	R/W	2	[0,05 , 1,25] x VT
0x29D2		10670	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x29D3		10671	Frequency Source	F012	1,000	R/W	1	0=LINE FRQ
								1=BUS FRQ
0x29E5			Confirmation address			W	1	
			UnderFrequency 2					
0x29E6		10672	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x29E7		10673	Pickup Level	F003	1,000	R/W	2	[20,00 , 65,00] Hz
0x29E9		10674	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x29EB		10675	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x29ED		10990	Minimum Voltage	F003	1,000	R/W	2	[0,05 , 1,25] x VT
0x29EF		10677	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x29F0		10678	Frequency Source	F012	1,000	R/W	1	0=LINE FRQ
								1=BUS FRQ
0x2A02			Confirmation address			W	1	
			UnderFrequency 3					
0x2A03		10679	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2A04		10680	Pickup Level	F003	1,000	R/W	2	[20,00 , 65,00] Hz
0x2A06		10681	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2A08		10682	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2A0A		10991	Minimum Voltage	F003	1,000	R/W	2	[0,05 , 1,25] x VT
0x2A0C		10684	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2A0D		10685	Frequency Source	F012	1,000	R/W	1	0=LINE FRQ
								1=BUS FRQ
0x2A1F			Confirmation address			W	1	
			Oscillography					
0x2A7C		4844	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2A7D		6818	Trigger Position	F004	1,000	R/W	1	[5 , 95] %
0x2A7E		6819	Samples/Cycle	F012	1,000	R/W	1	0=64
								1=32
								2=16

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								3=8
								4=4
0x2A7F		6820	Max. Number Osc.	F004	1,000	R/W	1	[1 , 20]
0x2A80		6821	Automatic Overwrite	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2A81		6899	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2A92			Confirmation address			W	1	
			Fault Report					
0x2A93		4864	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2A94		4865	Pos Seq Module	F003	1,000	R/W	2	[0,01 , 250,00] Ohm
0x2A96		4866	Pos Seq Angle	F003	1,000	R/W	2	[25 , 90] Deg
0x2A98		4867	Zero Seq Module	F003	1,000	R/W	2	[0,01 , 750,00] Ohm
0x2A9A		4868	Zero Seq Angle	F003	1,000	R/W	2	[25 , 90] Deg
0x2A9C		4869	Line Length	F003	1,000	R/W	2	[0,0 , 2000,0]
0x2A9E		6846	Show Fault On HMI	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2A9F		6905	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2AA0		10228	CT Direction	F012	1,000	R/W	1	0=REVERSE
								1=FORWARD
0x2AB1			Confirmation address			W	1	
			Setting Group					
0x2AB2		4873	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2AB3		10834	Active Group	F012	1,000	R/W	1	0=GROUP 1
								1=GROUP 2
								2=GROUP 3
								3=GROUP 4
								4=GROUP 5
								5=GROUP 6
0x2AB4		6903	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2AC7			Confirmation address			W	1	
			Osc digital channels text					
0x2AC8		4882	Channel 1 Txt	F009	1,000	R/W	16	
0x2AD8		4883	Channel 2 Txt	F009	1,000	R/W	16	
0x2AE8		4884	Channel 3 Txt	F009	1,000	R/W	16	
0x2AF8		4885	Channel 4 Txt	F009	1,000	R/W	16	
0x2B08		4886	Channel 5 Txt	F009	1,000	R/W	16	
0x2B18		4887	Channel 6 Txt	F009	1,000	R/W	16	
0x2B28		4888	Channel 7 Txt	F009	1,000	R/W	16	
0x2B38		4889	Channel 8 Txt	F009	1,000	R/W	16	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2B48		4890	Channel 9 Txt	F009	1,000	R/W	16	
0x2B58		4891	Channel 10 Txt	F009	1,000	R/W	16	
0x2B68		4892	Channel 11 Txt	F009	1,000	R/W	16	
0x2B78		4893	Channel 12 Txt	F009	1,000	R/W	16	
0x2B88		4894	Channel 13 Txt	F009	1,000	R/W	16	
0x2B98		4895	Channel 14 Txt	F009	1,000	R/W	16	
0x2BA8		4896	Channel 15 Txt	F009	1,000	R/W	16	
0x2BB8		4897	Channel 16 Txt	F009	1,000	R/W	16	
0x2C07			Confirmation address			W	1	
			Broken Conductor 1					
0x2C08		10773	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2C09		10774	Tap	F003	1,000	R/W	2	[20,0 , 100,0] %
0x2C0B		10775	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2C0D		10776	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2C0E		11004	Operation Threshold	F003	1,000	R/W	2	[0,00 , 1,00] x CT
0x2C20			Confirmation address			W	1	
			Broken Conductor 2					
0x2C21		10778	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2C22		10779	Tap	F003	1,000	R/W	2	[20,0 , 100,0] %
0x2C24		10780	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2C26		10781	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2C27		11005	Operation Threshold	F003	1,000	R/W	2	[0,00 , 1,00] x CT
0x2C39			Confirmation address			W	1	
			Broken Conductor 3					
0x2C3A		10783	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2C3B		10784	Tap	F003	1,000	R/W	2	[20,0 , 100,0] %
0x2C3D		10785	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2C3F		10786	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2C40		11006	Operation Threshold	F003	1,000	R/W	2	[0,00 , 1,00] x CT
0x2C52			Confirmation address			W	1	
			Ethernet A					
0x2C53		4917	IP Address Oct1	F004	1,000	R/W	1	[0 , 255]
0x2C54		4918	IP Address Oct2	F004	1,000	R/W	1	[0 , 255]
0x2C55		4919	IP Address Oct3	F004	1,000	R/W	1	[0 , 255]
0x2C56		4920	IP Address Oct4	F004	1,000	R/W	1	[0 , 255]
0x2C57		4921	Netmask Oct1	F004	1,000	R/W	1	[0 , 255]
0x2C58		4922	Netmask Oct2	F004	1,000	R/W	1	[0 , 255]
0x2C59		4923	Netmask Oct3	F004	1,000	R/W	1	[0 , 255]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2C5A		4924	Netmask Oct4	F004	1,000	R/W	1	[0 , 255]
0x2C86			Confirmation address			W	1	
			Ethernet B					
0x2C87		4929	IP Address Oct1	F004	1,000	R/W	1	[0 , 255]
0x2C88		4930	IP Address Oct2	F004	1,000	R/W	1	[0 , 255]
0x2C89		4931	IP Address Oct3	F004	1,000	R/W	1	[0 , 255]
0x2C8A		4932	IP Address Oct4	F004	1,000	R/W	1	[0 , 255]
0x2C8B		4933	Netmask Oct1	F004	1,000	R/W	1	[0 , 255]
0x2C8C		4934	Netmask Oct2	F004	1,000	R/W	1	[0 , 255]
0x2C8D		4935	Netmask Oct3	F004	1,000	R/W	1	[0 , 255]
0x2C8E		4936	Netmask Oct4	F004	1,000	R/W	1	[0 , 255]
0x2CBA			Confirmation address			W	1	
			DNP3 Slave 1					
0x2CBB		10221	Physical Port	F012	1,000	R/W	1	0=NONE
								1=COM1
								2=COM2
								3=NETWORK_TCP
								4=NETWORK_UDP
0x2CBC		4942	Address	F005	1,000	R/W	2	[0 , 65534]
0x2CBE		4943	IP Addr Client1 Oct1	F004	1,000	R/W	1	[0 , 255]
0x2CBF		4944	IP Addr Client1 Oct2	F004	1,000	R/W	1	[0 , 255]
0x2CC0		4945	IP Addr Client1 Oct3	F004	1,000	R/W	1	[0 , 255]
0x2CC1		4946	IP Addr Client1 Oct4	F004	1,000	R/W	1	[0 , 255]
0x2CC2		4947	IP Addr Client2 Oct1	F004	1,000	R/W	1	[0 , 255]
0x2CC3		4948	IP Addr Client2 Oct2	F004	1,000	R/W	1	[0 , 255]
0x2CC4		4949	IP Addr Client2 Oct3	F004	1,000	R/W	1	[0 , 255]
0x2CC5		4950	IP Addr Client2 Oct4	F004	1,000	R/W	1	[0 , 255]
0x2CC6		4951	IP Addr Client3 Oct1	F004	1,000	R/W	1	[0 , 255]
0x2CC7		4952	IP Addr Client3 Oct2	F004	1,000	R/W	1	[0 , 255]
0x2CC8		4953	IP Addr Client3 Oct3	F004	1,000	R/W	1	[0 , 255]
0x2CC9		4954	IP Addr Client3 Oct4	F004	1,000	R/W	1	[0 , 255]
0x2CCA		4955	IP Addr Client4 Oct1	F004	1,000	R/W	1	[0 , 255]
0x2CCB		4956	IP Addr Client4 Oct2	F004	1,000	R/W	1	[0 , 255]
0x2CCC		4957	IP Addr Client4 Oct3	F004	1,000	R/W	1	[0 , 255]
0x2CCD		4958	IP Addr Client4 Oct4	F004	1,000	R/W	1	[0 , 255]
0x2CCE		4959	IP Addr Client5 Oct1	F004	1,000	R/W	1	[0 , 255]
0x2CCF		4960	IP Addr Client5 Oct2	F004	1,000	R/W	1	[0 , 255]
0x2CD0		4961	IP Addr Client5 Oct3	F004	1,000	R/W	1	[0 , 255]
0x2CD1		4962	IP Addr Client5 Oct4	F004	1,000	R/W	1	[0 , 255]
0x2CD2		4963	TCP/UDP Port	F005	1,000	R/W	2	[0 , 65535]
0x2CD4		4964	Unsol Resp Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2CD5		4965	Unsol Resp TimeOut	F005	1,000	R/W	2	[0 , 60] s
0x2CD7		4966	Unsol Resp Max Ret	F004	1,000	R/W	1	[0 , 255]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2CD8		4967	Unsol Resp Dest Adr	F005	1,000	R/W	2	[0 , 65519]
0x2CDA		6769	Current Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x2CDB		6770	Voltage Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x2CDC		6771	Power Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x2CDD		6772	Energy Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x2CDE		6773	Other Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x2CDF		4973	Current Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2CE1		4974	Voltage Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2CE3		4975	Power Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2CE5		4976	Energy Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2CE7		4977	Other Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2CE9		4978	Msg Fragment Size	F005	1,000	R/W	2	[30 , 2048]
0x2CEB		9303	Binary Input Block 1	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2CEC		9304	Binary Input Block 2	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2CED		9305	Binary Input Block 3	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2CEE		9306	Binary Input Block 4	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								18=BOARD J 17-32
0x2CEF		9307	Binary Input Block 5	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2CF0		9308	Binary Input Block 6	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2CF1		9309	Binary Input Block 7	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2CF2		9310	Binary Input Block 8	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2CF3		9311	Binary Input Block 9	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2CF4		9312	Binary Input Block 10	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2CF5		11870	Default Analog Map	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
								2=EXTENDED
0x2CF6		10341	Analog Inp Point 0	F004	1,000	R/W	1	[0 , 32767]
0x2CF7		10342	Analog Inp Point 1	F004	1,000	R/W	1	[0 , 32767]
0x2CF8		10343	Analog Inp Point 2	F004	1,000	R/W	1	[0 , 32767]
0x2CF9		10344	Analog Inp Point 3	F004	1,000	R/W	1	[0 , 32767]
0x2CFA		10345	Analog Inp Point 4	F004	1,000	R/W	1	[0 , 32767]
0x2CFB		10346	Analog Inp Point 5	F004	1,000	R/W	1	[0 , 32767]
0x2CFC		10347	Analog Inp Point 6	F004	1,000	R/W	1	[0 , 32767]
0x2CFD		10348	Analog Inp Point 7	F004	1,000	R/W	1	[0 , 32767]
0x2CFE		10349	Analog Inp Point 8	F004	1,000	R/W	1	[0 , 32767]
0x2CFF		10350	Analog Inp Point 9	F004	1,000	R/W	1	[0 , 32767]
0x2D00		10351	Analog Inp Point 10	F004	1,000	R/W	1	[0 , 32767]
0x2D01		10352	Analog Inp Point 11	F004	1,000	R/W	1	[0 , 32767]
0x2D02		10353	Analog Inp Point 12	F004	1,000	R/W	1	[0 , 32767]
0x2D03		10354	Analog Inp Point 13	F004	1,000	R/W	1	[0 , 32767]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2D04		10355	Analog Inp Point 14	F004	1,000	R/W	1	[0 , 32767]
0x2D05		10356	Analog Inp Point 15	F004	1,000	R/W	1	[0 , 32767]
0x2D06		10357	Analog Inp Point 16	F004	1,000	R/W	1	[0 , 32767]
0x2D07		10358	Analog Inp Point 17	F004	1,000	R/W	1	[0 , 32767]
0x2D08		10359	Analog Inp Point 18	F004	1,000	R/W	1	[0 , 32767]
0x2D09		10360	Analog Inp Point 19	F004	1,000	R/W	1	[0 , 32767]
0x2D0A		10361	Analog Inp Point 20	F004	1,000	R/W	1	[0 , 32767]
0x2D0B		10362	Analog Inp Point 21	F004	1,000	R/W	1	[0 , 32767]
0x2D0C		10363	Analog Inp Point 22	F004	1,000	R/W	1	[0 , 32767]
0x2D0D		10364	Analog Inp Point 23	F004	1,000	R/W	1	[0 , 32767]
0x2D0E		10365	Analog Inp Point 24	F004	1,000	R/W	1	[0 , 32767]
0x2D0F		10366	Analog Inp Point 25	F004	1,000	R/W	1	[0 , 32767]
0x2D10		10367	Analog Inp Point 26	F004	1,000	R/W	1	[0 , 32767]
0x2D11		10368	Analog Inp Point 27	F004	1,000	R/W	1	[0 , 32767]
0x2D12		10369	Analog Inp Point 28	F004	1,000	R/W	1	[0 , 32767]
0x2D13		10370	Analog Inp Point 29	F004	1,000	R/W	1	[0 , 32767]
0x2D14		10371	Analog Inp Point 30	F004	1,000	R/W	1	[0 , 32767]
0x2D15		10372	Analog Inp Point 31	F004	1,000	R/W	1	[0 , 32767]
0x2D16		10657	PF Deadband	F004	1,000	R/W	1	[0 , 32767]
0x2D17		10658	PF Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x2D1C			Confirmation address			W	1	
			DNP3 Slave 2					
0x2D1D		10222	Physical Port	F012	1,000	R/W	1	0=NONE
								1=COM1
								2=COM2
								3=NETWORK_TCP
								4=NETWORK_UDP
0x2D1E		4980	Address	F005	1,000	R/W	2	[0 , 65534]
0x2D20		4981	IP Addr Client1 Oct1	F004	1,000	R/W	1	[0 , 255]
0x2D21		4982	IP Addr Client1 Oct2	F004	1,000	R/W	1	[0 , 255]
0x2D22		4983	IP Addr Client1 Oct3	F004	1,000	R/W	1	[0 , 255]
0x2D23		4984	IP Addr Client1 Oct4	F004	1,000	R/W	1	[0 , 255]
0x2D24		4985	IP Addr Client2 Oct1	F004	1,000	R/W	1	[0 , 255]
0x2D25		4986	IP Addr Client2 Oct2	F004	1,000	R/W	1	[0 , 255]
0x2D26		4987	IP Addr Client2 Oct3	F004	1,000	R/W	1	[0 , 255]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2D27		4988	IP Addr Client2 Oct4	F004	1,000	R/W	1	[0 , 255]
0x2D28		4989	IP Addr Client3 Oct1	F004	1,000	R/W	1	[0 , 255]
0x2D29		4990	IP Addr Client3 Oct2	F004	1,000	R/W	1	[0 , 255]
0x2D2A		4991	IP Addr Client3 Oct3	F004	1,000	R/W	1	[0 , 255]
0x2D2B		4992	IP Addr Client3 Oct4	F004	1,000	R/W	1	[0 , 255]
0x2D2C		4993	IP Addr Client4 Oct1	F004	1,000	R/W	1	[0 , 255]
0x2D2D		4994	IP Addr Client4 Oct2	F004	1,000	R/W	1	[0 , 255]
0x2D2E		4995	IP Addr Client4 Oct3	F004	1,000	R/W	1	[0 , 255]
0x2D2F		4996	IP Addr Client4 Oct4	F004	1,000	R/W	1	[0 , 255]
0x2D30		4997	IP Addr Client5 Oct1	F004	1,000	R/W	1	[0 , 255]
0x2D31		4998	IP Addr Client5 Oct2	F004	1,000	R/W	1	[0 , 255]
0x2D32		4999	IP Addr Client5 Oct3	F004	1,000	R/W	1	[0 , 255]
0x2D33		5000	IP Addr Client5 Oct4	F004	1,000	R/W	1	[0 , 255]
0x2D34		5001	TCP/UDP Port	F005	1,000	R/W	2	[0 , 65535]
0x2D36		5002	Unsol Resp Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2D37		5003	Unsol Resp TimeOut	F005	1,000	R/W	2	[0 , 60] s
0x2D39		5004	Unsol Resp Max Ret	F004	1,000	R/W	1	[0 , 255]
0x2D3A		5005	Unsol Resp Dest Adr	F005	1,000	R/W	2	[0 , 65519]
0x2D3C		6784	Current Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x2D3D		6785	Voltage Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x2D3E		6786	Power Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x2D3F		6787	Energy Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x2D40		6788	Other Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x2D41		5011	Current Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2D43		5012	Voltage Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2D45		5013	Power Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2D47		5014	Energy Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2D49		5015	Other Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2D4B		5016	Msg Fragment Size	F005	1,000	R/W	2	[30 , 2048]
0x2D4D		9313	Binary Input Block 1	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2D4E		9314	Binary Input Block 2	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2D4F		9315	Binary Input Block 3	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2D50		9316	Binary Input Block 4	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2D51		9317	Binary Input Block 5	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2D52		9318	Binary Input Block 6	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2D53		9319	Binary Input Block 7	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2D54		9320	Binary Input Block 8	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2D55		9321	Binary Input Block 9	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2D56		9322	Binary Input Block 10	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								18=BOARD J 17-32
0x2D57		11871	Default Analog Map	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
								2=EXTENDED
0x2D58		10374	Analog Inp Point 0	F004	1,000	R/W	1	[0 , 32767]
0x2D59		10375	Analog Inp Point 1	F004	1,000	R/W	1	[0 , 32767]
0x2D5A		10376	Analog Inp Point 2	F004	1,000	R/W	1	[0 , 32767]
0x2D5B		10377	Analog Inp Point 3	F004	1,000	R/W	1	[0 , 32767]
0x2D5C		10378	Analog Inp Point 4	F004	1,000	R/W	1	[0 , 32767]
0x2D5D		10379	Analog Inp Point 5	F004	1,000	R/W	1	[0 , 32767]
0x2D5E		10380	Analog Inp Point 6	F004	1,000	R/W	1	[0 , 32767]
0x2D5F		10381	Analog Inp Point 7	F004	1,000	R/W	1	[0 , 32767]
0x2D60		10382	Analog Inp Point 8	F004	1,000	R/W	1	[0 , 32767]
0x2D61		10383	Analog Inp Point 9	F004	1,000	R/W	1	[0 , 32767]
0x2D62		10384	Analog Inp Point 10	F004	1,000	R/W	1	[0 , 32767]
0x2D63		10385	Analog Inp Point 11	F004	1,000	R/W	1	[0 , 32767]
0x2D64		10386	Analog Inp Point 12	F004	1,000	R/W	1	[0 , 32767]
0x2D65		10387	Analog Inp Point 13	F004	1,000	R/W	1	[0 , 32767]
0x2D66		10388	Analog Inp Point 14	F004	1,000	R/W	1	[0 , 32767]
0x2D67		10389	Analog Inp Point 15	F004	1,000	R/W	1	[0 , 32767]
0x2D68		10390	Analog Inp Point 16	F004	1,000	R/W	1	[0 , 32767]
0x2D69		10391	Analog Inp Point 17	F004	1,000	R/W	1	[0 , 32767]
0x2D6A		10392	Analog Inp Point 18	F004	1,000	R/W	1	[0 , 32767]
0x2D6B		10393	Analog Inp Point 19	F004	1,000	R/W	1	[0 , 32767]
0x2D6C		10394	Analog Inp Point 20	F004	1,000	R/W	1	[0 , 32767]
0x2D6D		10395	Analog Inp Point 21	F004	1,000	R/W	1	[0 , 32767]
0x2D6E		10396	Analog Inp Point 22	F004	1,000	R/W	1	[0 , 32767]
0x2D6F		10397	Analog Inp Point 23	F004	1,000	R/W	1	[0 , 32767]
0x2D70		10398	Analog Inp Point 24	F004	1,000	R/W	1	[0 , 32767]
0x2D71		10399	Analog Inp Point 25	F004	1,000	R/W	1	[0 , 32767]
0x2D72		10400	Analog Inp Point 26	F004	1,000	R/W	1	[0 , 32767]
0x2D73		10401	Analog Inp Point 27	F004	1,000	R/W	1	[0 , 32767]
0x2D74		10402	Analog Inp Point 28	F004	1,000	R/W	1	[0 , 32767]
0x2D75		10403	Analog Inp Point 29	F004	1,000	R/W	1	[0 , 32767]
0x2D76		10404	Analog Inp Point 30	F004	1,000	R/W	1	[0 , 32767]
0x2D77		10405	Analog Inp Point 31	F004	1,000	R/W	1	[0 , 32767]
0x2D78		10659	PF Deadband	F004	1,000	R/W	1	[0 , 32767]
0x2D79		10660	PF Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								7=100
								8=1000
								9=10000
0x2D7E			Confirmation address			W	1	
			DNP3 Slave 3					
0x2D7F		10223	Physical Port	F012	1,000	R/W	1	0=NONE
								1=COM1
								2=COM2
								3=NETWORK_TCP
								4=NETWORK_UDP
0x2D80		5018	Address	F005	1,000	R/W	2	[0 , 65534]
0x2D82		5019	IP Addr Client1 Oct1	F004	1,000	R/W	1	[0 , 255]
0x2D83		5020	IP Addr Client1 Oct2	F004	1,000	R/W	1	[0 , 255]
0x2D84		5021	IP Addr Client1 Oct3	F004	1,000	R/W	1	[0 , 255]
0x2D85		5022	IP Addr Client1 Oct4	F004	1,000	R/W	1	[0 , 255]
0x2D86		5023	IP Addr Client2 Oct1	F004	1,000	R/W	1	[0 , 255]
0x2D87		5024	IP Addr Client2 Oct2	F004	1,000	R/W	1	[0 , 255]
0x2D88		5025	IP Addr Client2 Oct3	F004	1,000	R/W	1	[0 , 255]
0x2D89		5026	IP Addr Client2 Oct4	F004	1,000	R/W	1	[0 , 255]
0x2D8A		5027	IP Addr Client3 Oct1	F004	1,000	R/W	1	[0 , 255]
0x2D8B		5028	IP Addr Client3 Oct2	F004	1,000	R/W	1	[0 , 255]
0x2D8C		5029	IP Addr Client3 Oct3	F004	1,000	R/W	1	[0 , 255]
0x2D8D		5030	IP Addr Client3 Oct4	F004	1,000	R/W	1	[0 , 255]
0x2D8E		5031	IP Addr Client4 Oct1	F004	1,000	R/W	1	[0 , 255]
0x2D8F		5032	IP Addr Client4 Oct2	F004	1,000	R/W	1	[0 , 255]
0x2D90		5033	IP Addr Client4 Oct3	F004	1,000	R/W	1	[0 , 255]
0x2D91		5034	IP Addr Client4 Oct4	F004	1,000	R/W	1	[0 , 255]
0x2D92		5035	IP Addr Client5 Oct1	F004	1,000	R/W	1	[0 , 255]
0x2D93		5036	IP Addr Client5 Oct2	F004	1,000	R/W	1	[0 , 255]
0x2D94		5037	IP Addr Client5 Oct3	F004	1,000	R/W	1	[0 , 255]
0x2D95		5038	IP Addr Client5 Oct4	F004	1,000	R/W	1	[0 , 255]
0x2D96		5039	TCP/UDP Port	F005	1,000	R/W	2	[0 , 65535]
0x2D98		5040	Unsol Resp Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2D99		5041	Unsol Resp TimeOut	F005	1,000	R/W	2	[0 , 60] s
0x2D9B		5042	Unsol Resp Max Ret	F004	1,000	R/W	1	[0 , 255]
0x2D9C		5043	Unsol Resp Dest Adr	F005	1,000	R/W	2	[0 , 65519]
0x2D9E		6799	Current Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								7=100
								8=1000
								9=10000
0x2D9F		6800	Voltage Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x2DA0		6801	Power Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x2DA1		6802	Energy Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x2DA2		6803	Other Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								8=1000
								9=10000
0x2DA3		5049	Current Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2DA5		5050	Voltage Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2DA7		5051	Power Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2DA9		5052	Energy Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2DAB		5053	Other Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2DAD		5054	Msg Fragment Size	F005	1,000	R/W	2	[30 , 2048]
0x2DAF		9323	Binary Input Block 1	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2DB0		9324	Binary Input Block 2	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2DB1		9325	Binary Input Block 3	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2DB2		9326	Binary Input Block 4	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2DB3		9327	Binary Input Block 5	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2DB4		9328	Binary Input Block 6	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2DB5		9329	Binary Input Block 7	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2DB6		9330	Binary Input Block 8	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2DB7		9331	Binary Input Block 9	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2DB8		9332	Binary Input Block 10	F012	1,000	R/W	1	0=NOT USED
								1=CTL EVENTS 1-16
								2=CTL EVENTS 17-32
								3=CTL EVENTS 33-48
								4=CTL EVENTS 49-64
								5=CTL EVENTS 65-80
								6=CTL EVENTS 81-96
								7=CTL EVENTS 97-112
								8=CTL EVENTS 113-128
								9=SWITCHGEAR 1-8
								10=SWITCHGEAR 9-16
								11=BOARD F 1-16
								12=BOARD F 17-32
								13=BOARD G 1-16
								14=BOARD G 17-32
								15=BOARD H 1-16
								16=BOARD H 17-32
								17=BOARD J 1-16
								18=BOARD J 17-32
0x2DB9		11872	Default Analog Map	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
								2=EXTENDED
0x2DBA		10407	Analog Inp Point 0	F004	1,000	R/W	1	[0 , 32767]
0x2DBB		10408	Analog Inp Point 1	F004	1,000	R/W	1	[0 , 32767]
0x2DBC		10409	Analog Inp Point 2	F004	1,000	R/W	1	[0 , 32767]
0x2DBD		10410	Analog Inp Point 3	F004	1,000	R/W	1	[0 , 32767]
0x2DBE		10411	Analog Inp Point 4	F004	1,000	R/W	1	[0 , 32767]
0x2DBF		10412	Analog Inp Point 5	F004	1,000	R/W	1	[0 , 32767]
0x2DC0		10413	Analog Inp Point 6	F004	1,000	R/W	1	[0 , 32767]
0x2DC1		10414	Analog Inp Point 7	F004	1,000	R/W	1	[0 , 32767]
0x2DC2		10415	Analog Inp Point 8	F004	1,000	R/W	1	[0 , 32767]
0x2DC3		10416	Analog Inp Point 9	F004	1,000	R/W	1	[0 , 32767]
0x2DC4		10417	Analog Inp Point 10	F004	1,000	R/W	1	[0 , 32767]
0x2DC5		10418	Analog Inp Point 11	F004	1,000	R/W	1	[0 , 32767]
0x2DC6		10419	Analog Inp Point 12	F004	1,000	R/W	1	[0 , 32767]
0x2DC7		10420	Analog Inp Point 13	F004	1,000	R/W	1	[0 , 32767]
0x2DC8		10421	Analog Inp Point 14	F004	1,000	R/W	1	[0 , 32767]
0x2DC9		10422	Analog Inp Point 15	F004	1,000	R/W	1	[0 , 32767]
0x2DCA		10423	Analog Inp Point 16	F004	1,000	R/W	1	[0 , 32767]
0x2DCB		10424	Analog Inp Point 17	F004	1,000	R/W	1	[0 , 32767]
0x2DCC		10425	Analog Inp Point 18	F004	1,000	R/W	1	[0 , 32767]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2DCD		10426	Analog Inp Point 19	F004	1,000	R/W	1	[0 , 32767]
0x2DCE		10427	Analog Inp Point 20	F004	1,000	R/W	1	[0 , 32767]
0x2DCF		10428	Analog Inp Point 21	F004	1,000	R/W	1	[0 , 32767]
0x2DD0		10429	Analog Inp Point 22	F004	1,000	R/W	1	[0 , 32767]
0x2DD1		10430	Analog Inp Point 23	F004	1,000	R/W	1	[0 , 32767]
0x2DD2		10431	Analog Inp Point 24	F004	1,000	R/W	1	[0 , 32767]
0x2DD3		10432	Analog Inp Point 25	F004	1,000	R/W	1	[0 , 32767]
0x2DD4		10433	Analog Inp Point 26	F004	1,000	R/W	1	[0 , 32767]
0x2DD5		10434	Analog Inp Point 27	F004	1,000	R/W	1	[0 , 32767]
0x2DD6		10435	Analog Inp Point 28	F004	1,000	R/W	1	[0 , 32767]
0x2DD7		10436	Analog Inp Point 29	F004	1,000	R/W	1	[0 , 32767]
0x2DD8		10437	Analog Inp Point 30	F004	1,000	R/W	1	[0 , 32767]
0x2DD9		10438	Analog Inp Point 31	F004	1,000	R/W	1	[0 , 32767]
0x2DDA		10661	PF Deadband	F004	1,000	R/W	1	[0 , 32767]
0x2DDB		10662	PF Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x2DE0			Confirmation address			W	1	
			Miscellaneous Settings					
0x2DE2		10498	Relay Out Of Service	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2DE3		10499	Local/Remote Blocked	F012	1,000	R/W	1	0=OFF
								1=ON
0x2DE4		10339	Active Language	F004	1,000	R/W	1	[0 , 1]
0x2DF5			Confirmation address			W	1	
			Isolated Ground IOC 1					
0x2DF6		5116	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2DF7		10953	Vh Level	F003	1,000	R/W	2	[0,020 , 0,400] x VT
0x2DF9		10954	Il LEVEL	F003	1,000	R/W	2	[0,025 , 2,000] x CTsg
0x2DFB		10955	Vl LEVEL	F003	1,000	R/W	2	[0,020 , 0,400] x VT
0x2DFD		10956	Ih LEVEL	F003	1,000	R/W	2	[0,025 , 2,000] x CTsg
0x2DFF		5121	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2E01		5122	Time to inst	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2E03		6947	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2E16			Confirmation address			W	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
			Isolated Ground IOC 2					
0x2E17		5126	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2E18		10957	Vh Level	F003	1,000	R/W	2	[0,020 , 0,400] x VT
0x2E1A		10958	Il LEVEL	F003	1,000	R/W	2	[0,025 , 2,000] x CTsg
0x2E1C		10959	Vl LEVEL	F003	1,000	R/W	2	[0,020 , 0,400] x VT
0x2E1E		10960	Ih LEVEL	F003	1,000	R/W	2	[0,025 , 2,000] x CTsg
0x2E20		5131	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2E22		5132	Time to inst	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2E24		6948	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2E37			Confirmation address			W	1	
			Isolated Ground IOC 3					
0x2E38		5136	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2E39		10961	Vh Level	F003	1,000	R/W	2	[0,020 , 0,400] x VT
0x2E3B		10962	Il LEVEL	F003	1,000	R/W	2	[0,025 , 2,000] x CTsg
0x2E3D		10963	Vl LEVEL	F003	1,000	R/W	2	[0,020 , 0,400] x VT
0x2E3F		10964	Ih LEVEL	F003	1,000	R/W	2	[0,025 , 2,000] x CTsg
0x2E41		5141	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2E43		5142	Time to inst	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2E45		6949	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2E58			Confirmation address			W	1	
			Sensitive Ground Directional 1					
0x2E59		5146	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2E5A		5147	MTA	F003	1,000	R/W	2	[-90 , 90] Deg
0x2E5C		5148	Direction	F012	1,000	R/W	1	0=REVERSE
								1=FORWARD
0x2E5D		5149	Block Logic	F012	1,000	R/W	1	0=PERMISSION
								1=BLOCK
0x2E5E		10947	Pol V Threshold	F003	1,000	R/W	2	[0,00 , 1,25] x VT
0x2E60		6998	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2E73			Confirmation address			W	1	
			Sensitive Ground Directional 2					
0x2E74		5154	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2E75		5155	MTA	F003	1,000	R/W	2	[-90 , 90] Deg
0x2E77		5156	Direction	F012	1,000	R/W	1	0=REVERSE
								1=FORWARD
0x2E78		5157	Block Logic	F012	1,000	R/W	1	0=PERMISSION
								1=BLOCK

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2E79		10948	Pol V Threshold	F003	1,000	R/W	2	[0,00 , 1,25] x VT
0x2E7B		6999	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2E8E			Confirmation address			W	1	
			Sensitive Ground Directional 3					
0x2E8F		5162	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2E90		5163	MTA	F003	1,000	R/W	2	[-90 , 90] Deg
0x2E92		5164	Direction	F012	1,000	R/W	1	0=REVERSE
								1=FORWARD
0x2E93		5165	Block Logic	F012	1,000	R/W	1	0=PERMISSION
								1=BLOCK
0x2E94		10949	Pol V Threshold	F003	1,000	R/W	2	[0,00 , 1,25] x VT
0x2E96		7000	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2EA9			Confirmation address			W	1	
			Forward Power 1					
0x2EAA		5170	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2EAB		5171	Blk Time After Close	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2EAD		5172	Stage 1 Tap	F003	1,000	R/W	2	[0,00 , 10000,00] MW
0x2EAF		5173	Stage 1 Time	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2EB1		5174	Stage 2 Tap	F003	1,000	R/W	2	[0,00 , 10000,00] MW
0x2EB3		5175	Stage 2 Time	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2EB5		6931	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2EC8			Confirmation address			W	1	
			Forward Power 2					
0x2EC9		5181	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2ECA		5182	Blk Time After Close	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2ECC		5183	Stage 1 Tap	F003	1,000	R/W	2	[0,00 , 10000,00] MW
0x2ECE		5184	Stage 1 Time	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2ED0		5185	Stage 2 Tap	F003	1,000	R/W	2	[0,00 , 10000,00] MW
0x2ED2		5186	Stage 2 Time	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2ED4		6932	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2EE7			Confirmation address			W	1	
			Forward Power 3					
0x2EE8		5192	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2EE9		5193	Blk Time After Close	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2EEB		5194	Stage 1 Tap	F003	1,000	R/W	2	[0,00 , 10000,00] MW
0x2EED		5195	Stage 1 Time	F003	1,000	R/W	2	[0,00 , 900,00] s

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2EEF		5196	Stage 2 Tap	F003	1,000	R/W	2	[0,00 , 10000,00] MW
0x2EF1		5197	Stage 2 Time	F003	1,000	R/W	2	[0,00 , 900,00] s
0x2EF3		6933	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2F06			Confirmation address			W	1	
			Demand					
0x2F07		5203	Demand Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2F08		5204	CRNT Demand Method	F012	1,000	R/W	1	0=THERMAL EXPONENTIAL
								1=BLOCK INTERVAL
								2=ROLLING DEMAND
0x2F09		5205	POWER Demand Method	F012	1,000	R/W	1	0=THERMAL EXPONENTIAL
								1=BLOCK INTERVAL
								2=ROLLING DEMAND
0x2F0A		5206	Demand Interval	F012	1,000	R/W	1	0=5 Minutes
								1=10 Minutes
								2=15 Minutes
								3=20 Minutes
								4=30 Minutes
								5=60 Minutes
0x2F0B		5207	Trigger Enabled	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2F0C		6906	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2F1F			Confirmation address			W	1	
			IEC 870-5-104					
0x2F20		5237	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2F21		5238	TCP Port	F005	1,000	R/W	2	[0 , 65535]
0x2F23		5239	Common Addr of ASDU	F005	1,000	R/W	2	[0 , 65535]
0x2F25		5240	Cyclic Meter Period	F005	1,000	R/W	2	[0 , 3600]
0x2F27		5241	Synchronization Event	F005	1,000	R/W	2	[0 , 1400]
0x2F29		10185	104 Net1 CLI1 Octet1	F004	1,000	R/W	1	[0 , 255]
0x2F2A		10186	104 Net1 CLI1 Octet2	F004	1,000	R/W	1	[0 , 255]
0x2F2B		10187	104 Net1 CLI1 Octet3	F004	1,000	R/W	1	[0 , 255]
0x2F2C		10188	104 Net1 CLI1 Octet4	F004	1,000	R/W	1	[0 , 255]
0x2F2D		10189	104 Net1 CLI2 Octet1	F004	1,000	R/W	1	[0 , 255]
0x2F2E		10190	104 Net1 CLI2 Octet2	F004	1,000	R/W	1	[0 , 255]
0x2F2F		10191	104 Net1 CLI2 Octet3	F004	1,000	R/W	1	[0 , 255]
0x2F30		10192	104 Net1 CLI2 Octet4	F004	1,000	R/W	1	[0 , 255]
0x2F31		10193	Function 2	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x2F32		10194	TCP Port 2	F005	1,000	R/W	2	[0 , 65535]
0x2F34		10195	Common Addr of ASDU 2	F005	1,000	R/W	2	[0 , 65535]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2F36		10196	104 Net2 CLI1 Octet1	F004	1,000	R/W	1	[0 , 255]
0x2F37		10197	104 Net2 CLI1 Octet2	F004	1,000	R/W	1	[0 , 255]
0x2F38		10198	104 Net2 CLI1 Octet3	F004	1,000	R/W	1	[0 , 255]
0x2F39		10199	104 Net2 CLI1 Octet4	F004	1,000	R/W	1	[0 , 255]
0x2F3A		10200	104 Net2 CLI2 Octet1	F004	1,000	R/W	1	[0 , 255]
0x2F3B		10201	104 Net2 CLI2 Octet2	F004	1,000	R/W	1	[0 , 255]
0x2F3C		10202	104 Net2 CLI2 Octet3	F004	1,000	R/W	1	[0 , 255]
0x2F3D		10203	104 Net2 CLI2 Octet4	F004	1,000	R/W	1	[0 , 255]
0x2F3E		10204	Current Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x2F3F		10205	Voltage Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x2F40		10206	Power Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x2F41		10207	Energy Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								6=10
								7=100
								8=1000
								9=10000
0x2F42		10208	Other Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x2F43		10209	Current Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2F45		10210	Voltage Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2F47		10211	Power Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2F49		10212	Energy Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2F4B		10213	Other Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2F4D		10214	IOA Binaries	F013	1,000	R/W	1	[0 , 65535]
0x2F4E		10215	IOA Double Points	F013	1,000	R/W	1	[0 , 65535]
0x2F4F		10216	IOA Analogs	F013	1,000	R/W	1	[0 , 65535]
0x2F50		10217	IOA Counters	F013	1,000	R/W	1	[0 , 65535]
0x2F51		10218	IOA Commands	F013	1,000	R/W	1	[0 , 65535]
0x2F52		10219	IOA Analog Param	F013	1,000	R/W	1	[0 , 65535]
0x2F53		10663	PF Deadband	F004	1,000	R/W	1	[0 , 32767]
0x2F54		10664	PF Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x2F5A			Confirmation address			W	1	
			Board H					
0x2F5B		7391	I/O Board Type_H	F012	1,000	R/W	1	0=NONE
								1=16INP + 8OUT
								2=8INP + 8OUT + SUPV
								3=16OUT
								4=32INP
								5=16INP + 8ANA

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2F5C		5243	Voltage Threshold A_H	F004	1,000	R/W	1	[10 , 230] V
0x2F5D		5244	Voltage Threshold B_H	F004	1,000	R/W	1	[10 , 230] V
0x2F5E		5245	Debounce Time A_H	F004	1,000	R/W	1	[1 , 50] ms
0x2F5F		5246	Debounce Time B_H	F004	1,000	R/W	1	[1 , 50] ms
0x2F60		5247	Input Type_H_CC1	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F61		5248	Input Type_H_CC2	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F62		5249	Input Type_H_CC3	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F63		5250	Input Type_H_CC4	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F64		5251	Input Type_H_CC5	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F65		5252	Input Type_H_CC6	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F66		5253	Input Type_H_CC7	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F67		5254	Input Type_H_CC8	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F68		5255	Input Type_H_CC9	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F69		5256	Input Type_H_CC10	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2F6A		5257	Input Type_H_CC11	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F6B		5258	Input Type_H_CC12	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F6C		5259	Input Type_H_CC13	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F6D		5260	Input Type_H_CC14	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F6E		5261	Input Type_H_CC15	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F6F		5262	Input Type_H_CC16	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F70		5263	Input Type_H_CC17	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F71		5264	Input Type_H_CC18	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F72		5265	Input Type_H_CC19	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F73		5266	Input Type_H_CC20	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F74		5267	Input Type_H_CC21	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2F75		5268	Input Type_H_CC22	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F76		5269	Input Type_H_CC23	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F77		5270	Input Type_H_CC24	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F78		5271	Input Type_H_CC25	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F79		5272	Input Type_H_CC26	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F7A		5273	Input Type_H_CC27	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F7B		5274	Input Type_H_CC28	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F7C		5275	Input Type_H_CC29	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F7D		5276	Input Type_H_CC30	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F7E		5277	Input Type_H_CC31	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x2F7F		5278	Input Type_H_CC32	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2F80		5279	Delay Input Time_H_CC1	F005	1,000	R/W	2	[0 , 60000] ms
0x2F82		5280	Delay Input Time_H_CC2	F005	1,000	R/W	2	[0 , 60000] ms
0x2F84		5281	Delay Input Time_H_CC3	F005	1,000	R/W	2	[0 , 60000] ms
0x2F86		5282	Delay Input Time_H_CC4	F005	1,000	R/W	2	[0 , 60000] ms
0x2F88		5283	Delay Input Time_H_CC5	F005	1,000	R/W	2	[0 , 60000] ms
0x2F8A		5284	Delay Input Time_H_CC6	F005	1,000	R/W	2	[0 , 60000] ms
0x2F8C		5285	Delay Input Time_H_CC7	F005	1,000	R/W	2	[0 , 60000] ms
0x2F8E		5286	Delay Input Time_H_CC8	F005	1,000	R/W	2	[0 , 60000] ms
0x2F90		5287	Delay Input Time_H_CC9	F005	1,000	R/W	2	[0 , 60000] ms
0x2F92		5288	Delay Input Time_H_CC10	F005	1,000	R/W	2	[0 , 60000] ms
0x2F94		5289	Delay Input Time_H_CC11	F005	1,000	R/W	2	[0 , 60000] ms
0x2F96		5290	Delay Input Time_H_CC12	F005	1,000	R/W	2	[0 , 60000] ms
0x2F98		5291	Delay Input Time_H_CC13	F005	1,000	R/W	2	[0 , 60000] ms
0x2F9A		5292	Delay Input Time_H_CC14	F005	1,000	R/W	2	[0 , 60000] ms
0x2F9C		5293	Delay Input Time_H_CC15	F005	1,000	R/W	2	[0 , 60000] ms
0x2F9E		5294	Delay Input Time_H_CC16	F005	1,000	R/W	2	[0 , 60000] ms
0x2FA0		5295	Delay Input Time_H_CC17	F005	1,000	R/W	2	[0 , 60000] ms
0x2FA2		5296	Delay Input Time_H_CC18	F005	1,000	R/W	2	[0 , 60000] ms
0x2FA4		5297	Delay Input Time_H_CC19	F005	1,000	R/W	2	[0 , 60000] ms
0x2FA6		5298	Delay Input Time_H_CC20	F005	1,000	R/W	2	[0 , 60000] ms
0x2FA8		5299	Delay Input Time_H_CC21	F005	1,000	R/W	2	[0 , 60000] ms
0x2FAA		5300	Delay Input Time_H_CC22	F005	1,000	R/W	2	[0 , 60000] ms
0x2FAC		5301	Delay Input Time_H_CC23	F005	1,000	R/W	2	[0 , 60000] ms
0x2FAE		5302	Delay Input Time_H_CC24	F005	1,000	R/W	2	[0 , 60000] ms
0x2FB0		5303	Delay Input Time_H_CC25	F005	1,000	R/W	2	[0 , 60000] ms
0x2FB2		5304	Delay Input Time_H_CC26	F005	1,000	R/W	2	[0 , 60000] ms
0x2FB4		5305	Delay Input Time_H_CC27	F005	1,000	R/W	2	[0 , 60000] ms
0x2FB6		5306	Delay Input Time_H_CC28	F005	1,000	R/W	2	[0 , 60000] ms
0x2FB8		5307	Delay Input Time_H_CC29	F005	1,000	R/W	2	[0 , 60000] ms
0x2FBA		5308	Delay Input Time_H_CC30	F005	1,000	R/W	2	[0 , 60000] ms
0x2FBC		5309	Delay Input Time_H_CC31	F005	1,000	R/W	2	[0 , 60000] ms
0x2FBE		5310	Delay Input Time_H_CC32	F005	1,000	R/W	2	[0 , 60000] ms
0x2FC0		5311	Output Logic_H_01	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2FC1		5312	Output Logic_H_02	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2FC2		5313	Output Logic_H_03	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2FC3		5314	Output Logic_H_04	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2FC4		5315	Output Logic_H_05	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2FC5		5316	Output Logic_H_06	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2FC6		5317	Output Logic_H_07	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2FC7		5318	Output Logic_H_08	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2FC8		5319	Output Logic_H_09	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2FC9		5320	Output Logic_H_10	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2FCA		5321	Output Logic_H_11	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2FCB		5322	Output Logic_H_12	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2FCC		5323	Output Logic_H_13	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2FCD		5324	Output Logic_H_14	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2FCE		5325	Output Logic_H_15	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2FCF		5326	Output Logic_H_16	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x2FD0		5327	Output Type_H_01	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2FD1		5328	Output Type_H_02	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2FD2		5329	Output Type_H_03	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2FD3		5330	Output Type_H_04	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2FD4		5331	Output Type_H_05	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2FD5		5332	Output Type_H_06	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2FD6		5333	Output Type_H_07	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2FD7		5334	Output Type_H_08	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x2FD8		5335	Output Type_H_09	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2FD9		5336	Output Type_H_10	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2FDA		5337	Output Type_H_11	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2FDB		5338	Output Type_H_12	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2FDC		5339	Output Type_H_13	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2FDD		5340	Output Type_H_14	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2FDE		5341	Output Type_H_15	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2FDF		5342	Output Type_H_16	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x2FE0		5343	Pulse Output Time_H_01	F005	1,000	R/W	2	[0 , 60000] ms
0x2FE2		5344	Pulse Output Time_H_02	F005	1,000	R/W	2	[0 , 60000] ms
0x2FE4		5345	Pulse Output Time_H_03	F005	1,000	R/W	2	[0 , 60000] ms
0x2FE6		5346	Pulse Output Time_H_04	F005	1,000	R/W	2	[0 , 60000] ms
0x2FE8		5347	Pulse Output Time_H_05	F005	1,000	R/W	2	[0 , 60000] ms
0x2FEA		5348	Pulse Output Time_H_06	F005	1,000	R/W	2	[0 , 60000] ms
0x2FEC		5349	Pulse Output Time_H_07	F005	1,000	R/W	2	[0 , 60000] ms
0x2FEE		5350	Pulse Output Time_H_08	F005	1,000	R/W	2	[0 , 60000] ms
0x2FF0		5351	Pulse Output Time_H_09	F005	1,000	R/W	2	[0 , 60000] ms
0x2FF2		5352	Pulse Output Time_H_10	F005	1,000	R/W	2	[0 , 60000] ms
0x2FF4		5353	Pulse Output Time_H_11	F005	1,000	R/W	2	[0 , 60000] ms
0x2FF6		5354	Pulse Output Time_H_12	F005	1,000	R/W	2	[0 , 60000] ms
0x2FF8		5355	Pulse Output Time_H_13	F005	1,000	R/W	2	[0 , 60000] ms
0x2FFA		5356	Pulse Output Time_H_14	F005	1,000	R/W	2	[0 , 60000] ms
0x2FFC		5357	Pulse Output Time_H_15	F005	1,000	R/W	2	[0 , 60000] ms
0x2FFE		5358	Pulse Output Time_H_16	F005	1,000	R/W	2	[0 , 60000] ms
0x3000		6896	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x3001		7392	Voltage Threshold C_H	F004	1,000	R/W	1	[10 , 230] V
0x3002		7393	Voltage Threshold D_H	F004	1,000	R/W	1	[10 , 230] V

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x3003		7394	Debounce Time C_H	F004	1,000	R/W	1	[1 , 50] ms
0x3004		7395	Debounce Time D_H	F004	1,000	R/W	1	[1 , 50] ms
0x3005		7396	Range_H_01	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x3006		7397	Range_H_02	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x3007		7398	Range_H_03	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x3008		7399	Range_H_04	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x3009		7400	Range_H_05	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x300A		7401	Range_H_06	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x300B		7402	Range_H_07	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x300C		7403	Range_H_08	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x300D		7404	Min Value_H_01	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x300F		7405	Min Value_H_02	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x3011		7406	Min Value_H_03	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x3013		7407	Min Value_H_04	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x3015		7408	Min Value_H_05	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x3017		7409	Min Value_H_06	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x3019		7410	Min Value_H_07	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x301B		7411	Min Value_H_08	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x301D		7412	Max Value_H_01	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x301F		7413	Max Value_H_02	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x3021		7414	Max Value_H_03	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x3023		7415	Max Value_H_04	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x3025		7416	Max Value_H_05	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x3027		7417	Max Value_H_06	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x3029		7418	Max Value_H_07	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x302B		7419	Max Value_H_08	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x302D		7420	Channelx1a_H_01	F003	1,000	R/W	2	[0,950 , 1,050]
0x302F		7421	Channelx1a_H_02	F003	1,000	R/W	2	[0,950 , 1,050]
0x3031		7422	Channelx1a_H_03	F003	1,000	R/W	2	[0,950 , 1,050]
0x3033		7423	Channelx1a_H_04	F003	1,000	R/W	2	[0,950 , 1,050]
0x3035		7424	Channelx1a_H_05	F003	1,000	R/W	2	[0,950 , 1,050]
0x3037		7425	Channelx1a_H_06	F003	1,000	R/W	2	[0,950 , 1,050]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x3039		7426	Channelx1a_H_07	F003	1,000	R/W	2	[0,950 , 1,050]
0x303B		7427	Channelx1a_H_08	F003	1,000	R/W	2	[0,950 , 1,050]
0x303D		7428	Channelx1b_H_01	F004	1,000	R/W	1	[-1000 , 1000]
0x303E		7429	Channelx1b_H_02	F004	1,000	R/W	1	[-1000 , 1000]
0x303F		7430	Channelx1b_H_03	F004	1,000	R/W	1	[-1000 , 1000]
0x3040		7431	Channelx1b_H_04	F004	1,000	R/W	1	[-1000 , 1000]
0x3041		7432	Channelx1b_H_05	F004	1,000	R/W	1	[-1000 , 1000]
0x3042		7433	Channelx1b_H_06	F004	1,000	R/W	1	[-1000 , 1000]
0x3043		7434	Channelx1b_H_07	F004	1,000	R/W	1	[-1000 , 1000]
0x3044		7435	Channelx1b_H_08	F004	1,000	R/W	1	[-1000 , 1000]
0x3045		7436	Channelx10a_H_01	F003	1,000	R/W	2	[0,950 , 1,050]
0x3047		7437	Channelx10a_H_02	F003	1,000	R/W	2	[0,950 , 1,050]
0x3049		7438	Channelx10a_H_03	F003	1,000	R/W	2	[0,950 , 1,050]
0x304B		7439	Channelx10a_H_04	F003	1,000	R/W	2	[0,950 , 1,050]
0x304D		7440	Channelx10a_H_05	F003	1,000	R/W	2	[0,950 , 1,050]
0x304F		7441	Channelx10a_H_06	F003	1,000	R/W	2	[0,950 , 1,050]
0x3051		7442	Channelx10a_H_07	F003	1,000	R/W	2	[0,950 , 1,050]
0x3053		7443	Channelx10a_H_08	F003	1,000	R/W	2	[0,950 , 1,050]
0x3055		7444	Channelx10b_H_01	F004	1,000	R/W	1	[-1000 , 1000]
0x3056		7445	Channelx10b_H_02	F004	1,000	R/W	1	[-1000 , 1000]
0x3057		7446	Channelx10b_H_03	F004	1,000	R/W	1	[-1000 , 1000]
0x3058		7447	Channelx10b_H_04	F004	1,000	R/W	1	[-1000 , 1000]
0x3059		7448	Channelx10b_H_05	F004	1,000	R/W	1	[-1000 , 1000]
0x305A		7449	Channelx10b_H_06	F004	1,000	R/W	1	[-1000 , 1000]
0x305B		7450	Channelx10b_H_07	F004	1,000	R/W	1	[-1000 , 1000]
0x305C		7451	Channelx10b_H_08	F004	1,000	R/W	1	[-1000 , 1000]
0x305D		7452	Calibration Type_H	F012	1,000	R/W	1	0=NONE
								1=OFFSET
								2=CALIBRATION
								3=GET CALIBRATION
0x30FF			Confirmation address			W	1	
			Board J					
0x3100		7461	I/O Board Type_J	F012	1,000	R/W	1	0=NONE
								1=16INP + 8OUT
								2=8INP + 8OUT + SUPV
								3=16OUT
								4=32INP
								5=16INP + 8ANA
0x3101		5441	Voltage Threshold A_J	F004	1,000	R/W	1	[10 , 230] V
0x3102		5442	Voltage Threshold B_J	F004	1,000	R/W	1	[10 , 230] V
0x3103		5443	Debounce Time A_J	F004	1,000	R/W	1	[1 , 50] ms
0x3104		5444	Debounce Time B_J	F004	1,000	R/W	1	[1 , 50] ms
0x3105		5445	Input Type_J_CC1	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								2=POSITIVE
								3=NEGATIVE
0x3106		5446	Input Type_J_CC2	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x3107		5447	Input Type_J_CC3	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x3108		5448	Input Type_J_CC4	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x3109		5449	Input Type_J_CC5	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x310A		5450	Input Type_J_CC6	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x310B		5451	Input Type_J_CC7	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x310C		5452	Input Type_J_CC8	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x310D		5453	Input Type_J_CC9	F012	1,000	R/W	1	0=POSITIVE-EDGE

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x310E		5454	Input Type_J_CC10	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x310F		5455	Input Type_J_CC11	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x3110		5456	Input Type_J_CC12	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x3111		5457	Input Type_J_CC13	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x3112		5458	Input Type_J_CC14	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x3113		5459	Input Type_J_CC15	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x3114		5460	Input Type_J_CC16	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x3115		5461	Input Type_J_CC17	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x3116		5462	Input Type_J_CC18	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x3117		5463	Input Type_J_CC19	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x3118		5464	Input Type_J_CC20	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x3119		5465	Input Type_J_CC21	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x311A		5466	Input Type_J_CC22	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x311B		5467	Input Type_J_CC23	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x311C		5468	Input Type_J_CC24	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x311D		5469	Input Type_J_CC25	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x311E		5470	Input Type_J_CC26	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x311F		5471	Input Type_J_CC27	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x3120		5472	Input Type_J_CC28	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x3121		5473	Input Type_J_CC29	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x3122		5474	Input Type_J_CC30	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x3123		5475	Input Type_J_CC31	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x3124		5476	Input Type_J_CC32	F012	1,000	R/W	1	0=POSITIVE-EDGE
								1=NEGATIVE-EDGE
								2=POSITIVE
								3=NEGATIVE
0x3125		5477	Delay Input Time_J_CC1	F005	1,000	R/W	2	[0 , 60000] ms
0x3127		5478	Delay Input Time_J_CC2	F005	1,000	R/W	2	[0 , 60000] ms
0x3129		5479	Delay Input Time_J_CC3	F005	1,000	R/W	2	[0 , 60000] ms
0x312B		5480	Delay Input Time_J_CC4	F005	1,000	R/W	2	[0 , 60000] ms
0x312D		5481	Delay Input Time_J_CC5	F005	1,000	R/W	2	[0 , 60000] ms
0x312F		5482	Delay Input Time_J_CC6	F005	1,000	R/W	2	[0 , 60000] ms
0x3131		5483	Delay Input Time_J_CC7	F005	1,000	R/W	2	[0 , 60000] ms
0x3133		5484	Delay Input Time_J_CC8	F005	1,000	R/W	2	[0 , 60000] ms
0x3135		5485	Delay Input Time_J_CC9	F005	1,000	R/W	2	[0 , 60000] ms
0x3137		5486	Delay Input Time_J_CC10	F005	1,000	R/W	2	[0 , 60000] ms
0x3139		5487	Delay Input Time_J_CC11	F005	1,000	R/W	2	[0 , 60000] ms
0x313B		5488	Delay Input Time_J_CC12	F005	1,000	R/W	2	[0 , 60000] ms
0x313D		5489	Delay Input Time_J_CC13	F005	1,000	R/W	2	[0 , 60000] ms
0x313F		5490	Delay Input Time_J_CC14	F005	1,000	R/W	2	[0 , 60000] ms
0x3141		5491	Delay Input Time_J_CC15	F005	1,000	R/W	2	[0 , 60000] ms
0x3143		5492	Delay Input Time_J_CC16	F005	1,000	R/W	2	[0 , 60000] ms
0x3145		5493	Delay Input Time_J_CC17	F005	1,000	R/W	2	[0 , 60000] ms
0x3147		5494	Delay Input Time_J_CC18	F005	1,000	R/W	2	[0 , 60000] ms
0x3149		5495	Delay Input Time_J_CC19	F005	1,000	R/W	2	[0 , 60000] ms
0x314B		5496	Delay Input Time_J_CC20	F005	1,000	R/W	2	[0 , 60000] ms
0x314D		5497	Delay Input Time_J_CC21	F005	1,000	R/W	2	[0 , 60000] ms
0x314F		5498	Delay Input Time_J_CC22	F005	1,000	R/W	2	[0 , 60000] ms
0x3151		5499	Delay Input Time_J_CC23	F005	1,000	R/W	2	[0 , 60000] ms
0x3153		5500	Delay Input Time_J_CC24	F005	1,000	R/W	2	[0 , 60000] ms
0x3155		5501	Delay Input Time_J_CC25	F005	1,000	R/W	2	[0 , 60000] ms
0x3157		5502	Delay Input Time_J_CC26	F005	1,000	R/W	2	[0 , 60000] ms
0x3159		5503	Delay Input Time_J_CC27	F005	1,000	R/W	2	[0 , 60000] ms
0x315B		5504	Delay Input Time_J_CC28	F005	1,000	R/W	2	[0 , 60000] ms
0x315D		5505	Delay Input Time_J_CC29	F005	1,000	R/W	2	[0 , 60000] ms
0x315F		5506	Delay Input Time_J_CC30	F005	1,000	R/W	2	[0 , 60000] ms
0x3161		5507	Delay Input Time_J_CC31	F005	1,000	R/W	2	[0 , 60000] ms
0x3163		5508	Delay Input Time_J_CC32	F005	1,000	R/W	2	[0 , 60000] ms
0x3165		5509	Output Logic_J_01	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x3166		5510	Output Logic_J_02	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x3167		5511	Output Logic_J_03	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x3168		5512	Output Logic_J_04	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x3169		5513	Output Logic_J_05	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x316A		5514	Output Logic_J_06	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x316B		5515	Output Logic_J_07	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x316C		5516	Output Logic_J_08	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x316D		5517	Output Logic_J_09	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x316E		5518	Output Logic_J_10	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x316F		5519	Output Logic_J_11	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x3170		5520	Output Logic_J_12	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x3171		5521	Output Logic_J_13	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x3172		5522	Output Logic_J_14	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x3173		5523	Output Logic_J_15	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x3174		5524	Output Logic_J_16	F012	1,000	R/W	1	0=POSITIVE
								1=NEGATIVE
0x3175		5525	Output Type_J_01	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x3176		5526	Output Type_J_02	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x3177		5527	Output Type_J_03	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x3178		5528	Output Type_J_04	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x3179		5529	Output Type_J_05	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x317A		5530	Output Type_J_06	F012	1,000	R/W	1	0=NORMAL

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								1=PULSE
								2=LATCH
0x317B		5531	Output Type_J_07	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x317C		5532	Output Type_J_08	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x317D		5533	Output Type_J_09	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x317E		5534	Output Type_J_10	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x317F		5535	Output Type_J_11	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x3180		5536	Output Type_J_12	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x3181		5537	Output Type_J_13	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x3182		5538	Output Type_J_14	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x3183		5539	Output Type_J_15	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x3184		5540	Output Type_J_16	F012	1,000	R/W	1	0=NORMAL
								1=PULSE
								2=LATCH
0x3185		5541	Pulse Output Time_J_01	F005	1,000	R/W	2	[0 , 60000] ms
0x3187		5542	Pulse Output Time_J_02	F005	1,000	R/W	2	[0 , 60000] ms
0x3189		5543	Pulse Output Time_J_03	F005	1,000	R/W	2	[0 , 60000] ms
0x318B		5544	Pulse Output Time_J_04	F005	1,000	R/W	2	[0 , 60000] ms
0x318D		5545	Pulse Output Time_J_05	F005	1,000	R/W	2	[0 , 60000] ms
0x318F		5546	Pulse Output Time_J_06	F005	1,000	R/W	2	[0 , 60000] ms
0x3191		5547	Pulse Output Time_J_07	F005	1,000	R/W	2	[0 , 60000] ms
0x3193		5548	Pulse Output Time_J_08	F005	1,000	R/W	2	[0 , 60000] ms
0x3195		5549	Pulse Output Time_J_09	F005	1,000	R/W	2	[0 , 60000] ms
0x3197		5550	Pulse Output Time_J_10	F005	1,000	R/W	2	[0 , 60000] ms
0x3199		5551	Pulse Output Time_J_11	F005	1,000	R/W	2	[0 , 60000] ms
0x319B		5552	Pulse Output Time_J_12	F005	1,000	R/W	2	[0 , 60000] ms

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x319D		5553	Pulse Output Time_J_13	F005	1,000	R/W	2	[0 , 60000] ms
0x319F		5554	Pulse Output Time_J_14	F005	1,000	R/W	2	[0 , 60000] ms
0x31A1		5555	Pulse Output Time_J_15	F005	1,000	R/W	2	[0 , 60000] ms
0x31A3		5556	Pulse Output Time_J_16	F005	1,000	R/W	2	[0 , 60000] ms
0x31A5		6897	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x31A6		7462	Voltage Threshold C_J	F004	1,000	R/W	1	[10 , 230] V
0x31A7		7463	Voltage Threshold D_J	F004	1,000	R/W	1	[10 , 230] V
0x31A8		7464	Debounce Time C_J	F004	1,000	R/W	1	[1 , 50] ms
0x31A9		7465	Debounce Time D_J	F004	1,000	R/W	1	[1 , 50] ms
0x31AA		7466	Range_J_01	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x31AB		7467	Range_J_02	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x31AC		7468	Range_J_03	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x31AD		7469	Range_J_04	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x31AE		7470	Range_J_05	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x31AF		7471	Range_J_06	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x31B0		7472	Range_J_07	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x31B1		7473	Range_J_08	F012	1,000	R/W	1	0=NONE
								1=-1 to 0 mA
								2=0 to 1 mA
								3=-1 to 1 mA
								4=0 to 5 mA
								5=0 to 10 mA
								6=0 to 20 mA
								7=4 to 20 mA
0x31B2		7474	Min Value_J_01	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x31B4		7475	Min Value_J_02	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x31B6		7476	Min Value_J_03	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x31B8		7477	Min Value_J_04	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x31BA		7478	Min Value_J_05	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x31BC		7479	Min Value_J_06	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x31BE		7480	Min Value_J_07	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x31C0		7481	Min Value_J_08	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x31C2		7482	Max Value_J_01	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x31C4		7483	Max Value_J_02	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x31C6		7484	Max Value_J_03	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x31C8		7485	Max Value_J_04	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x31CA		7486	Max Value_J_05	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x31CC		7487	Max Value_J_06	F003	1,000	R/W	2	[-9999,99 , 9999,99]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x31CE		7488	Max Value_J_07	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x31D0		7489	Max Value_J_08	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x31D2		7490	Channelx1a_J_01	F003	1,000	R/W	2	[0,950 , 1,050]
0x31D4		7491	Channelx1a_J_02	F003	1,000	R/W	2	[0,950 , 1,050]
0x31D6		7492	Channelx1a_J_03	F003	1,000	R/W	2	[0,950 , 1,050]
0x31D8		7493	Channelx1a_J_04	F003	1,000	R/W	2	[0,950 , 1,050]
0x31DA		7494	Channelx1a_J_05	F003	1,000	R/W	2	[0,950 , 1,050]
0x31DC		7495	Channelx1a_J_06	F003	1,000	R/W	2	[0,950 , 1,050]
0x31DE		7496	Channelx1a_J_07	F003	1,000	R/W	2	[0,950 , 1,050]
0x31E0		7497	Channelx1a_J_08	F003	1,000	R/W	2	[0,950 , 1,050]
0x31E2		7498	Channelx1b_J_01	F004	1,000	R/W	1	[-1000 , 1000]
0x31E3		7499	Channelx1b_J_02	F004	1,000	R/W	1	[-1000 , 1000]
0x31E4		7500	Channelx1b_J_03	F004	1,000	R/W	1	[-1000 , 1000]
0x31E5		7501	Channelx1b_J_04	F004	1,000	R/W	1	[-1000 , 1000]
0x31E6		7502	Channelx1b_J_05	F004	1,000	R/W	1	[-1000 , 1000]
0x31E7		7503	Channelx1b_J_06	F004	1,000	R/W	1	[-1000 , 1000]
0x31E8		7504	Channelx1b_J_07	F004	1,000	R/W	1	[-1000 , 1000]
0x31E9		7505	Channelx1b_J_08	F004	1,000	R/W	1	[-1000 , 1000]
0x31EA		7506	Channelx10a_J_01	F003	1,000	R/W	2	[0,950 , 1,050]
0x31EC		7507	Channelx10a_J_02	F003	1,000	R/W	2	[0,950 , 1,050]
0x31EE		7508	Channelx10a_J_03	F003	1,000	R/W	2	[0,950 , 1,050]
0x31F0		7509	Channelx10a_J_04	F003	1,000	R/W	2	[0,950 , 1,050]
0x31F2		7510	Channelx10a_J_05	F003	1,000	R/W	2	[0,950 , 1,050]
0x31F4		7511	Channelx10a_J_06	F003	1,000	R/W	2	[0,950 , 1,050]
0x31F6		7512	Channelx10a_J_07	F003	1,000	R/W	2	[0,950 , 1,050]
0x31F8		7513	Channelx10a_J_08	F003	1,000	R/W	2	[0,950 , 1,050]
0x31FA		7514	Channelx10b_J_01	F004	1,000	R/W	1	[-1000 , 1000]
0x31FB		7515	Channelx10b_J_02	F004	1,000	R/W	1	[-1000 , 1000]
0x31FC		7516	Channelx10b_J_03	F004	1,000	R/W	1	[-1000 , 1000]
0x31FD		7517	Channelx10b_J_04	F004	1,000	R/W	1	[-1000 , 1000]
0x31FE		7518	Channelx10b_J_05	F004	1,000	R/W	1	[-1000 , 1000]
0x31FF		7519	Channelx10b_J_06	F004	1,000	R/W	1	[-1000 , 1000]
0x3200		7520	Channelx10b_J_07	F004	1,000	R/W	1	[-1000 , 1000]
0x3201		7521	Channelx10b_J_08	F004	1,000	R/W	1	[-1000 , 1000]
0x3202		7522	Calibration Type_J	F012	1,000	R/W	1	0=NONE
								1=OFFSET
								2=CALIBRATION
								3=GET CALIBRATION
0x32A4			Confirmation address			W	1	
			Phase TOC Low 1					
0x32A5		5641	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x32A6		5642	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x32A7		10926	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x32A9		6763	Curve	F012	1,000	R/W	1	0=IEEE Ext Inv
								1=IEEE Very Inv
								2=IEEE Mod Inv
								3=IEC Curve A
								4=IEC Curve B
								5=IEC Curve C
								6=IEC Long-Time Inv
								7=IEC Short-Time Inv
								8=IAC Ext Inv
								9=IAC Very Inv
								10=IAC Mod Inv
								11=ANSI Ext Inv
								12=ANSI Very Inv
								13=ANSI Norm Inv
								14=ANSI Mod Inv
								15=I2t
								16=Definite Time
								17=Rectifier Curve
								18=User Curve A
								19=User Curve B
								20=User Curve C
								21=User Curve D
0x32AA		5645	TD Multiplier	F003	1,000	R/W	2	[0,00 , 900,00] s
0x32AC		5646	Reset	F012	1,000	R/W	1	0=INSTANTANEOUS
								1=LINEAR
0x32AD		5647	Voltage Restraint	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x32AE		6971	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x32C1			Confirmation address			W	1	
			Phase TOC Low 2					
0x32C2		5659	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x32C3		5660	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS
0x32C4		10927	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x32C6		6764	Curve	F012	1,000	R/W	1	0=IEEE Ext Inv
								1=IEEE Very Inv
								2=IEEE Mod Inv
								3=IEC Curve A
								4=IEC Curve B
								5=IEC Curve C
								6=IEC Long-Time Inv

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								7=IEC Short-Time Inv
								8=IAC Ext Inv
								9=IAC Very Inv
								10=IAC Mod Inv
								11=ANSI Ext Inv
								12=ANSI Very Inv
								13=ANSI Norm Inv
								14=ANSI Mod Inv
								15=I2t
								16=Definite Time
								17=Rectifier Curve
								18=User Curve A
								19=User Curve B
								20=User Curve C
								21=User Curve D
0x32C7		5663	TD Multiplier	F003	1,000	R/W	2	[0,00 , 900,00] s
0x32C9		5664	Reset	F012	1,000	R/W	1	0=INSTANTANEOUS
								1=LINEAR
0x32CA		5665	Voltage Restraint	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x32CB		6972	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x32DE			Confirmation address			W	1	
			Phase TOC Low 3					
0x32DF		5677	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x32E0		5678	Input	F012	1,000	R/W	1	0=PHASOR(DFT)
								1=RMS
0x32E1		10928	Pickup Level	F003	1,000	R/W	2	[0,05 , 20,00] x CT
0x32E3		6765	Curve	F012	1,000	R/W	1	0=IEEE Ext Inv
								1=IEEE Very Inv
								2=IEEE Mod Inv
								3=IEC Curve A
								4=IEC Curve B
								5=IEC Curve C
								6=IEC Long-Time Inv
								7=IEC Short-Time Inv
								8=IAC Ext Inv
								9=IAC Very Inv
								10=IAC Mod Inv
								11=ANSI Ext Inv
								12=ANSI Very Inv
								13=ANSI Norm Inv
								14=ANSI Mod Inv

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								15=I2t
								16=Definite Time
								17=Rectifier Curve
								18=User Curve A
								19=User Curve B
								20=User Curve C
								21=User Curve D
0x32E4		5681	TD Multiplier	F003	1,000	R/W	2	[0,00 , 900,00] s
0x32E6		5682	Reset	F012	1,000	R/W	1	0=INSTANTANEOUS
								1=LINEAR
0x32E7		5683	Voltage Restraint	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x32E8		6973	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x32FB			Confirmation address			W	1	
			Switchgear					
0x32FC		5695	CONTACTS TYPE_01	F012	1,000	R/W	1	0=52a + 52b
								1=52a
								2=52b
								3=NONE
0x32FD		5696	CONTACTS TYPE_02	F012	1,000	R/W	1	0=52a + 52b
								1=52a
								2=52b
								3=NONE
0x32FE		5697	CONTACTS TYPE_03	F012	1,000	R/W	1	0=52a + 52b
								1=52a
								2=52b
								3=NONE
0x32FF		5698	CONTACTS TYPE_04	F012	1,000	R/W	1	0=52a + 52b
								1=52a
								2=52b
								3=NONE
0x3300		5699	CONTACTS TYPE_05	F012	1,000	R/W	1	0=52a + 52b
								1=52a
								2=52b
								3=NONE
0x3301		5700	CONTACTS TYPE_06	F012	1,000	R/W	1	0=52a + 52b
								1=52a
								2=52b
								3=NONE
0x3302		5701	CONTACTS TYPE_07	F012	1,000	R/W	1	0=52a + 52b
								1=52a
								2=52b
								3=NONE

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x3303		5702	CONTACTS TYPE_08	F012	1,000	R/W	1	0=52a + 52b
								1=52a
								2=52b
								3=NONE
0x3304		5703	CONTACTS TYPE_09	F012	1,000	R/W	1	0=52a + 52b
								1=52a
								2=52b
								3=NONE
0x3305		5704	CONTACTS TYPE_10	F012	1,000	R/W	1	0=52a + 52b
								1=52a
								2=52b
								3=NONE
0x3306		5705	CONTACTS TYPE_11	F012	1,000	R/W	1	0=52a + 52b
								1=52a
								2=52b
								3=NONE
0x3307		5706	CONTACTS TYPE_12	F012	1,000	R/W	1	0=52a + 52b
								1=52a
								2=52b
								3=NONE
0x3308		5707	CONTACTS TYPE_13	F012	1,000	R/W	1	0=52a + 52b
								1=52a
								2=52b
								3=NONE
0x3309		5708	CONTACTS TYPE_14	F012	1,000	R/W	1	0=52a + 52b
								1=52a
								2=52b
								3=NONE
0x330A		5709	CONTACTS TYPE_15	F012	1,000	R/W	1	0=52a + 52b
								1=52a
								2=52b
								3=NONE
0x330B		5710	CONTACTS TYPE_16	F012	1,000	R/W	1	0=52a + 52b
								1=52a
								2=52b
								3=NONE
0x330C		5711	FAIL TO OPEN 01 t	F004	1,000	R/W	1	[0 , 30000] ms
0x330D		5712	FAIL TO OPEN 02 t	F004	1,000	R/W	1	[0 , 30000] ms
0x330E		5713	FAIL TO OPEN 03 t	F004	1,000	R/W	1	[0 , 30000] ms
0x330F		5714	FAIL TO OPEN 04 t	F004	1,000	R/W	1	[0 , 30000] ms
0x3310		5715	FAIL TO OPEN 05 t	F004	1,000	R/W	1	[0 , 30000] ms
0x3311		5716	FAIL TO OPEN 06 t	F004	1,000	R/W	1	[0 , 30000] ms
0x3312		5717	FAIL TO OPEN 07 t	F004	1,000	R/W	1	[0 , 30000] ms
0x3313		5718	FAIL TO OPEN 08 t	F004	1,000	R/W	1	[0 , 30000] ms

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x3314		5719	FAIL TO OPEN 09 t	F004	1,000	R/W	1	[0 , 30000] ms
0x3315		5720	FAIL TO OPEN 10 t	F004	1,000	R/W	1	[0 , 30000] ms
0x3316		5721	FAIL TO OPEN 11 t	F004	1,000	R/W	1	[0 , 30000] ms
0x3317		5722	FAIL TO OPEN 12 t	F004	1,000	R/W	1	[0 , 30000] ms
0x3318		5723	FAIL TO OPEN 13 t	F004	1,000	R/W	1	[0 , 30000] ms
0x3319		5724	FAIL TO OPEN 14 t	F004	1,000	R/W	1	[0 , 30000] ms
0x331A		5725	FAIL TO OPEN 15 t	F004	1,000	R/W	1	[0 , 30000] ms
0x331B		5726	FAIL TO OPEN 16 t	F004	1,000	R/W	1	[0 , 30000] ms
0x331C		5727	FAIL TO CLOSE 01 t	F004	1,000	R/W	1	[0 , 30000] ms
0x331D		5728	FAIL TO CLOSE 02 t	F004	1,000	R/W	1	[0 , 30000] ms
0x331E		5729	FAIL TO CLOSE 03 t	F004	1,000	R/W	1	[0 , 30000] ms
0x331F		5730	FAIL TO CLOSE 04 t	F004	1,000	R/W	1	[0 , 30000] ms
0x3320		5731	FAIL TO CLOSE 05 t	F004	1,000	R/W	1	[0 , 30000] ms
0x3321		5732	FAIL TO CLOSE 06 t	F004	1,000	R/W	1	[0 , 30000] ms
0x3322		5733	FAIL TO CLOSE 07 t	F004	1,000	R/W	1	[0 , 30000] ms
0x3323		5734	FAIL TO CLOSE 08 t	F004	1,000	R/W	1	[0 , 30000] ms
0x3324		5735	FAIL TO CLOSE 09 t	F004	1,000	R/W	1	[0 , 30000] ms
0x3325		5736	FAIL TO CLOSE 10 t	F004	1,000	R/W	1	[0 , 30000] ms
0x3326		5737	FAIL TO CLOSE 11 t	F004	1,000	R/W	1	[0 , 30000] ms
0x3327		5738	FAIL TO CLOSE 12 t	F004	1,000	R/W	1	[0 , 30000] ms
0x3328		5739	FAIL TO CLOSE 13 t	F004	1,000	R/W	1	[0 , 30000] ms
0x3329		5740	FAIL TO CLOSE 14 t	F004	1,000	R/W	1	[0 , 30000] ms
0x332A		5741	FAIL TO CLOSE 15 t	F004	1,000	R/W	1	[0 , 30000] ms
0x332B		5742	FAIL TO CLOSE 16 t	F004	1,000	R/W	1	[0 , 30000] ms
0x332C		6908	Snapshot Events SWGR 1	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x332D		6909	Snapshot Events SWGR 2	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x332E		6910	Snapshot Events SWGR 3	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x332F		6911	Snapshot Events SWGR 4	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x3330		6912	Snapshot Events SWGR 5	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x3331		6913	Snapshot Events SWGR 6	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x3332		6914	Snapshot Events SWGR 7	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x3333		6915	Snapshot Events SWGR 8	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x3334		6916	Snapshot Events SWGR 9	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x3335		6917	Snapshot Events SWGR 10	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x3336		6918	Snapshot Events SWGR 11	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x3337		6919	Snapshot Events SWGR 12	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x3338		6920	Snapshot Events SWGR 13	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x3339		6921	Snapshot Events SWGR 14	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x333A		6922	Snapshot Events SWGR 15	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x333B		6923	Snapshot Events SWGR 16	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x334C			Confirmation address			W	1	
			Modbus User Map					
0x3384		5963	Address 00	F013	1,000	R/W	1	[0 , 65535]
0x3385		5964	Address 01	F013	1,000	R/W	1	[0 , 65535]
0x3386		5965	Address 02	F013	1,000	R/W	1	[0 , 65535]
0x3387		5966	Address 03	F013	1,000	R/W	1	[0 , 65535]
0x3388		5967	Address 04	F013	1,000	R/W	1	[0 , 65535]
0x3389		5968	Address 05	F013	1,000	R/W	1	[0 , 65535]
0x338A		5969	Address 06	F013	1,000	R/W	1	[0 , 65535]
0x338B		5970	Address 07	F013	1,000	R/W	1	[0 , 65535]
0x338C		5971	Address 08	F013	1,000	R/W	1	[0 , 65535]
0x338D		5972	Address 09	F013	1,000	R/W	1	[0 , 65535]
0x338E		5973	Address 10	F013	1,000	R/W	1	[0 , 65535]
0x338F		5974	Address 11	F013	1,000	R/W	1	[0 , 65535]
0x3390		5975	Address 12	F013	1,000	R/W	1	[0 , 65535]
0x3391		5976	Address 13	F013	1,000	R/W	1	[0 , 65535]
0x3392		5977	Address 14	F013	1,000	R/W	1	[0 , 65535]
0x3393		5978	Address 15	F013	1,000	R/W	1	[0 , 65535]
0x3394		5979	Address 16	F013	1,000	R/W	1	[0 , 65535]
0x3395		5980	Address 17	F013	1,000	R/W	1	[0 , 65535]
0x3396		5981	Address 18	F013	1,000	R/W	1	[0 , 65535]
0x3397		5982	Address 19	F013	1,000	R/W	1	[0 , 65535]
0x3398		5983	Address 20	F013	1,000	R/W	1	[0 , 65535]
0x3399		5984	Address 21	F013	1,000	R/W	1	[0 , 65535]
0x339A		5985	Address 22	F013	1,000	R/W	1	[0 , 65535]
0x339B		5986	Address 23	F013	1,000	R/W	1	[0 , 65535]
0x339C		5987	Address 24	F013	1,000	R/W	1	[0 , 65535]
0x339D		5988	Address 25	F013	1,000	R/W	1	[0 , 65535]
0x339E		5989	Address 26	F013	1,000	R/W	1	[0 , 65535]
0x339F		5990	Address 27	F013	1,000	R/W	1	[0 , 65535]
0x33A0		5991	Address 28	F013	1,000	R/W	1	[0 , 65535]
0x33A1		5992	Address 29	F013	1,000	R/W	1	[0 , 65535]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x33A2		5993	Address 30	F013	1,000	R/W	1	[0 , 65535]
0x33A3		5994	Address 31	F013	1,000	R/W	1	[0 , 65535]
0x33A4		5995	Address 32	F013	1,000	R/W	1	[0 , 65535]
0x33A5		5996	Address 33	F013	1,000	R/W	1	[0 , 65535]
0x33A6		5997	Address 34	F013	1,000	R/W	1	[0 , 65535]
0x33A7		5998	Address 35	F013	1,000	R/W	1	[0 , 65535]
0x33A8		5999	Address 36	F013	1,000	R/W	1	[0 , 65535]
0x33A9		6000	Address 37	F013	1,000	R/W	1	[0 , 65535]
0x33AA		6001	Address 38	F013	1,000	R/W	1	[0 , 65535]
0x33AB		6002	Address 39	F013	1,000	R/W	1	[0 , 65535]
0x33AC		6003	Address 40	F013	1,000	R/W	1	[0 , 65535]
0x33AD		6004	Address 41	F013	1,000	R/W	1	[0 , 65535]
0x33AE		6005	Address 42	F013	1,000	R/W	1	[0 , 65535]
0x33AF		6006	Address 43	F013	1,000	R/W	1	[0 , 65535]
0x33B0		6007	Address 44	F013	1,000	R/W	1	[0 , 65535]
0x33B1		6008	Address 45	F013	1,000	R/W	1	[0 , 65535]
0x33B2		6009	Address 46	F013	1,000	R/W	1	[0 , 65535]
0x33B3		6010	Address 47	F013	1,000	R/W	1	[0 , 65535]
0x33B4		6011	Address 48	F013	1,000	R/W	1	[0 , 65535]
0x33B5		6012	Address 49	F013	1,000	R/W	1	[0 , 65535]
0x33B6		6013	Address 50	F013	1,000	R/W	1	[0 , 65535]
0x33B7		6014	Address 51	F013	1,000	R/W	1	[0 , 65535]
0x33B8		6015	Address 52	F013	1,000	R/W	1	[0 , 65535]
0x33B9		6016	Address 53	F013	1,000	R/W	1	[0 , 65535]
0x33BA		6017	Address 54	F013	1,000	R/W	1	[0 , 65535]
0x33BB		6018	Address 55	F013	1,000	R/W	1	[0 , 65535]
0x33BC		6019	Address 56	F013	1,000	R/W	1	[0 , 65535]
0x33BD		6020	Address 57	F013	1,000	R/W	1	[0 , 65535]
0x33BE		6021	Address 58	F013	1,000	R/W	1	[0 , 65535]
0x33BF		6022	Address 59	F013	1,000	R/W	1	[0 , 65535]
0x33C0		6023	Address 60	F013	1,000	R/W	1	[0 , 65535]
0x33C1		6024	Address 61	F013	1,000	R/W	1	[0 , 65535]
0x33C2		6025	Address 62	F013	1,000	R/W	1	[0 , 65535]
0x33C3		6026	Address 63	F013	1,000	R/W	1	[0 , 65535]
0x33C4		6027	Address 64	F013	1,000	R/W	1	[0 , 65535]
0x33C5		6028	Address 65	F013	1,000	R/W	1	[0 , 65535]
0x33C6		6029	Address 66	F013	1,000	R/W	1	[0 , 65535]
0x33C7		6030	Address 67	F013	1,000	R/W	1	[0 , 65535]
0x33C8		6031	Address 68	F013	1,000	R/W	1	[0 , 65535]
0x33C9		6032	Address 69	F013	1,000	R/W	1	[0 , 65535]
0x33CA		6033	Address 70	F013	1,000	R/W	1	[0 , 65535]
0x33CB		6034	Address 71	F013	1,000	R/W	1	[0 , 65535]
0x33CC		6035	Address 72	F013	1,000	R/W	1	[0 , 65535]
0x33CD		6036	Address 73	F013	1,000	R/W	1	[0 , 65535]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x33CE		6037	Address 74	F013	1,000	R/W	1	[0 , 65535]
0x33CF		6038	Address 75	F013	1,000	R/W	1	[0 , 65535]
0x33D0		6039	Address 76	F013	1,000	R/W	1	[0 , 65535]
0x33D1		6040	Address 77	F013	1,000	R/W	1	[0 , 65535]
0x33D2		6041	Address 78	F013	1,000	R/W	1	[0 , 65535]
0x33D3		6042	Address 79	F013	1,000	R/W	1	[0 , 65535]
0x33D4		6043	Address 80	F013	1,000	R/W	1	[0 , 65535]
0x33D5		6044	Address 81	F013	1,000	R/W	1	[0 , 65535]
0x33D6		6045	Address 82	F013	1,000	R/W	1	[0 , 65535]
0x33D7		6046	Address 83	F013	1,000	R/W	1	[0 , 65535]
0x33D8		6047	Address 84	F013	1,000	R/W	1	[0 , 65535]
0x33D9		6048	Address 85	F013	1,000	R/W	1	[0 , 65535]
0x33DA		6049	Address 86	F013	1,000	R/W	1	[0 , 65535]
0x33DB		6050	Address 87	F013	1,000	R/W	1	[0 , 65535]
0x33DC		6051	Address 88	F013	1,000	R/W	1	[0 , 65535]
0x33DD		6052	Address 89	F013	1,000	R/W	1	[0 , 65535]
0x33DE		6053	Address 90	F013	1,000	R/W	1	[0 , 65535]
0x33DF		6054	Address 91	F013	1,000	R/W	1	[0 , 65535]
0x33E0		6055	Address 92	F013	1,000	R/W	1	[0 , 65535]
0x33E1		6056	Address 93	F013	1,000	R/W	1	[0 , 65535]
0x33E2		6057	Address 94	F013	1,000	R/W	1	[0 , 65535]
0x33E3		6058	Address 95	F013	1,000	R/W	1	[0 , 65535]
0x33E4		6059	Address 96	F013	1,000	R/W	1	[0 , 65535]
0x33E5		6060	Address 97	F013	1,000	R/W	1	[0 , 65535]
0x33E6		6061	Address 98	F013	1,000	R/W	1	[0 , 65535]
0x33E7		6062	Address 99	F013	1,000	R/W	1	[0 , 65535]
0x33E8		6063	Address 100	F013	1,000	R/W	1	[0 , 65535]
0x33E9		6064	Address 101	F013	1,000	R/W	1	[0 , 65535]
0x33EA		6065	Address 102	F013	1,000	R/W	1	[0 , 65535]
0x33EB		6066	Address 103	F013	1,000	R/W	1	[0 , 65535]
0x33EC		6067	Address 104	F013	1,000	R/W	1	[0 , 65535]
0x33ED		6068	Address 105	F013	1,000	R/W	1	[0 , 65535]
0x33EE		6069	Address 106	F013	1,000	R/W	1	[0 , 65535]
0x33EF		6070	Address 107	F013	1,000	R/W	1	[0 , 65535]
0x33F0		6071	Address 108	F013	1,000	R/W	1	[0 , 65535]
0x33F1		6072	Address 109	F013	1,000	R/W	1	[0 , 65535]
0x33F2		6073	Address 110	F013	1,000	R/W	1	[0 , 65535]
0x33F3		6074	Address 111	F013	1,000	R/W	1	[0 , 65535]
0x33F4		6075	Address 112	F013	1,000	R/W	1	[0 , 65535]
0x33F5		6076	Address 113	F013	1,000	R/W	1	[0 , 65535]
0x33F6		6077	Address 114	F013	1,000	R/W	1	[0 , 65535]
0x33F7		6078	Address 115	F013	1,000	R/W	1	[0 , 65535]
0x33F8		6079	Address 116	F013	1,000	R/W	1	[0 , 65535]
0x33F9		6080	Address 117	F013	1,000	R/W	1	[0 , 65535]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x33FA		6081	Address 118	F013	1,000	R/W	1	[0 , 65535]
0x33FB		6082	Address 119	F013	1,000	R/W	1	[0 , 65535]
0x33FC		6083	Address 120	F013	1,000	R/W	1	[0 , 65535]
0x33FD		6084	Address 121	F013	1,000	R/W	1	[0 , 65535]
0x33FE		6085	Address 122	F013	1,000	R/W	1	[0 , 65535]
0x33FF		6086	Address 123	F013	1,000	R/W	1	[0 , 65535]
0x3400		6087	Address 124	F013	1,000	R/W	1	[0 , 65535]
0x3401		6088	Address 125	F013	1,000	R/W	1	[0 , 65535]
0x3402		6089	Address 126	F013	1,000	R/W	1	[0 , 65535]
0x3403		6090	Address 127	F013	1,000	R/W	1	[0 , 65535]
0x3404		6091	Address 128	F013	1,000	R/W	1	[0 , 65535]
0x3405		6092	Address 129	F013	1,000	R/W	1	[0 , 65535]
0x3406		6093	Address 130	F013	1,000	R/W	1	[0 , 65535]
0x3407		6094	Address 131	F013	1,000	R/W	1	[0 , 65535]
0x3408		6095	Address 132	F013	1,000	R/W	1	[0 , 65535]
0x3409		6096	Address 133	F013	1,000	R/W	1	[0 , 65535]
0x340A		6097	Address 134	F013	1,000	R/W	1	[0 , 65535]
0x340B		6098	Address 135	F013	1,000	R/W	1	[0 , 65535]
0x340C		6099	Address 136	F013	1,000	R/W	1	[0 , 65535]
0x340D		6100	Address 137	F013	1,000	R/W	1	[0 , 65535]
0x340E		6101	Address 138	F013	1,000	R/W	1	[0 , 65535]
0x340F		6102	Address 139	F013	1,000	R/W	1	[0 , 65535]
0x3410		6103	Address 140	F013	1,000	R/W	1	[0 , 65535]
0x3411		6104	Address 141	F013	1,000	R/W	1	[0 , 65535]
0x3412		6105	Address 142	F013	1,000	R/W	1	[0 , 65535]
0x3413		6106	Address 143	F013	1,000	R/W	1	[0 , 65535]
0x3414		6107	Address 144	F013	1,000	R/W	1	[0 , 65535]
0x3415		6108	Address 145	F013	1,000	R/W	1	[0 , 65535]
0x3416		6109	Address 146	F013	1,000	R/W	1	[0 , 65535]
0x3417		6110	Address 147	F013	1,000	R/W	1	[0 , 65535]
0x3418		6111	Address 148	F013	1,000	R/W	1	[0 , 65535]
0x3419		6112	Address 149	F013	1,000	R/W	1	[0 , 65535]
0x341A		6113	Address 150	F013	1,000	R/W	1	[0 , 65535]
0x341B		6114	Address 151	F013	1,000	R/W	1	[0 , 65535]
0x341C		6115	Address 152	F013	1,000	R/W	1	[0 , 65535]
0x341D		6116	Address 153	F013	1,000	R/W	1	[0 , 65535]
0x341E		6117	Address 154	F013	1,000	R/W	1	[0 , 65535]
0x341F		6118	Address 155	F013	1,000	R/W	1	[0 , 65535]
0x3420		6119	Address 156	F013	1,000	R/W	1	[0 , 65535]
0x3421		6120	Address 157	F013	1,000	R/W	1	[0 , 65535]
0x3422		6121	Address 158	F013	1,000	R/W	1	[0 , 65535]
0x3423		6122	Address 159	F013	1,000	R/W	1	[0 , 65535]
0x3424		6123	Address 160	F013	1,000	R/W	1	[0 , 65535]
0x3425		6124	Address 161	F013	1,000	R/W	1	[0 , 65535]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x3426		6125	Address 162	F013	1,000	R/W	1	[0 , 65535]
0x3427		6126	Address 163	F013	1,000	R/W	1	[0 , 65535]
0x3428		6127	Address 164	F013	1,000	R/W	1	[0 , 65535]
0x3429		6128	Address 165	F013	1,000	R/W	1	[0 , 65535]
0x342A		6129	Address 166	F013	1,000	R/W	1	[0 , 65535]
0x342B		6130	Address 167	F013	1,000	R/W	1	[0 , 65535]
0x342C		6131	Address 168	F013	1,000	R/W	1	[0 , 65535]
0x342D		6132	Address 169	F013	1,000	R/W	1	[0 , 65535]
0x342E		6133	Address 170	F013	1,000	R/W	1	[0 , 65535]
0x342F		6134	Address 171	F013	1,000	R/W	1	[0 , 65535]
0x3430		6135	Address 172	F013	1,000	R/W	1	[0 , 65535]
0x3431		6136	Address 173	F013	1,000	R/W	1	[0 , 65535]
0x3432		6137	Address 174	F013	1,000	R/W	1	[0 , 65535]
0x3433		6138	Address 175	F013	1,000	R/W	1	[0 , 65535]
0x3434		6139	Address 176	F013	1,000	R/W	1	[0 , 65535]
0x3435		6140	Address 177	F013	1,000	R/W	1	[0 , 65535]
0x3436		6141	Address 178	F013	1,000	R/W	1	[0 , 65535]
0x3437		6142	Address 179	F013	1,000	R/W	1	[0 , 65535]
0x3438		6143	Address 180	F013	1,000	R/W	1	[0 , 65535]
0x3439		6144	Address 181	F013	1,000	R/W	1	[0 , 65535]
0x343A		6145	Address 182	F013	1,000	R/W	1	[0 , 65535]
0x343B		6146	Address 183	F013	1,000	R/W	1	[0 , 65535]
0x343C		6147	Address 184	F013	1,000	R/W	1	[0 , 65535]
0x343D		6148	Address 185	F013	1,000	R/W	1	[0 , 65535]
0x343E		6149	Address 186	F013	1,000	R/W	1	[0 , 65535]
0x343F		6150	Address 187	F013	1,000	R/W	1	[0 , 65535]
0x3440		6151	Address 188	F013	1,000	R/W	1	[0 , 65535]
0x3441		6152	Address 189	F013	1,000	R/W	1	[0 , 65535]
0x3442		6153	Address 190	F013	1,000	R/W	1	[0 , 65535]
0x3443		6154	Address 191	F013	1,000	R/W	1	[0 , 65535]
0x3444		6155	Address 192	F013	1,000	R/W	1	[0 , 65535]
0x3445		6156	Address 193	F013	1,000	R/W	1	[0 , 65535]
0x3446		6157	Address 194	F013	1,000	R/W	1	[0 , 65535]
0x3447		6158	Address 195	F013	1,000	R/W	1	[0 , 65535]
0x3448		6159	Address 196	F013	1,000	R/W	1	[0 , 65535]
0x3449		6160	Address 197	F013	1,000	R/W	1	[0 , 65535]
0x344A		6161	Address 198	F013	1,000	R/W	1	[0 , 65535]
0x344B		6162	Address 199	F013	1,000	R/W	1	[0 , 65535]
0x344C		6163	Address 200	F013	1,000	R/W	1	[0 , 65535]
0x344D		6164	Address 201	F013	1,000	R/W	1	[0 , 65535]
0x344E		6165	Address 202	F013	1,000	R/W	1	[0 , 65535]
0x344F		6166	Address 203	F013	1,000	R/W	1	[0 , 65535]
0x3450		6167	Address 204	F013	1,000	R/W	1	[0 , 65535]
0x3451		6168	Address 205	F013	1,000	R/W	1	[0 , 65535]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x3452		6169	Address 206	F013	1,000	R/W	1	[0 , 65535]
0x3453		6170	Address 207	F013	1,000	R/W	1	[0 , 65535]
0x3454		6171	Address 208	F013	1,000	R/W	1	[0 , 65535]
0x3455		6172	Address 209	F013	1,000	R/W	1	[0 , 65535]
0x3456		6173	Address 210	F013	1,000	R/W	1	[0 , 65535]
0x3457		6174	Address 211	F013	1,000	R/W	1	[0 , 65535]
0x3458		6175	Address 212	F013	1,000	R/W	1	[0 , 65535]
0x3459		6176	Address 213	F013	1,000	R/W	1	[0 , 65535]
0x345A		6177	Address 214	F013	1,000	R/W	1	[0 , 65535]
0x345B		6178	Address 215	F013	1,000	R/W	1	[0 , 65535]
0x345C		6179	Address 216	F013	1,000	R/W	1	[0 , 65535]
0x345D		6180	Address 217	F013	1,000	R/W	1	[0 , 65535]
0x345E		6181	Address 218	F013	1,000	R/W	1	[0 , 65535]
0x345F		6182	Address 219	F013	1,000	R/W	1	[0 , 65535]
0x3460		6183	Address 220	F013	1,000	R/W	1	[0 , 65535]
0x3461		6184	Address 221	F013	1,000	R/W	1	[0 , 65535]
0x3462		6185	Address 222	F013	1,000	R/W	1	[0 , 65535]
0x3463		6186	Address 223	F013	1,000	R/W	1	[0 , 65535]
0x3464		6187	Address 224	F013	1,000	R/W	1	[0 , 65535]
0x3465		6188	Address 225	F013	1,000	R/W	1	[0 , 65535]
0x3466		6189	Address 226	F013	1,000	R/W	1	[0 , 65535]
0x3467		6190	Address 227	F013	1,000	R/W	1	[0 , 65535]
0x3468		6191	Address 228	F013	1,000	R/W	1	[0 , 65535]
0x3469		6192	Address 229	F013	1,000	R/W	1	[0 , 65535]
0x346A		6193	Address 230	F013	1,000	R/W	1	[0 , 65535]
0x346B		6194	Address 231	F013	1,000	R/W	1	[0 , 65535]
0x346C		6195	Address 232	F013	1,000	R/W	1	[0 , 65535]
0x346D		6196	Address 233	F013	1,000	R/W	1	[0 , 65535]
0x346E		6197	Address 234	F013	1,000	R/W	1	[0 , 65535]
0x346F		6198	Address 235	F013	1,000	R/W	1	[0 , 65535]
0x3470		6199	Address 236	F013	1,000	R/W	1	[0 , 65535]
0x3471		6200	Address 237	F013	1,000	R/W	1	[0 , 65535]
0x3472		6201	Address 238	F013	1,000	R/W	1	[0 , 65535]
0x3473		6202	Address 239	F013	1,000	R/W	1	[0 , 65535]
0x3474		6203	Address 240	F013	1,000	R/W	1	[0 , 65535]
0x3475		6204	Address 241	F013	1,000	R/W	1	[0 , 65535]
0x3476		6205	Address 242	F013	1,000	R/W	1	[0 , 65535]
0x3477		6206	Address 243	F013	1,000	R/W	1	[0 , 65535]
0x3478		6207	Address 244	F013	1,000	R/W	1	[0 , 65535]
0x3479		6208	Address 245	F013	1,000	R/W	1	[0 , 65535]
0x347A		6209	Address 246	F013	1,000	R/W	1	[0 , 65535]
0x347B		6210	Address 247	F013	1,000	R/W	1	[0 , 65535]
0x347C		6211	Address 248	F013	1,000	R/W	1	[0 , 65535]
0x347D		6212	Address 249	F013	1,000	R/W	1	[0 , 65535]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x347E		6213	Address 250	F013	1,000	R/W	1	[0 , 65535]
0x347F		6214	Address 251	F013	1,000	R/W	1	[0 , 65535]
0x3480		6215	Address 252	F013	1,000	R/W	1	[0 , 65535]
0x3481		6216	Address 253	F013	1,000	R/W	1	[0 , 65535]
0x3482		6217	Address 254	F013	1,000	R/W	1	[0 , 65535]
0x3483		6218	Address 255	F013	1,000	R/W	1	[0 , 65535]
0x3494			Confirmation address			W	1	
			Flex Curves 1					
0x3495		6220	Time 0.00xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3497		6221	Time 0.05xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3499		6222	Time 0.10xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x349B		6223	Time 0.15xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x349D		6224	Time 0.20xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x349F		6225	Time 0.25xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34A1		6226	Time 0.30xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34A3		6227	Time 0.35xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34A5		6228	Time 0.40xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34A7		6229	Time 0.45xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34A9		6230	Time 0.48xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34AB		6231	Time 0.50xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34AD		6232	Time 0.52xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34AF		6233	Time 0.54xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34B1		6234	Time 0.56xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34B3		6235	Time 0.58xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34B5		6236	Time 0.60xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34B7		6237	Time 0.62xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34B9		6238	Time 0.64xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34BB		6239	Time 0.66xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34BD		6240	Time 0.68xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34BF		6241	Time 0.70xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34C1		6242	Time 0.72xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34C3		6243	Time 0.74xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34C5		6244	Time 0.76xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34C7		6245	Time 0.78xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34C9		6246	Time 0.80xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34CB		6247	Time 0.82xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34CD		6248	Time 0.84xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34CF		6249	Time 0.86xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34D1		6250	Time 0.88xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34D3		6251	Time 0.90xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34D5		6252	Time 0.91xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34D7		6253	Time 0.92xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34D9		6254	Time 0.93xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34DB		6255	Time 0.94xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x34DD		6256	Time 0.95xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34DF		6257	Time 0.96xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34E1		6258	Time 0.97xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34E3		6259	Time 0.98xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34E5		6260	Time 1.03xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34E7		6261	Time 1.05xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34E9		6262	Time 1.10xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34EB		6263	Time 1.20xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34ED		6264	Time 1.30xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34EF		6265	Time 1.40xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34F1		6266	Time 1.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34F3		6267	Time 1.60xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34F5		6268	Time 1.70xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34F7		6269	Time 1.80xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34F9		6270	Time 1.90xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34FB		6271	Time 2.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34FD		6272	Time 2.10xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x34FF		6273	Time 2.20xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3501		6274	Time 2.30xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3503		6275	Time 2.40xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3505		6276	Time 2.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3507		6277	Time 2.60xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3509		6278	Time 2.70xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x350B		6279	Time 2.80xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x350D		6280	Time 2.90xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x350F		6281	Time 3.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3511		6282	Time 3.10xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3513		6283	Time 3.20xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3515		6284	Time 3.30xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3517		6285	Time 3.40xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3519		6286	Time 3.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x351B		6287	Time 3.60xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x351D		6288	Time 3.70xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x351F		6289	Time 3.80xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3521		6290	Time 3.90xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3523		6291	Time 4.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3525		6292	Time 4.10xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3527		6293	Time 4.20xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3529		6294	Time 4.30xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x352B		6295	Time 4.40xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x352D		6296	Time 4.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x352F		6297	Time 4.60xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x3531		6298	Time 4.70xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3533		6299	Time 4.80xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3535		6300	Time 4.90xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3537		6301	Time 5.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3539		6302	Time 5.10xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x353B		6303	Time 5.20xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x353D		6304	Time 5.30xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x353F		6305	Time 5.40xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3541		6306	Time 5.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3543		6307	Time 5.60xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3545		6308	Time 5.70xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3547		6309	Time 5.80xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3549		6310	Time 5.90xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x354B		6311	Time 6.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x354D		6312	Time 6.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x354F		6313	Time 7.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3551		6314	Time 7.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3553		6315	Time 8.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3555		6316	Time 8.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3557		6317	Time 9.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3559		6318	Time 9.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x355B		6319	Time 10.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x355D		6320	Time 10.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x355F		6321	Time 11.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3561		6322	Time 11.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3563		6323	Time 12.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3565		6324	Time 12.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3567		6325	Time 13.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3569		6326	Time 13.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x356B		6327	Time 14.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x356D		6328	Time 14.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x356F		6329	Time 15.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3571		6330	Time 15.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3573		6331	Time 16.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3575		6332	Time 16.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3577		6333	Time 17.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3579		6334	Time 17.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x357B		6335	Time 18.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x357D		6336	Time 18.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x357F		6337	Time 19.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3581		6338	Time 19.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3583		6339	Time 20.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3598			Confirmation address			W	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
			Flex Curves 2					
0x3599		6341	Time 0.00xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x359B		6342	Time 0.05xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x359D		6343	Time 0.10xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x359F		6344	Time 0.15xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35A1		6345	Time 0.20xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35A3		6346	Time 0.25xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35A5		6347	Time 0.30xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35A7		6348	Time 0.35xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35A9		6349	Time 0.40xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35AB		6350	Time 0.45xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35AD		6351	Time 0.48xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35AF		6352	Time 0.50xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35B1		6353	Time 0.52xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35B3		6354	Time 0.54xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35B5		6355	Time 0.56xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35B7		6356	Time 0.58xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35B9		6357	Time 0.60xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35BB		6358	Time 0.62xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35BD		6359	Time 0.64xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35BF		6360	Time 0.66xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35C1		6361	Time 0.68xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35C3		6362	Time 0.70xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35C5		6363	Time 0.72xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35C7		6364	Time 0.74xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35C9		6365	Time 0.76xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35CB		6366	Time 0.78xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35CD		6367	Time 0.80xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35CF		6368	Time 0.82xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35D1		6369	Time 0.84xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35D3		6370	Time 0.86xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35D5		6371	Time 0.88xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35D7		6372	Time 0.90xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35D9		6373	Time 0.91xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35DB		6374	Time 0.92xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35DD		6375	Time 0.93xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35DF		6376	Time 0.94xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35E1		6377	Time 0.95xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35E3		6378	Time 0.96xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35E5		6379	Time 0.97xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35E7		6380	Time 0.98xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35E9		6381	Time 1.03xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35EB		6382	Time 1.05xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35ED		6383	Time 1.10xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x35EF		6384	Time 1.20xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35F1		6385	Time 1.30xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35F3		6386	Time 1.40xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35F5		6387	Time 1.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35F7		6388	Time 1.60xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35F9		6389	Time 1.70xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35FB		6390	Time 1.80xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35FD		6391	Time 1.90xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x35FF		6392	Time 2.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3601		6393	Time 2.10xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3603		6394	Time 2.20xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3605		6395	Time 2.30xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3607		6396	Time 2.40xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3609		6397	Time 2.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x360B		6398	Time 2.60xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x360D		6399	Time 2.70xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x360F		6400	Time 2.80xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3611		6401	Time 2.90xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3613		6402	Time 3.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3615		6403	Time 3.10xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3617		6404	Time 3.20xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3619		6405	Time 3.30xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x361B		6406	Time 3.40xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x361D		6407	Time 3.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x361F		6408	Time 3.60xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3621		6409	Time 3.70xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3623		6410	Time 3.80xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3625		6411	Time 3.90xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3627		6412	Time 4.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3629		6413	Time 4.10xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x362B		6414	Time 4.20xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x362D		6415	Time 4.30xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x362F		6416	Time 4.40xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3631		6417	Time 4.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3633		6418	Time 4.60xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3635		6419	Time 4.70xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3637		6420	Time 4.80xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3639		6421	Time 4.90xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x363B		6422	Time 5.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x363D		6423	Time 5.10xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x363F		6424	Time 5.20xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3641		6425	Time 5.30xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3643		6426	Time 5.40xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3645		6427	Time 5.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x3647		6428	Time 5.60xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3649		6429	Time 5.70xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x364B		6430	Time 5.80xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x364D		6431	Time 5.90xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x364F		6432	Time 6.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3651		6433	Time 6.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3653		6434	Time 7.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3655		6435	Time 7.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3657		6436	Time 8.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3659		6437	Time 8.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x365B		6438	Time 9.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x365D		6439	Time 9.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x365F		6440	Time 10.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3661		6441	Time 10.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3663		6442	Time 11.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3665		6443	Time 11.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3667		6444	Time 12.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3669		6445	Time 12.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x366B		6446	Time 13.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x366D		6447	Time 13.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x366F		6448	Time 14.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3671		6449	Time 14.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3673		6450	Time 15.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3675		6451	Time 15.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3677		6452	Time 16.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3679		6453	Time 16.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x367B		6454	Time 17.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x367D		6455	Time 17.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x367F		6456	Time 18.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3681		6457	Time 18.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3683		6458	Time 19.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3685		6459	Time 19.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3687		6460	Time 20.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x369C			Confirmation address			W	1	
			Flex Curves 3					
0x369D		6462	Time 0.00xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x369F		6463	Time 0.05xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36A1		6464	Time 0.10xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36A3		6465	Time 0.15xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36A5		6466	Time 0.20xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36A7		6467	Time 0.25xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36A9		6468	Time 0.30xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36AB		6469	Time 0.35xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36AD		6470	Time 0.40xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x36AF		6471	Time 0.45xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36B1		6472	Time 0.48xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36B3		6473	Time 0.50xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36B5		6474	Time 0.52xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36B7		6475	Time 0.54xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36B9		6476	Time 0.56xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36BB		6477	Time 0.58xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36BD		6478	Time 0.60xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36BF		6479	Time 0.62xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36C1		6480	Time 0.64xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36C3		6481	Time 0.66xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36C5		6482	Time 0.68xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36C7		6483	Time 0.70xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36C9		6484	Time 0.72xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36CB		6485	Time 0.74xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36CD		6486	Time 0.76xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36CF		6487	Time 0.78xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36D1		6488	Time 0.80xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36D3		6489	Time 0.82xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36D5		6490	Time 0.84xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36D7		6491	Time 0.86xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36D9		6492	Time 0.88xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36DB		6493	Time 0.90xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36DD		6494	Time 0.91xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36DF		6495	Time 0.92xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36E1		6496	Time 0.93xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36E3		6497	Time 0.94xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36E5		6498	Time 0.95xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36E7		6499	Time 0.96xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36E9		6500	Time 0.97xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36EB		6501	Time 0.98xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36ED		6502	Time 1.03xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36EF		6503	Time 1.05xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36F1		6504	Time 1.10xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36F3		6505	Time 1.20xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36F5		6506	Time 1.30xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36F7		6507	Time 1.40xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36F9		6508	Time 1.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36FB		6509	Time 1.60xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36FD		6510	Time 1.70xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x36FF		6511	Time 1.80xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3701		6512	Time 1.90xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3703		6513	Time 2.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3705		6514	Time 2.10xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x3707		6515	Time 2.20xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3709		6516	Time 2.30xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x370B		6517	Time 2.40xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x370D		6518	Time 2.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x370F		6519	Time 2.60xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3711		6520	Time 2.70xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3713		6521	Time 2.80xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3715		6522	Time 2.90xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3717		6523	Time 3.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3719		6524	Time 3.10xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x371B		6525	Time 3.20xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x371D		6526	Time 3.30xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x371F		6527	Time 3.40xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3721		6528	Time 3.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3723		6529	Time 3.60xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3725		6530	Time 3.70xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3727		6531	Time 3.80xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3729		6532	Time 3.90xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x372B		6533	Time 4.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x372D		6534	Time 4.10xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x372F		6535	Time 4.20xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3731		6536	Time 4.30xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3733		6537	Time 4.40xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3735		6538	Time 4.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3737		6539	Time 4.60xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3739		6540	Time 4.70xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x373B		6541	Time 4.80xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x373D		6542	Time 4.90xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x373F		6543	Time 5.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3741		6544	Time 5.10xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3743		6545	Time 5.20xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3745		6546	Time 5.30xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3747		6547	Time 5.40xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3749		6548	Time 5.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x374B		6549	Time 5.60xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x374D		6550	Time 5.70xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x374F		6551	Time 5.80xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3751		6552	Time 5.90xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3753		6553	Time 6.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3755		6554	Time 6.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3757		6555	Time 7.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3759		6556	Time 7.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x375B		6557	Time 8.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x375D		6558	Time 8.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x375F		6559	Time 9.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3761		6560	Time 9.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3763		6561	Time 10.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3765		6562	Time 10.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3767		6563	Time 11.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3769		6564	Time 11.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x376B		6565	Time 12.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x376D		6566	Time 12.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x376F		6567	Time 13.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3771		6568	Time 13.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3773		6569	Time 14.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3775		6570	Time 14.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3777		6571	Time 15.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3779		6572	Time 15.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x377B		6573	Time 16.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x377D		6574	Time 16.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x377F		6575	Time 17.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3781		6576	Time 17.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3783		6577	Time 18.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3785		6578	Time 18.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3787		6579	Time 19.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3789		6580	Time 19.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x378B		6581	Time 20.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37A0			Confirmation address			W	1	
			Flex Curves 4					
0x37A1		6583	Time 0.00xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37A3		6584	Time 0.05xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37A5		6585	Time 0.10xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37A7		6586	Time 0.15xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37A9		6587	Time 0.20xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37AB		6588	Time 0.25xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37AD		6589	Time 0.30xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37AF		6590	Time 0.35xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37B1		6591	Time 0.40xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37B3		6592	Time 0.45xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37B5		6593	Time 0.48xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37B7		6594	Time 0.50xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37B9		6595	Time 0.52xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37BB		6596	Time 0.54xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37BD		6597	Time 0.56xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37BF		6598	Time 0.58xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37C1		6599	Time 0.60xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37C3		6600	Time 0.62xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37C5		6601	Time 0.64xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x37C7		6602	Time 0.66xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37C9		6603	Time 0.68xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37CB		6604	Time 0.70xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37CD		6605	Time 0.72xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37CF		6606	Time 0.74xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37D1		6607	Time 0.76xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37D3		6608	Time 0.78xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37D5		6609	Time 0.80xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37D7		6610	Time 0.82xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37D9		6611	Time 0.84xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37DB		6612	Time 0.86xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37DD		6613	Time 0.88xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37DF		6614	Time 0.90xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37E1		6615	Time 0.91xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37E3		6616	Time 0.92xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37E5		6617	Time 0.93xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37E7		6618	Time 0.94xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37E9		6619	Time 0.95xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37EB		6620	Time 0.96xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37ED		6621	Time 0.97xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37EF		6622	Time 0.98xPKP [RST]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37F1		6623	Time 1.03xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37F3		6624	Time 1.05xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37F5		6625	Time 1.10xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37F7		6626	Time 1.20xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37F9		6627	Time 1.30xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37FB		6628	Time 1.40xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37FD		6629	Time 1.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x37FF		6630	Time 1.60xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3801		6631	Time 1.70xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3803		6632	Time 1.80xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3805		6633	Time 1.90xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3807		6634	Time 2.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3809		6635	Time 2.10xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x380B		6636	Time 2.20xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x380D		6637	Time 2.30xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x380F		6638	Time 2.40xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3811		6639	Time 2.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3813		6640	Time 2.60xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3815		6641	Time 2.70xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3817		6642	Time 2.80xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3819		6643	Time 2.90xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x381B		6644	Time 3.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x381D		6645	Time 3.10xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x381F		6646	Time 3.20xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3821		6647	Time 3.30xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3823		6648	Time 3.40xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3825		6649	Time 3.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3827		6650	Time 3.60xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3829		6651	Time 3.70xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x382B		6652	Time 3.80xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x382D		6653	Time 3.90xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x382F		6654	Time 4.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3831		6655	Time 4.10xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3833		6656	Time 4.20xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3835		6657	Time 4.30xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3837		6658	Time 4.40xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3839		6659	Time 4.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x383B		6660	Time 4.60xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x383D		6661	Time 4.70xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x383F		6662	Time 4.80xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3841		6663	Time 4.90xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3843		6664	Time 5.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3845		6665	Time 5.10xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3847		6666	Time 5.20xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3849		6667	Time 5.30xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x384B		6668	Time 5.40xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x384D		6669	Time 5.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x384F		6670	Time 5.60xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3851		6671	Time 5.70xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3853		6672	Time 5.80xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3855		6673	Time 5.90xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3857		6674	Time 6.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3859		6675	Time 6.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x385B		6676	Time 7.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x385D		6677	Time 7.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x385F		6678	Time 8.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3861		6679	Time 8.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3863		6680	Time 9.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3865		6681	Time 9.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3867		6682	Time 10.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3869		6683	Time 10.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x386B		6684	Time 11.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x386D		6685	Time 11.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x386F		6686	Time 12.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3871		6687	Time 12.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3873		6688	Time 13.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3875		6689	Time 13.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x3877		6690	Time 14.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3879		6691	Time 14.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x387B		6692	Time 15.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x387D		6693	Time 15.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x387F		6694	Time 16.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3881		6695	Time 16.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3883		6696	Time 17.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3885		6697	Time 17.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3887		6698	Time 18.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x3889		6699	Time 18.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x388B		6700	Time 19.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x388D		6701	Time 19.50xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x388F		6702	Time 20.00xPKP [OP]	F003	1,000	R/W	2	[0,000 , 65,535] s
0x38A4			Confirmation address			W	1	
			Modbus Protocol					
0x38A5		6840	Modbus Address COM1	F004	1,000	R/W	1	[1 , 255]
0x38A6		6841	Modbus Address COM2	F004	1,000	R/W	1	[1 , 255]
0x38A7		6842	Modbus Port Number	F005	1,000	R/W	2	[0 , 65535]
0x38BC			Confirmation address			W	1	
			Serial Ports					
0x38BD		6843	COM1 Baud Rate	F012	1,000	R/W	1	0=300
								1=600
								2=1200
								3=2400
								4=4800
								5=9600
								6=19200
								7=38400
								8=57600
								9=115200
0x38BE		6844	COM2 Baud Rate	F012	1,000	R/W	1	0=300
								1=600
								2=1200
								3=2400
								4=4800
								5=9600
								6=19200
								7=38400
								8=57600
								9=115200
0x38BF		8078	COM1 Parity	F012	1,000	R/W	1	0=NONE
								1=ODD
								2=EVEN
0x38C0		8079	COM2 Parity	F012	1,000	R/W	1	0=NONE

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								1=ODD
								2=EVEN
0x38D3			Confirmation address			W	1	
			Data Logger					
0x38D4		6852	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x38D5		6853	Data Logger Rate	F012	1,000	R/W	1	0=1 s
								1=5 Minutes
								2=10 Minutes
								3=15 Minutes
								4=20 Minutes
								5=30 Minutes
								6=60 Minutes
0x38D6		6854	Data Logger Chnl 1	F004	1,000	R/W	1	[0 , 32767]
0x38D7		6855	Data Logger Chnl 2	F004	1,000	R/W	1	[0 , 32767]
0x38D8		6856	Data Logger Chnl 3	F004	1,000	R/W	1	[0 , 32767]
0x38D9		6857	Data Logger Chnl 4	F004	1,000	R/W	1	[0 , 32767]
0x38DA		6858	Data Logger Chnl 5	F004	1,000	R/W	1	[0 , 32767]
0x38DB		6859	Data Logger Chnl 6	F004	1,000	R/W	1	[0 , 32767]
0x38DC		6860	Data Logger Chnl 7	F004	1,000	R/W	1	[0 , 32767]
0x38DD		6861	Data Logger Chnl 8	F004	1,000	R/W	1	[0 , 32767]
0x38DE		6862	Data Logger Chnl 9	F004	1,000	R/W	1	[0 , 32767]
0x38DF		6863	Data Logger Chnl 10	F004	1,000	R/W	1	[0 , 32767]
0x38E0		6864	Data Logger Chnl 11	F004	1,000	R/W	1	[0 , 32767]
0x38E1		6865	Data Logger Chnl 12	F004	1,000	R/W	1	[0 , 32767]
0x38E2		6866	Data Logger Chnl 13	F004	1,000	R/W	1	[0 , 32767]
0x38E3		6867	Data Logger Chnl 14	F004	1,000	R/W	1	[0 , 32767]
0x38E4		6868	Data Logger Chnl 15	F004	1,000	R/W	1	[0 , 32767]
0x38E5		6869	Data Logger Chnl 16	F004	1,000	R/W	1	[0 , 32767]
0x38E6		11854	Data Logger Scale 1	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x38E7		11855	Data Logger Scale 2	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x38E8		11856	Data Logger Scale 3	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x38E9		11857	Data Logger Scale 4	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x38EA		11858	Data Logger Scale 5	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x38EB		11859	Data Logger Scale 6	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								9=10000
0x38EC		11860	Data Logger Scale 7	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x38ED		11861	Data Logger Scale 8	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x38EE		11862	Data Logger Scale 9	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x38EF		11863	Data Logger Scale 10	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x38F0		11864	Data Logger Scale 11	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x38F1		11865	Data Logger Scale 12	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x38F2		11866	Data Logger Scale 13	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x38F3		11867	Data Logger Scale 14	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x38F4		11868	Data Logger Scale 15	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								7=100
								8=1000
								9=10000
0x38F5		11869	Data Logger Scale 16	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x38F9			Confirmation address			W	1	
			Directional Power 1					
0x38FA		7008	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x38FB		7009	Blk Time After Close	F003	1,000	R/W	2	[0,00 , 900,00] s
0x38FD		7010	Dir Power Angle 1	F003	1,000	R/W	2	[0,00 , 359,99] Deg
0x38FF		7011	Stage 1 Tap	F003	1,000	R/W	2	[-10000,00 , 10000,00] MW
0x3901		7012	Stage 1 Time	F003	1,000	R/W	2	[0,00 , 900,00] s
0x3903		7013	Dir Power Angle 2	F003	1,000	R/W	2	[0,00 , 359,99] Deg
0x3905		7014	Stage 2 Tap	F003	1,000	R/W	2	[-10000,00 , 10000,00] MW
0x3907		7015	Stage 2 Time	F003	1,000	R/W	2	[0,00 , 900,00] s
0x3909		7016	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x391C			Confirmation address			W	1	
			Directional Power 2					
0x391D		7024	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x391E		7025	Blk Time After Close	F003	1,000	R/W	2	[0,00 , 900,00] s
0x3920		7026	Dir Power Angle 1	F003	1,000	R/W	2	[0,00 , 359,99] Deg
0x3922		7027	Stage 1 Tap	F003	1,000	R/W	2	[-10000,00 , 10000,00] MW
0x3924		7028	Stage 1 Time	F003	1,000	R/W	2	[0,00 , 900,00] s
0x3926		7029	Dir Power Angle 2	F003	1,000	R/W	2	[0,00 , 359,99] Deg
0x3928		7030	Stage 2 Tap	F003	1,000	R/W	2	[-10000,00 , 10000,00] MW
0x392A		7031	Stage 2 Time	F003	1,000	R/W	2	[0,00 , 900,00] s
0x392C		7032	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x393F			Confirmation address			W	1	
			Directional Power 3					
0x3940		7040	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x3941		7041	Blk Time After Close	F003	1,000	R/W	2	[0,00 , 900,00] s

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x3943		7042	Dir Power Angle 1	F003	1,000	R/W	2	[0,00 , 359,99] Deg
0x3945		7043	Stage 1 Tap	F003	1,000	R/W	2	[-10000,00 , 10000,00] MW
0x3947		7044	Stage 1 Time	F003	1,000	R/W	2	[0,00 , 900,00] s
0x3949		7045	Dir Power Angle 2	F003	1,000	R/W	2	[0,00 , 359,99] Deg
0x394B		7046	Stage 2 Tap	F003	1,000	R/W	2	[-10000,00 , 10000,00] MW
0x394D		7047	Stage 2 Time	F003	1,000	R/W	2	[0,00 , 900,00] s
0x394F		7048	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x3962			Confirmation address			W	1	
			Phase OV 1					
0x39A2		7094	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x39A3		11155	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x39A5		7096	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x39A7		7097	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x39A9		7098	Logic	F012	1,000	R/W	1	0=ANY PHASE
								1=TWO PHASES
								2=ALL PHASES
0x39AA		7099	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x39BD			Confirmation address			W	1	
			Phase UV 1					
0x39BE		7109	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x39BF		7110	Mode	F012	1,000	R/W	1	0=PHASE-PHASE
								1=PHASE-GROUND
0x39C0		11186	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x39C2		7112	Curve	F012	1,000	R/W	1	0=DEFINITE TIME
								1=INVERSE TIME
0x39C3		7113	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x39C5		11187	Minimum Voltage	F003	1,000	R/W	2	[0,00 , 1,25] x VT
0x39C7		7115	Logic	F012	1,000	R/W	1	0=ANY PHASE
								1=TWO PHASES
								2=ALL PHASES
0x39C8		7116	Supervised by 52	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x39C9		7117	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x39DC			Confirmation address			W	1	
			Remote Comms					
0x3A76		8002	Remote Comms	F012	1,000	R/W	1	0=NONE
								1=GSSE
								2=GOOSE
0x3A77		7532	650 ID	F009	1,000	R/W	33	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x3A98		7533	Hold Time	F005	1,000	R/W	2	[1000 , 60000] ms
0x3A9A		7534	Snapshot Events Remote Out	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x3A9B		7535	Remote Device 1	F009	1,000	R/W	33	
0x3ABC		7536	Bit Pair 1	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3ABD		7537	Default Value 1	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3ABE		7538	Remote Device 2	F009	1,000	R/W	33	
0x3ADF		7539	Bit Pair 2	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3AE0		7540	Default Value 2	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3AE1		7541	Remote Device 3	F009	1,000	R/W	33	
0x3B02		7542	Bit Pair 3	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3B03		7543	Default Value 3	F012	1,000	R/W	1	0=OFF
								1=ON

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								2=Latest OFF
								3=Latest ON
0x3B04		7544	Remote Device 4	F009	1,000	R/W	33	
0x3B25		7545	Bit Pair 4	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3B26		7546	Default Value 4	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3B27		7547	Remote Device 5	F009	1,000	R/W	33	
0x3B48		7548	Bit Pair 5	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3B49		7549	Default Value 5	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3B4A		7550	Remote Device 6	F009	1,000	R/W	33	
0x3B6B		7551	Bit Pair 6	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3B6C		7552	Default Value 6	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x3B6D		7553	Remote Device 7	F009	1,000	R/W	33	
0x3B8E		7554	Bit Pair 7	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3B8F		7555	Default Value 7	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3B90		7556	Remote Device 8	F009	1,000	R/W	33	
0x3BB1		7557	Bit Pair 8	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3BB2		7558	Default Value 8	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3BB3		7559	Remote Device 9	F009	1,000	R/W	33	
0x3BD4		7560	Bit Pair 9	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3BD5		7561	Default Value 9	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3BD6		7562	Remote Device 10	F009	1,000	R/W	33	
0x3BF7		7563	Bit Pair 10	F012	1,000	R/W	1	0=None

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3BF8		7564	Default Value 10	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3BF9		7565	Remote Device 11	F009	1,000	R/W	33	
0x3C1A		7566	Bit Pair 11	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3C1B		7567	Default Value 11	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3C1C		7568	Remote Device 12	F009	1,000	R/W	33	
0x3C3D		7569	Bit Pair 12	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3C3E		7570	Default Value 12	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3C3F		7571	Remote Device 13	F009	1,000	R/W	33	
0x3C60		7572	Bit Pair 13	F012	1,000	R/W	1	0=None
								1=DNA-1

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3C61		7573	Default Value 13	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3C62		7574	Remote Device 14	F009	1,000	R/W	33	
0x3C83		7575	Bit Pair 14	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3C84		7576	Default Value 14	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3C85		7577	Remote Device 15	F009	1,000	R/W	33	
0x3CA6		7578	Bit Pair 15	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3CA7		7579	Default Value 15	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3CA8		7580	Remote Device 16	F009	1,000	R/W	33	
0x3CC9		7581	Bit Pair 16	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3CCA		7582	Default Value 16	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3CCB		7583	Remote Device 17	F009	1,000	R/W	33	
0x3CEC		7584	Bit Pair 17	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3CED		7585	Default Value 17	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3CEE		7586	Remote Device 18	F009	1,000	R/W	33	
0x3D0F		7587	Bit Pair 18	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3D10		7588	Default Value 18	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3D11		7589	Remote Device 19	F009	1,000	R/W	33	
0x3D32		7590	Bit Pair 19	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3D33		7591	Default Value 19	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3D34		7592	Remote Device 20	F009	1,000	R/W	33	
0x3D55		7593	Bit Pair 20	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3D56		7594	Default Value 20	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3D57		7595	Remote Device 21	F009	1,000	R/W	33	
0x3D78		7596	Bit Pair 21	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3D79		7597	Default Value 21	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3D7A		7598	Remote Device 22	F009	1,000	R/W	33	
0x3D9B		7599	Bit Pair 22	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3D9C		7600	Default Value 22	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3D9D		7601	Remote Device 23	F009	1,000	R/W	33	
0x3DBE		7602	Bit Pair 23	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3DBF		7603	Default Value 23	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3DC0		7604	Remote Device 24	F009	1,000	R/W	33	
0x3DE1		7605	Bit Pair 24	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3DE2		7606	Default Value 24	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3DE3		7607	Remote Device 25	F009	1,000	R/W	33	
0x3E04		7608	Bit Pair 25	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								96=UserSt-64
0x3E05		7609	Default Value 25	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3E06		7610	Remote Device 26	F009	1,000	R/W	33	
0x3E27		7611	Bit Pair 26	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3E28		7612	Default Value 26	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3E29		7613	Remote Device 27	F009	1,000	R/W	33	
0x3E4A		7614	Bit Pair 27	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3E4B		7615	Default Value 27	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3E4C		7616	Remote Device 28	F009	1,000	R/W	33	
0x3E6D		7617	Bit Pair 28	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3E6E		7618	Default Value 28	F012	1,000	R/W	1	0=OFF

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								1=ON
								2=Latest OFF
								3=Latest ON
0x3E6F		7619	Remote Device 29	F009	1,000	R/W	33	
0x3E90		7620	Bit Pair 29	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3E91		7621	Default Value 29	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3E92		7622	Remote Device 30	F009	1,000	R/W	33	
0x3EB3		7623	Bit Pair 30	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3EB4		7624	Default Value 30	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3EB5		7625	Remote Device 31	F009	1,000	R/W	33	
0x3ED6		7626	Bit Pair 31	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3ED7		7627	Default Value 31	F012	1,000	R/W	1	0=OFF
								1=ON

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								2=Latest OFF
								3=Latest ON
0x3ED8		7628	Remote Device 32	F009	1,000	R/W	33	
0x3EF9		7629	Bit Pair 32	F012	1,000	R/W	1	0=None
								1=DNA-1
								2=DNA-2
								3=DNA-3
								4=DNA-4
								5=DNA-5
								6=DNA-6
								7=DNA-7
								8=DNA-8
								9=DNA-9
								10=DNA-10
								11=DNA-11
								12=DNA-12
								13=DNA-13
								14=DNA-14
								15=DNA-15
								16=DNA-16
								17=DNA-17
								18=DNA-18
								19=DNA-19
								20=DNA-20
								21=DNA-21
								22=DNA-22
								23=DNA-23
								24=DNA-24
								25=DNA-25
								26=DNA-26
								27=DNA-27
								28=DNA-28
								29=DNA-29
								30=DNA-30
								31=DNA-31
								32=DNA-32
								33=UserSt-1
								34=UserSt-2
								35=UserSt-3
								36=UserSt-4
								37=UserSt-5
								38=UserSt-6
								39=UserSt-7
								40=UserSt-8

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								41=UserSt-9
								42=UserSt-10
								43=UserSt-11
								44=UserSt-12
								45=UserSt-13
								46=UserSt-14
								47=UserSt-15
								48=UserSt-16
								49=UserSt-17
								50=UserSt-18
								51=UserSt-19
								52=UserSt-20
								53=UserSt-21
								54=UserSt-22
								55=UserSt-23
								56=UserSt-24
								57=UserSt-25
								58=UserSt-26
								59=UserSt-27
								60=UserSt-28
								61=UserSt-29
								62=UserSt-30
								63=UserSt-31
								64=UserSt-32
								65=UserSt-33
								66=UserSt-34
								67=UserSt-35
								68=UserSt-36
								69=UserSt-37
								70=UserSt-38
								71=UserSt-39
								72=UserSt-40
								73=UserSt-41
								74=UserSt-42
								75=UserSt-43
								76=UserSt-44
								77=UserSt-45
								78=UserSt-46
								79=UserSt-47
								80=UserSt-48
								81=UserSt-49
								82=UserSt-50
								83=UserSt-51
								84=UserSt-52

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								85=UserSt-53
								86=UserSt-54
								87=UserSt-55
								88=UserSt-56
								89=UserSt-57
								90=UserSt-58
								91=UserSt-59
								92=UserSt-60
								93=UserSt-61
								94=UserSt-62
								95=UserSt-63
								96=UserSt-64
0x3EFA		7630	Default Value 32	F012	1,000	R/W	1	0=OFF
								1=ON
								2=Latest OFF
								3=Latest ON
0x3EFB		7631	Snapshot Events Remote Inp	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x3EFC		10092	Destination MAC Data1	F004	1,000	R/W	1	
0x3EFD		10093	Destination MAC Data2	F004	1,000	R/W	1	
0x3EFE		10094	Destination MAC Data3	F004	1,000	R/W	1	
0x3EFF		10095	GSSE RemDevice01 MAC Data1	F004	1,000	R/W	1	
0x3F00		10096	GSSE RemDevice01 MAC Data2	F004	1,000	R/W	1	
0x3F01		10097	GSSE RemDevice01 MAC Data3	F004	1,000	R/W	1	
0x3F02		10098	GSSE RemDevice02 MAC Data1	F004	1,000	R/W	1	
0x3F03		10099	GSSE RemDevice02 MAC Data2	F004	1,000	R/W	1	
0x3F04		10100	GSSE RemDevice02 MAC Data3	F004	1,000	R/W	1	
0x3F05		10101	GSSE RemDevice03 MAC Data1	F004	1,000	R/W	1	
0x3F06		10102	GSSE RemDevice03 MAC Data2	F004	1,000	R/W	1	
0x3F07		10103	GSSE RemDevice03 MAC Data3	F004	1,000	R/W	1	
0x3F08		10104	GSSE RemDevice04 MAC Data1	F004	1,000	R/W	1	
0x3F09		10105	GSSE RemDevice04 MAC Data2	F004	1,000	R/W	1	
0x3F0A		10106	GSSE RemDevice04 MAC Data3	F004	1,000	R/W	1	
0x3F0B		10107	GSSE RemDevice05 MAC Data1	F004	1,000	R/W	1	
0x3F0C		10108	GSSE RemDevice05 MAC Data2	F004	1,000	R/W	1	
0x3F0D		10109	GSSE RemDevice05 MAC Data3	F004	1,000	R/W	1	
0x3F0E		10110	GSSE RemDevice06 MAC Data1	F004	1,000	R/W	1	
0x3F0F		10111	GSSE RemDevice06 MAC Data2	F004	1,000	R/W	1	
0x3F10		10112	GSSE RemDevice06 MAC Data3	F004	1,000	R/W	1	
0x3F11		10113	GSSE RemDevice07 MAC Data1	F004	1,000	R/W	1	
0x3F12		10114	GSSE RemDevice07 MAC Data2	F004	1,000	R/W	1	
0x3F13		10115	GSSE RemDevice07 MAC Data3	F004	1,000	R/W	1	
0x3F14		10116	GSSE RemDevice08 MAC Data1	F004	1,000	R/W	1	
0x3F15		10117	GSSE RemDevice08 MAC Data2	F004	1,000	R/W	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x3F16		10118	GSSE RemDevice08 MAC Data3	F004	1,000	R/W	1	
0x3F17		10119	GSSE RemDevice09 MAC Data1	F004	1,000	R/W	1	
0x3F18		10120	GSSE RemDevice09 MAC Data2	F004	1,000	R/W	1	
0x3F19		10121	GSSE RemDevice09 MAC Data3	F004	1,000	R/W	1	
0x3F1A		10122	GSSE RemDevice10 MAC Data1	F004	1,000	R/W	1	
0x3F1B		10123	GSSE RemDevice10 MAC Data2	F004	1,000	R/W	1	
0x3F1C		10124	GSSE RemDevice10 MAC Data3	F004	1,000	R/W	1	
0x3F1D		10125	GSSE RemDevice11 MAC Data1	F004	1,000	R/W	1	
0x3F1E		10126	GSSE RemDevice11 MAC Data2	F004	1,000	R/W	1	
0x3F1F		10127	GSSE RemDevice11 MAC Data3	F004	1,000	R/W	1	
0x3F20		10128	GSSE RemDevice12 MAC Data1	F004	1,000	R/W	1	
0x3F21		10129	GSSE RemDevice12 MAC Data2	F004	1,000	R/W	1	
0x3F22		10130	GSSE RemDevice12 MAC Data3	F004	1,000	R/W	1	
0x3F23		10131	GSSE RemDevice13 MAC Data1	F004	1,000	R/W	1	
0x3F24		10132	GSSE RemDevice13 MAC Data2	F004	1,000	R/W	1	
0x3F25		10133	GSSE RemDevice13 MAC Data3	F004	1,000	R/W	1	
0x3F26		10134	GSSE RemDevice14 MAC Data1	F004	1,000	R/W	1	
0x3F27		10135	GSSE RemDevice14 MAC Data2	F004	1,000	R/W	1	
0x3F28		10136	GSSE RemDevice14 MAC Data3	F004	1,000	R/W	1	
0x3F29		10137	GSSE RemDevice15 MAC Data1	F004	1,000	R/W	1	
0x3F2A		10138	GSSE RemDevice15 MAC Data2	F004	1,000	R/W	1	
0x3F2B		10139	GSSE RemDevice15 MAC Data3	F004	1,000	R/W	1	
0x3F2C		10140	GSSE RemDevice16 MAC Data1	F004	1,000	R/W	1	
0x3F2D		10141	GSSE RemDevice16 MAC Data2	F004	1,000	R/W	1	
0x3F2E		10142	GSSE RemDevice16 MAC Data3	F004	1,000	R/W	1	
0x3F2F		10143	GSSE RemDevice17 MAC Data1	F004	1,000	R/W	1	
0x3F30		10144	GSSE RemDevice17 MAC Data2	F004	1,000	R/W	1	
0x3F31		10145	GSSE RemDevice17 MAC Data3	F004	1,000	R/W	1	
0x3F32		10146	GSSE RemDevice18 MAC Data1	F004	1,000	R/W	1	
0x3F33		10147	GSSE RemDevice18 MAC Data2	F004	1,000	R/W	1	
0x3F34		10148	GSSE RemDevice18 MAC Data3	F004	1,000	R/W	1	
0x3F35		10149	GSSE RemDevice19 MAC Data1	F004	1,000	R/W	1	
0x3F36		10150	GSSE RemDevice19 MAC Data2	F004	1,000	R/W	1	
0x3F37		10151	GSSE RemDevice19 MAC Data3	F004	1,000	R/W	1	
0x3F38		10152	GSSE RemDevice20 MAC Data1	F004	1,000	R/W	1	
0x3F39		10153	GSSE RemDevice20 MAC Data2	F004	1,000	R/W	1	
0x3F3A		10154	GSSE RemDevice20 MAC Data3	F004	1,000	R/W	1	
0x3F3B		10155	GSSE RemDevice21 MAC Data1	F004	1,000	R/W	1	
0x3F3C		10156	GSSE RemDevice21 MAC Data2	F004	1,000	R/W	1	
0x3F3D		10157	GSSE RemDevice21 MAC Data3	F004	1,000	R/W	1	
0x3F3E		10158	GSSE RemDevice22 MAC Data1	F004	1,000	R/W	1	
0x3F3F		10159	GSSE RemDevice22 MAC Data2	F004	1,000	R/W	1	
0x3F40		10160	GSSE RemDevice22 MAC Data3	F004	1,000	R/W	1	
0x3F41		10161	GSSE RemDevice23 MAC Data1	F004	1,000	R/W	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x3F42		10162	GSSE RemDevice23 MAC Data2	F004	1,000	R/W	1	
0x3F43		10163	GSSE RemDevice23 MAC Data3	F004	1,000	R/W	1	
0x3F44		10164	GSSE RemDevice24 MAC Data1	F004	1,000	R/W	1	
0x3F45		10165	GSSE RemDevice24 MAC Data2	F004	1,000	R/W	1	
0x3F46		10166	GSSE RemDevice24 MAC Data3	F004	1,000	R/W	1	
0x3F47		10167	GSSE PORT	F012	1,000	R/W	1	0=PORT A
								1=PORT B
								2=BOTH
0x3F5B			Confirmation address			W	1	
			SNTP Client 1					
0x3F5C		7776	Function	F012	1,000	R/W	1	0=DISABLED
								1=UNICAST
								2=BROADCAST
								3=ANYCAST
0x3F5D		7777	UDP Port	F005	1,000	R/W	2	[1 , 65535]
0x3F5F		7778	Server IP Oct1	F004	1,000	R/W	1	[0 , 255]
0x3F60		7779	Server IP Oct2	F004	1,000	R/W	1	[0 , 255]
0x3F61		7780	Server IP Oct3	F004	1,000	R/W	1	[0 , 255]
0x3F62		7781	Server IP Oct4	F004	1,000	R/W	1	[0 , 255]
0x3F66			Confirmation address			W	1	
			SNTP Client 2					
0x3F67		10650	Server2 UDP Port	F005	1,000	R/W	2	[1 , 65535]
0x3F69		10651	Server2 IP Oct1	F004	1,000	R/W	1	[0 , 255]
0x3F6A		10652	Server2 IP Oct2	F004	1,000	R/W	1	[0 , 255]
0x3F6B		10653	Server2 IP Oct3	F004	1,000	R/W	1	[0 , 255]
0x3F6C		10654	Server2 IP Oct4	F004	1,000	R/W	1	[0 , 255]
0x3F87			Confirmation address			W	1	
			Pulse Counters					
0x3F88		7790	PulseCntr Enabled 1	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x3F89		7791	PulseCntr Name 1	F009	1,000	R/W	16	
0x3F99		7792	PulseCntr Factor 1	F003	1,000	R/W	2	[0,000 , 65000,000]
0x3F9B		7793	PulseCntr Overflow 1	F005	1,000	R/W	2	[0 , 1000000]
0x3F9D		7794	PulseCntr Board Origin 1	F012	1,000	R/W	1	0=F
								1=G
								2=H
								3=J
								4=2H
								5=2J
0x3F9E		7795	PulseCntr Input Origin 1	F004	1,000	R/W	1	[1 , 32]
0x3F9F		7796	PulseCntr Enabled 2	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x3FA0		7797	PulseCntr Name 2	F009	1,000	R/W	16	
0x3FB0		7798	PulseCntr Factor 2	F003	1,000	R/W	2	[0,000 , 65000,000]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x3FB2		7799	PulseCntr Overflow 2	F005	1,000	R/W	2	[0 , 1000000]
0x3FB4		7800	PulseCntr Board Origin 2	F012	1,000	R/W	1	0=F
								1=G
								2=H
								3=J
								4=2H
								5=2J
0x3FB5		7801	PulseCntr Input Origin 2	F004	1,000	R/W	1	[1 , 32]
0x3FB6		7802	PulseCntr Enabled 3	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x3FB7		7803	PulseCntr Name 3	F009	1,000	R/W	16	
0x3FC7		7804	PulseCntr Factor 3	F003	1,000	R/W	2	[0,000 , 65000,000]
0x3FC9		7805	PulseCntr Overflow 3	F005	1,000	R/W	2	[0 , 1000000]
0x3FCB		7806	PulseCntr Board Origin 3	F012	1,000	R/W	1	0=F
								1=G
								2=H
								3=J
								4=2H
								5=2J
0x3FCC		7807	PulseCntr Input Origin 3	F004	1,000	R/W	1	[1 , 32]
0x3FCD		7808	PulseCntr Enabled 4	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x3FCE		7809	PulseCntr Name 4	F009	1,000	R/W	16	
0x3FDE		7810	PulseCntr Factor 4	F003	1,000	R/W	2	[0,000 , 65000,000]
0x3FE0		7811	PulseCntr Overflow 4	F005	1,000	R/W	2	[0 , 1000000]
0x3FE2		7812	PulseCntr Board Origin 4	F012	1,000	R/W	1	0=F
								1=G
								2=H
								3=J
								4=2H
								5=2J
0x3FE3		7813	PulseCntr Input Origin 4	F004	1,000	R/W	1	[1 , 32]
0x3FE4		7814	PulseCntr Enabled 5	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x3FE5		7815	PulseCntr Name 5	F009	1,000	R/W	16	
0x3FF5		7816	PulseCntr Factor 5	F003	1,000	R/W	2	[0,000 , 65000,000]
0x3FF7		7817	PulseCntr Overflow 5	F005	1,000	R/W	2	[0 , 1000000]
0x3FF9		7818	PulseCntr Board Origin 5	F012	1,000	R/W	1	0=F
								1=G
								2=H
								3=J
								4=2H
								5=2J
0x3FFA		7819	PulseCntr Input Origin 5	F004	1,000	R/W	1	[1 , 32]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x3FFB		7820	PulseCntr Enabled 6	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x3FFC		7821	PulseCntr Name 6	F009	1,000	R/W	16	
0x400C		7822	PulseCntr Factor 6	F003	1,000	R/W	2	[0,000 , 65000,000]
0x400E		7823	PulseCntr Overflow 6	F005	1,000	R/W	2	[0 , 1000000]
0x4010		7824	PulseCntr Board Origin 6	F012	1,000	R/W	1	0=F
								1=G
								2=H
								3=J
								4=2H
								5=2J
0x4011		7825	PulseCntr Input Origin 6	F004	1,000	R/W	1	[1 , 32]
0x4012		7826	PulseCntr Enabled 7	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4013		7827	PulseCntr Name 7	F009	1,000	R/W	16	
0x4023		7828	PulseCntr Factor 7	F003	1,000	R/W	2	[0,000 , 65000,000]
0x4025		7829	PulseCntr Overflow 7	F005	1,000	R/W	2	[0 , 1000000]
0x4027		7830	PulseCntr Board Origin 7	F012	1,000	R/W	1	0=F
								1=G
								2=H
								3=J
								4=2H
								5=2J
0x4028		7831	PulseCntr Input Origin 7	F004	1,000	R/W	1	[1 , 32]
0x4029		7832	PulseCntr Enabled 8	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x402A		7833	PulseCntr Name 8	F009	1,000	R/W	16	
0x403A		7834	PulseCntr Factor 8	F003	1,000	R/W	2	[0,000 , 65000,000]
0x403C		7835	PulseCntr Overflow 8	F005	1,000	R/W	2	[0 , 1000000]
0x403E		7836	PulseCntr Board Origin 8	F012	1,000	R/W	1	0=F
								1=G
								2=H
								3=J
								4=2H
								5=2J
0x403F		7837	PulseCntr Input Origin 8	F004	1,000	R/W	1	[1 , 32]
0x4052			Confirmation address			W	1	
			Analog Comparators					
0x4053		7854	Analog Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4054		7855	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4055		7856	Analog Input 01	F004	1,000	R/W	1	[0 , 32767]
0x4056		7857	Analog Maximum 1	F003	1,000	R/W	2	[-100000,000 , 100000,000]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x4058		7858	Analog Minimum 1	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x405A		7859	Analog Delay 01	F003	1,000	R/W	2	[0,00 , 900,00] s
0x405C		7860	Analog Hysteresis 1	F003	1,000	R/W	2	[0,0 , 50,0]
0x405E		7861	Analog Direction 1	F012	1,000	R/W	1	0=OUT
								1=IN
0x405F		7862	Analog Input 2	F004	1,000	R/W	1	[0 , 32767]
0x4060		7863	Analog Maximum 2	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x4062		7864	Analog Minimum 2	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x4064		7865	Analog Delay 2	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4066		7866	Analog Hysteresis 2	F003	1,000	R/W	2	[0,0 , 50,0]
0x4068		7867	Analog Direction 2	F012	1,000	R/W	1	0=OUT
								1=IN
0x4069		7868	Analog Input 3	F004	1,000	R/W	1	[0 , 32767]
0x406A		7869	Analog Maximum 3	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x406C		7870	Analog Minimum 3	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x406E		7871	Analog Delay 3	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4070		7872	Analog Hysteresis 3	F003	1,000	R/W	2	[0,0 , 50,0]
0x4072		7873	Analog Direction 3	F012	1,000	R/W	1	0=OUT
								1=IN
0x4073		7874	Analog Input 4	F004	1,000	R/W	1	[0 , 32767]
0x4074		7875	Analog Maximum 4	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x4076		7876	Analog Minimum 4	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x4078		7877	Analog Delay 4	F003	1,000	R/W	2	[0,00 , 900,00] s
0x407A		7878	Analog Hysteresis 4	F003	1,000	R/W	2	[0,0 , 50,0]
0x407C		7879	Analog Direction 4	F012	1,000	R/W	1	0=OUT
								1=IN
0x407D		7880	Analog Input 5	F004	1,000	R/W	1	[0 , 32767]
0x407E		7881	Analog Maximum 5	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x4080		7882	Analog Minimum 5	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x4082		7883	Analog Delay 5	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4084		7884	Analog Hysteresis 5	F003	1,000	R/W	2	[0,0 , 50,0]
0x4086		7885	Analog Direction 5	F012	1,000	R/W	1	0=OUT
								1=IN
0x4087		7886	Analog Input 6	F004	1,000	R/W	1	[0 , 32767]
0x4088		7887	Analog Maximum 6	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x408A		7888	Analog Minimum 6	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x408C		7889	Analog Delay 6	F003	1,000	R/W	2	[0,00 , 900,00] s
0x408E		7890	Analog Hysteresis 6	F003	1,000	R/W	2	[0,0 , 50,0]
0x4090		7891	Analog Direction 6	F012	1,000	R/W	1	0=OUT
								1=IN
0x4091		7892	Analog Input 7	F004	1,000	R/W	1	[0 , 32767]
0x4092		7893	Analog Maximum 7	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x4094		7894	Analog Minimum 7	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x4096		7895	Analog Delay 7	F003	1,000	R/W	2	[0,00 , 900,00] s

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x4098		7896	Analog Hysteresis 7	F003	1,000	R/W	2	[0,0 , 50,0]
0x409A		7897	Analog Direction 7	F012	1,000	R/W	1	0=OUT
								1=IN
0x409B		7898	Analog Input 8	F004	1,000	R/W	1	[0 , 32767]
0x409C		7899	Analog Maximum 8	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x409E		7900	Analog Minimum 8	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x40A0		7901	Analog Delay 8	F003	1,000	R/W	2	[0,00 , 900,00] s
0x40A2		7902	Analog Hysteresis 8	F003	1,000	R/W	2	[0,0 , 50,0]
0x40A4		7903	Analog Direction 8	F012	1,000	R/W	1	0=OUT
								1=IN
0x40A5		7904	Analog Input 9	F004	1,000	R/W	1	[0 , 32767]
0x40A6		7905	Analog Maximum 9	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x40A8		7906	Analog Minimum 9	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x40AA		7907	Analog Delay 9	F003	1,000	R/W	2	[0,00 , 900,00] s
0x40AC		7908	Analog Hysteresis 9	F003	1,000	R/W	2	[0,0 , 50,0]
0x40AE		7909	Analog Direction 9	F012	1,000	R/W	1	0=OUT
								1=IN
0x40AF		7910	Analog Input 10	F004	1,000	R/W	1	[0 , 32767]
0x40B0		7911	Analog Maximum 10	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x40B2		7912	Analog Minimum 10	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x40B4		7913	Analog Delay 10	F003	1,000	R/W	2	[0,00 , 900,00] s
0x40B6		7914	Analog Hysteresis 10	F003	1,000	R/W	2	[0,0 , 50,0]
0x40B8		7915	Analog Direction 10	F012	1,000	R/W	1	0=OUT
								1=IN
0x40B9		7916	Analog Input 11	F004	1,000	R/W	1	[0 , 32767]
0x40BA		7917	Analog Maximum 11	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x40BC		7918	Analog Minimum 11	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x40BE		7919	Analog Delay 11	F003	1,000	R/W	2	[0,00 , 900,00] s
0x40C0		7920	Analog Hysteresis 11	F003	1,000	R/W	2	[0,0 , 50,0]
0x40C2		7921	Analog Direction 11	F012	1,000	R/W	1	0=OUT
								1=IN
0x40C3		7922	Analog Input 12	F004	1,000	R/W	1	[0 , 32767]
0x40C4		7923	Analog Maximum 12	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x40C6		7924	Analog Minimum 12	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x40C8		7925	Analog Delay 12	F003	1,000	R/W	2	[0,00 , 900,00] s
0x40CA		7926	Analog Hysteresis 12	F003	1,000	R/W	2	[0,0 , 50,0]
0x40CC		7927	Analog Direction 12	F012	1,000	R/W	1	0=OUT
								1=IN
0x40CD		7928	Analog Input 13	F004	1,000	R/W	1	[0 , 32767]
0x40CE		7929	Analog Maximum 13	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x40D0		7930	Analog Minimum 13	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x40D2		7931	Analog Delay 13	F003	1,000	R/W	2	[0,00 , 900,00] s
0x40D4		7932	Analog Hysteresis 13	F003	1,000	R/W	2	[0,0 , 50,0]
0x40D6		7933	Analog Direction 13	F012	1,000	R/W	1	0=OUT

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								1=IN
0x40D7		7934	Analog Input 14	F004	1,000	R/W	1	[0 , 32767]
0x40D8		7935	Analog Maximum 14	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x40DA		7936	Analog Minimum 14	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x40DC		7937	Analog Delay 14	F003	1,000	R/W	2	[0,00 , 900,00] s
0x40DE		7938	Analog Hysteresis 14	F003	1,000	R/W	2	[0,0 , 50,0]
0x40E0		7939	Analog Direction 14	F012	1,000	R/W	1	0=OUT
								1=IN
0x40E1		7940	Analog Input 15	F004	1,000	R/W	1	[0 , 32767]
0x40E2		7941	Analog Maximum 15	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x40E4		7942	Analog Minimum 15	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x40E6		7943	Analog Delay 15	F003	1,000	R/W	2	[0,00 , 900,00] s
0x40E8		7944	Analog Hysteresis 15	F003	1,000	R/W	2	[0,0 , 50,0]
0x40EA		7945	Analog Direction 15	F012	1,000	R/W	1	0=OUT
								1=IN
0x40EB		7946	Analog Input 16	F004	1,000	R/W	1	[0 , 32767]
0x40EC		7947	Analog Maximum 16	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x40EE		7948	Analog Minimum 16	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x40F0		7949	Analog Delay 16	F003	1,000	R/W	2	[0,00 , 900,00] s
0x40F2		7950	Analog Hysteresis 16	F003	1,000	R/W	2	[0,0 , 50,0]
0x40F4		7951	Analog Direction 16	F012	1,000	R/W	1	0=OUT
								1=IN
0x40F5		7952	Analog Input 17	F004	1,000	R/W	1	[0 , 32767]
0x40F6		7953	Analog Maximum 17	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x40F8		7954	Analog Minimum 17	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x40FA		7955	Analog Delay 17	F003	1,000	R/W	2	[0,00 , 900,00] s
0x40FC		7956	Analog Hysteresis 17	F003	1,000	R/W	2	[0,0 , 50,0]
0x40FE		7957	Analog Direction 17	F012	1,000	R/W	1	0=OUT
								1=IN
0x40FF		7958	Analog Input 18	F004	1,000	R/W	1	[0 , 32767]
0x4100		7959	Analog Maximum 18	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x4102		7960	Analog Minimum 18	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x4104		7961	Analog Delay 18	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4106		7962	Analog Hysteresis 18	F003	1,000	R/W	2	[0,0 , 50,0]
0x4108		7963	Analog Direction 18	F012	1,000	R/W	1	0=OUT
								1=IN
0x4109		7964	Analog Input 19	F004	1,000	R/W	1	[0 , 32767]
0x410A		7965	Analog Maximum 19	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x410C		7966	Analog Minimum 19	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x410E		7967	Analog Delay 19	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4110		7968	Analog Hysteresis 19	F003	1,000	R/W	2	[0,0 , 50,0]
0x4112		7969	Analog Direction 19	F012	1,000	R/W	1	0=OUT
								1=IN
0x4113		7970	Analog Input 20	F004	1,000	R/W	1	[0 , 32767]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x4114		7971	Analog Maximum 20	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x4116		7972	Analog Minimum 20	F003	1,000	R/W	2	[-100000,000 , 100000,000]
0x4118		7973	Analog Delay 20	F003	1,000	R/W	2	[0,00 , 900,00] s
0x411A		7974	Analog Hysteresis 20	F003	1,000	R/W	2	[0,0 , 50,0]
0x411C		7975	Analog Direction 20	F012	1,000	R/W	1	0=OUT
								1=IN
0x412F			Confirmation address			W	1	
0x418F			Confirmation address			W	1	
			Watt Gnd Flt 1					
0x44A0		8574	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x44A1		10995	Voltage Pickup Level	F003	1,000	R/W	2	[0,02 , 1,00] x VT
0x44A3		8576	Current Selection	F012	1,000	R/W	1	0=IN
								1=IG
0x44A4		10996	OC Pickup Level	F003	1,000	R/W	2	[0,002 , 0,400] x CT
0x44A6		8578	OC Pickup Delay	F003	1,000	R/W	2	[0,00 , 600,00] s
0x44A8		10997	Power Pickup	F003	1,000	R/W	2	[0,001 , 1,200] CTxVT
0x44AA		8580	MTA	F004	1,000	R/W	1	[0 , 360] Deg
0x44AB		8581	Power Pickup Delay	F003	1,000	R/W	2	[0,00 , 600,00] s
0x44AD		8582	Curve	F012	1,000	R/W	1	0=DEFINITE TIME
								1=INVERSE TIME
								2=USER CURVE A
								3=USER CURVE B
								4=USER CURVE C
								5=USER CURVE D
0x44AE		8583	Multiplier	F003	1,000	R/W	2	[0,02 , 2,00] s
0x44B0		8584	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x44BA			Confirmation address			W	1	
			Watt Gnd Flt 2					
0x44BB		8590	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x44BC		10998	Voltage Pickup Level	F003	1,000	R/W	2	[0,02 , 1,00] x VT
0x44BE		8592	Current Selection	F012	1,000	R/W	1	0=IN
								1=IG
0x44BF		10999	OC Pickup Level	F003	1,000	R/W	2	[0,002 , 0,400] x CT
0x44C1		8594	OC Pickup Delay	F003	1,000	R/W	2	[0,00 , 600,00] s
0x44C3		11000	Power Pickup	F003	1,000	R/W	2	[0,001 , 1,200] CTxVT
0x44C5		8596	MTA	F004	1,000	R/W	1	[0 , 360] Deg
0x44C6		8597	Power Pickup Delay	F003	1,000	R/W	2	[0,00 , 600,00] s
0x44C8		8598	Curve	F012	1,000	R/W	1	0=DEFINITE TIME
								1=INVERSE TIME
								2=USER CURVE A
								3=USER CURVE B

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								4=USER CURVE C
								5=USER CURVE D
0x44C9		8599	Multiplier	F003	1,000	R/W	2	[0,02 , 2,00] s
0x44CB		8600	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x44D5			Confirmation address			W	1	
			Watt Gnd Flt 3					
0x44D6		8606	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x44D7		11001	Voltage Pickup Level	F003	1,000	R/W	2	[0,02 , 1,00] x VT
0x44D9		8608	Current Selection	F012	1,000	R/W	1	0=IN
								1=IG
0x44DA		11002	OC Pickup Level	F003	1,000	R/W	2	[0,002 , 0,400] x CT
0x44DC		8610	OC Pickup Delay	F003	1,000	R/W	2	[0,00 , 600,00] s
0x44DE		11003	Power Pickup	F003	1,000	R/W	2	[0,001 , 1,200] CTxVT
0x44E0		8612	MTA	F004	1,000	R/W	1	[0 , 360] Deg
0x44E1		8613	Power Pickup Delay	F003	1,000	R/W	2	[0,00 , 600,00] s
0x44E3		8614	Curve	F012	1,000	R/W	1	0=DEFINITE TIME
								1=INVERSE TIME
								2=USER CURVE A
								3=USER CURVE B
								4=USER CURVE C
								5=USER CURVE D
0x44E4		8615	Multiplier	F003	1,000	R/W	2	[0,02 , 2,00] s
0x44E6		8616	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x44F0			Confirmation address			W	1	
			IEC 870-5-103					
0x4542		8752	COMM Port	F012	1,000	R/W	1	0=NONE
								1=COM 1
0x4543		8753	Slave Number	F004	1,000	R/W	1	[0 , 254]
0x4544		8754	Synchronization Timeout	F004	1,000	R/W	1	[0 , 1440] min
0x454E			Confirmation address			W	1	
			Time Settings					
0x454F		8756	LOC. TIME OFFS. UTC	F003	1,000	R/W	2	[-24,0 , 24,0]
0x4551		8757	DAYLIG SAVINGS TIME	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4552		8758	DST START MONTH	F012	1,000	R/W	1	0=JAN
								1=FEB
								2=MAR
								3=APR
								4=MAY
								5=JUN
								6=JUL

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								7=AUG
								8=SEP
								9=OCT
								10=NOV
								11=DEC
0x4553		8759	DST START WEEKDAY	F012	1,000	R/W	1	0=MONDAY
								1=TUESDAY
								2=WEDNESDAY
								3=THURSDAY
								4=FRIDAY
								5=SATURDAY
								6=SUNDAY
0x4554		8760	DST START DAY INST	F012	1,000	R/W	1	0=FIRST
								1=SECOND
								2=THIRD
								3=FOURTH
								4=LAST
0x4555		8761	DST START HOUR	F004	1,000	R/W	1	[0 , 23]
0x4556		8762	DST STOP MONTH	F012	1,000	R/W	1	0=JAN
								1=FEB
								2=MAR
								3=APR
								4=MAY
								5=JUN
								6=JUL
								7=AUG
								8=SEP
								9=OCT
								10=NOV
								11=DEC
0x4557		8763	DST STOP WEEKDAY	F012	1,000	R/W	1	0=MONDAY
								1=TUESDAY
								2=WEDNESDAY
								3=THURSDAY
								4=FRIDAY
								5=SATURDAY
								6=SUNDAY
0x4558		8764	DST STOP DAY INST	F012	1,000	R/W	1	0=FIRST
								1=SECOND
								2=THIRD
								3=FOURTH
								4=LAST
0x4559		8765	DST STOP HOUR	F004	1,000	R/W	1	[0 , 23]
0x455A		8766	IRIG-B LOCAL TIME	F012	1,000	R/W	1	0=OFF

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								1=ON
0x455B		10220	IRIGB Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x455C		10474	PTP IRIGB Priority	F012	1,000	R/W	1	0=PTP-1588
								1=IRIG-B
0x4564			Confirmation address			W	1	
			Digital Counters					
0x48B8		9911	DigCnt 1 Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x48B9		9912	DigCnt 1 Name	F009	1,000	R/W	16	
0x48C9		9913	DigCnt 1 Preset	F005	1,000	R/W	2	[-2147483648 , 2147483647]
0x48CB		9914	DigCnt 1 Compare	F005	1,000	R/W	2	[-2147483648 , 2147483647]
0x48CD		9915	DigCnt 2 Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x48CE		9916	DigCnt 2 Name	F009	1,000	R/W	16	
0x48DE		9917	DigCnt 2 Preset	F005	1,000	R/W	2	[-2147483648 , 2147483647]
0x48E0		9918	DigCnt 2 Compare	F005	1,000	R/W	2	[-2147483648 , 2147483647]
0x48E2		9919	DigCnt 3 Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x48E3		9920	DigCnt 3 Name	F009	1,000	R/W	16	
0x48F3		9921	DigCnt 3 Preset	F005	1,000	R/W	2	[-2147483648 , 2147483647]
0x48F5		9922	DigCnt 3 Compare	F005	1,000	R/W	2	[-2147483648 , 2147483647]
0x48F7		9923	DigCnt 4 Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x48F8		9924	DigCnt 4 Name	F009	1,000	R/W	16	
0x4908		9925	DigCnt 4 Preset	F005	1,000	R/W	2	[-2147483648 , 2147483647]
0x490A		9926	DigCnt 4 Compare	F005	1,000	R/W	2	[-2147483648 , 2147483647]
0x490C		9927	DigCnt 5 Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x490D		9928	DigCnt 5 Name	F009	1,000	R/W	16	
0x491D		9929	DigCnt 5 Preset	F005	1,000	R/W	2	[-2147483648 , 2147483647]
0x491F		9930	DigCnt 5 Compare	F005	1,000	R/W	2	[-2147483648 , 2147483647]
0x4921		9931	DigCnt 6 Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4922		9932	DigCnt 6 Name	F009	1,000	R/W	16	
0x4932		9933	DigCnt 6 Preset	F005	1,000	R/W	2	[-2147483648 , 2147483647]
0x4934		9934	DigCnt 6 Compare	F005	1,000	R/W	2	[-2147483648 , 2147483647]
0x4936		9935	DigCnt 7 Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4937		9936	DigCnt 7 Name	F009	1,000	R/W	16	
0x4947		9937	DigCnt 7 Preset	F005	1,000	R/W	2	[-2147483648 , 2147483647]
0x4949		9938	DigCnt 7 Compare	F005	1,000	R/W	2	[-2147483648 , 2147483647]
0x494B		9939	DigCnt 8 Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x494C		9940	DigCnt 8 Name	F009	1,000	R/W	16	
0x495C		9941	DigCnt 8 Preset	F005	1,000	R/W	2	[-2147483648 , 2147483647]
0x495E		9942	DigCnt 8 Compare	F005	1,000	R/W	2	[-2147483648 , 2147483647]
0x4960		9943	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x496A			Confirmation address			W	1	
			PTP-1588					
0x4975		10175	PTP FUNCTION	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4976		10176	PORTA DELAY ADDER	F005	1,000	R/W	2	[0 , 60000] ns
0x4978		10177	PORTA DELAY ASYM	F004	1,000	R/W	1	[-1000 , 1000] ns
0x497A		10179	PORTB DELAY ADDER	F005	1,000	R/W	2	[0 , 60000] ns
0x497C		10180	PORTB DELAY ASYM	F004	1,000	R/W	1	[-1000 , 1000] ns
0x497D		10181	STRICT POWER PROFILE	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x497E		10182	PTP DOMAIN NUMBER	F004	1,000	R/W	1	[0 , 255]
0x497F		10183	PTP VLAN PRIORITY	F004	1,000	R/W	1	[0 , 7]
0x4980		10184	PTP VLAN ID	F004	1,000	R/W	1	[0 , 4095]
0x4981		10448	PTP EPOCH	F012	1,000	R/W	1	0=UTC_SINCE_2000
								1=UTC_SINCE_1900
								2=UTC_SINCE_1970
0x4988			Confirmation address			W	1	
			Routing					
0x4989		10250	Default RT GWY Oct1	F004	1,000	R/W	1	[0 , 255]
0x498A		10251	Default RT GWY Oct2	F004	1,000	R/W	1	[0 , 255]
0x498B		10252	Default RT GWY Oct3	F004	1,000	R/W	1	[0 , 255]
0x498C		10253	Default RT GWY Oct4	F004	1,000	R/W	1	[0 , 255]
0x498D		10254	Static RT1 IP Oct1	F004	1,000	R/W	1	[0 , 255]
0x498E		10255	Static RT1 IP Oct2	F004	1,000	R/W	1	[0 , 255]
0x498F		10256	Static RT1 IP Oct3	F004	1,000	R/W	1	[0 , 255]
0x4990		10257	Static RT1 IP Oct4	F004	1,000	R/W	1	[0 , 255]
0x4991		10258	Static RT1 Mask Oct1	F004	1,000	R/W	1	[0 , 255]
0x4992		10259	Static RT1 Mask Oct2	F004	1,000	R/W	1	[0 , 255]
0x4993		10260	Static RT1 Mask Oct3	F004	1,000	R/W	1	[0 , 255]
0x4994		10261	Static RT1 Mask Oct4	F004	1,000	R/W	1	[0 , 255]
0x4995		10262	Static RT1 GWY Oct1	F004	1,000	R/W	1	[0 , 255]
0x4996		10263	Static RT1 GWY Oct2	F004	1,000	R/W	1	[0 , 255]
0x4997		10264	Static RT1 GWY Oct3	F004	1,000	R/W	1	[0 , 255]
0x4998		10265	Static RT1 GWY Oct4	F004	1,000	R/W	1	[0 , 255]
0x4999		10266	Static RT2 IP Oct1	F004	1,000	R/W	1	[0 , 255]
0x499A		10267	Static RT2 IP Oct2	F004	1,000	R/W	1	[0 , 255]
0x499B		10268	Static RT2 IP Oct3	F004	1,000	R/W	1	[0 , 255]
0x499C		10269	Static RT2 IP Oct4	F004	1,000	R/W	1	[0 , 255]
0x499D		10270	Static RT2 Mask Oct1	F004	1,000	R/W	1	[0 , 255]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x499E		10271	Static RT2 Mask Oct2	F004	1,000	R/W	1	[0 , 255]
0x499F		10272	Static RT2 Mask Oct3	F004	1,000	R/W	1	[0 , 255]
0x49A0		10273	Static RT2 Mask Oct4	F004	1,000	R/W	1	[0 , 255]
0x49A1		10274	Static RT2 GWY Oct1	F004	1,000	R/W	1	[0 , 255]
0x49A2		10275	Static RT2 GWY Oct2	F004	1,000	R/W	1	[0 , 255]
0x49A3		10276	Static RT2 GWY Oct3	F004	1,000	R/W	1	[0 , 255]
0x49A4		10277	Static RT2 GWY Oct4	F004	1,000	R/W	1	[0 , 255]
0x49A5		10278	Static RT3 IP Oct1	F004	1,000	R/W	1	[0 , 255]
0x49A6		10279	Static RT3 IP Oct2	F004	1,000	R/W	1	[0 , 255]
0x49A7		10280	Static RT3 IP Oct3	F004	1,000	R/W	1	[0 , 255]
0x49A8		10281	Static RT3 IP Oct4	F004	1,000	R/W	1	[0 , 255]
0x49A9		10282	Static RT3 Mask Oct1	F004	1,000	R/W	1	[0 , 255]
0x49AA		10283	Static RT3 Mask Oct2	F004	1,000	R/W	1	[0 , 255]
0x49AB		10284	Static RT3 Mask Oct3	F004	1,000	R/W	1	[0 , 255]
0x49AC		10285	Static RT3 Mask Oct4	F004	1,000	R/W	1	[0 , 255]
0x49AD		10286	Static RT3 GWY Oct1	F004	1,000	R/W	1	[0 , 255]
0x49AE		10287	Static RT3 GWY Oct2	F004	1,000	R/W	1	[0 , 255]
0x49AF		10288	Static RT3 GWY Oct3	F004	1,000	R/W	1	[0 , 255]
0x49B0		10289	Static RT3 GWY Oct4	F004	1,000	R/W	1	[0 , 255]
0x49B1		10290	Static RT4 IP Oct1	F004	1,000	R/W	1	[0 , 255]
0x49B2		10291	Static RT4 IP Oct2	F004	1,000	R/W	1	[0 , 255]
0x49B3		10292	Static RT4 IP Oct3	F004	1,000	R/W	1	[0 , 255]
0x49B4		10293	Static RT4 IP Oct4	F004	1,000	R/W	1	[0 , 255]
0x49B5		10294	Static RT4 Mask Oct1	F004	1,000	R/W	1	[0 , 255]
0x49B6		10295	Static RT4 Mask Oct2	F004	1,000	R/W	1	[0 , 255]
0x49B7		10296	Static RT4 Mask Oct3	F004	1,000	R/W	1	[0 , 255]
0x49B8		10297	Static RT4 Mask Oct4	F004	1,000	R/W	1	[0 , 255]
0x49B9		10298	Static RT4 GWY Oct1	F004	1,000	R/W	1	[0 , 255]
0x49BA		10299	Static RT4 GWY Oct2	F004	1,000	R/W	1	[0 , 255]
0x49BB		10300	Static RT4 GWY Oct3	F004	1,000	R/W	1	[0 , 255]
0x49BC		10301	Static RT4 GWY Oct4	F004	1,000	R/W	1	[0 , 255]
0x49BD		10302	Static RT5 IP Oct1	F004	1,000	R/W	1	[0 , 255]
0x49BE		10303	Static RT5 IP Oct2	F004	1,000	R/W	1	[0 , 255]
0x49BF		10304	Static RT5 IP Oct3	F004	1,000	R/W	1	[0 , 255]
0x49C0		10305	Static RT5 IP Oct4	F004	1,000	R/W	1	[0 , 255]
0x49C1		10306	Static RT5 Mask Oct1	F004	1,000	R/W	1	[0 , 255]
0x49C2		10307	Static RT5 Mask Oct2	F004	1,000	R/W	1	[0 , 255]
0x49C3		10308	Static RT5 Mask Oct3	F004	1,000	R/W	1	[0 , 255]
0x49C4		10309	Static RT5 Mask Oct4	F004	1,000	R/W	1	[0 , 255]
0x49C5		10310	Static RT5 GWY Oct1	F004	1,000	R/W	1	[0 , 255]
0x49C6		10311	Static RT5 GWY Oct2	F004	1,000	R/W	1	[0 , 255]
0x49C7		10312	Static RT5 GWY Oct3	F004	1,000	R/W	1	[0 , 255]
0x49C8		10313	Static RT5 GWY Oct4	F004	1,000	R/W	1	[0 , 255]
0x49C9		10314	Static RT6 IP Oct1	F004	1,000	R/W	1	[0 , 255]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x49CA		10315	Static RT6 IP Oct2	F004	1,000	R/W	1	[0 , 255]
0x49CB		10316	Static RT6 IP Oct3	F004	1,000	R/W	1	[0 , 255]
0x49CC		10317	Static RT6 IP Oct4	F004	1,000	R/W	1	[0 , 255]
0x49CD		10318	Static RT6 Mask Oct1	F004	1,000	R/W	1	[0 , 255]
0x49CE		10319	Static RT6 Mask Oct2	F004	1,000	R/W	1	[0 , 255]
0x49CF		10320	Static RT6 Mask Oct3	F004	1,000	R/W	1	[0 , 255]
0x49D0		10321	Static RT6 Mask Oct4	F004	1,000	R/W	1	[0 , 255]
0x49D1		10322	Static RT6 GWY Oct1	F004	1,000	R/W	1	[0 , 255]
0x49D2		10323	Static RT6 GWY Oct2	F004	1,000	R/W	1	[0 , 255]
0x49D3		10324	Static RT6 GWY Oct3	F004	1,000	R/W	1	[0 , 255]
0x49D4		10325	Static RT6 GWY Oct4	F004	1,000	R/W	1	[0 , 255]
0x49EC			Confirmation address			W	1	
			Ethernet E					
0x49ED		10242	IP Address Oct1	F004	1,000	R/W	1	[0 , 255]
0x49EE		10243	IP Address Oct2	F004	1,000	R/W	1	[0 , 255]
0x49EF		10244	IP Address Oct3	F004	1,000	R/W	1	[0 , 255]
0x49F0		10245	IP Address Oct4	F004	1,000	R/W	1	[0 , 255]
0x49F1		10246	Netmask Oct1	F004	1,000	R/W	1	[0 , 255]
0x49F2		10247	Netmask Oct2	F004	1,000	R/W	1	[0 , 255]
0x49F3		10248	Netmask Oct3	F004	1,000	R/W	1	[0 , 255]
0x49F4		10249	Netmask Oct4	F004	1,000	R/W	1	[0 , 255]
0x4A05			Confirmation address			W	1	
			Redundancy					
0x4A06		10168	REDUNDANCY MODE	F012	1,000	R/W	1	0=INDEPENDENT
								1=LLA
								2=PRP
0x4A07		10336	LLA Priority	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4A08		10337	LLA Timeout	F005	1,000	R/W	2	[0 , 600000] ms
0x4A0A		10439	RSTP BRIDGE PRIORITY	F005	1,000	R/W	2	[0 , 61440]
0x4A0C		10440	RSTP PORTA PRIORITY	F005	1,000	R/W	2	[0 , 240]
0x4A0E		10441	RSTP PORTA PATHCOST	F005	1,000	R/W	2	[1 , 2000000]
0x4A10		10442	RSTP PORTB PRIORITY	F005	1,000	R/W	2	[0 , 240]
0x4A12		10443	RSTP PORTB PATHCOST	F005	1,000	R/W	2	[1 , 2000000]
0x4A1E			Confirmation address			W	1	
			Cold Load Pickup					
0x4A1F		10460	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4A20		10461	Cold Outage Time	F004	1,000	R/W	1	[1 , 1000] min
0x4A21		10462	Cold Blocking Time	F004	1,000	R/W	1	[1 , 1000] s
0x4A22		10463	Cold Load Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4A28			Confirmation address			W	1	
			60CTS Failure					

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x4A65		10838	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4A66		11037	3IO Current PKP	F003	1,000	R/W	2	[0,05 , 2,00] x CT
0x4A68		11038	3VO Voltage Inhibit	F003	1,000	R/W	2	[0,00 , 1,25] x VT
0x4A6A		11039	GND Current Inhibit	F003	1,000	R/W	2	[0,05 , 2,00] x CTg
0x4A6C		11040	SGND Current Inhibit	F003	1,000	R/W	2	[0,025 , 1,000] x CTsg
0x4A6E		10842	Time Delay	F003	1,000	R/W	2	[0,00 , 600,00] s
0x4A70		10843	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4A78			Confirmation address			W	1	
			2nd HRMC Inhibit					
0x4A79		10847	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4A7A		10848	Pickup Level	F003	1,000	R/W	2	[1,0 , 40,0] %
0x4A7C		10849	Delay	F003	1,000	R/W	2	[0,00 , 600,00] s
0x4A7E		11041	Minimum Current	F003	1,000	R/W	2	[0,05 , 2,00] x CT
0x4A80		10851	Phases For Operation	F012	1,000	R/W	1	0=ANY ONE
								1=ANY TWO
								2=ALL THREE
								3=AVERAGE
0x4A81		10852	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4A87			Confirmation address			W	1	
			Current Sensing					
0x4A88		11042	Phase CT Primary	F003	1,000	R/W	2	[1,0 , 6000,0] A
0x4A8A		11043	Phase CT Secondary	F012	1,000	R/W	1	0=1 A
								1=5 A
0x4A8B		11044	Ground CT Primary	F003	1,000	R/W	2	[1,0 , 6000,0] A
0x4A8D		11045	Ground CT Secondary	F012	1,000	R/W	1	0=1 A
								1=5 A
0x4A8E		11046	Stv Gnd CT Primary	F003	1,000	R/W	2	[1,0 , 6000,0] A
0x4A90		11047	Stv Gnd CT Secondary	F012	1,000	R/W	1	0=0.2 A
								1=1 A
								2=5 A
0x4A96			Confirmation address			W	1	
			Load Volt Sensing					
0x4A97		11049	Load VT Ratio	F013	1,000	R/W	1	[1 , 10000]
0x4A98		11050	Volt Rated Sec LEA	F003	1,000	R/W	2	[0,50 , 10,00] V
0x4A9A		11051	Voltage Rated Sec	F003	1,000	R/W	2	[1,0 , 250,0] V
0x4A9C		11052	Phase VT Connection	F012	1,000	R/W	1	0=WYE
								1=DELTA
0x4A9D		11053	Phase Angle	F003	1,000	R/W	2	[0,0 , 359,9] Deg
0x4A9F		11054	Sensor 1 Mag Correc	F003	1,000	R/W	2	[-15,0 , 15,0] %
0x4AA1		11055	Sensor 1 Ang Correc	F003	1,000	R/W	2	[0,0 , 359,9] Deg

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x4AA3		11056	Sensor 2 Mag Correc	F003	1,000	R/W	2	[-15,0 , 15,0] %
0x4AA5		11057	Sensor 2 Ang Correc	F003	1,000	R/W	2	[0,0 , 359,9] Deg
0x4AA7		11058	Sensor 3 Mag Correc	F003	1,000	R/W	2	[-15,0 , 15,0] %
0x4AA9		11059	Sensor 3 Ang Correc	F003	1,000	R/W	2	[0,0 , 359,9] Deg
0x4AB4			Confirmation address			W	1	
			Source Volt. Sensing					
0x4AB5		11096	Source VT Ratio	F013	1,000	R/W	1	[1 , 10000]
0x4AB6		11097	Volt Rated Sec LEA	F003	1,000	R/W	2	[0,50 , 10,00] V
0x4AB8		11098	Voltage Rated Sec	F003	1,000	R/W	2	[1,0 , 250,0] V
0x4ABA		11099	Phase VT Connection	F012	1,000	R/W	1	0=WYE
								1=DELTA
0x4ABB		11100	Phase Angle	F003	1,000	R/W	2	[0,0 , 359,9] Deg
0x4ABD		11101	Sensor 1 Mag Correc	F003	1,000	R/W	2	[-15,0 , 15,0] %
0x4ABF		11102	Sensor 1 Ang Correc	F003	1,000	R/W	2	[0,0 , 359,9] Deg
0x4AC1		11103	Sensor 2 Mag Correc	F003	1,000	R/W	2	[-15,0 , 15,0] %
0x4AC3		11104	Sensor 2 Ang Correc	F003	1,000	R/W	2	[0,0 , 359,9] Deg
0x4AC5		11105	Sensor 3 Mag Correc	F003	1,000	R/W	2	[-15,0 , 15,0] %
0x4AC7		11106	Sensor 3 Ang Correc	F003	1,000	R/W	2	[0,0 , 359,9] Deg
0x4AD2			Confirmation address			W	1	
			Phase OV 2					
0x4AD3		11156	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4AD4		11157	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x4AD6		11158	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4AD8		11159	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4ADA		11160	Logic	F012	1,000	R/W	1	0=ANY PHASE
								1=TWO PHASES
								2=ALL PHASES
0x4ADB		11161	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4AE1			Confirmation address			W	1	
			Phase OV 3					
0x4AE2		11171	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4AE3		11172	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x4AE5		11173	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4AE7		11174	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4AE9		11175	Logic	F012	1,000	R/W	1	0=ANY PHASE
								1=TWO PHASES
								2=ALL PHASES
0x4AEA		11176	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4AF0			Confirmation address			W	1	
			Phase UV 2					

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x4AF1		11188	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4AF2		11189	Mode	F012	1,000	R/W	1	0=PHASE-PHASE
								1=PHASE-GROUND
0x4AF3		11190	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x4AF5		11191	Curve	F012	1,000	R/W	1	0=DEFINITE TIME
								1=INVERSE TIME
0x4AF6		11192	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4AF8		11193	Minimum Voltage	F003	1,000	R/W	2	[0,00 , 1,25] x VT
0x4AFA		11194	Logic	F012	1,000	R/W	1	0=ANY PHASE
								1=TWO PHASES
								2=ALL PHASES
0x4AFB		11195	Supervised by 52	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4AFC		11196	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4B04			Confirmation address			W	1	
			Phase UV 3					
0x4B05		11212	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4B06		11213	Mode	F012	1,000	R/W	1	0=PHASE-PHASE
								1=PHASE-GROUND
0x4B07		11214	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x4B09		11215	Curve	F012	1,000	R/W	1	0=DEFINITE TIME
								1=INVERSE TIME
0x4B0A		11216	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4B0C		11217	Minimum Voltage	F003	1,000	R/W	2	[0,00 , 1,25] x VT
0x4B0E		11218	Logic	F012	1,000	R/W	1	0=ANY PHASE
								1=TWO PHASES
								2=ALL PHASES
0x4B0F		11219	Supervised by 52	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4B10		11220	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4B18			Confirmation address			W	1	
			Negative Sequence OV 1					
0x4B19		11236	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4B1A		11237	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x4B1C		11238	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4B1E		11239	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4B20		11240	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4B27			Confirmation address			W	1	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
			Negative Sequence OV 2					
0x4B28		11244	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4B29		11245	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x4B2B		11246	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4B2D		11247	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4B2F		11248	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4B36			Confirmation address			W	1	
			Negative Sequence OV 3					
0x4B37		11252	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4B38		11253	Pickup Level	F003	1,000	R/W	2	[0,02 , 1,25] x VT
0x4B3A		11254	Trip Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4B3C		11255	Reset Delay	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4B3E		11256	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4B45			Confirmation address			W	1	
			Autoreclose					
0x4B46		11287	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4B47		11288	Max Number Shots	F004	1,000	R/W	1	[1 , 4]
0x4B48		11289	Dead Time 1	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4B4A		11290	Dead Time 2	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4B4C		11291	Dead Time 3	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4B4E		11292	Dead Time 4	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4B50		11293	Reclaim Time	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4B52		11294	Reset Time	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4B54		11295	Halt Time	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4B56		11296	Cond. Permission	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4B57		11297	Cond. Time	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4B59		11298	Lockout Type	F012	1,000	R/W	1	0=AUTOMATIC
								1=MANUAL
0x4B5A		11299	Coor. Time	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4B5C		11300	Reset Shot Time	F003	1,000	R/W	2	[0,00 , 900,00] s
0x4B5E		11301	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4B68			Confirmation address			W	1	
			Recloser Settings					
0x4B69		11399	Recloser Type	F012	1,000	R/W	1	0=SINGLE-PHASE
								1=THREE-PHASE
0x4B6A		11404	Max Openings 1 Hour	F004	1,000	R/W	1	[1 , 60]
0x4B6B		11405	RCL Wear Monitor FN	F012	1,000	R/W	1	0=DISABLED

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								1=ENABLED
0x4B6C		11406	RCL Wear Monitor AL	F003	1,000	R/W	2	[20,0 , 100,0] %
0x4B6E		11407	Int Duty Current 1	F003	1,000	R/W	2	[0,00 , 999,99] KA
0x4B70		11408	Int Duty Oper 1	F013	1,000	R/W	1	[0 , 65000]
0x4B71		11409	Int Duty Current 2	F003	1,000	R/W	2	[0,00 , 999,99] KA
0x4B73		11410	Int Duty Oper 2	F013	1,000	R/W	1	[0 , 65000]
0x4B74		11411	Int Duty Current 3	F003	1,000	R/W	2	[0,00 , 999,99] KA
0x4B76		11412	Int Duty Oper 3	F013	1,000	R/W	1	[0 , 65000]
0x4B77		11413	Max Number Openings	F013	1,000	R/W	1	[0 , 65000]
0x4B78		11414	Max Interrupting KA	F003	1,000	R/W	2	[0,00 , 999,99]
0x4B7A		11567	Statistic Int Number	F013	1,000	R/W	1	[5 , 60]
0x4B7B		11415	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4B86			Confirmation address			W	1	
			Single-Three Pole					
0x4B87		11464	Trip Mode	F012	1,000	R/W	1	0=ONE POLE
								1=THREE POLE
0x4B88		11465	Trip Min Seal Time	F003	1,000	R/W	2	[0,02 , 60,00] s
0x4B8A		11466	Yellow Handle Timer	F003	1,000	R/W	2	[0,00 , 60,00] s
0x4B8C		11467	Min Current Supv	F003	1,000	R/W	2	[0,05 , 1,00] CT
0x4B8E		11468	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4B8F		11706	Yellow Handle Trip	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4B95			Confirmation address			W	1	
			Coil Circuit Supervision					
0x4B96		11492	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4B97		11493	Trip Time	F003	1,000	R/W	2	[0,10 , 60,00] s
0x4B99		11494	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4B9F			Confirmation address			W	1	
			Conf Events					
0x4BA0		11511	Event Metering 1	F004	1,000	R/W	1	[0 , 32767]
0x4BA1		11512	Event Metering 2	F004	1,000	R/W	1	[0 , 32767]
0x4BA2		11513	Event Metering 3	F004	1,000	R/W	1	[0 , 32767]
0x4BA3		11514	Event Metering 4	F004	1,000	R/W	1	[0 , 32767]
0x4BA4		11515	Event Metering 5	F004	1,000	R/W	1	[0 , 32767]
0x4BA5		11516	Event Metering 6	F004	1,000	R/W	1	[0 , 32767]
0x4BA6		11517	Event Metering 7	F004	1,000	R/W	1	[0 , 32767]
0x4BA7		11518	Event Metering 8	F004	1,000	R/W	1	[0 , 32767]
0x4BA8		11519	Event Metering 9	F004	1,000	R/W	1	[0 , 32767]
0x4BA9		11520	Event Metering 10	F004	1,000	R/W	1	[0 , 32767]
0x4BAA		11521	Event Metering 11	F004	1,000	R/W	1	[0 , 32767]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x4BAB		11522	Event Metering 12	F004	1,000	R/W	1	[0 , 32767]
0x4BAC		11523	Event Metering 13	F004	1,000	R/W	1	[0 , 32767]
0x4BAD		11524	Event Metering 14	F004	1,000	R/W	1	[0 , 32767]
0x4BAE		11525	Event Metering 15	F004	1,000	R/W	1	[0 , 32767]
0x4BAF		11526	Event Metering 16	F004	1,000	R/W	1	[0 , 32767]
0x4BB0		11527	Event Metering 17	F004	1,000	R/W	1	[0 , 32767]
0x4BB1		11528	Event Metering 18	F004	1,000	R/W	1	[0 , 32767]
0x4BB2		11529	Event Metering 19	F004	1,000	R/W	1	[0 , 32767]
0x4BB3		11530	Event Metering 20	F004	1,000	R/W	1	[0 , 32767]
0x4BB4		11531	Event Metering 21	F004	1,000	R/W	1	[0 , 32767]
0x4BB5		11532	Event Metering 22	F004	1,000	R/W	1	[0 , 32767]
0x4BB6		11533	Event Metering 23	F004	1,000	R/W	1	[0 , 32767]
0x4BB7		11534	Event Metering 24	F004	1,000	R/W	1	[0 , 32767]
0x4BC2			Confirmation address			W	1	
			IEC 870-5-101					
0x4BC3		11537	IEC101 COM1	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4BC4		11538	Common Addr ASDU1	F013	1,000	R/W	1	[0 , 65534]
0x4BC5		11539	Link Address1	F013	1,000	R/W	1	[0 , 65534]
0x4BC6		11540	IEC101 COM2	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4BC7		11541	Common Addr ASDU2	F013	1,000	R/W	1	[0 , 65534]
0x4BC8		11542	Link Address2	F013	1,000	R/W	1	[0 , 65534]
0x4BC9		11543	ASDU Addr Size	F013	1,000	R/W	1	[1 , 2]
0x4BCA		11544	COT Size	F013	1,000	R/W	1	[1 , 2]
0x4BCB		11545	IOA Size	F013	1,000	R/W	1	[1 , 3]
0x4BCC		11546	Link Addr Size	F013	1,000	R/W	1	[1 , 2]
0x4BCD		11547	Cyclic Meter Period	F013	1,000	R/W	1	[0 , 3600]
0x4BCE		11548	Synchronization Event	F013	1,000	R/W	1	[0 , 1400]
0x4BCF		11549	Current Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x4BD0		11550	Voltage Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x4BD1		11551	Power Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x4BD2		11552	Energy Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x4BD3		11553	PF Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000
								9=10000
0x4BD4		11554	Other Scale Factor	F012	1,000	R/W	1	0=0.00001
								1=0.0001
								2=0.001
								3=0.01
								4=0.1
								5=1
								6=10
								7=100
								8=1000

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
								9=10000
0x4BD5		11555	Current Deadband	F013	1,000	R/W	1	[0 , 65535]
0x4BD6		11556	Voltage Deadband	F013	1,000	R/W	1	[0 , 65535]
0x4BD7		11557	Power Deadband	F013	1,000	R/W	1	[0 , 65535]
0x4BD8		11558	Energy Deadband	F013	1,000	R/W	1	[0 , 65535]
0x4BD9		11559	PF Deadband	F013	1,000	R/W	1	[0 , 65535]
0x4BDA		11560	Other Deadband	F013	1,000	R/W	1	[0 , 65535]
0x4BDB		11561	IOA Binaries	F013	1,000	R/W	1	[0 , 65535]
0x4BDC		11562	IOA Double Points	F013	1,000	R/W	1	[0 , 65535]
0x4BDD		11563	IOA Analogs	F013	1,000	R/W	1	[0 , 65535]
0x4BDE		11564	IOA Counters	F013	1,000	R/W	1	[0 , 65535]
0x4BDF		11565	IOA Commands	F013	1,000	R/W	1	[0 , 65535]
0x4BE0		11566	IOA Analog Param	F013	1,000	R/W	1	[0 , 65535]
0x4BE5			Confirmation address			W	1	
			Breaker Failure					
0x4BE6		11622	Function	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4BE7		11623	Trip Mode	F012	1,000	R/W	1	0=ONE POLE
								1=THREE POLE
0x4BE8		11624	Current Supv	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4BE9		11625	PH Current Supv	F003	1,000	R/W	2	[0,05 , 20,00] CT
0x4BEB		11626	GND Current Supv	F003	1,000	R/W	2	[0,05 , 20,00] x CTg
0x4BED		11627	SGND Current Supv	F003	1,000	R/W	2	[0,05 , 20,00] x CTg
0x4BEF		11628	Retrip Time Delay	F003	1,000	R/W	2	[0,00 , 999,99] s
0x4BF1		11629	PH Hiset PKP Level	F003	1,000	R/W	2	[0,05 , 20,00] CT
0x4BF3		11630	GND Hiset PKP Level	F003	1,000	R/W	2	[0,05 , 20,00] x CTg
0x4BF5		11631	SGND Hiset PKP Level	F003	1,000	R/W	2	[0,05 , 20,00] x CTg
0x4BF7		11632	Hiset 1 Pole Delay	F003	1,000	R/W	2	[0,00 , 999,99] s
0x4BF9		11633	Hiset 3 Pole Delay	F003	1,000	R/W	2	[0,00 , 999,99] s
0x4BFB		11634	PH Loset PKP Level	F003	1,000	R/W	2	[0,05 , 20,00] CT
0x4BFD		11635	GND Loset PKP Level	F003	1,000	R/W	2	[0,05 , 20,00] x CTg
0x4BFF		11636	SGND Loset PKP Level	F003	1,000	R/W	2	[0,05 , 20,00] x CTg
0x4C01		11637	Loset 1 Pole Delay	F003	1,000	R/W	2	[0,00 , 999,99] s
0x4C03		11638	Loset 3 Pole Delay	F003	1,000	R/W	2	[0,00 , 999,99] s
0x4C05		11639	2nd Stage Delay	F003	1,000	R/W	2	[0,00 , 999,99] s
0x4C07		11640	Intern Arc PKP Level	F003	1,000	R/W	2	[0,05 , 30,00] CT
0x4C09		11641	Intern Arc PKP Delay	F003	1,000	R/W	2	[0,00 , 999,99] s
0x4C0B		11642	BF WO Current Delay	F003	1,000	R/W	2	[0,00 , 999,99] s
0x4C0D		11643	Snapshot Events	F012	1,000	R/W	1	0=DISABLED
								1=ENABLED
0x4C12			Confirmation address			W	1	
			Reclose Maintenance					
0x4C13		11873	PHA Openings CNT	F013	1,000	R/W	1	[0 , 65500]

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0x4C14		11874	PHB Openings CNT	F013	1,000	R/W	1	[0 , 65500]
0x4C15		11875	PHC Openings CNT	F013	1,000	R/W	1	[0 , 65500]
0x4C16		11876	PHA Closings CNT	F013	1,000	R/W	1	[0 , 65500]
0x4C17		11877	PHB Closings CNT	F013	1,000	R/W	1	[0 , 65500]
0x4C18		11878	PHC Closings CNT	F013	1,000	R/W	1	[0 , 65500]
0x4C19		11879	PHA WEAR MON CNT	F003	1,000	R/W	2	[0,00 , 100,00] %
0x4C1B		11880	PHB WEAR MON CNT	F003	1,000	R/W	2	[0,00 , 100,00] %
0x4C1D		11881	PHC WEAR MON CNT	F003	1,000	R/W	2	[0,00 , 100,00] %
0x4C26			Confirmation address			W	1	
0x6000			PLC equations	F009		R	15360	
0x9C00			LCD configuration			R	768	
0xAFFE	0x0001		Operation 1	F001		W		1
0xAFFE	0x0002		Operation 2	F001		W		1
0xAFFE	0x0004		Operation 3	F001		W		1
0xAFFE	0x0008		Operation 4	F001		W		1
0xAFFE	0x0010		Operation 5	F001		W		1
0xAFFE	0x0020		Operation 6	F001		W		1
0xAFFE	0x0040		Operation 7	F001		W		1
0xAFFE	0x0080		Operation 8	F001		W		1
0xAFFE	0x0100		Operation 9	F001		W		1
0xAFFE	0x0200		Operation 10	F001		W		1
0xAFFE	0x0400		Operation 11	F001		W		1
0xAFFE	0x0800		Operation 12	F001		W		1
0xAFFE	0x1000		Operation 13	F001		W		1
0xAFFE	0x2000		Operation 14	F001		W		1
0xAFFE	0x4000		Operation 15	F001		W		1
0xAFFE	0x8000		Operation 16	F001		W		1
0xAFFF	0x0001		Operation 17	F001		W	1	
0xAFFF	0x0002		Operation 18	F001		W	1	
0xAFFF	0x0004		Operation 19	F001		W	1	
0xAFFF	0x0008		Operation 20	F001		W	1	
0xAFFF	0x0010		Operation 21	F001		W	1	
0xAFFF	0x0020		Operation 22	F001		W	1	
0xAFFF	0x0040		Operation 23	F001		W	1	
0xAFFF	0x0080		Operation 24	F001		W	1	
0xB000			Relay model	F009		R	8	
0xB008			Firmware version	F009		R	2	
0xB018			Year(0=2000,1=2001,...) and part of firmware compilation	F001		R	1	
0xB019			Day and month of firmware compilation	F001		R	1	
0xB020			Address of PLC equations	F005		R	2	
0xB022			Address of LCD configuration	F005		R	2	

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0xB027			MAC address	F009		R	6	
0xB02D			Serial number	F009		R	4	
0xB031			Manufacturing date	F009		R	8	
0xF000			Status and acknowledge of the 192 control events	F001		R	24	Status = 24 first bytes
								1st byte: 1st eight control events (First event=bit less significant)
								2nd byte: 2nd eight control events (Ninth event=bit less significant)
								. . .
								Ack = 24 second bytes
								25th byte: 1st eight control events (First event=bit less significant)
								26th byte: 2nd eight control events (Ninth event=bit less significant)
								. . .
0xF018			Indicate which control events are configurated as alarm	F001		R	12	1st byte: 1st eight control events (First event=bit less significant)
								2nd byte: 2nd eight control events (Ninth event=bit less significant)
								. . .
0xF024			Date/Time of the 1-16 alarms	F011		R	64	
0xF064			Date/Time of the 17-32 alarms	F011		R	64	
0xF0A4			Date/Time of the 33-48 alarms	F011		R	64	
0xF0E4			Date/Time of the 49-64 alarms	F011		R	64	
0xF124			Date/Time of the 65-80 alarms	F011		R	64	
0xF164			Date/Time of the 81-96 alarms	F011		R	64	
0xF1A4			Date/Time of the 97-112 alarms	F011		R	64	
0xF1E4			Date/Time of the 113-128 alarms	F011		R	64	
0xF224			Date/Time of the 129-144 alarms	F011		R	64	
0xF264			Date/Time of the 145-160 alarms	F011		R	64	
0xF2A4			Date/Time of the 161-176 alarms	F011		R	64	
0xF2E4			Date/Time of the 177-192 alarms	F011		R	64	
0xF324			Alarm acknowledge	F001		W	12	1st byte: 1st eight alarms (First alarm=bit less significant)
								2nd byte: 2nd eight alarms (Ninth alarm=bit less significant)
								. . .

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
0xF430			64 Virtual Inputs (32 Latched + 32 Self Reset)	F001		R/W	4	2nd byte: 1st eight virtual inputs (First virtual input=bit less significant)
								1st byte: 2nd eight virtual inputs (Ninth virtual input=bit less significant)
								. . .
0xFE00			Name of the events file to read	F009		W		EVE.TXT: all snapshot-events are sent in ASCII format
								NEW_EVE.TXT: the new snapshot-events are sent in ASCII format
								EVE.BIN: all snapshot-events are sent in BINARY format
								NEW_EVE.BIN: the new snapshot-events are sent in BINARY format
0xFE20			Opening force output file	F004		W	3	Write "OUTPUT"
0xFE28			Closing force output file	F004		W	3	Write "OUTPUT"
0xFE40			Name of the oscillography/fault report file to read	F009		W	OSCXXX.DAT, OSCXXX.CFG, OSCXXX.HDR,	
								FLTXXX.TXT (where XXX=001 to 999)
0xFF00			Character position of current block within events file	F005		R	2	
0xFF02			Size of currently-available data block of events file	F004		R	1	
0xFF03			Block of data requested events file (122 items)	F004		R	1	
0xFF20			Forcing outputs	F004		W	5	First word = Board number;
0xFF40			Character position of current block within osc file	F005		R	2	
0xFF42			Size of currently-available data block of osc file	F004		R	1	
0xFF43			Block of data requested osc file (122 items)	F004		R	1	
0xFFF0			Synchronization (miliseconds from 01/01/2000)	F011		R/W	4	
			FORMATS DESCRIPTION					
		F001	UNSIGNED INT 16 BIT (BITMASK)					
		F002	SIGNED INT 32 BIT					
		F003	FLOAT 32 BIT					
		F004	SIGNED INT 16 BIT					
		F005	SIGNED INT 32 BIT					
		F006	DOUBLE 64 BIT					
		F007	UNSIGNED INT 8 BIT					
		F008	SIGNED INT 8 BIT					
		F009	STRING					

Address	Bit	Identifier	Name	Format	Scale	Mode	Length	Miscellaneous
		F011	UNSIGNED INT 64 BIT (MILISECONDS FROM 01/01/2000)					
		F012	UNSIGNED INT 16 BIT (ENUMERATED)					
		F013	UNSIGNED INT 16 BIT (SETTINGS)					

R650 Recloser Controller

Appendix C: DNP 3.0 protocol for R650

C.1 DNP 3.0 protocol settings

R650 units enable the programming of certain parameters related to DNP3 protocol. These parameters are called DNP3 protocol settings and can be modified from the front panel or from the Level 2 software. The R650 relay supports communication with multiple masters (3) and maintains three separate groups of DNP3 settings. Each group of DNP3 settings is related to a single **logical DNP3 slave device**. The R650 relay is able to communicate simultaneously with up to three different DNP3 master stations. Each master communicates with a different **logical DNP3 slave**, these logical slaves appearing as separate physical DNP3 slaves. This is achieved by keeping separate set of settings, event queues and set of states for each logical device.

Notice that it is necessary to set different **DNP Address** and **TCP/UDP Port** for each **logical DNP3 slave device**.

Time synchronization through DNP protocol is available from all three DNP masters that can communicate with R650. However the date & time are taken from only one master at the same moment. It is recommended to use only one master to do time sync through DNP.

Setting No	Setting Name	Default Value	Range
1	Physical Port	NONE	NONE, COM1, COM2, NETWORK_TCP, NETWORK_UDP
2	Address	255	0 to 65534, step 1
3	IP Addr Client1 Oct1	0	0 to 255 step 1
4	IP Addr Client1 Oct2	0	0 to 255 step 1
5	IP Addr Client1 Oct3	0	0 to 255 step 1
6	IP Addr Client1 Oct4	0	0 to 255 step 1
7	IP Addr Client2 Oct1	0	0 to 255 step 1
8	IP Addr Client2 Oct2	0	0 to 255 step 1
9	IP Addr Client2 Oct3	0	0 to 255 step 1
10	IP Addr Client2 Oct4	0	0 to 255 step 1
11	IP Addr Client3 Oct1	0	0 to 255 step 1
12	IP Addr Client3 Oct2	0	0 to 255 step 1
13	IP Addr Client3 Oct3	0	0 to 255 step 1
14	IP Addr Client3 Oct4	0	0 to 255 step 1
15	IP Addr Client4 Oct1	0	0 to 255 step 1
16	IP Addr Client4 Oct2	0	0 to 255 step 1

Setting No	Setting Name	Default Value	Range
17	IP Addr Client4 Oct3	0	0 to 255 step 1
18	IP Addr Client4 Oct4	0	0 to 255 step 1
19	IP Addr Client5 Oct1	0	0 to 255 step 1
20	IP Addr Client5 Oct2	0	0 to 255 step 1
21	IP Addr Client5 Oct3	0	0 to 255 step 1
22	IP Addr Client5 Oct4	0	0 to 255 step 1
23	TCP/UDP Port	20000	1 to 65535, step 1
24	Unsol Resp Function	DISABLED	DISABLED, ENABLED
25	Unsol Resp TimeOut	5 s	0 to 60 sec, step 1
26	Unsol Resp Max Ret	10	1 to 255, step 1
27	Unsol Resp Dest Adr	200	0 to 65519, step 1
28	Current Scale Factor	1	0.00001, 0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000
29	Voltage Scale Factor	1	0.00001, 0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000
30	Power Scale Factor	1	0.00001, 0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000
31	Energy Scale Factor	1	0.00001, 0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000
32	Other Scale Factor	1	0.00001, 0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000
33	Current Deadband	30000	0 to 65535, step 1
34	Voltage Deadband	30000	0 to 65535, step 1
35	Power Deadband	30000	0 to 65535, step 1
36	Energy Deadband	30000	0 to 65535, step 1
37	Other Deadband	30000	0 to 65535, step 1
38	Msg Fragment Size	240	30 to 2048, step 1
39	Binary Input Block1	CTL EVENTS 1-16	See the explanation below
40	Binary Input Block2	CTL EVENTS 17-32	See the explanation below
41	Binary Input Block3	CTL EVENTS 33-48	See the explanation below
42	Binary Input Block4	CTL EVENTS 49-64	See the explanation below
43	Binary Input Block5	CTL EVENTS 65-80	See the explanation below
44	Binary Input Block6	CTL EVENTS 81-96	See the explanation below
45	Binary Input Block7	CTL EVENTS 97-112	See the explanation below
46	Binary Input Block8	CTL EVENTS 113-128	See the explanation below
47	Binary Input Block9	SWITCHGEAR 1-8	See the explanation below
48	Binary Input Block10	SWITCHGEAR 9-16	See the explanation below
49	Default analog Map	Disabled	See the explanation below
50	Analog Input Point 0	End Of List	See the explanation below
51	Analog Input Point 1	End Of List	See the explanation below
52	Analog Input Point 2	End Of List	See the explanation below
53	Analog Input Point 3	End Of List	See the explanation below
54	Analog Input Point 4	End Of List	See the explanation below
55	Analog Input Point 5	End Of List	See the explanation below
56	Analog Input Point 6	End Of List	See the explanation below
57	Analog Input Point 7	End Of List	See the explanation below
58	Analog Input Point 8	End Of List	See the explanation below
59	Analog Input Point 9	End Of List	See the explanation below
60	Analog Input Point 10	End Of List	See the explanation below
61	Analog Input Point 11	End Of List	See the explanation below
62	Analog Input Point 12	End Of List	See the explanation below
63	Analog Input Point 13	End Of List	See the explanation below
64	Analog Input Point 14	End Of List	See the explanation below
65	Analog Input Point 15	End Of List	See the explanation below
66	Analog Input Point 16	End Of List	See the explanation below

Setting No	Setting Name	Default Value	Range
67	Analog Input Point 17	End Of List	See the explanation below
68	Analog Input Point 18	End Of List	See the explanation below
69	Analog Input Point 19	End Of List	See the explanation below
70	Analog Input Point 20	End Of List	See the explanation below
71	Analog Input Point 21	End Of List	See the explanation below
72	Analog Input Point 22	End Of List	See the explanation below
73	Analog Input Point 23	End Of List	See the explanation below
74	Analog Input Point 24	End Of List	See the explanation below
75	Analog Input Point 25	End Of List	See the explanation below
76	Analog Input Point 26	End Of List	See the explanation below
77	Analog Input Point 27	End Of List	See the explanation below
78	Analog Input Point 28	End Of List	See the explanation below
79	Analog Input Point 29	End Of List	See the explanation below
80	Analog Input Point 30	End Of List	See the explanation below
81	Analog Input Point 31	End Of List	See the explanation below
82	DEADBAND PF	30000	0 to 32767, step 1
83	SCALE FACTOR PF	0.00001	0.00001, 0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000

1. **Physical Port**: The R650 supports the Distributed Network Protocol (DNP) version 3.0. The R650 can be used as a DNP slave device connected up to three DNP masters (usually RTUs or SCADA master stations). The Physical Port setting is used to select the communications port assigned to the DNP protocol for a specific logical DNP slave device of R650. When this setting is set to "NETWORK_TCP", the DNP protocol can be used over TCP/IP. When this value is set to "NETWORK_UDP", the DNP protocol can be used over UDP/IP.

2. **Address**: This setting is the DNP slave address. This number identifies de R650 on a DNP communications link. Each logical DNP slave should be assigned a unique address.

3-22. **IP Addr Client x Oct x:** this setting is one of four octets of an IP address. The R650 relay can respond to a maximum of 5 specific DNP masters (not in the same time). To set the IP address of DNP master it is necessary to set four octets (e.g. to set the IP address of the first DNP master to 192.168.48.125, you should set **IP Addr Client1 Oct1** = 192, **IP Addr Client1 Oct2** = 168, **IP Addr Client1 Oct3** = 48, **IP Addr Client1 Oct4** = 125).

23. **TCP/UDP Port**: TCP/UDP port number for the case of DNP3 communication being performed through the Ethernet.

24. **Unsol Resp Function**: ENABLED, if unsolicited responses are allowed, and DISABLED otherwise.

25. **Unsol Resp TimeOut**: sets the time the R650 waits for a DNP master to confirm an unsolicited response.

26. **Unsol Resp Max Ret**: This setting determines the number of times the R650 retransmits an unsolicited response without receiving a confirmation from the master. Once this limit has been exceeded, the unsolicited response is sent at a larger interval. This interval is called the unsolicited offline interval and is fixed at 10 minutes.

27. **Unsol Resp Dest Adr**: This setting is DNP address to which all unsolicited responses are sent. The IP address to which unsolicited responses are sent is determined by the R650 from either the current DNP TCP connection or the most recent UDP message.

28-32, 83. Scale Factor: These settings are numbers used to scale Analog Input point values. These settings group the R650 Analog Input data into types: current, voltage, power, energy, and other. Each setting represents the scale factor for all Analog Input points of that type. For example, if the **Voltage Scale Factor** is set to a value of 1000, all DNP Analog Input points that are voltages are returned with the values 1000 times smaller (e.g. a value 72000 V on the R650 is returned as 72). These settings are useful when Analog Input values must be adjusted to fit within certain ranges in DNP masters. Note that a scale factor of 0.1 is equivalent to a multiplier of 10 (i.e. the value is 10 times larger).

33-37, 82. Deadband: These settings are the values used by the R650 to determine when to trigger unsolicited responses containing Analog Input data. These settings group the R650 Analog Input data into types: current, voltage, power, energy, and other. Each setting represents the default deadband value for all Analog Input points of that type. For example, in order to trigger unsolicited responses from the R650 when any current values change by 15 A, the

Current Deadband setting should be set to 15. Note that these settings are the default values of the deadbands. DNP object 34 points can be used to change deadband values, from the default, for each individual DNP Analog Input point. Whenever power is removed and re-applied to the R650, the default deadbands are in effect.

38. **Msg Fragment Size**: This setting determines the size, in bytes, at which message fragmentation occurs. Large fragment sizes allow for more efficient throughput; smaller fragment sizes cause more application layer confirmations to be necessary which can provide for more robust data transfer over noisy communication channels

39-48. **Binary Input Block x**: These settings allow customization and change of the size of DNP Binary Inputs point list. The default Binary Inputs point list contains 160 points representing binary states that are configured using ***Setpoint > Relay Configuration*** in the EnerVista 650 Setup program. These 160 binary states are grouped in 10 blocks of 16 points each. There are 128 bits (8 blocks of 16) called *Control Events* and 32 bits (2 blocks of 16) corresponding to the states of 16 *switchgears* available in R650 relay. If not all of the 160 points are required in the DNP master, a custom Binary Inputs point list can be created by selecting up to 10 blocks of 16 points. Each block represents 16 Binary Input points. Block 1 represents Binary Input points 0-15, block 2 represents Binary Input points 16- 31, block 3 represents Binary Input points 32-47, etc. The minimum number of Binary Input points that can be selected is 16 (1 block). If all of the **Binary Input Block x** settings are set to "NOT USED", the default list of 160 points is in effect. The R650 forms the Binary Inputs points list from the **Binary Input Block x** settings up to the first occurrence of a setting value "NOT USED". Permitted values for these settings are: NOT USED, CTL EVENTS 1-16, CTL EVENTS 17-32, CTL EVENTS 33-48, CTL EVENTS 49-64, CTL EVENTS 65-80, CTL EVENTS 81-96, CTL EVENTS 97-112, CTL EVENTS 113-128, SWITCHGEAR 1-8, SWITCHGEAR 9-16,BOARD F 1-16,BOARD F 17-32, BOARD G 1-16, BOARD G 17-32,BOARD H 1-16, BOARD H 17-32, BOARD J 1-16,BOARD J 17-32.

49. This setting allows selection between predefined Analog Input Points or choosing preferred Analog Input Points (from 50 to 81). DISABLED, if predefined Analog Input Point, ENABLED, if choosing preferred Analog Input Points (from 50 to 81) and EXTENDED, to add the preferred Analog Input Points (from 50 to 81) to the predefined Analog Input Points.

50-81. **Analog Input Point X**: These settings allow customization and change the size of DNP Analog Input point list.

C.2 DNP 3.0 device profile document

The following table provides a “Device Profile Document” in the standard format defined in the DNP 3.0 Subset Definitions Document.

DNP V3.00 DEVICE PROFILE DOCUMENT (Sheet 1 of 3)

<table>
<tr><td colspan="2">(Also see the IMPLEMENTATION TABLE in the following section)</td></tr>
<tr><td colspan="2">Vendor Name: General Electric Multilin</td></tr>
<tr><td colspan="2">Device Name: R650 Relay</td></tr>
<tr><td>Highest DNP Level Supported:
For Requests: Level 2
For Responses: Level 2</td><td>Device Function:
☐ Master
✔ Slave</td></tr>
<tr><td colspan="2">Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table):
Binary Inputs (Object 1)
Binary Inputs Changes (Object 2)
Binary Outputs (Object 10)
Binary Counters (Object 20)
Frozen Counters (21)
Binary Counters Change (Object 22)
Frozen Counter Change (23)
Analog Inputs (Object 30)
Analog Input Changes (Object 32)
Analog Deadbands (Object 34)</td></tr>
<tr><td>Maximum Data Link String Size (octets):
Transmitted: 292
Received: 292</td><td>Maximum Application Fragment Size (octets):
Transmitted: Configurable up to 2048
Received: 2048</td></tr>
<tr><td>Maximum Data Link Re-tries:
☐ None
✔ Fixed at 2
☐ Configurable</td><td>Maximum Application Layer Re-tries:
✔ None
☐ Configurable</td></tr>
<tr><td colspan="2">Requires Data Link Layer Confirmation:
✔ Never
☐ Always
☐ Sometimes
☐ Configurable</td></tr>
</table>

DNP V3.00 DEVICE PROFILE DOCUMENT (Sheet 2 of 3)

Requires Application Layer Confirmation:

☐ Never
☐ Always
✔ **When reporting Event Data**
✔ **When sending multi-fragment responses**
☐ Sometimes
☐ Configurable

Timeouts while waiting for:

Data Link Confirm:	☐ None	✔ **Fixed at 3 s**	☐ Variable	☐ Configurable
Complete Appl. Fragment:	✔ **None**	☐ Fixed at	☐ Variable	☐ Configurable
Application Confirm:	☐ None	✔ **Fixed at 4 s**	☐ Variable	☐ Configurable
Complete Appl. Response	✔ **NoOne**	☐ Fixed at	☐ Variable	☐ Configurable

Others:

Transmission Delay:	**No intentional delay**
Need Time Delay:	**10 min.**
Select/Operate Arm Timeout:	**10 s**
Binary Input change scanning period:	**1 ms**
Packed binary change process period:	**1 s**
Analog Input change scanning period:	**500 ms**
Unsolicited response notification delay:	**500 ms**
Unsolicited response retry delay:	**Configurable 0 to 60 s**
Unsolicited offline interval:	**10 min.**

Sends/Executes Control Operations:

WRITE Binary Outputs	✔ **Never**	☐ Always	☐ Sometimes	☐ Configurable
SELECT/OPERATE	☐ Never	✔ **Always**	☐ Sometimes	☐ Configurable
DIRECT OPERATE	☐ Never	✔ **Always**	☐ Sometimes	☐ Configurable
DIRECT OPERATE – NO ACK	☐ Never	✔ **Always**	☐ Sometimes	☐ Configurable
Count > 1	✔ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Pulse On	☐ Never	✔ **Always**	☐ Sometimes	☐ Configurable
Pulse Off	✔ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Latch On	✔ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Latch Off	✔ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Queue	✔ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Clear Queue	✔ **Never**	☐ Always	☐ Sometimes	☐ Configurable

DNP V3.00 DEVICE PROFILE DOCUMENT (Sheet 3 of 3)

Reports Binary Input Change Events when no specific variation requested: ☐ Never ✔ **Only time-tagged** ☐ Only non-time-tagged ☐ Configurable	***Reports time-tagged Binary Input Change Events when no specific variation requested:*** ☐ Never ✔ **Binary Input Change With Time** ☐ Binary Input Change With Relative Time ☐ Configurable (attach explanation)
Sends Unsolicited Responses: ☐ Never ☐ Configurable ☐ Only certain objects ✔ **Sometimes (attach explanation)** ✔ **ENABLE/DISABLE** unsolicited Function codes supported **Explanation of 'Sometimes':** It will be disabled for RS-485 applications, since there is no collision avoidance mechanism. For ethernet communication it will be available and it can be disabled or enabled with the proper function code.	***Sends Static Data in Unsolicited Responses:*** ✔ **Never** ☐ When Device Restarts ☐ When Status Flag Change No other options permitted
Default CounterObject/Variation: ☐ No Counters Reported ☐ Configurable (attach explanation) ✔ **Default Object: 20.** **Default Variation: 1** ✔ **Point-by-point list attached**	***Counters Roll Over at:*** ☐ No Counters Reported ☐ Configurable (attach explanation) ☐ 16 Bits ✔ **32 Bits** ☐ Other Value: ______ ✔ **Point-by-point list attached**
Sends Multi-Fragment Responses: ✔ **Yes** ☐ No	

C.3 Implementation table

The following table shows objects, variations, function codes and qualifiers supported by R650 units, both in requests and responses for DNP3 protocol. For static (non-change-event) objects, requests sent with qualifiers 00, 01, 06, 07 or 08, are responded to with qualifiers 00 or 01. Static object requests sent with qualifiers 17 or 28 are responded to with qualifiers 17 or 28. For change-event objects, qualifiers 17 or 28 are always responded.

Text in ***bold and italic*** indicates functionality higher than DNP3 implementation level 2.

IMPLEMENTATION TABLE (Sheet 1 out of 3)

OBJECT			REQUEST		RESPONSE	
Object No.	Variation No.	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes	Qualifier Codes (hex)
1	0	Binary Input (Variation 0 is used to request default variation)	1 (read) ***22 (assign class)***	06 (no range, or all) ***00,01 (start-stop)*** ***07,08 (limited qty)*** ***17,28 (index)***		
1	1	Binary Input	1 (read) ***22 (assign class)***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	129 (response)	00, 01 (start-stop) ***17,28 (index)*** See Note 2
1	2	Binary Input with Status (default – see Note 1)	1 (read) ***22 (assign class)***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	129 (response)	00, 01 (start-stop) ***17,28 (index)*** See Note 2
2	0	Binary Input Change - All Variations See Note 1	1 (read)	06 (no range, or all) 07,08 (limited qty)		
2	1	Binary Input Change without Time	1 (read)	06 (no range, or all) 07,08 (limited qty)	129 (response) 130 (unsol. resp.)	17, 28 (index)
2	2	Binary Input Change with Time	1 (read)	06 (no range, or all) 07,08 (limited qty)	129 (response) 130 (unsol. resp.)	17, 28 (index)
10	0	Binary Output - All Variations	1 (read)	06 (no range, or all) ***00,01 (start-stop)*** ***07,08 (limited qty)*** ***17,28 (index)***		
10	2	Binary Output Status See Note 1	***1 read***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	129 (response)	00, 01 (start-stop) ***17,28 (index)*** See Note 2
12	1	Control Relay Output Block	3 (select) 4 (operate) 5 (direct op) 6 (dir.op, noack)	***00,01 (start-stop)*** ***07,08 (limited qty)*** 17, 28 (index)	129 (response)	echo of request
20	0	Binary Counter - All Variations	1 (select) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz.cl. noack)	06 (no range, or all)		

Note 1: A default variation refers to the variation responded when variation 0 is requested and/or in class 0, 1, 2, or 3 scans.

Note 2: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, are responded to with qualifiers 00 or 01 (for change-event objects, qualifiers 17 or 28 are always responded).

Note 3: Cold restarts are implemented the same as warm restarts – The R650 is not restarted, but the DNP process is restarted.

IMPLEMENTATION TABLE (Sheet 2 out of 3)

OBJECT			REQUEST		RESPONSE	
Object No.	Variation No.	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes	Qualifier Codes (hex)
21	0	Frozen Counter - All Variations	1 (read)	06 (no range, or all)		
22	0	Counter Change Event - All Variations	1 (read)	06 (no range, or all) 07,08 (limited qty)		
23	0	Frozen Counter Change Event	1 (read)	06 (no range, or all) 07,08 (limited qty)		
30	0	Analog Input - All Variations	1 (read) ***22 (assign class)***	06 (no range, or all) ***00,01 (start-stop)*** ***07,08 (limited qty)*** ***17,28 (index)***		
30	1	32-Bit Analog Input See Note 1	1 (read) ***22 (assign class)***	***000,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	129 (response)	00, 01 (start-stop) ***17,28 (index)*** See Note 2
30	2	16-Bit Analog Input	1 (read) ***22 (assign class)***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	129 (response)	00, 01 (start-stop) ***17,28 (index)*** See Note 2
30	3	32-Bit Analog Input without Flag	1 (read) ***22 (assign class)***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	129 (response)	00, 01 (start-stop) ***17,28 (index)*** See Note 2
30	4	16-Bit Analog Input without Flag	1 (read) ***22 (assign class)***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	129 (response)	00, 01 (start-stop) ***17,28 (index)*** See Note 2
30	5	Analog Short Float	1 (read) ***22 (assign class)***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	129 (response)	00, 01 (start-stop) ***17,28 (index)*** See Note 2
32	0	Analog Change Event - All Variations	1 (read)	06 (no range, or all) 07,08 (limited qty)		
32	1	32-Bit Analog Change Event without Time See Note 1	***1 (read)***	***06 (no range, or all)*** ***07,08 (limited qty)***	129 (response) 130 (unsol.resp)	17, 28 (index)
32	2	16-Bit Analog Change Event without Time	***1 (read)***	***06 (no range, or all)*** ***07,08 (limited qty)***	129 (response) 130 (unsol.resp)	17, 28 (index)
32	3	32-Bit Analog Change Event with Time	***1 (read)***	***06 (no range, or all)*** ***07,08 (limited qty)***	***129 (response)*** ***130 (unsol.resp)***	***17,28 (index)***
32	4	16-Bit Analog Change Event with Time	***1 (read)***	***06 (no range, or all)*** ***07,08 (limited qty)***	***129 (response)*** ***130 (unsol.resp)***	***17,28 (index)***
32	5	Analogs (Short-float) without time	***1 (read)***	***06 (no range, or all)*** ***07,08 (limited qty)***	***129 (response)*** ***130 (unsol.resp)***	***17,28 (index)***
32	7	Analogs (Short-float) with time	***1 (read)***	***06 (no range, or all)*** ***07,08 (limited qty)***	***129 (response)*** ***130 (unsol.resp)***	***17,28 (index)***
34	0	Analog Input Reporting Deadband	***1 (read)***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***		
34	1	16-Bit Analog Input Reporting Deadband See Note 1	***1 (read)***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	***129 (response)***	***00,01 (start-stop)*** ***17,28 (index)*** See Note 2

Note 1: A default variation refers to the variation responded when variation 0 is requested and/or in class 0, 1, 2, or 3 scans.

Note 2: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, are responded to with qualifiers 00 or 01 (for change-event objects, qualifiers 17 or 28 are always responded).

Note 3: Cold restarts are implemented the same as warm restarts – The R650 is not restarted, but the DNP process is restarted.

IMPLEMENTATION TABLE (Sheet 3 out of 3)

OBJECT			REQUEST		RESPONSE	
Object No.	Variation No.	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes	Qualifier Codes (hex)
34	2	32-Bit Analog Input Reporting Deadband See Note 1	***2 (write)***	***00,01 (start-stop)*** ***07,08 (limited qty)*** ***17,28 (index)***		
50	0	Time and Date - All Variations	***1 (read)***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	***129 (response)***	***00,01 (start-stop)*** ***17,28 (index)*** ***See Note 2***
50	1	Time and Date See Note 1	***1 (read)*** ***2 (write)***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07 (limited qty=1)*** ***08 (limited qty)*** ***17,28 (index)***	***129 (response)***	***00,01 (start-stop)*** ***17,28 (index)*** ***See Note 2***
52	2	Time Delay Fine	***1 (read)*** 2 (write)		***129 (response)***	07 (limited qty) quantity=1
60	0	Class 0, 1, 2, and 3 Data	***1 (read)*** ***20 (enable unsol)*** ***21 (disable unsol)*** ***22 (assign class)***	06 (no range, or all)		
60	1	Class 0 Data		06 (no range, or all)		
60	2	Class 1 Data	1 (read) ***20 (enable unsol)*** ***21 (disable unsol)*** ***22 (assign class)***	06 (no range, or all) 07,08 (limited qty)		
60	3	Class 2 Data	1 (read) ***20 (enable unsol)*** ***21 (disable unsol)*** ***22 (assign class)***	06 (no range, or all) 07,08 (limited qty)		
60	4	Class 3 Data	1 (read) ***20 (enable unsol)*** ***21 (disable unsol)*** ***22 (assign class)***	06 (no range, or all) 07,08 (limited qty)		
80	1	Internal Indications	2 (write)	00 (start-stop) (index must =7)		
		No Object (function code only) See Note 3	13 (cold restart)			
		No Object (function code only)	14 (warm restart)			
		No Object (function code only)	23 (delay meas.)			

Note 1: A default variation refers to the variation responded when variation 0 is requested and/or in class 0, 1, 2, or 3 scans.

Note 2: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, are responded to with qualifiers 00 or 01 (for change-event objects, qualifiers 17 or 28 are always responded).

Note 3: Cold restarts are implemented the same as warm restarts – The R650 is not restarted, but the DNP process is restarted.

C.4 Binary input points

The R650 relay has a configurable Map of DNP Binary Input points. This map can be formed by up to 10 blocks of 16 binary states that are configured using ***Setpoint > Relay Configuration*** in the EnerVista 650 Setup program. The minimum number of DNP Binary Input points is 16 and the maximum number is 160. Within these 160 DNP points, 128 bits (8 blocks of 16) are mapped to *Control Events* (***Setpoint > Relay Configuration > Control Events***) and 32 bits (2 block of 16) are mapped to contacts A, B of 16 *Switchgears* (***Setpoint > Relay Configuration > Switchgear***). Each *Switchgear* in R650 is mapped into two DNP Binary Input points. Lets say the setting Binary Input Block1 has been set the value Switchgear 1-8, it means that DNP Binary Input point 0 = Switchgear 1Contact A, DNP Binary Input point 1 = Switchgear 1 Contact B, DNP Binary Input point 2 = Switchgear 2 Contact A, etc.

To each *Control Event* or *Switchgear Contact*, assign any of the binary states of the R650 relay. These states are contact inputs and outputs, virtual outputs, protection element states, PLC states, etc. DNP Points that correspond to *Control Events* or *Switchgear Contacts* that are not configured have a zero value in the response.

Using the PLC-Editor, through the EnerVista 650 Setup program select ***Setpoint > Logic Configuration*** to implement complex logic, more than simple OR and NOT previous functions. To accomplich this, under ***Setpoint > Relay Configuration > Control Events,*** assign a Virtual Output to a selected point, and then implement wished logic with the PLC-Editor.

BINARY INPUT POINTS
Static (Steady-State) Object Number: **1**
Change Event Object Number: **2**
Request Function Codes supported: **1 (read), 22 (assign class)**
Static Variation Reported when variation 0 requested: **2 (Binary Input Change with status)**
Change Event Variation reported when variation 0 requested: **2 (Binary Input Change with Time)**
Default Class for all points: **1**

DEFAULT BINARY INPUT POINTS MAP

POINT INDEX	**NAME/DESCRIPTION**
0-127	Control Events 1-128
128	Switchgear 1 Contact A
129	Switchgear 1 Contact B
130	Switchgear 2 Contact A
131	Switchgear 2 Contact B
132	Switchgear 3 Contact A
133	Switchgear 3 Contact B
134	Switchgear 4 Contact A
135	Switchgear 4 Contact B
136	Switchgear 5 Contact A
137	Switchgear 5 Contact B
138	Switchgear 6 Contact A
139	Switchgear 6 Contact B
140	Switchgear 7 Contact A
141	Switchgear 7 Contact B
142	Switchgear 8 Contact A
143	Switchgear 8 Contact B
144	Switchgear 9 Contact A

POINT INDEX	**NAME/DESCRIPTION**
145	Switchgear 9 Contact B
146	Switchgear 10 Contact A
147	Switchgear 10 Contact B
148	Switchgear 11 Contact A
149	Switchgear 11 Contact B
150	Switchgear 12 Contact A
151	Switchgear 12 Contact B
152	Switchgear 13 Contact A
153	Switchgear 13 Contact B
154	Switchgear 14 Contact A
155	Switchgear 14 Contact B
156	Switchgear 15 Contact A
157	Switchgear 15 Contact B
158	Switchgear 16 Contact A
159	Switchgear 16 Contact B

C.5 DNP configuration examples

C.5.1 Configuring DNP user map

For example, consider configuring DNP Binary Inputs Map with 8 Contact Inputs, 8 Protection states, 8 Contact Outputs and 2 Switchgears. This configuration can be done in two steps. In first step, select **Setpoint > Relay Configuration** from the EnerVista 650 Setup program and then configure the **Control Events** bits and **Switchgear** bits. This is shown in figures 9.1 and 9.2. In the second step, select **Setpoint > System Setup > Communication settings > DNP** in order to change the DNP Binary Input Block settings. Set the values of the first three Binary Input blocks, Binary Input Block1 = CTL EVENTS 1-16, Binary Input Block2 = CTL EVENTS 17-32, Binary Input Block3 = SWITCHGEAR 1-8. This is shown in Figure C-1: Configuration of Control Events bits 13-1

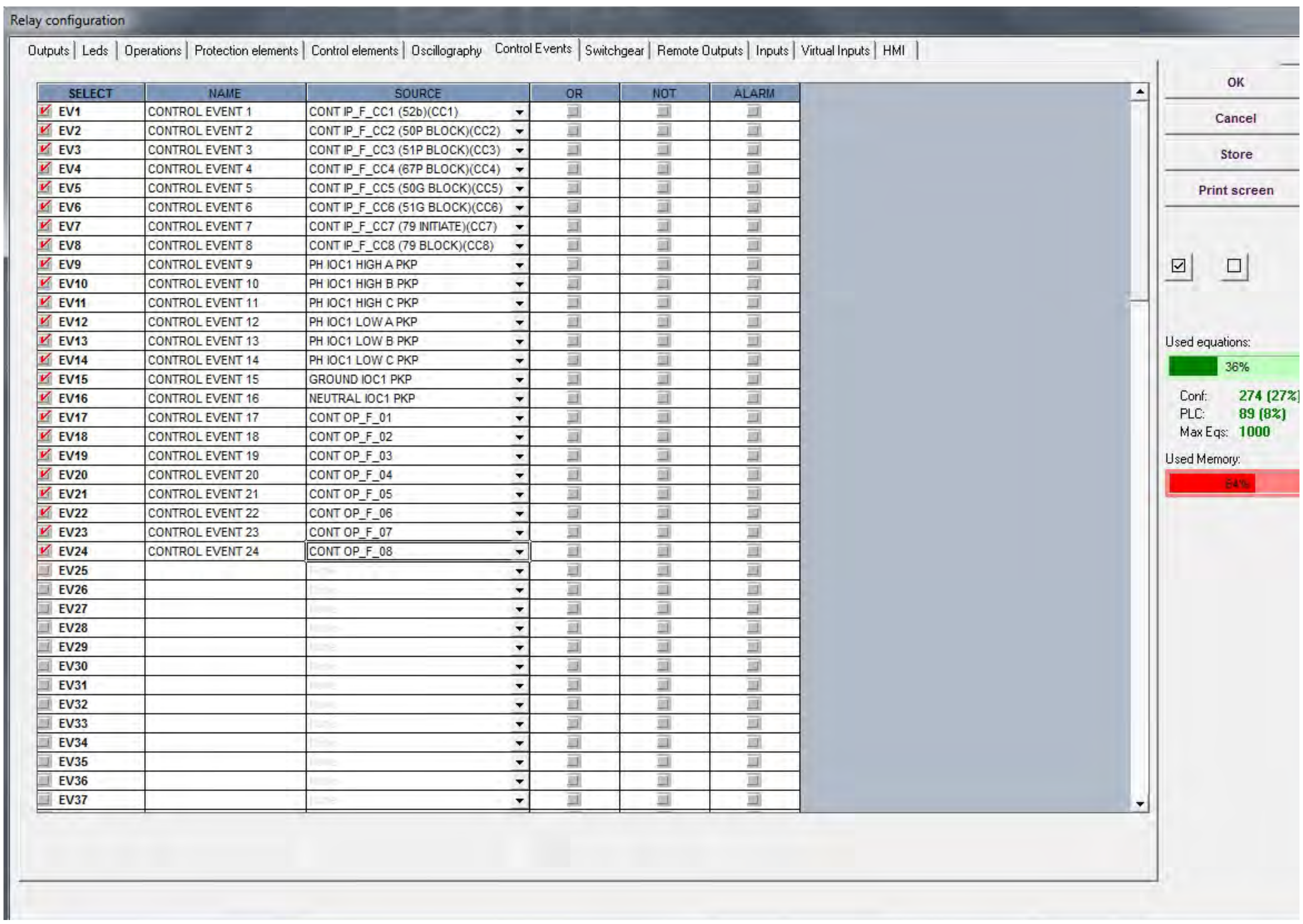


Figure C-1: Configuration of Control Events bits

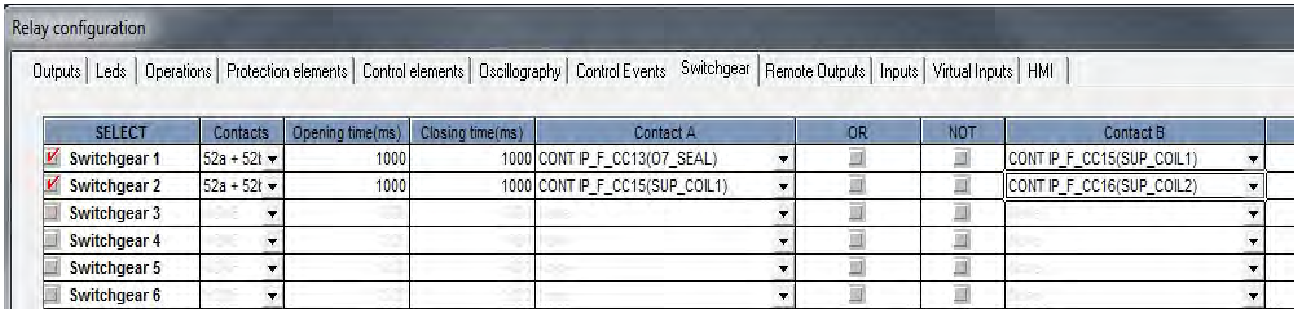


Figure C-2: CONFIGURATION OF SWITCHGEAR

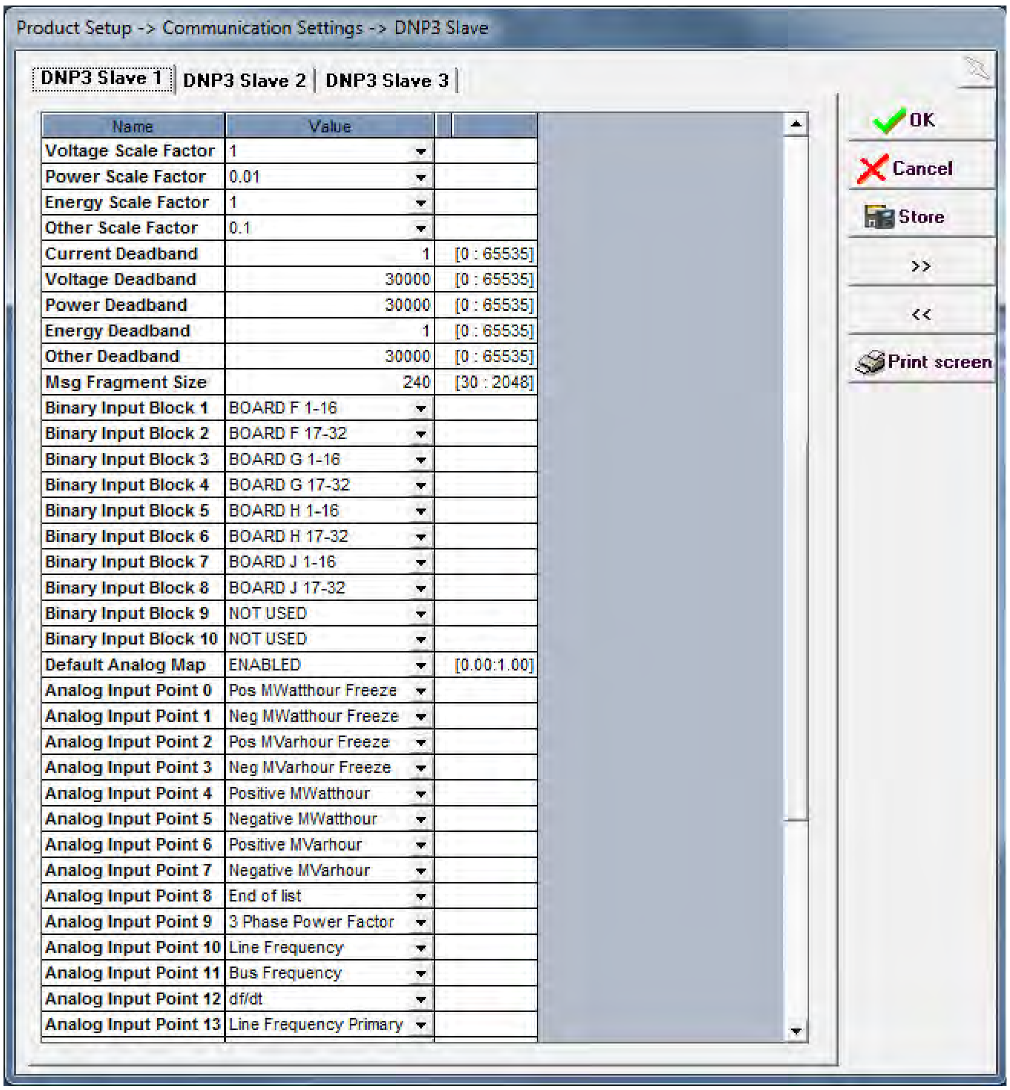


Figure C-3: CONFIGURATION OF DNP BINARY INPUT BLOCKS

In the example presented in this chapter the R650 relay has 48 Binary Input points, as shown in the table below.

C.5.2 Example of custom binary input points map

POINT INDEX	NAME/DESCRIPTION
0	CONT_IP_F_CC1(CC1)
1	CONT_IP_F_CC2(CC2)
2	CONT_IP_F_CC3(CC3)
3	CONT_IP_F_CC4(CC4)
4	CONT_IP_F_CC5(CC5)
5	CONT_IP_F_CC6(CC6)
6	CONT_IP_F_CC7(CC7)
7	CONT_IP_F_CC8(CC8)
8	PH IOC1 HIGH A PKP
9	PH IOC1 HIGH B PKP
10	PH IOC1 HIGH C PKP
11	PH IOC1 LOW A PKP
12	PH IOC1 LOW B PKP
13	PH IOC1 LOW C PKP
14	GROUND IOC1 PKP
15	NEUTRAL IOC1 PKP
16	CONT OP_F_01
17	CONT OP_F_02
18	CONT OP_F_03
19	CONT OP_F_04
20	CONT OP_F_05
21	CONT OP_F_06
22	CONT OP_F_07
23	CONT OP_F_08
24	Not Configured
25	Not Configured
26	Not Configured
27	Not Configured
28	Not Configured
29	Not Configured
30	Not Configured
31	Not Configured
32	CONT_IP_F_CC13 (CC13)
33	CONT_IP_F_CC14(CC14)
34	CONT_IP_F_CC15(CC15)
35	CONT_IP_F_CC16(CC16)
36	Not Configured
37	Not Configured
38	Not Configured
39	Not Configured
40	Not Configured
41	Not Configured
42	Not Configured
43	Not Configured
44	Not Configured

POINT INDEX	NAME/DESCRIPTION
45	Not Configured
46	Not Configured
47	Not Configured

C.5.3 Multiple DNP 3.0 masters communication with R650

Typical architecture of multi-master communication using DNP 3.0.

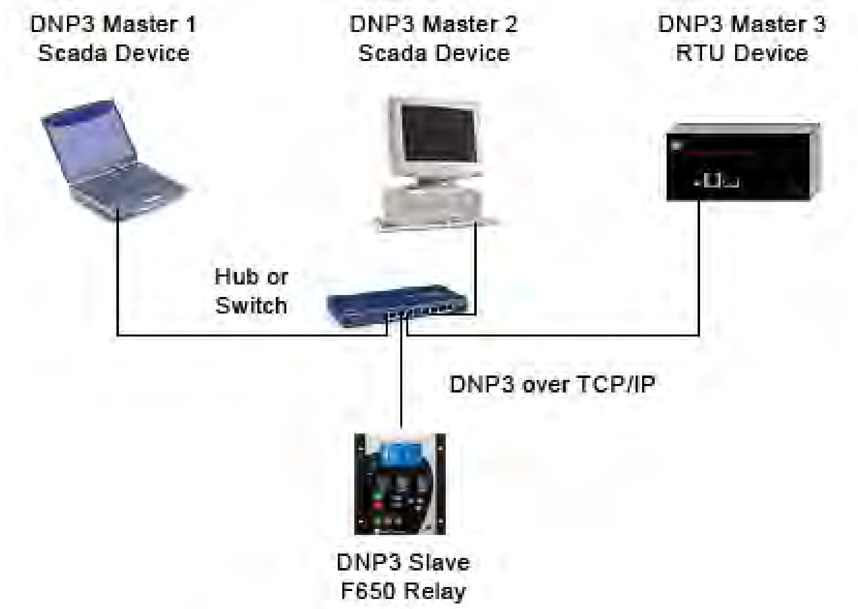


Figure C-4: Multiple DNP3.0 masters communicating with R650

DNP 3.0 Slave – F650	DNP 3.0 Master 1	DNP 3.0 Master 2	DNP 3.0 Master 3
Ethernet Config IP Addr: 192.168.37.20 Netmask: 255.255.255.0	Ethernet Config IP Addr: 192.168.37.1 Netmask: 255.255.255.0	Ethernet Config IP Addr: 192.168.37.2 Netmask: 255.255.255.0	Ethernet Config IP Addr: 192.168.37.3 Netmask: 255.255.255.0
DNP 3.0 slave 1 Physical Port: Network Address: 255 IP Addr Cli1: 192.168.37.1 TCP/UDP Port : 20000 Unsol Dest Addr: 200	DNP3 over TCP/IP DNP Addr: 200 DNP Dest Addr: 255 IP Dest: 192.168.37.20 TCP Dest Port: 20000	DNP3 over TCP/IP DNP Addr: 201 DNP Dest Addr: 256 IP Dest : 192.168.37.20 TCP Dest Port: 20001	DNP3 over TCP/IP DNP Addr: 202 DNP Dest Addr: 257 IP Dest: 192.168.37.20 TCP Dest Port: 20002
DNP 3.0 slave 2 Physical Port: Network Address: 256 IP Addr Cli1: 192.168.37.2 TCP/UDP Port : 20001 Unsol Dest Addr: 201			
DNP 3.0 slave 3 Physical Port: Network Address: 257 IP Addr Cli1: 192.168.37.3 TCP/UDP Port : 20002 Unsol Dest Addr: 202			

Figure C-5: SETTINGS FOR DNP3.0 MULTI-master communicatiONS with R650

C.6 Binary output and control relay output

Supported Control Relay Output Block fields: Pulse On.

The R650 relay provides 24 DNP Binary/Control Output points. These outputs are mapped to the first 24 commands configured in the R650. Executing a command is equal to activate the PLC equation that was attached to this command. Thus all of the 24 DNP Binary/Control Output points are pulsed points. It means that only Pulse On flag is accepted in DNP control operations on those points. All commands have configurable names. Changing the command's name can be done using the EnerVista 650 Setup program.

BINARY OUTPUT STATUS POINTS

Object Number: **10**

Request Function Codes supported: **1 (read)**

Default Variation Reported when variation 0 requested: **2 (Binary Output Status)**

CONTROL RELAY OUTPUT BLOCKS

Object Number: **12**

Request Function Codes supported: **3 (select), 4 (operate), 5 (direct operate), 6 (direct operate, no ack)**

BINARY/CONTROL OUTPUT POINTS	
POINT INDEX	NAME/DESCRIPTION
0	OPERATION1
1	OPERATION2
2	OPERATION3
3	OPERATION4
4	OPERATION5
5	OPERATION6
6	OPERATION7
7	OPERATION8
8	OPERATION9
9	OPERATION10
10	OPERATION11
11	OPERATION12
12	OPERATION13
13	OPERATION14
14	OPERATION15
15	OPERATION16
16	OPERATION17
17	OPERATION18
18	OPERATION19
19	OPERATION20
20	OPERATION21
21	OPERATION22
22	OPERATION23
23	OPERATION24
24-55	VI latched 1-32
56	VI Self Reset 1-2
57	VI Self Reset 3-4
58	VI Self Reset 5-6

BINARY/CONTROL OUTPUT POINTS	
POINT INDEX	NAME/DESCRIPTION
59	VI Self Reset 7-8
60	VI Self Reset 9-10
61	VI Self Reset 11-12
62	VI Self Reset 13-14
63	VI Self Reset 15-16
64	VI Self Reset 17-18
65	VI Self Reset 19-20
66	VI Self Reset 21-22
67	VI Self Reset 23-24
68	VI Self Reset 25-26
69	VI Self Reset 27-28
70	VI Self Reset 29-30
71	VI Self Reset 31-32

C.7 Binary counters

The following table lists both Binary Counters (Object 20) and Frozen Counters (Object 21). When a freeze function is performed on a Binary Counter point, the frozen value is available in the corresponding Frozen Counter point. Digital Counter values are represented as 32-bit integers. The DNP 3.0 protocol defines counters to be unsigned integers. Care should be taken when interpreting negative counter values.

BINARY COUNTERS

Static (Steady-State) Object Number: **20**
Change Event Object Number: **22**
Request Function Codes supported: **1 (read), 7 (freeze), 8 (freeze no ack), 9 (freeze and clear), 10 (freeze and clear, no ack), 22 (assign class)**
Static Variation reported when variation 0 requested: **1 (32-Bit Binary Counter with Flag)**
Change Event Variation reported when variation 0 requested: **1 (32-Bit Counter Change Event without time)**
Default Class for all points: **3**

FROZEN COUNTERS

Static (Steady-State) Object Number: **21**
Change Event Object Number: **23**
Request Function Codes supported: **1 (read)**
Static Variation reported when variation 0 requested: **1 (32-Bit Frozen Counter with Flag)**
Change Event Variation reported when variation 0 requested: **1 (32-Bit Frozen Counter Event without time)**
Default Class for all points: **3**

BINARY AND FROZEN COUNTERS POINT INDEX NAME/DESCRIPTION:

0 Pulse Counter 1	16 Pos MWatthour
1 Pulse Counter 2	17 Neg MWatthour
2 Pulse Counter 3	18 Pos MVatthour
3 Pulse Counter 4	19 Neg MVatthour
4 Pulse Counter 5	
5 Pulse Counter 6	
6 Pulse Counter 7	
7 Pulse Counter 8	
8 Digital Counter 1	
9 Digital Counter 2	
10 Digital Counter 3	
11 Digital Counter 4	
12 Digital Counter 5	
13 Digital Counter 6	
14 Digital Counter 7	
15 Digital Counter 8	

C.8 Analog inputs

It is important to note that 16-bit and 32-bit variations of Analog Inputs are transmitted through DNP as signed numbers. Even for analog input points that are not valid as negative values, the maximum positive representation is 32767. This is a DNP requirement.

The deadbands for all Analog Input points are in the same units as the Analog Input quantity. For example, an Analog Input quantity measured in volts has a corresponding deadband in units of volts. This is in conformance with DNP Technical Bulletin 9809-001 Analog Input Reporting Deadband. The scale factors apply also to deadbands. For example if Current Scale Factor is set to 0.001, and it is desired that a specific Analog Input point (that is of type current) trigger an event when its value changes by 1 kA, then the deadband for this point should be set to 1000. Relay settings are available to set default deadband values according to data type. Deadbands for individual Analog Input Points can be set using DNP Object 34.

ANALOG INPUT POINTS

Static (Steady-State) Object Number: **30**

Change Event Object Number: **32**

Request Function Codes supported: **1 (read), 2 (write, deadbands only), 22 (assign class)**

Static Variation Reported when variation 0 requested: **1 (32-Bit Analog Input)**

Change Event Variation reported when variation 0 requested: 1 **(Analog Change event without Time)**

Change Event Scan Rate: defaults to **500ms.**

Default Class for all points: **1**

Units for Analog Input points are as follows:

Current:	kA/A	Apparent Power:	MVA/KVA
Voltage:	kV/V	Energy:	MWh, MVArh/ kWh, kVArh
Real Power:	MW/KV	Frequency:	Hz
Reactive Power:	MVAr/kVAr	Angle:	degrees

DEFAULT ANALOG MAP

POINT	DESCRIPTION	UNIT
0	Phasor Ia Primary	kA/A
1	Phasor Ib Primary	kA/A
2	Phasor Ic Primary	kA/A
3	Phasor Ig Primary	kA/A
4	Phasor Isg Primary	kA/A
5	Phasor In Primary	kA/A
6	I0 Primary	kA/A
7	I1 Primary	kA/A
8	I2 Primary	kA/A
9	Ia Angle	degrees
10	Ib Angle	degrees
11	Ic Angle	degrees

POINT	DESCRIPTION	UNIT
12	In Angle	degrees
13	Ig Angle	degrees
14	Isg Angle	degrees
15	Load V0 Primary	kV/V
16	Load V1 Primary	kV/V
17	Load V2 Primary	kV/V
18	Load Vab Primary	kV/V
19	Load Vbc Primary	kV/V
20	Load Vca Primary	kV/V
21	Load Vn Primary	kV/V
22	Load Va Primary	kV/V
23	Load Vb Primary	kV/V
24	Load Vc Primary	kV/V
25	Load Va Angle	degrees
26	Load Vb Angle	degrees
27	Load Vc Angle	degrees
28	Load Vn Angle	degrees
29	Load Vab Angle	degrees
30	Load Vbc Angle	degrees
31	Load Vca Angle	degrees
32	Load Voltage	kV/V
33	Source V0 Primary	kV/V
34	Source V1 Primary	kV/V
35	Source V2 Primary	kV/V
36	Source Vab Primary	kV/V
37	Source Vbc Primary	kV/V
38	Source Vca Primary	kV/V
39	Source Vn Primary	kV/V
40	Source Va Primary	kV/V
41	Source Vb Primary	kV/V
42	Source Vc Primary	kV/V
43	Source Va Angle	degrees
44	Source Vb Angle	degrees
45	Source Vc Angle	degrees
46	Source Vn Angle	degrees
47	Source Vab Angle	degrees
48	Source Vbc Angle	degrees
49	Source Vca Angle	degrees
50	Source Voltage	kV/V
51	Voltage Capacitor	kV/V
52	PhA Reactive Pwr Pri	MVAr/kVAr
53	PhA Apparent Pwr Pri	MVA/kVA

POINT	DESCRIPTION	UNIT
54	PhA Real Pwr Pri	MW/kW
55	PhB Reactive Pwr Pri	MVAr/kVAr
56	PhB Apparent Pwr Pri	MVA/kVA
57	PhB Real Pwr Pri	MW/kW
58	PhC Reactive Pwr Pri	MVAr/kVAr
59	PhC Apparent Pwr Pri	MVA/kVA
60	PhC Real Pwr Pri	MW/kW
61	3 Ph Reactive Pwr Pri	MVAr/kVAr
62	3 Ph Apparent Pwr Pri	MVA/kVA
63	3 Ph Real Pwr Pri	MW/kW
64	PhA Power Factor Pri	
65	PhB Power Factor Pri	
66	PhC Power Factor Pri	
67	3 Ph Power Factor Pri	
68	Load Frequency	Hz
69	Source Frequency	Hz
70	Pos MVarhour Freeze	MVArh/kVArh
71	Neg MVarhour Freeze	MVArh/kVArh
72	Pos MWatthour Freeze	MWh/kWh
73	Neg MWatthour Freeze	MWh/kWh
74	Positive Mvarhour	MVArh/kVArh
75	Negative MVarhour	MVArh/kVArh
76	Positive MWatthour	MWh/kWh
77	Negative MWatthour	MWh/kWh
78	PreFault Ia Mod	kA/A
79	PreFault Ia Ang	degrees
80	PreFault Ib Mod	kA/A
81	PreFault Ib Ang	degrees
82	PreFault Ic Mod	kA/A
83	PreFault Ic Ang	degrees
84	PreFault Vab Mod	kV/V
85	PreFault Vab Ang	degrees
86	PreFault Vbc Mod	kV/V
87	PreFault Vbc Ang	degrees
88	PreFault Vca Mod	kV/V
89	PreFault Vca Ang	degrees
90	PostFault Ia Mod	kA/A
91	PostFault Ia Ang	degrees
92	PostFault Ib Mod	kA/A
93	PostFault Ib Ang	degrees
94	PostFault Ic Mod	kA/A
95	PostFault Ic Ang	degrees

POINT	DESCRIPTION	UNIT
96	PostFault Vab Mod	kV/V
97	PostFault Vab Ang	degrees
98	PostFault Vbc Mod	kV/V
99	PostFault Vbc Ang	degrees
100	PostFault Vca Mod	kV/V
101	PostFault Vca Ang	degrees
102	FAULT TYPE	Enum
103	FAULT LOCATION	km
104	PreFault Ig Mod	kA/A
105	PreFault Ig Ang	degrees
106	PreFault Isg Mod	kA/A
107	PreFault Isg Ang	degrees
108	PostFault Ig Mod	kA/A
109	PostFault Ig Ang	degrees
110	PostFault Isg Mod	kA/A
111	PostFault Isg Ang	degrees
112	% of Load-To-Trip	%
113	RCL PHA WEAR MON	%
114	RCL PHB WEAR MON	%
115	RCL PHC WEAR MON	%
116	RCL 3P WEAR MON	%
117	Current THD Phase A	%
118	Current THD Phase B	%
119	Current THD Phase C	%
120	Source THD Phase A	%
121	Source THD Phase B	%
122	Source THD Phase C	%
123	Load THD Phase A	%
124	Load THD Phase B	%
125	Load THD Phase C	%

The "Fault Type" is represented by enumeration value. The table below shows values with DNP3 setting "Other Scale Factor = 1".

ENUM VALUE	FAULT TYPE
0	GROUND
1	PHASE
2	TRIPH
3	AG
4	ABG
5	AB
6	BG
7	BCG
8	BC
9	CG
10	CAG
11	CA
12	NAF

If the DNP3 setting "Other Scale Factor" has a value different from "1" then "Enum Value" is scaled by the adjusted factor. For example if "Other Scale Factor = 0.001", then the value corresponding to "TRIPH" fault type is 2000.

NAF indicates that the type of fault has not been calculated.

R650 Recloser Controller

Appendix D: IEC 60870-5-104 protocol

D.1 Introduction

The R650 implements functionality of an IEC 60870-5-104 server. The devices responds to client requests or can send spontaneous transmissions. R650 implementation of 60870-5-104 provides analog metering and states.

The IEC 60870-5-104 communications protocol is supported on Ethernet ports A and B only.

D.2 Technical description

ASDU is the information unit used for data transmission. An ASDU may have data inside or not. The ASDU is encapsulated in another package of the link layer. ASDU address takes up 2 bytes.

Communication frames can be control or data frames. Control strings do not have ASDU inside.

A frame is consisting of 3 parts. (2 of them are not always present):

Link data + [ASDU header+ [ASDU data]]

The data between brackets can be omitted.

In IEC104 communication is made by TCP/IP protocols. Actually, it is a TCP communication. The default port is the 2404.

The R650 is listening as a server and supports up to two different IEC60870-5-104 masters simultaneously.

D.3 Basic application functions

Cyclic data transmission

Cyclic data transmission is used to send measured values to the IEC 60870-5-104 master.

Spontaneous Transmission:

Information objects may be transmitted without a specific request from the IEC 60870-5-104 master.

The data that can be sent spontaneously are:

- Measured values when a deadband overflow takes place.
- Single points in the time the event is produced.
- Double points in the time the event is produced.
- Integrated Totals

Clock synchronization

R650 supports clock synchronization from IEC 60870-5-104 master.

If IRIG-B, PTP-1588 or SNTP is being used for time synchronization, the IEC 60870-5-104 clock synchronization command does not set the R650 real time clock.

Command transmission

R650 is allowed to accept single commands and double commands.

D.4 IEC 104 settings

The Communication settings for IEC 60870-5-104 protocol are the following:

Product Setup > Communication Settings > IEC 870-5-104			
Name	**Value**	**Units**	**Range**
Function	DISABLED		
TCP Port	2404		[0:65535]
Common Addr of ASDU	255		[0:65535]
Cyclic Meter Period	0	Seconds	[0:3600]
Synchronization Event	0	Minutes	[0:1400]
IEC104 NET1 CLI1 OCTET1	0		[0 : 255]
IEC104 NET1 CLI1 OCTET2	0		[0 : 255]
IEC104 NET1 CLI1 OCTET3	0		[0 : 255]
IEC104 NET1 CLI1 OCTET4	0		[0 : 255]
IEC104 NET1 CLI2 OCTET1	0		[0 : 255]
IEC104 NET1 CLI2 OCTET2	0		[0 : 255]
IEC104 NET1 CLI2 OCTET3	0		[0 : 255]
IEC104 NET1 CLI2 OCTET4	0		[0 : 255]
Function 2	DISABLED		
TCP Port 2	2404		[0:65535]
Common Addr of ASDU 2	255		[0:65535]
IEC104 NET2 CLI1 OCTET1	0		0 : 255]
IEC104 NET2 CLI1 OCTET2	0		0 : 255]
IEC104 NET2 CLI1 OCTET3	0		0 : 255]
IEC104 NET2 CLI1 OCTET4	0		0 : 255]
IEC104 NET2 CLI2 OCTET1	0		0 : 255]
IEC104 NET2 CLI2 OCTET2	0		0 : 255]
IEC104 NET2 CLI2 OCTET3	0		0 : 255]
IEC104 NET2 CLI2 OCTET4	0		0 : 255]
SCALE CURRENT	1		
SCALE VOLTAGE	1		
SCALE POWER	1		
SCALE ENERGY	1		
SCALE OTHER	1		
DEADBAND CURRENT	30000		[0:65535]
DEADBAND VOLTAGE	30000		[0:65535]
DEADBAND POWER	30000		[0:65535]
DEADBAND ENERGY	30000		[0:65535]
DEADBAND OTHER	30000		[0:65535]
IOA BINARIES	1000		[0:65535]
IOA DOUBLE POINTS	1500		[0:65535]
IOA ANALOGS	2000		[0:65535]
IOA COUNTERS	4000		[0:65535]
IOA COMMANDS	3000		[0:65535]
IOA ANALOG PARAMETERS	5000		[0:65535]

Function:	Enable or disable the protocol operation for the first IEC 60870-5-104 connection.
TCP Port:	Listening TCP port in the relay. Default value is 2404.
Common Addr of ASDU:	Address in the ASDU header. Default value is 255.
Cyclic Meter Period:	Number of seconds for cyclical data sending, 0 means no spontaneous meterings.
Synchronization event:	Period of time (in minutes) for which timestamps are considered valid after receiving a clock synchronization command.
IEC104 NET1 CLI1 OCTET1 to 4:	These four octets define the IP address of the first client that is accepted in the first connection. The R650 relay can respond to a maximum of 2 IEC 60870-5-104 masters (not at the same time) in this connection.
EC104 NET1 CLI2 OCTET1 to 4:	These four octets define the IP address of the second client that is accepted in the first connection. The R650 relay can respond to a maximum of 2 IEC 60870-5-104 masters (not at the same time) in this connection.
Function 2:	Enable or disable the protocol operation for the second connection.
TCP Port 2:	Listening TCP port in the relay. Default value is 2404.
Common Addr of ASDU2:	Address in the ASDU header. Default value is 255.
IEC104 NET2 CLI1 OCTET1 to 4:	These four octets define the IP address of the first client that is accepted in the second connection. The R650 relay can respond to a maximum of 2 IEC 60870-5-104 masters (not at the same time) in this connection.
IEC104 NET2 CLI2 OCTET1 to 4:	These four octets define the IP address of the second client that is accepted in the second connection. The R650 relay can respond to a maximum of 2 IEC 60870-5-104 masters (not at the same time) in this connection.
SCALE CURRENT, VOLTAGE, POWER, ENERGY, PF, OTHER:	These settings are numbers used to scale Analog Input point values. These settings group the R650 Analog Input data into types: current, voltage, power, energy, and other. Each setting represents the scale factor for all Analog Input points of that type. For example, if the **SCALE VOLTAGE** is set to a value of 1000, all IEC104 Analog Input points that are voltages are returned with the values 1000 times smaller (e.g. a value 72000 V on the R650 is returned as 72). These settings are useful when Analog Input values must be adjusted to fit within certain ranges in IEC 60870-5-104 masters. Note that a scale factor of 0.1 is equivalent to a multiplier of 10 (i.e. the value is 10 times larger).
DEADBAND CURRENT, VOLTAGE, POWER, ENERGY, PF, OTHER:	These settings are the values used by the R650 to determine when to trigger spontaneous responses containing Analog Input data. These settings group the R650 Analog Input data into types: current, voltage, power, energy, and other. Each setting represents the default deadband value for all Analog Input points of that type. For example, in order to trigger spontaneous responses from the R650 when any current values change by 15 A, the **IEC104 DEADBAND CURRENT** setting should be set to 15. Note that these settings are the default values of the deadbands. Parameter of measured value ASDU can be used to change deadband values, from the default, for each individual IEC104 Analog Input point. Whenever power is removed and re-applied to the R650, the default deadbands are in effect.

IOA BINARIES:	Starting Information Object Address for Single Points.
IOA DOUBLE POINTS:	Starting Information Object Address for Double Points.
IOA ANALOGS:	Starting Information Object Address for Analog Inputs.
IOA COUNTERS:	Starting Information Object Address for Counters.
IOA COMMANDS:	Starting Information Object Address for Single or Double Commands.
IOA ANALOG PARAMETERS:	Starting Information Object Address for Parameter of measured value. Each Measured value has a Parameter of measured value associated with its threshold.

The R650 relay has a custom Binary Inputs points list, called User Map; it is common for any protocol. In the case of IEC 104 Protocol, those points are GROUP1 and GROUP2.

The IEC 104 User Map can be configured using the **EnerVista 650 Setup** software in ***Setpoint > Relay Configuration > Control Events***.

The User Map contains 128 Binary Inputs. To each point of the User Map, assign any of the binary states of the R650 relay. It is also possible to combine those states using OR and NOT functions. These states are: contact inputs and outputs, virtual outputs, protection element states, PLC states, etc. The User Map always has a size of 128 Binary Inputs. Points in the User Map that are not configured have a zero value in the answer.

It is possible to implement more complex logic than simple OR and NOT using the **PLC Editor** tool in **EnerVista 650 Setup** in the menu ***Setpoint > Logic Configuration.*** These complex signals (Virtual Outputs) can be assigned to the binary points in the Control Events configuration for the IEC 104 user map.

Groups of Data

The data is organized into groups in order to provide values when the controlling station requests them by a general or group interrogation.

Groups 1, 2 & 4 are set by the 256 Single Points (M_SP_NA_1).

Group 3 is set by the 16 Double Points (M_DP_NA_1).

Groups 5 and 6 are set by the 126 Analog Inputs, short floating-point (M_ME_NC_1).

Group 7 is set by the 126 Parameter of measured value, short floating-point (P_ME_NC_1).

These 256 Single Points, 16 Double points and 120 Measured Values are also sent as a response to a General Interrogation.

The 20 Integrated Totals (M_IT_NA_1) has its own Counter Group and it is sent as a response to a General Request Counter.

Group 1 Status	
POINT	DESCRIPTION
M_SP_NA_1	
1000-1063	CONTROL EVENTS 1-64

Group 2 Status	
POINT	DESCRIPTION
M_SP_NA_1	
1064-1127	CONTROL EVENTS 65-128

Group 3 Status	
POINT	DESCRIPTION
M_DP_NA_1	
1500-1515	SWITCHGEAR EVENTS

Group 4 Status	
POINT	DESCRIPTION
M_SP_NA_1	
1128-1255	BOARD F 1-32, G 1-32, H 1-32, J 1-32

Group 5 Metering	
POINT	DESCRIPTION
M_ME_NC_1	
2000	Phasor Ia Primary
2001	Phasor Ib Primary
2002	Phasor Ic Primary
2003	Phasor Ig Primary
2004	Phasor Isg Primary
2005	Phasor In Primary
2006	I0 Primary
2007	I1 Primary
2008	I2 Primary
2009	Ia Angle
2010	Ib Angle
2011	Ic Angle
2012	In Angle
2013	Ig Angle
2014	Isg Angle
2015	Load V0 Primary
2016	Load V1 Primary
2017	Load V2 Primary
2018	Load Vab Primary
2019	Load Vbc Primary
2020	Load Vca Primary
2021	Load Vn Primary
2022	Load Va Primary
2023	Load Vb Primary
2024	Load Vc Primary
2025	Load Va Angle
2026	Load Vb Angle
2027	Load Vc Angle

Group 5 Metering	
POINT	DESCRIPTION
2028	Load Vn Angle
2029	Load Vab Angle
2030	Load Vbc Angle
2031	Load Vca Angle
2032	Load Voltage
2033	Source V0 Primary
2034	Source V1 Primary
2035	Source V2 Primary
2036	Source Vab Primary
2037	Source Vbc Primary
2038	Source Vca Primary
2039	Source Vn Primary
2040	Source Va Primary
2041	Source Vb Primary
2042	Source Vc Primary
2043	Source Va Angle
2044	Source Vb Angle
2045	Source Vc Angle
2046	Source Vn Angle
2047	Source Vab Angle
2048	Source Vbc Angle
2049	Source Vca Angle
2050	Source Voltage
2051	Voltage Capacitor
2052	PhA Reactive Pwr Pri
2053	PhA Apparent Pwr Pri
2054	PhA Real Pwr Pri
2055	PhB Reactive Pwr Pri
2056	PhB Apparent Pwr Pri
2057	PhB Real Pwr Pri
2058	PhC Reactive Pwr Pri
2059	PhC Apparent Pwr Pri

Group 6 Metering	
POINT	DESCRIPTION
M_ME_NC_1	
2060	PhC Real Pwr Pri
2061	3 Ph Reactive Pwr Pri
2062	3 Ph Apparent Pwr Pri
2063	3 Ph Real Pwr Pri
2064	PhA Power Factor Pri

Group 6 Metering	
POINT	DESCRIPTION
2065	PhB Power Factor Pri
2066	PhC Power Factor Pri
2067	3 Ph Power Factor Pri
2068	Load Frequency
2069	Source Frequency
2070	Pos MVarhour Freeze
2071	Neg MVarhour Freeze
2072	Pos MWatthour Freeze
2073	Neg MWatthour Freeze
2074	Positive Mvarhour
2075	Negative MVarhour
2076	Positive MWatthour
2077	Negative MWatthour
2078	PreFault Ia Mod
2079	PreFault Ia Ang
2080	PreFault Ib Mod
2081	PreFault Ib Ang
2082	PreFault Ic Mod
2083	PreFault Ic Ang
2084	PreFault Vab Mod
2085	PreFault Vab Ang
2086	PreFault Vbc Mod
2087	PreFault Vbc Ang
2088	PreFault Vca Mod
2089	PreFault Vca Ang
2090	PostFault Ia Mod
2091	PostFault Ia Ang
2092	PostFault Ib Mod
2093	PostFault Ib Ang
2094	PostFault Ic Mod
2095	PostFault Ic Ang
2096	PostFault Vab Mod
2097	PostFault Vab Ang
2098	PostFault Vbc Mod
2099	PostFault Vbc Ang
2100	PostFault Vca Mod
2101	PostFault Vca Ang
2102	FAULT TYPE
2103	FAULT LOCATION
2104	PreFault Ig Mod
2105	PreFault Ig Ang

Group 6 Metering	
POINT	DESCRIPTION
2106	PreFault Isg Mod
2107	PreFault Isg Ang
2108	PostFault Ig Mod
2109	PostFault Ig Ang
2110	PostFault Isg Mod
2111	PostFault Isg Ang
2112	% of Load-To-Trip
2113	RCL PHA WEAR MON
2114	RCL PHB WEAR MON
2115	RCL PHC WEAR MON
2116	RCL 3P WEAR MON
2117	Current THD Phase A
2118	Current THD Phase B
2119	Current THD Phase C
2120	Source THD Phase A
2121	Source THD Phase B
2122	Source THD Phase C
2123	Load THD Phase A
2124	Load THD Phase B
2125	Load THD Phase C

Group 7 Deadband	
POINT	DESCRIPTION
P_ME_NC_1	
5000-5125	Analog Input Deadbands 2000-2125

Integrated Totals	
POINT	DESCRIPTION
M_IT_NA_1	
4000-4007	Pulse Counter 1-8
4008-4015	Digital Counters 1-8
4016-4019	Energy Counters

D.5 IEC 60870-5-104 point list

OPERATIONS IN IEC 60870-5-104 FOR R650

The two standard procedures for command transmission are accepted, Direct command or Select and Execute command. The following table determines how a command can be executed in R650

Commands		
POINT	DESCRIPTION	COMMAND MODE
3000	Operation 1 (OFF) + Operation 2(ON)	Select and Execute Double Command
---	---	---
3005	Operation 11 (OFF) + Operation 12(ON)	Select and Execute Double Command
3006	Operation 13 (OFF) + Operation 14(ON)	Direct Double Command
---	---	---
3015	Operation 23 (OFF) + Operation 24(ON)	Direct Double Command
3016	Virtual Self Reset 1 (OFF) + Virtual Self Reset 2(ON)	Direct Double Command
---	---	---
3031	Virtual Self Reset 31 (OFF) + Virtual Self Reset 32(ON)	Direct Double Command
3032-3063	Virtual Latched 1-32	Direct Single Command

There are 24 available operation in R650 device; they must be configured using EnerVista 650 Setup in ***Setting > Relay Configuration > Operations***.

ASDU address must start with 3000; the addresses for operation are from 3000 to 3011. The operations go from 0 to 23.

D.6 IEC 60870-5-104 Interoperability

This companion standard presents sets of parameters and alternatives from which subsets must be selected to implement particular telecontrol systems. Certain parameter values, such as the choice of "structured" or "unstructured" fields of the INFORMATION OBJECT ADDRESS of ASDUs represent mutually exclusive alternatives. This means that only one value of the defined parameters is admitted per system. Other parameters, such as the listed set of different process information in command and in monitor direction allow the specification of the complete set or subsets, as appropriate for given applications. This clause summarizes the parameters of the previous clauses to facilitate a suitable selection for a specific application. If a system is composed of equipment stemming from different manufacturers, it is necessary that all partners agree on the selected parameters.

The interoperability list is defined as in IEC 60870-5-101 and extended with parameters used in this standard. The text descriptions of parameters which are not applicable to this companion standard are strike-through (corresponding check box is marked black).

NOTEIn addition, the full specification of a system may require individual selection of certain parameters for certain parts of the system, such as the individual selection of scaling factors for individually addressable measured values.

The selected parameters should be marked in the white boxes as follows

	Function or ASDU is not used
X	Function or ASDU is used as standardized (default)
R	Function or ASDU is used in reverse mode
B	Function or ASDU is used in standard and reverse mode

The possible selection (blank, X, R, or B) is specified for each specific clause or parameter.

A black check box indicates that the option cannot be selected in this companion standard.

<u>System or device</u>

(system-specific parameter, indicate definition of a system or a device by marking one of the following with "**X**")

	System definition
X	Controlling station definition (Master)
R	Controlled station definition (Slave)

<u>Network configuration</u>

(network-specific parameter, all configurations that are used are to be marked "**X**")

■	~~Point-to-point~~	■	~~Multipoint-partyline~~
■	~~Multiple point-to-point~~	■	~~Multipoint-star~~

Physical layer
(network-specific parameter, all interfaces and data rates that are used are to be marked "**X**")

Transmission speed (control direction)

Unbalanced interchange	Unbalanced interchange	Balanced interchange	
Circuit V.24/V.28	Circuit V.24/V.28	Circuit X.24/X.27	
Standard	Recommended if >1 200 bit/s		
■ ~~100 bit/s~~	■ ~~2 400 bit/s~~	■ ~~2 400 bit/s~~	■ ~~56 000 bit/s~~
■ ~~200 bit/s~~	■ ~~4 800 bit/s~~	■ ~~4 800 bit/s~~	■ ~~64 000 bit/s~~
■ ~~300 bit/s~~	■ ~~9 600 bit/s~~	■ ~~9 600 bit/s~~	
■ ~~600 bit/s~~		■ ~~19 200 bit/s~~	
■ ~~1 200 bit/s~~		■ ~~38 400 bit/s~~	

Transmission speed (monitor direction)

Unbalanced interchange	Unbalanced interchange	Balanced interchange	
Circuit V.24/V.28	Circuit V.24/V.28	Circuit X.24/X.27	
Standard	Recommended if >1 200 bit/s		
■ ~~100 bit/s~~	■ ~~2 400 bit/s~~	■ ~~2 400 bit/s~~	■ ~~56 000 bit/s~~
■ ~~200 bit/s~~	■ ~~4 800 bit/s~~	■ ~~4 800 bit/s~~	■ ~~64 000 bit/s~~
■ ~~300 bit/s~~	■ ~~9 600 bit/s~~	■ ~~9 600 bit/s~~	
■ ~~600 bit/s~~		■ ~~19 200 bit/s~~	
■ ~~1 200 bit/s~~		■ ~~38 400 bit/s~~	

Link layer
(network-specific parameter, all options that are used are to be marked “X”. Specify the maximum frame length. If a non-standard assignment of class 2 messages is implemented for unbalanced transmission, indicate the Type ID and COT of all messages assigned to class 2.)

~~Frame format FT 1.2, single character 1 and the fixed time out interval are used exclusively in this companion standard.~~

Link transmission

■ ~~Balanced transmission~~

■ ~~Unbalanced transmission~~

Frame length

■ ~~Balanced transmission~~

■ ~~Unbalanced transmission~~

Address field of the link

■ ~~not present (balanced transmission only)~~

■ ~~One octet~~

■ ~~Two octets~~

■ ~~Structured~~

■ ~~Unstructured~~

When using an unbalanced link layer, the following ASDU types are returned in class 2 messages (low priority) with the indicated causes of transmission:

■ ~~The standard assignment of ASDUs to class 2 messages is used as follows:~~

Type identification	Cause of transmission
9, 11, 13, 21	<1>

■ ~~A special assignment of ASDUs to class 2 messages is used as follows:~~

Type identification	Cause of transmission

~~Note: (In response to a class 2 poll, a controlled station may respond with class 1 data when there is no class 2 data available).~~

Application layer

Transmission mode for application data

Mode 1 (Least significant octet first), as defined in 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

Common address of ASDU

(system-specific parameter, all configurations that are used are to be marked "**X**")

■ ~~One octet~~ ☒ Two octets

Information object address
(system-specific parameter, all configurations that are used are to be marked "**X**")

■ ~~One octet~~
■ ~~Two octets~~
☒ Three octets

☒ Structured
☒ Unstructured

Cause of transmission
(system-specific parameter, all configurations that are used are to be marked "**X**")

■ ~~One octet~~

☒ Two octets (with originator address). Originator address is set to zero if not used

Length of APDU
(system-specific parameter, specify the maximum length of the APDU per system)

The maximum length of APDU for both directions is 253. It is a fixed system parameter.

■ Maximum length of APDU per system in control direction
■ Maximum length of APDU per system in monitor direction

Selection of standard ASDUs

Process information in monitor direction
(station-specific parameter, mark each Type ID "X" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "B" if used in both directions).

X	<1> :=	Single-point information	M_SP_NA_1
■	~~<2> :=~~	~~Single-point information with time tag~~	~~M_SP_TA_1~~
X	<3> :=	Double-point information	M_DP_NA_1
■	~~<4> :=~~	~~Double-point information with time tag~~	~~M_DP_TA_1~~
	<5> :=	Step position information	M_ST_NA_1
■	~~<6> :=~~	~~Step position information with time tag~~	~~M_ST_TA_1~~
	<7> :=	Bitstring of 32 bit	M_BO_NA_1
■	~~<8> :=~~	~~Bitstring of 32 bit with time tag~~	~~M_BO_TA_1~~
	<9> :=	Measured value, normalized value	M_ME_NA_1
■	~~<10> :=~~	~~Measured value, normalized value with time tag~~	~~M_ME_TA_1~~
	<11> :=	Measured value, scaled value	M_ME_NB_1
■	~~<12> :=~~	~~Measured value, scaled value with time tag~~	~~M_ME_TB_1~~
X	<13> :=	Measured value, short floating point value	M_ME_NC_1
■	~~<14> :=~~	~~Measured value, short floating point value with time tag~~	~~M_ME_TC_1~~
X	<15> :=	Integrated totals	M_IT_NA_1
■	~~<16> :=~~	~~Integrated totals with time tag~~	~~M_IT_TA_1~~
■	~~<17> :=~~	~~Event of protection equipment with time tag~~	~~M_EP_TA_1~~
■	~~<18> :=~~	~~Packed start events of protection equipment with time tag~~	~~M_EP_TB_1~~
■	~~<19> :=~~	~~Packed output circuit information of protection equipment with time tag~~	~~M_EP_TC_1~~
	<20> :=	Packed single-point information with status change detection	M_SP_NA_1
	<21> :=	Measured value, normalized value without quality descriptor	M_ME_ND_1
X	<30> :=	Single-point information with time tag CP56Time2a	M_SP_TB_1
X	<31> :=	Double-point information with time tag CP56Time2a	M_DP_TB_1
	<32> :=	Step position information with time tag CP56Time2a	M_ST_TB_1
	<33> :=	Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
	<34> :=	Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
	<35> :=	Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
X	<36> :=	Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
X	<37> :=	Integrated totals with time tag CP56Time2a	M_IT_TB_1
	<38> :=	Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
	<39> :=	Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
	<40> :=	Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

In this companion standard only the use of the set <30> – <40> for ASDUs with time tag is permitted.

Process information in control direction

(station-specific parameter, mark each Type ID "X" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	<45> :=	Single command	C_SC_NA_1
X	<46> :=	Double command	C_DC_NA_1
	<47> :=	Regulating step command	C_RC_NA_1
	<48> :=	Set point command, normalized value	C_SE_NA_1
	<49> :=	Set point command, scaled value	C_SE_NB_1
	<50> :=	Set point command, short floating point value	C_SE_NC_1
	<51> :=	Bitstring of 32 bit	C_BO_NA_1
X	<58> :=	Single command with time tag CP56Time2a	C_SC_TA_1
X	<59> :=	Double command with time tag CP56Time2a	C_DC_TA_1
	<60> :=	Regulating step command with time tag CP56Time2a	C_RC_TA_1
	<61> :=	Set point command, normalized value with time tag CP56Time2a	C_SE_TA_1
	<62> :=	Set point command, scaled value with time tag CP56Time2a	C_SE_TB_1
	<63> :=	Set point command, short floating point value with time tag CP56Time2a	C_SE_TC_1
	<64> :=	Bitstring of 32 bit with time tag CP56Time2a	C_BO_TA_1

Either the ASDUs of the set <45> – <51> or of the set <58> – <64> are used.

System information in monitor direction

(station-specific parameter, mark with an "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	<70> :=	End of initialization	M EI NA 1

System information in control direction

(station-specific parameter, mark each Type ID "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	<100>:=	Interrogation command	C_IC_NA_1
X	<101>:=	Counter interrogation command	C_CI_NA_1
X	<102>:=	Read command	C_RD_NA_1
X	<103>:=	Clock synchronization command (option see 7.6)	C_CS_NA_1
■	~~<104>:=~~	~~Test command~~	~~C_TS_NA_1~~
X	<105>:=	Reset process command	C_RP_NA_1
■	~~<106>:=~~	~~Delay acquisition command~~	~~C_CD_NA_1~~
X	<107>:=	Test command with time tag CP56Time2a	C_TS_TA_1

Parameter in control direction

(station-specific parameter, mark each Type ID "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

☐	<110>:=	Parameter of measured value, normalized value	P_ME_NA_1
☐	<111>:=	Parameter of measured value, scaled value	P_ME_NB_1
X	<112>:=	Parameter of measured value, short floating point value	P_ME_NC_1
☐	<113>:=	Parameter activation	P_AC_NA_1

File transfer

(station-specific parameter, mark each Type ID "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

☐	<120>:=	File ready	F_FR_NA_1
☐	<121>:=	Section ready	F_SR_NA_1
☐	<122>:=	Call directory, select file, call file, call section	F_SC_NA_1
☐	<123>:=	Last section, last segment	F_LS_NA_1
☐	<124>:=	Ack file, ack section	F_AF_NA_1
☐	<125>:=	Segment	F_SG_NA_1
☐	<126>:=	Directory {blank or X, only available in monitor (standard) direction}	F_DR_TA_1
☐	<127>:=	Query Log – Request archive file	F_SC_NB_1

Type identifier and cause of transmission assignments

(station-specific parameters)

Shaded boxes: option not required.

Black boxes: option not permitted in this companion standard

Blank: functions or ASDU not used.

Mark Type Identification/Cause of transmission combinations:

"**X**" if only used in the standard direction;

"**R**" if only used in the reverse direction;

"**B**" if used in both directions.

Type identification		**Cause of transmission**																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<1>	M_SP_NA_1					**X**									**X**					
~~<2>~~	~~M_SP_TA_1~~																			
<3>	M_DP_NA_1					**X**									**X**					
~~<4>~~	~~M_DP_TA_1~~																			
<5>	M_ST_NA_1																			

~~<6>~~	~~M_ST_TA_1~~																			
<7>	M_BO_NA_1																			
~~<8>~~	~~M_BO_TA_1~~																			
<9>	M_ME_NA_1																			
~~<10>~~	~~M_ME_TA_1~~																			
<11>	M_ME_NB_1																			
~~<12>~~	~~M_ME_TB_1~~																			
<13>	M_ME_NC_1	X				X									X					
~~<14>~~	~~M_ME_TC_1~~																			
<15>	M_IT_NA_1															X				
~~<16>~~	~~M_IT_TA_1~~																			
~~<17>~~	~~M_EP_TA_1~~																			
~~<18>~~	~~M_EP_TB_1~~																			
~~<19>~~	~~M_EP_TC_1~~																			
<20>	M_PS_NA_1																			
<21>	M_ME_ND_1																			
<30>	M_SP_TB_1			X																
<31>	M_DP_TB_1																			
<32>	M_ST_TB_1																			
<33>	M_BO_TB_1																			
<34>	M_ME_TD_1																			
<35>	M_ME_TE_1																			
<36>	M_ME_TF_1			X																
<37>	M_IT_TB_1			X																
<38>	M_EP_TD_1																			
<39>	M_EP_TE_1																			
<40>	M_EP_TF_1																			
<45>	C_SC_NA_1						X	X	X	X	X									
<46>	C_DC_NA_1						X	X	X	X	X									
<47>	C_RC_NA_1																			
<48>	C_SE_NA_1																			
<49>	C_SE_NB_1																			
<50>	C_SE_NC_1																			
<51>	C_BO_NA_1																			
<58>	C_SC_TA_1						X	X	X	X	X									
<59>	C_DC_TA_1						X	X	X	X	X									
<60>	C_RC_TA_1																			
Type identification		**Cause of transmission**																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<61>	C_SE_TA_1																			
<62>	C_SE_TB_1																			
<63>	C_SE_TC_1																			
<64>	C_BO_TA_1																			
<70>	M_EI_NA_1*				X															
<100>	C_IC_NA_1						X	X	X	X	X									

<101>	C_CI_NA_1						X	X			X									
<102>	C_RD_NA_1					X														
<103>	C_CS_NA_1						X	X												
~~<104>~~	~~C_TS_NA_1~~																			
<105>	C_RP_NA_1						X	X												
~~<106>~~	~~C_CD_NA_1~~																			
<107>	C_TS_TA_1																			
<110>	P_ME_NA_1																			
<111>	P_ME_NB_1																			
<112>	P_ME_NC_1						X	X							X					
<113>	P_AC_NA_1																			
<120>	F_FR_NA_1																			
<121>	F_SR_NA_1																			
<122>	F_SC_NA_1																			
<123>	F_LS_NA_1																			
<124>	F_AF_NA_1																			
<125>	F_SG_NA_1																			
<126>	F_DR_TA_1*																			
<127>	F_SC_NB_1*																			
* Blank or X only																				

<u>Basic application functions</u>

Station initialization

(station-specific parameter, mark "**X**" if function is used)

X	Remote initialization

Cyclic data transmission

(station-specific parameter, mark “X” if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions)

X	Cyclic data transmission

Read procedure

(station-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions)

X	Read procedure

Spontaneous transmission

(station-specific parameter, mark “X” if function is only used in the standard direction, "**R**" if only used in the reverse direction, and “B” if used in both directions)

X	Spontaneous transmission

Double transmission of information objects with cause of transmission spontaneous
(station-specific parameter, mark each information type "**X**" where both a Type ID without time and corresponding Type ID with time are issued in response to a single spontaneous change of a monitored object)

The following type identifications may be transmitted in succession caused by a single status change of an information object. The particular information object addresses for which double transmission is enabled are defined in a project-specific list.

- ☐ Single-point information M_SP_NA_1, M_SP_TA_1, M_SP_TB_1 and M_PS_NA_1
- ☐ Double-point information M_DP_NA_1, M_DP_TA_1 and M_DP_TB_1
- ☐ Step position information M_ST_NA_1, M_ST_TA_1 and M_ST_TB_1
- ☐ Bitstring of 32 bit M_BO_NA_1, M_BO_TA_1 and M_BO_TB_1 (if defined for a specific project)
- ☐ Measured value, normalized value M_ME_NA_1, M_ME_TA_1, M_ME_ND_1 and M_ME_TD_1
- ☐ Measured value, scaled value M_ME_NB_1, M_ME_TB_1 and M_ME_TE_1
- ☐ Measured value, short floating point number M_ME_NC_1, M_ME_TC_1 and M_ME_TF_1

Station interrogation
(station-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

[X] global		
[X] group 1	[X] group 7	[X] group 13
[X] group 2	[X] group 8	[X] group 14
[X] group 3	[X] group 9	[X] group 15
[X] group 4	[X] group 10	[X] group 16
[X] group 5	[X] group 11	
[X] group 6	[X] group 12	

Information object addresses assigned to each group must be shown in a separate table.

Clock synchronization
(station-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	Spontaneous transmission
	Day of week used
	RES1, GEN (time tag substituted/ not substituted) used
	SU-bit (summertime) used

optional, see 7.6

Command transmission

(object-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	Direct command transmission
	Direct set point command transmission
X	Select and execute command
	Select and execute set point command
X	C_SE ACTTERM used

X	No additional definition
X	Short-pulse duration (duration determined by a system parameter in the outstation)
X	Long-pulse duration (duration determined by a system parameter in the outstation)
X	Persistent output

X	Supervision of maximum delay in command direction of commands and set point commands

10s	Maximum allowable delay of commands and set point commands

Transmission of integrated totals

(station- or object-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	Mode A: Local freeze with spontaneous transmission
X	Mode B: Local freeze with counter interrogation
X	Mode C: Freeze and transmit by counter-interrogation commands
X	Mode D: Freeze by counter-interrogation command, frozen values reported

X	Counter read
X	Counter freeze without reset
X	Counter freeze with reset
X	Counter freeze with reset

X	General request counter
X	Request counter group 1
X	Request counter group 2
X	Request counter group 3
	Request counter group 4

Parameter loading

(object-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	Threshold value
	Smoothing factor
	Low limit for transmission of measured values
	Low limit for transmission of measured values

Parameter activation

(object-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

	Act/deact of persistent cyclic or periodic transmission of the addressed object

Test procedure

(station-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

	Test procedure

File transfer

(station-specific parameter, mark "**X**" if function is used).

File transfer in monitor direction

	Transparent file
	Transmission of disturbance data of protection equipment
	Transmission of sequences of events
	Transmission of sequences of recorded analogue values

File transfer in control direction

	Transparent file

Background scan

(station-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

	Background scan

Acquisition of transmission delay

(station-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

☐ ~~Acquisition of transmission delay~~

Definition of time outs

Parameter	Default value	Remarks	Selected value
t0	30 s	Time-out of connection establishment	**N/A**
t1	15 s	Time-out of send or test APDUs	**15 s**
t2	10 s	Time-out for acknowledges in case of no data messages t2 < t1	**10 s**
t3	20 s	Time-out for sending test frames in case of a long idle state	**20 s**

Maximum range for timeouts t0 to t2: 1 s to 255 s, accuracy 1 s.

Recommended range for timeout t3: 1 s to 48 h, resolution 1 s.

Long timeouts for t3 may be needed in special cases where satellite links or dialup connections are used (for instance to establish connection and collect values only once per day or week).

Maximum number of outstanding I format APDUs *k* and latest acknowledge APDUs (*w*)

Parameter	Default value	Remarks	Selected value
k	12 APDUs	Maximum difference receive sequence number to send state variable	**12 APDUs**
w	8 APDUs	Latest acknowledge after receiving *w* I format APDUs	**8 APDUs**

Maximum range of values *k*: 1 to 32767 (215–1) APDUs, accuracy 1 APDU

Maximum range of values *w*: 1 to 32767 APDUs, accuracy 1 APDU (Recommendation: *w* should not exceed two-thirds of *k*).

Portnumber

Parameter	Value	Remarks
Portnumber	2404	In all cases

Redundant connections

☐ Number N of redundancy group connections used

RFC 2200 suite

RFC 2200 is an official Internet Standard which describes the state of standardization of protocols used in the Internet as determined by the Internet Architecture Board (IAB). It offers a broad spectrum of actual standards used in the Internet. The suitable selection of documents from RFC 2200 defined in this standard for a given projects has to be chosen by the user of this standard.

X	Ethernet 802.3
	Serial X.21 interface
	Other selection from RFC 2200:

List of valid documents from RFC 2200

1. ....
2. ....
3. ....
4. ....
5. ....
6. ....
7. etc.

R650 Recloser Controller

Appendix E: IEC 60870-5-101 protocol

E.1 Introduction

The companion standard for basic telecontrol tasks (IEC 60870-5-101) utilizes standards of the IEC 61850-5 series of documents.

This standard enables interoperability among compatible telecontrol equipment.

E.2 Protocol structure

The IEC 60870-5-101 standard is based on the three-layer reference model "Enhanced Performance Architecture" (EPA), as specified in Clause 4 of IEC 60870-5-3.

Selected application functions of IEC 60870-5-5	**User process**
Selected application information elements of IEC 60870-5-4	**Application (layer 7)**
Selected application service data units of IEC 60870-5-3	
Selected link transmission procedures of IEC 60870-5-2	**Link (layer 2)**
Selected transmission frame formats of IEC 60870-5-1	
Selected ITU-T recommendations	**Physical (layer 1)**

In the **physical layer** the companion standard specifies ITU-T recommendations which define the interfaces between DCE and DTE equipment of the controlling and controlled station.

The **link layer** defines procedures using a control field and the address field, operating in either an unbalanced or a balanced transmission mode. It also defines the frame format chosen for transmission frames in IEC 60870-5-1.

The **application layer** defines the appropriate ASDUs using the definition and coding specifications for application information elements given in IEC 60870.5-4.

The **user process** offers one or more instances of the basic application functions of IEC 60870-5-5 to provide the required set of input/output application procedure to suit the specific telecontrol system.

E.3 Transmission procedures

The R650 is always secondary (slave) in unbalanced link transmission system.

E.4 Basic application functions

The following basic application functions, defined in IEC 60870-5-5 are implemented in the R650:

Station initialization (IEC 60870-5-5, 6.1)

Data acquisition by polling (IEC 60870-5-5, 6.2)

Data acquisition by polling is used in SCADA systems operating with unbalanced data transmission procedures to update the controlling station with actual states of process variables in controlled stations. The controlling station performs polling by interrogating controlled stations sequentially. Controlled stations may transmit only when they are polled.

Cyclic data transmission (IEC 60870-5-5, 6.3)

Cyclic data transmission is used to send measured values to the IEC 60870-5-101 master.

Acquisition of events (IEC 60870-5-5, 6.4)

Events occur spontaneously at the application level. Procedures that perform the task of informing remote stations of events depend on the operation of the communication system. In every case, the local process requires an event buffer to collect events that may appear faster than their transmission to the remote station can be accomplished. In unbalanced communication systems, the process in the controlled station is obliged to wait for a request for transmission from the controlling station.

The data that can be sent spontaneously are:

- Measured values when a deadband overflow takes place
- Single points in the time the event is produced
- Double points in the time the event is produced
- Integrated Totals

General interrogation (IEC 60870-5-5, 6.6)

The outstation interrogation function is used for updating the controlling station after the internal station initialization procedure or when the controlling station detects a loss of information. The general interrogation function of the controlling station requests the controlled stations to transmit the actual values of all their process variables.

Clock synchronization (IEC 60870-5-5, 6.7)

Clocks in controlled stations have to be synchronized with the clock in the controlling station to provide correct chronological sets of time-tagged events or information objects that are transmitted to the controlling station or logged locally. The clocks are initially synchronized by the controlling station after system initialization and then re-synchronized periodically.

If Irig-B, PTP-1588 or SNTP is being used for time synchronization, the IEC 60870-5-101 clock synchronization command will not set R650 real time clock.

Command transmission (IEC 60870-5-5, 6.8)

A command is used in telecontrol systems to cause a change of state of an operational equipment. Thus commands are used to drive a controlled process in an intended direction.

Commands may be initiated by an operator or by automatic supervisory procedures in the controlling station. Provisions against unauthorized access or against unwanted actions are system-or process-dependent matters.

There are two standard procedures for command transmission, namely:

1. Direct command and

2. Select and execute command

R650 is allowed to accept single commands and double commands.

Transmission of integrated totals (IEC 60870-5-5, 6.9)

An integrated total is a value that is integrated over a specified period of time.

Two different methods are applied to acquire counter information:

1.Acquisition of integrated totals:

The controlled stations memorize (freeze) the integrated totals periodically at specific points of time to buffer memories and then transmit the frozen values to the controlling station.

2.Acquisition of incremental information:

The controlled stations memorize (freeze) the integrated totals periodically at specific points of time to buffer memories and reset the integrated totals to zero. Then the frozen values are transmitted to the controlling station.

Test procedure (IEC 60870-5-5, 6.11)

The test procedure is used to check the complete loop from the controlling station to the controlled station and then back to the controlling station including the associated application functions.

Acquisition of transmission delay (IEC 60870-5-5, 6.13)

The value of time correction is determined by the sum of transmission delay and equipment internal delay. The latter depends on particular process requirements and is not subject to standardization. The transmission delay is a value which may be either acquired separately by parameterization or via a dynamic procedure, initiated by the controlling station.

E.5 IEC 101 settings

The Communication settings for IEC 60870-5-101 protocol are the following:

Product Setup > Communication Settings > IEC 870-5-101			
Name	**Value**	**Units**	**Range**
IEC101 COM1	DISABLED		
Common Addr ASDU1	255		[0 : 65535]
Link Address1	255		[0 : 65535]
IEC101 COM2	DISABLED		
Common Addr ASDU2	255		[0 : 65535]
Link Address2	255		[0 : 65535]
ASDU Addr Size	2		[1 : 2]
COT Size	1		[1 : 2]
IOA Size	2		[1 : 3]
Link Addr Size	1		[1 : 2]
Cyclic Meter Period	0	Seconds	[0 : 3600]
Synchronization Event	0	Minutes	[0 : 1400]
SCALE CURRENT	0.00001		
SCALE VOLTAGE	0.00001		
SCALE POWER	0.00001		
SCALE ENERGY	0.00001		
SCALE FACTOR PF	0.00001		
SCALE OTHER	0.00001		
DEADBAND CURRENT	30000		[0 : 65535]
DEADBAND VOLTAGE	30000		[0 : 65535]
DEADBAND POWER	30000		[0 : 65535]
DEADBAND ENERGY	30000		[0 : 65535]
DEADBAND PF	30000		[0 : 65535]
DEADBAND OTHER	30000		[0 : 65535]
IOA BINARIES	1000		[0 : 65535]
IOA DOUBLE POINTS	1500		[0 : 65535]
IOA ANALOGS	2000		[0 : 65535]
IOA COUNTERS	4000		[0 : 65535]
IOA COMMANDS	3000		[0 : 65535]
IOA ANALOG PARAM	5000		[0 : 65535]

IEC101 COM1: Enables or disables IEC 60870-5-101 protocol operation in the serial COM1 port.

Common Addr ASDU1: Address in the ASDU header for the slave instance running in COM1.

Link Address1: Link address for the slave running on COM1.

IEC101 COM2: Enables or disables IEC 60870-5-101 protocol operation in the serial COM2 port.

Common Addr ASDU2: Address in the ASDU header for the slave instance running in COM2.

Link Address2: Link address for the slave running on COM2.

ASDU Addr Size, COT size, IOA Size,

Link Addr Size: These parameters must be the same in the master and slave devices.

Cyclic Meter Period: Number of seconds for cyclical data sending; 0 means no spontaneous metering.

Synchronization Event: Period of time (in minutes) for which timestamps are considered valid after receiving a clock synchronization command.

SCALE CURRENT, VOLTAGE, POWER, ENERGY, FACTOR PF, OTHER: Numbers used to scale Analog Input point values. These settings group the R650 Analog Input data into types: current, voltage, power, energy, and other. Each setting represents the scale factor for all Analog Input points of that type. For example, if the SCALE VOLTAGE is set to a value of 1000, all IEC104 Analog Input points that are voltages will be returned with the values 1000 times smaller (e.g. a value 72000 V on the R650 will be returned as 72). These settings are useful when Analog Input values must be adjusted to fit within certain ranges in the masters. Note that a scale factor of 0.1 is equivalent to a multiplier of 10 (i.e. the value will be 10 times larger).

DEADBAND CURRENT, VOLTAGE, POWER, ENERGY, PF, OTHER: Values used by the R650 to determine when to trigger spontaneous responses containing Analog Input data. These settings group the R650 Analog Input data into types: current, voltage, power, energy, and other. Each setting represents the default deadband value for all Analog Input points of that type. For example, in order to trigger spontaneous responses from the R650 when any current values change by 15 A, the **DEADBAND CURRENT** setting should be set to 15. Note that these settings are the default values of the deadbands. Parameter of measured value ASDU can be used to change deadband values, from the default, for each individual IEC 101 Analog Input point. Whenever power is removed and re-applied to the R650, the default deadbands will be in effect.

IOA BINARIES: Starting Information Object Address for Single Points.

IOA DOUBLE POINTS: Starting Information Object Address for Double Points.

IOA ANALOGS: Starting Information Object Address for Analog Inputs.

IOA COUNTERS: Starting Information Object Address for Counters.

IOA COMMANDS: Starting Information Object Address for Single or Double Commands.

IOA ANALOG PARAM: Starting Information Object Address for Parameter of measured value. Each Measured value has a Parameter of measured value associated with its threshold.

E.6 Points List

E.6.1 IEC 60870-5-101 User Map

The R650 relay has a custom Binary Inputs points list, called a User Map; it is common for IEC 60870-5-101/104 protocols.

The User Map can be configured using the **EnerVista 650 Setup** software in ***Setpoint > Relay Configuration > Control Events***.

The User Map contains 128 Binary Inputs. To each point of the User Map, assign any of the binary states of the R650 relay. It is also possible to combine those states using OR and NOT functions. These states are: contact inputs and outputs, virtual outputs, protection element states, PLC states, etc. Points in the User Map that are not configured have a zero value in the response.

It is possible to implement more complex logic than simple OR and NOT using the **PLC Editor** tool in **EnerVista 650 Setup** in the menu ***Setpoint > Logic Configuration.*** These complex signals (Virtual Outputs) can be assigned to the binary points in the Control Events configuration for the IEC 101 user map.

E.6.2 Groups of Data

The data is organized into groups in order to provide values when the controlling station requests them by a general or group interrogation.

Groups 1, 2 & 4 are set by the 256 Single Points (M_SP_NA_1).

Group 3 is set by the 16 Double Points (M_DP_NA_1).

Groups 5 and 6 are set by the 126 Analog Inputs, short floating-point (M_ME_NC_1).

Group 7 is set by the 126 Parameter of measured value, short floating-point (P_ME_NC_1).

These 256 Single Points, 16 Double points and 129 Measured Values are also sent as a response to a General Interrogation.

The 20 Integrated Totals (M_IT_NA_1) has its own Counter Group and it is sent as a response to a General Request Counter.

Group 1 Status	
POINT	DESCRIPTION
M_SP_NA_1	
1000-1063	CONTROL EVENTS 1-64

Group 2 Status	
POINT	DESCRIPTION
M_SP_NA_1	
1064-1127	CONTROL EVENTS 65-128

Group 3 Status	
POINT	DESCRIPTION
M_DP_NA_1	
1500-1515	SWITCHGEAR EVENTS

Group 4 Status	
POINT	DESCRIPTION
M_SP_NA_1	
1128-1255	BOARD F 1-32, G 1-32, H 1-32, J 1-32

Group 5 Metering	
POINT	DESCRIPTION
M_ME_NC_1	
2000	Phasor Ia Primary
2001	Phasor Ib Primary
2002	Phasor Ic Primary
2003	Phasor Ig Primary
2004	Phasor Isg Primary
2005	Phasor In Primary
2006	I0 Primary
2007	I1 Primary
2008	I2 Primary
2009	Ia Angle
2010	Ib Angle
2011	Ic Angle
2012	In Angle
2013	Ig Angle
2014	Isg Angle
2015	Load V0 Primary
2016	Load V1 Primary
2017	Load V2 Primary
2018	Load Vab Primary
2019	Load Vbc Primary
2020	Load Vca Primary
2021	Load Vn Primary
2022	Load Va Primary
2023	Load Vb Primary
2024	Load Vc Primary
2025	Load Va Angle
2026	Load Vb Angle
2027	Load Vc Angle
2028	Load Vn Angle
2029	Load Vab Angle
2030	Load Vbc Angle
2031	Load Vca Angle
2032	Load Voltage
2033	Source V0 Primary

Group 5 Metering	
POINT	DESCRIPTION
2034	Source V1 Primary
2035	Source V2 Primary
2036	Source Vab Primary
2037	Source Vbc Primary
2038	Source Vca Primary
2039	Source Vn Primary
2040	Source Va Primary
2041	Source Vb Primary
2042	Source Vc Primary
2043	Source Va Angle
2044	Source Vb Angle
2045	Source Vc Angle
2046	Source Vn Angle
2047	Source Vab Angle
2048	Source Vbc Angle
2049	Source Vca Angle
2050	Source Voltage
2051	Voltage Capacitor
2052	PhA Reactive Pwr Pri
2053	PhA Apparent Pwr Pri
2054	PhA Real Pwr Pri
2055	PhB Reactive Pwr Pri
2056	PhB Apparent Pwr Pri
2057	PhB Real Pwr Pri
2058	PhC Reactive Pwr Pri
2059	PhC Apparent Pwr Pri

Group 6 Metering	
POINT	DESCRIPTION
M_ME_NC_1	
2060	PhC Real Pwr Pri
2061	3 Ph Reactive Pwr Pri
2062	3 Ph Apparent Pwr Pri
2063	3 Ph Real Pwr Pri
2064	PhA Power Factor Pri
2065	PhB Power Factor Pri
2066	PhC Power Factor Pri
2067	3 Ph Power Factor Pri
2068	Load Frequency
2069	Source Frequency
2070	Pos MVarhour Freeze

Group 6 Metering	
POINT	DESCRIPTION
2071	Neg MVarhour Freeze
2072	Pos MWatthour Freeze
2073	Neg MWatthour Freeze
2074	Positive Mvarhour
2075	Negative MVarhour
2076	Positive MWatthour
2077	Negative MWatthour
2078	PreFault Ia Mod
2079	PreFault Ia Ang
2080	PreFault Ib Mod
2081	PreFault Ib Ang
2082	PreFault Ic Mod
2083	PreFault Ic Ang
2084	PreFault Vab Mod
2085	PreFault Vab Ang
2086	PreFault Vbc Mod
2087	PreFault Vbc Ang
2088	PreFault Vca Mod
2089	PreFault Vca Ang
2090	PostFault Ia Mod
2091	PostFault Ia Ang
2092	PostFault Ib Mod
2093	PostFault Ib Ang
2094	PostFault Ic Mod
2095	PostFault Ic Ang
2096	PostFault Vab Mod
2097	PostFault Vab Ang
2098	PostFault Vbc Mod
2099	PostFault Vbc Ang
2100	PostFault Vca Mod
2101	PostFault Vca Ang
2102	FAULT TYPE
2103	FAULT LOCATION
2104	PreFault Ig Mod
2105	PreFault Ig Ang
2106	PreFault Isg Mod
2107	PreFault Isg Ang
2108	PostFault Ig Mod
2109	PostFault Ig Ang
2110	PostFault Isg Mod
2111	PostFault Isg Ang

Group 6 Metering	
POINT	DESCRIPTION
2112	% of Load-To-Trip
2113	RCL PHA WEAR MON
2114	RCL PHB WEAR MON
2115	RCL PHC WEAR MON
2116	RCL 3P WEAR MON
2117	Current THD Phase A
2118	Current THD Phase B
2119	Current THD Phase C
2120	Source THD Phase A
2121	Source THD Phase B
2122	Source THD Phase C
2123	Load THD Phase A
2124	Load THD Phase B
2125	Load THD Phase C

Group 7 Deadband	
POINT	DESCRIPTION
P_ME_NC_1	
5000-5125	Analog Input Deadbands 2000-2125

Integrated Totals	
POINT	DESCRIPTION
M_IT_NA_1	
4000-4007	Pulse Counter 1-8
4008-4015	Digital Counters 1-8
4016-4019	Energy Counters

E.6.3 Commands

The two standard procedures for command transmission are accepted, Direct command or Select and Execute command. The following table determines how a command can be executed in R650:

Commands		
POINT	DESCRIPTION	COMMAND MODE
3000	Operation 1 (OFF) + Operation 2(ON)	Select and Execute Double Command
---	---	---
3005	Operation 11 (OFF) + Operation 12(ON)	Select and Execute Double Command
3006	Operation 13 (OFF) + Operation 14(ON)	Direct Double Command
---	---	---
3015	Operation 23 (OFF) + Operation 24(ON)	Direct Double Command
3016	Virtual Self Reset 1 (OFF) + Virtual Self Reset 2(ON)	Direct Double Command
---	---	---
3031	Virtual Self Reset 31 (OFF) + Virtual Self Reset 32(ON)	Direct Double Command
3032-3063	Virtual Latched 1-32	Direct Single Command

There are 32 available operation in R650 device; they must be configured using EnerVista 650 Setup in ***Setting > Relay Configuration > Operations***.

E.7 IEC 60870-5-101 Interoperability

This companion standard presents sets of parameters and alternatives from which subsets have to be selected to implement particular telecontrol systems. Certain parameter values, such as the number of octets in the COMMON ADDRESS of ASDUs, represent mutually exclusive alternatives. This means that only one value of the defined parameters is admitted per system. Other parameters, such as the listed set of different process information in the command and monitor directions allow the specification of the complete set or subsets, as appropriate for given applications.This Clause summarizes the parameters of the previous Clauses to facilitate a suitable selection for a specific application. If a system is composed of equipment stemming from different manufacturers, it is necessary that all partners agree on the selected parameters.

The selected parameters should be marked in the white boxes as follows

	Function or ASDU is not used
X	Function or ASDU is used as standardized (default)
R	Function or ASDU is used in reverse mode
B	Function or ASDU is used in standard and reverse mode

The possible selection (blank, X, R, or B) is specified for each specific clause or parameter.

NOTE: In addition, the full specification of a system may require individual selection of certain parameters for certain parts of the system, such as the individual selection of scaling factors for individually addressable measured values.

E.7.1 System or device

(system-specific parameter, indicate definition of a system or a device by marking one of the following with "**X**")

	System definition
	Controlling station definition (Master)
X	Controlled station definition (Slave)

E.7.2 Network Configuration

(network-specific parameter, all configurations that are used are to be marked "**X**")

X	Point-to-point	X	Multipoint-partyline
	Multiple point-to-point		Multipoint-star

E.7.3 Physical layer

(network-specific parameter, all interfaces and data rates that are used are to be marked "**X**")

E.7.3.1 Transmission speed (control direction)

Unbalanced interchange	Unbalanced interchange	Balanced interchange
Circuit V.24/V.28	Circuit V.24/V.28	Circuit X.24/X.27

Standard Recommended if >1 200 bit/s

	100 bit/s	X	2400 bit/s		2400 bit/s		56000 bit/s
	200 bit/s	X	4800 bit/s		4800 bit/s		64000 bit/s
X	300 bit/s	X	9600 bit/s		9600 bit/s		
X	600 bit/s				19200 bit/s		
X	1200 bit/s				38400 bit/s		

E.7.3.2 Transmission speed (monitor direction)

Unbalanced interchange	Unbalanced interchange	Balanced interchange
Circuit V.24/V.28	Circuit V.24/V.28	Circuit X.24/X.27
Standard	Recommended if >1 200 bit/s	

	100 bit/s	X	2400 bit/s		2400 bit/s		56000 bit/s
	200 bit/s	X	4800 bit/s		4800 bit/s		64000 bit/s
X	300 bit/s	X	9600 bit/s		9600 bit/s		
X	600 bit/s				19200 bit/s		
X	1200 bit/s				38400 bit/s		

E.7.4 Link layer

(network-specific parameter, all options that are used are to be marked “X”. Specify the maximum frame length. If a non-standard assignment of class 2 messages is implemented for unbalanced transmission, indicate the Type ID and COT of all messages assigned to class 2.)

Frame format FT 1.2, single character 1 and the fixed time out interval are used exclusively in this companion standard.

	Link transmission procedure		**Address field of the link**
	Balanced transmission		Not present (balanced transmission only)
X	Unbalanced transmission	XX	One octet
255	Maximum length L (control direction)	X	Two octets
255	Maximum length L (monitor direction)	X	Structured
		X	Unstructured
	Time during which repetitions are permitted (Trp) or number of repetitions		

When using an unbalanced link layer, the following ASDU types are returned in class 2 messages (low priority) with the indicated causes of transmission:

X	The standard assignment of ASDUs to class 3 messages is used as follows:

Type identification	Cause of transmission
9, 11, 13, 21	<1>

☐ A special assignment of ASDUs to class 3 messages is used as follows:

Type identification	Cause of transmission

Note: (In response to a class 2 poll, a controlled station may respond with class 1 data when there is no class 2 data available).

E.7.5 Application layer

Transmission mode for application data

Mode 1 (Least significant octet first), as defined in 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

Common address of ASDU

(system-specific parameter, all configurations that are used are to be marked "**X**")

X	One octet	X	Two octets

Information object address

(system-specific parameter, all configurations that are used are to be marked "**X**")

X	One octet	X	Structured
X	Two octets	X	Unstructured
X	Three octets		

Cause of transmission

(system-specific parameter, all configurations that are used are to be marked "**X**")

X	One octet	X	Two octets (with originator address) Originator address is set to zero if not used

Selection of standard ASDUs

Process information in monitor direction

(station-specific parameter, mark each Type ID "X" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "B" if used in both directions).

X	<1>:= Single-point information	M_SP_NA_1
X	<2>:= Single-point information with time tag	M_SP_TA_1

X	<3>:= Double-point information	M_DP_NA_1
X	<4>:= Double-point information with time tag	M_DP_TA_1
	<5>:= Step position information	M_ST_NA_1
	<6>:= Step position information with time tag	M_ST_TA_1
	<7>:= Bitstring of 32 bits	M_BO_NA_1
	<8>:= Bitstring of 32 bits with time tag	M_BO_TA_1
	<9>:= Measured value, normalized value	M_ME_NA_1
	<10>:= Measured value, normalized value with time tag	M_ME_TA_1
	<11>:= Measured value, scaled value	M_SP_NB_1
	<12>:= Measured value, scaled value with time tag	M_ME_TB_1
X	<13>:= Measured value, short floating point value	M_ME_NC_1
X	<14>:= Measured value, short floating point value with time tag	M_SP_TC_1
X	<15>:= Integrated totals	M_IT_NA_1
X	<16>:= Integrated totals with time tag	M_IT_TA_1
	<17>:= Event of protection equipment with time tag	M_EP_TA_1
	<18>:= Packed start events of protection equipment with time tag	M_EP_TB_1
	<19>:= Packed output circuit information of protection equipment with time tag	M_EP_TC_1
	<20>:= Packed single-point information with status change detection	M_PS_NA_1
	<21>:= Measured value, normalized value, without quality descriptor	M_ME_ND_1
	<30>:= Single point information with time tag CP56Time2a	M_SP_TB_1
	<31>:= Double-point information with time tag CP56Time2a	M_DP_TB_1
	<32>:= Step position information with time tag CP56Time2a	M_ST_TB_1
	<33>:= Bitstring of 32 bits with time tag CP56Time2a	M_BO_TB_1
	<34>:= Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
	<35>:= Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
	<36>:= Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
	<37>:= Integrated totals with time tag CP56Time2a	M_IT_TB_1
	<38>:= Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
	<39>:= Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
	<40>:= Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

In this companion standard only the use of the set <30> – <40> for ASDUs with time tag is permitted.

Process information in control direction

(station-specific parameter, mark each Type ID "X" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	<45>:= Single command	C_SC_NA_1
X	<46>:= Double command	C_DC_NA_1
X	<47>:= Regulating step command	C_RC_NA_1
X	<48>:= Set point command, normalized value	C_SE_NA_1
X	<49>:= Set point command, scaled value	C_SE_NB_1
X	<50>:= Set point command, short floating point value	C_SE_NC_1
X	<51>:= Bitstring of 32 bits	C_BO_NA_1

System information in monitor direction

(station-specific parameter, mark with an “**X**” if it is only used in the standard direction, “**R**” if only used in the reverse direction, and “**B**” if used in both directions).

X	<70>:= End of initialization	M_EI_NA_1

System information in control direction

(station-specific parameter, mark each Type ID "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	<100>:= Interrogation command	C_IC_NA_1
X	<101>:= Counter interrogation command	C_CI_NA_1
X	<102>:= Read command	C_RD_NA_1
X	<103>:= Clock synchronization command	C_CS_NA_1
X	<104>:= Test command	C_TS_NA_1
X	<105>:= Reset process command	C_IC_NA_1
X	<106>:= Delay acquisition command	C_IC_NA_1

Parameter in control direction

(station-specific parameter, mark each Type ID "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

	<110>:= Parameter of measured value, normalized value	P_ME_NA_1
	<111>:= Parameter of measured value, scaled value	P_ME_NB_1
X	<112>:= Parameter of measured value, short floating point value	P_ME_NC_1
	<113>:= Parameter activation	P_AC_NA_1

File transfer

(station-specific parameter, mark each Type ID "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

☐	<120>:=	File ready	F_FR_NA_1
☐	<121>:=	Section ready	F_SR_NA_1
☐	<122>:=	Call directory, select file, call file, call section	F_SC_NA_1
☐	<123>:=	Last section, last segment	F_LS_NA_1
☐	<124>:=	Ack file, ack section	F_AF_NA_1
☐	<125>:=	Segment	F_SG_NA_1
☐	<126>:=	Directory {blank or X, only available in monitor (standard) direction}	F_DR_TA_1
☐	<127>:=	Query Log – Request archive file	F_SC_NB_1

Type identifier and cause of transmission assignments
(station-specific parameters)

Shaded boxes: option not required.

Black boxes: option not permitted in this companion standard

Blank: function or ASDU not used.

Mark Type Identification/Cause of transmission combinations:

"**X**" if only used in the standard direction;

"**R**" if only used in the reverse direction;

"**B**" if used in both directions.

Type identification		Cause of transmission																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<1>	M_SP_NA_1					X									X					
<2>	M_SP_TA_1																			
<3>	M_DP_NA_1					X									X					
<4>	M_DP_TA_1																			
<5>	M_ST_NA_1																			
<6>	M_ST_TA_1																			
<7>	M_BO_NA_1																			
<8>	M_BO_TA_1																			
<9>	M_ME_NA_1																			
<10>	M_ME_TA_1																			
<11>	M_ME_NB_1																			
<12>	M_ME_TB_1																			
<13>	M_ME_NC_1	X				X									X					
<14>	M_ME_TC_1			X																
<15>	M_IT_NA_1															X				
<16>	M_IT_TA_1																			
<17>	M_EP_TA_1																			
<18>	M_EP_TB_1																			
<19>	M_EP_TC_1																			

Type identification		Cause of transmission																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<20>	M_PS_NA_1																			
<21>	M_ME_ND_1																			
<30>	M_SP_TB_1			X																
<31>	M_DP_TB_1			X																
<32>	M_ST_TB_1																			
<33>	M_BO_TB_1																			
<34>	M_ME_TD_1																			
<35>	M_ME_TE_1																			
<36>	M_ME_TF_1			X																
<37>	M_IT_TB_1			X																
<38>	M_EP_TD_1																			
<39>	M_EP_TE_1																			
<40>	M_EP_TF_1																			
<45>	C_SC_NA_1						X	X	X	X	X									
<46>	C_DC_NA_1						X	X	X	X	X									
<47>	C_RC_NA_1																			
<48>	C_SE_NA_1																			
<49>	C_SE_NB_1																			
<50>	C_SE_NC_1																			
<51>	C_BO_NA_1																			
<70>	M_EI_NA_1				X															
<100>	C_IC_NA_1						X	X	X	X	X									
<101>	C_CI_NA_1						X	X			X									
<102>	C_RD_NA_1					X														
<103>	C_CS_NA_1						X	X												
<104>	C_TS_NA_1						X	X												
<105>	C_RP_NA_1						X	X												
<106>	C_CD_NA_1						X	X												
<107>	C_TS_TA_1																			
<110>	P_ME_NA_1																			
<111>	P_ME_NB_1																			
<112>	P_ME_NC_1						X	X							X					
<113>	P_AC_NA_1																			
<120>	F_FR_NA_1																			
<121>	F_SR_NA_1																			
<122>	F_SC_NA_1																			
<123>	F_LS_NA_1																			
<124>	F_AF_NA_1																			
<125>	F_SG_NA_1																			
<126>	F_DR_TA_1*																			

* Blank or X only

E.7.6 Basic application functions

Station initialization
(station-specific parameter, mark "**X**" if function is used)

- [X] Remote initialization

Cyclic data transmission
(station-specific parameter, mark "X" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions)

- [X] Cyclic data transmission

Read procedure
(station-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions)

- [X] Read procedure

Spontaneous transmission
(station-specific parameter, mark "X" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "B" if used in both directions)

- [X] Spontaneous transmission

Double transmission of information objects with cause of transmission spontaneous
(station-specific parameter, mark each information type "**X**" where both a Type ID without time and corresponding Type ID with time are issued in response to a single spontaneous change of a monitored object)

The following type identifications may be transmitted in succession caused by a single status change of an information object. The particular information object addresses for which double transmission is enabled are defined in a project-specific list.

- [ ] Single-point information M_SP_NA_1, M_SP_TA_1, M_SP_TB_1 and M_PS_NA_1
- [ ] Double-point information M_DP_NA_1, M_DP_TA_1 and M_DP_TB_1
- [ ] Step position information M_ST_NA_1, M_ST_TA_1 and M_ST_TB_1
- [ ] Bitstring of 32 bit M_BO_NA_1, M_BO_TA_1 and M_BO_TB_1 (if defined for a specific project)
- [ ] Measured value, normalized value M_ME_NA_1, M_ME_TA_1, M_ME_ND_1 and M_ME_TD_1
- [ ] Measured value, scaled value M_ME_NB_1, M_ME_TB_1 and M_ME_TE_1
- [ ] Measured value, short floating point number M_ME_NC_1, M_ME_TC_1 and M_ME_TF_1

Station interrogation
(station-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	global				
X	group 1	X	group 7		group 13
X	group 2		group 8		group 14
X	group 3		group 9		group 15
X	group 4		group 10		group 16
X	group 5		group 11		
X	group 6		group 12		

Clock synchronization
(station-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	Spontaneous transmission
	Day of week used
	RES1, GEN (time tag substituted/ not substituted) used
	SU-bit (summertime) used

Command transmission
(object-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	Direct command transmission
	Direct set point command transmission
X	Select and execute command
	Select and execute set point command
X	C_SE ACTTERM used

XX	No additional definition
X	Short-pulse duration (duration determined by a system parameter in the outstation)
X	Long-pulse duration (duration determined by a system parameter in the outstation)
X	Persistent output

Transmission of integrated totals
(station- or object-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	Mode A: Local freeze with spontaneous transmission
X	Mode B: Local freeze with counter interrogation

X	Mode C: Freeze and transmit by counter-interrogation commands
X	Mode D: Freeze by counter-interrogation command, frozen values reported

X	Counter read
X	Counter freeze without reset
X	Counter freeze with reset
X	Counter freeze with reset

X	General request counter
X	Request counter group 1
	Request counter group 2
	Request counter group 3
	Request counter group 4

Parameter loading

(object-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

	Threshold value
	Smoothing factor
	Low limit for transmission of measured values
	Low limit for transmission of measured values

Parameter activation

(object-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

	Act/deact of persistent cyclic or periodic transmission of the addressed object

Test procedure

(station-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	Test procedure

File transfer

(station-specific parameter, mark "**X**" if function is used).

File transfer in monitor direction

	Transparent file
	Transmission of disturbance data of protection equipment

	Transmission of sequences of events
	Transmission of sequences of recorded analogue values

File transfer in control direction

	Transparent file

Background scan
(station-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

	Background scan

Acquisition of transmission delay
(station-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	Acquisition of transmission delay

R650 Recloser Controller

Appendix F: IEC 60870-5-103 PROTOCOL

F.1 IEC 60870-5-103 protocol

F.1.1 Interoperability document

The R650 implements functionality of an IEC 60870-5-103 server.

This section describes the protocol IEC 60870-5-103 implementation in the unit.

1. PHYSICAL LAYER

Electrical interface

X	EIA RS-485
32	Number of loads for one protection equipment

Optical interface

X	Glass fibre
X	Plastic fibre
	F-SMA type connector
X	BFOC/2,5 type connector

Transmission speed

X	9600 bits/s
X	19200 bits/s

2. LINK LAYER

There are no choices for the link layer.

3. APPLICATION LAYER

Transmission mode for application data

Mode 1 (least significant octet first), as defined in 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

Common address of ASDU

X	One COMMON ADDRESS OF ASDU (identical with station address)
	More than one COMMON ADDRESS OF ASDU

Selection of standard information numbers in monitor direction

System functions in monitor direction

	INF	Semantics
X	<0>	End of general interrogation
X	<0>	Time synchronization
X	<2>	Reset FCB
X	<3>	Reset CU
X	<4>	Start/restart
X	<5>	Power on

Status indications in monitor direction

	INF	Semantics	R650 Identifier	R650 Data Text
X	<16>	Auto-recloser active	4591	AR READY
X	<17>	Teleprotection active	3895	LOCAL
	<18>	Protection active		
X	<19>	LED reset	6839	RESET LEDS
	<20>	Monitor direction blocked		
	<21>	Test mode		
	<22>	Local parameter setting		
X	<23>	Characteristic 1	4875	GROUP 1 ACT ON
X	<24>	Characteristic 2	4876	GROUP 2 ACT ON
X	<25>	Characteristic 3	4877	GROUP 3 ACT ON
	<26>	Characteristic 4		
	<27>	Auxiliary input 1		
	<28>	Auxiliary input 2		
	<29>	Auxiliary input 3		
	<30>	Auxiliary input 4		

Supervision indications in monitor direction

	INF	Semantics	R650 Identifier	R650 Data Text
	<32>	Measurand supervision I		
	<33>	Measurand supervision V		

	<35>	Phase sequence supervision		
X	<36>	Trip circuit supervision	4539	BREAKER FAIL SUPERVISION
	<37>	I>> back-up operation		
X	<38>	VT fuse failure	4545	VT FUSE FAILURE
	<39>	Teleprotection disturbed		
	<46>	Group warning		
	<47>	Group alarm		

Earth fault indications in monitor direction

	INF	Semantics	R650 Identifier	R650 Data Text
	<48>	Earth fault L1		
	<49>	Earth fault L2		
	<50>	Earth fault L3		
	<51>	Earth fault forward, i.e. line		
	<52>	Earth fault reverse, i.e. busbar		

Fault indications in monitor direction

	INF	Semantics	R650 Identifier	R650 Data Text
X	<64>	Start / pick-up L1	3997|4013|4029|4045|4061|4077|4164|4182|4200|5651|5669|5687	PH IOC/TOC 1/2/3 H/L A PKP
X	<65>	Start / pick-up L2	3999|4015|4031|4047|4063|4079|4166|4184|4202|5653|5671|5689	PH IOC/TOC 1/2/3 H/L B PKP
X	<66>	Start / pick-up L3	4001|4017|4033|4049|4065|4081|4168|4186|4204|5655|5673|5691	PH IOC/TOC 1/2/3 H/L C PKP
X	<67>	Start / pick-up N	4112|4120|4128|4239|4248|4257	GROUND IOC/TOC 1/2/3 PKP
X	<68>	General trip	4004|4020|4036|4052|4068|4084|4171|4189|4207|5658|5676|5694	PH IOC/TOC 1/2/3 H/L OP
X	<69>	Trip L1	3998|4014|4030|4046|4062|4078|4165|4183|4201|5652|5670|5688	PH IOC/TOC 1/2/3 H/L A OP
X	<70>	Trip L2	4000|4016|4032|4048|4064|4080|4167|4185|4203|5654|5672|5690	PH IOC/TOC 1/2/3 H/L B OP
X	<71>	Trip L3	4002|4018|4034|4050|4066|4082|4169|4187|4205|5656|5674|5692	PH IOC/TOC 1/2/3 H/L C OP
	<72>	Trip I>> (back-up operation)		
	<73>	Fault location X in ohms		
	<74>	Fault forward / line		
	<75>	Fault forward / Ibusbar		
	<76>	Teleprotection signal transmitted		

	<77>	Teleprotection signal received		
	<78>	Zone 1		
	<79>	Zone 2		
	<80>	Zone 3		
	<81>	Zone 4		
	<82>	Zone 5		
	<83>	Zone 6		
X	<84>	General start / pick-up	4003|4019|4035|4051|4067|4083|4170|4188|4206|5657|5675|5693|4112|4120|4128|4239|4248|4257	PH H/L / GND IOC/ TOC 1/2/3 PKP
X	<85>	Breaker failure	4537	BKR FAIL INITIATE
	<86>	Trip measuring system L1		
	<87>	Trip measuring system L2		
	<88>	Trip measuring system L3		
	<89>	Trip measuring system E		
X	<90>	Trip I>	4004|4020|4036|4052|4068|4084	PH IOC 1/2/3 H/L OP
X	<91>	Trip I>>	4171|4189|4207|5658|5676|5694	PH TOC 1/2/3 H/L OP
X	<92>	Trip IN>	4113|4121|4129	GND IOC 1/2/3 OP
X	<93>	Trip IN>>	4240|4249|4258	GND TOC 1/2/3 OP

Auto-reclosure indications in monitor direction

	INF	Semantics	R650 Identifier	R650 Data Text
X	<128>	CB 'on' by AR	4586	AR CLOSE BREAKER
	<129>	CB 'on' by long-time AR		
X	<130>	AR blocked	4593	AR BLOCK

Measurands in monitor direction

	INF	Semantics	R650 Identifier	R650 Data Text
X	<144>	Measurand I	5064	Ib Primary
X	<145>	Measurands I, V	5064-5080	Ib,Vab Primary
X	<146>	Measurands I, V, P, Q	5064-5080-5099-5100	Ib,Vab,P,Q Primary
X	<147>	Measurands In, Vn	5066-5086	Ig Primary, Vn Primary
X	<148>	Measurands IL123, VL123, P, Q, f	5063-5064-5065-5083-5084-5085-5099-5100-3969	Ia,Ib,Ic,Va,Vb,Vc,P,Q Primary ,Line Frequency

Generic functions in monitor direction

	INF	Semantics
	<240>	Read headings of all defined groups
	<241>	Read values or attributes of all entries of one group
	<243>	Read directory of a single entry
	<244>	Read value or attribute of a single entry
	<245>	End of general interrogation of generic data
	<249>	Write entry with confirmation
	<250>	Write entry with execution
	<251>	Write entry aborted

Selection of standard information numbers in control direction

System functions in control direction

	INF	Semantics
X	<0>	Initiation of general interrogation
X	<0>	Time synchronization

General commands in control direction

	INF	Semantics
	<16>	Auto-recloser on / off
	<17>	Teleprotection on / off
	<18>	Protection on / off
	<19>	LED reset
	<23>	Activate characteristic 1
	<24>	Activate characteristic 2
	<25>	Activate characteristic 3
	<26>	Activate characteristic 4

Generic functions in control direction

	INF	Semantics
	<240>	Read headings of all defined groups
	<241>	Read values or attributes of all entries of one group
	<243>	Read directory of a single entry
	<244>	Read value or attribute of a single entry
	<245>	End of general interrogation of generic data

	<248>	Write entry
	<249>	Write entry with confirmation
	<250>	Write entry with execution
	<251>	Write entry aborted

Basic application functions

	Test mode
	Blocking of monitor direction
	Disturbance data
	Generic services
	Private data

Miscellaneous

Measurand	Max. MVAL = times rated value		
	1,2	or	2,4
Current L1			X
Current L2			X
Current L3			X
Voltage L1-E			X
Voltage L2-E			X
Voltage L3-E			X
Active power P			X
Reactive power Q			X
Frequency f			X
Voltage L1-L2			X

F.1.2 Application level

1. Application Functions

The unbalanced transmission mode of the protocol is used to avoid the possibility that more than one protection equipment attempts to transmit on the channel at the same time, over the RS485 backside port.

Data is transferred to the primary or control station (master) using the "data acquisition by polling" principle. Cyclically, the master requests class 2 data to the secondary station (slave). When slave has class 1 data (high priority) pending, the ACD control bit is set to 1 demanding the master to request for that data. Periodically, the master can send a General Interrogation in order to update the complete database.

The measurands are sent to the primary station as a response to a class 2 request. There is a setting (0-60 min) in order to configure the desired interval, where 0 means transmission as fast as possible.

The following functions are supported:

- Initialization
- General Interrogation
- Synchronization
- Commands transmission

2. Type identification

The implemented Type Identification values are listed below:

TYPE IDENTIFICATION UI8[1..8] <1..255>

<1..31> := definitions of this companion standard(compatible range)

<32..255>:= for special use (private range)

Information in monitor direction:

<1>:= time-tagged message

<3>:= measurands I

<5>:= identification

<6>:= time synchronization

<8>:= general interrogation termination

<9>:= measurands II

Information in control direction:

<6>:= time synchronization

<7>:= general interrogation

<20>:= general command

3. Function Type

FUNCTION TYPE UI8 [1..8] <0..255>

<0..127>:= private range
<128..129>:= compatible range
<130..143>:= private range
<144..145>:= compatible range
<146..159>:= private range
<160..161>:= compatible range
<162..175>:= private range
<176..177>:= compatible range
<178..191>:= private range
<192..193>:= compatible range
<194..207>:= private range
<208..209>:= compatible range
<210..223>:= private range
<224..225>:= compatible range
<226..239>:= private range
<240..241>:= compatible range
<242..253>:= private range
<254..255>:= compatible range

The R650 device is identified at the protocol level as "overcurrent protection", so the Function Type <160> is used for all the digital and analogue points proposed by the standard and mapped in this profile. For the other data supported by the device, the number can be set from the private range.

4. Information Number

INFORMATION NUMBER := UI8 [1..8] <0..255>

Monitor direction := <0..255>
<0..15>:=system functions
<16..31>:= status
<32..47>:=supervision
<48..63>:=earth fault
<64..127>:=short circuit
<128..143>:=auto-reclosure
<144..159>:=measurands
<160..239>:=not used
<240..255>:=generic functions
Control direction:=<0..255>
<0..15>:=system functions
<16..31>:=general commands
<240..255>:=generic functions

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Appendix G: Redundancy protocol

G.1 PRP and HSR Ethernet protocols

Industrial real-time Ethernets typically demand much higher availability and uninterrupted operation than office Ethernet solutions can provide. Even a short loss of connectivity can result in loss of functionality, as for example in some automation, vehicular, power generation, and power distribution systems.

To recover from a network failure, different standard redundancy schemes are applied such as Parallel Redundancy Protocol (PRP), High-availability Seamless Redundancy (HSR) and others.

The basic concept of both protocols, PRP and HSR, is to send practically identical frames over different paths and discard one of the copies in reception, at best. If an error occurs or one of the paths is down, the frame travelling through that path does not reach the destination, but its copy does.

If the node to be attached to a redundant network has not the capability to do it (e.g. has only one p ort), it can be connected through a Redundancy Box (RedBox). This type of node allows single attached nodes connect transparently to a redundant network. An example can be seen in Figures 1.

PRP operates on two independent networks. Each frame is replicated on the sending node and transmitted over both networks. The receiving node processes the frame arriving first and discards the subsequent copy. The PRP layer is responsible for this replicate/discard function and hides the two networks from the upper layers. This scheme works without explicit reconfiguration and switchover and therefore does not show a period of unavailability.

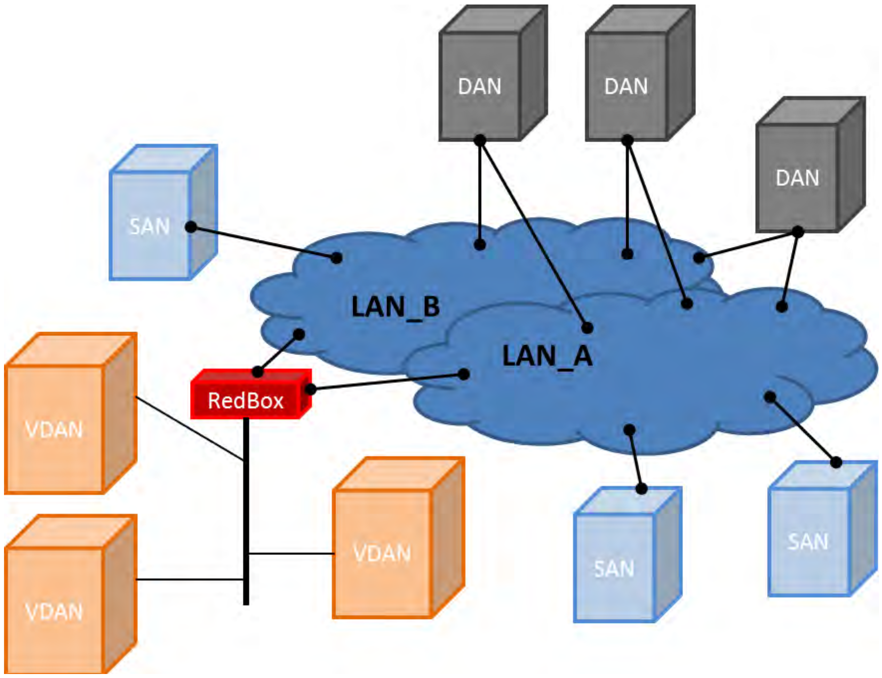

Figure G-1: Example of PRP with two LANs (LAN A and LAN B)

The two LANs, named LAN_A and LAN_B, are identical in protocol at the MAC level, but they can differ in performance and topology. Transmission delays can also be different. The LANs have no direct connection among them and they are assumed to be fail independent.

In some applications, only availability-critical nodes need a double attachment, while others do not. In order to meet the specific requirements, PRP defines different kinds of end nodes.

- The Dual Attached Node (DAN) is connected to both LANs.
- Uncritical nodes can be attached to only one LAN and are therefore called Single Attached Nodes (SAN). SANs that need to communicate with each other are on the same LAN.
- The Redundancy Box (RedBox) is used when a single interface node has to be attached to both networks. Such a node can communicate with all other nodes. Since a node behind a RedBox appears for other nodes like a DAN, it is called Virtual DANs (VDAN). The RedBox itself is a DAN and acts as a proxy on behalf of its VDANs. The RedBox has its own IP address for management purposes

Similarly to PRP, HSR is based in the duplication of every frame sent, but in a ring topology. Each copy of the frame is injected in a different direction of the ring. If any of the links between nodes is down, all nodes are still reachable. This topology forces every node in the net to be HSR aware because they have to forward every message until it reaches its destination. With that purpose, the redundancy information is located at the beginning of the frame allowing a faster forwarding, see next figure.

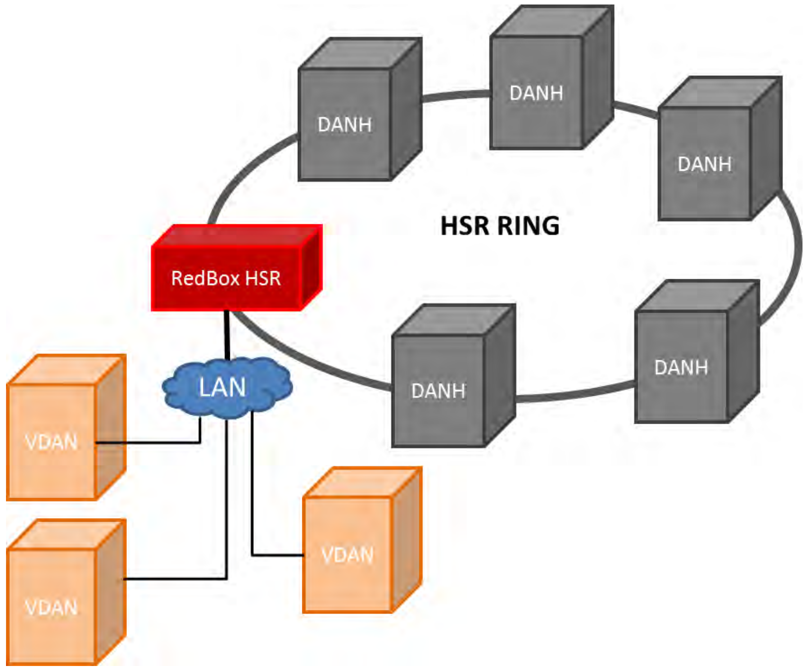

Figure G-2: Example of HSR with HSR ring

Definitions:

- PRP – Parallel Redundancy Protocol - redundancy protocol for high availability in substation automation networks based on IEC 62439-3 Clause 4 and applicable to networks based on Ethernet technology (ISO/IEC 8802-3).
- OSI - Open Systems Interconnection - model defined by the International Organization for Standardization (ISO) for standardizing the functions of a communication system in terms of abstraction layers. Similar communication functions are grouped into logical layers. A layer serves the layer above it and is served by the layer below it. There are 7 layers: physical, data link, network, transport, session, presentation, application.
- DANP – Doubly Attached Node running PRP – a node that has two ports which operate in parallel and are attached to the upper layers of the OSI communications stack through a Link Redundancy Entity module.
- DANH – Doubly Attached Node with HSR protocol.
- LRE - Link Redundancy Entity – module operating at the link layer of the OSI stack and responsible for handling duplicates and managing redundancy.
- SAN – Singly Attached Node – regular nodes with non-redundant network adapters
- RedBox – device attaching singly attached nodes (SANs) to a redundant network.

- RCT – Redundancy Check Trailer – PRP trailer added to frames and consisting of the following fields:

    ~16-bit sequence number (SeqNr);

    ~4-bit LAN identifier (LanId);

    ~12 bit frame size (LSDUsize)

    ~16-bit suffix (PRPsuffix).

G.1.1 PRP

PRP defines a redundancy protocol for high availability in substation automation networks. It is applicable to networks based on Ethernet technology (ISO/IEC 8802-3).

PRP is designed to provide seamless recovery in case of a single failure in the network, by using a combination of LAN duplication and frame duplication technique. Identical frames are sent on two completely independent networks that connect source and destination, see next figure.

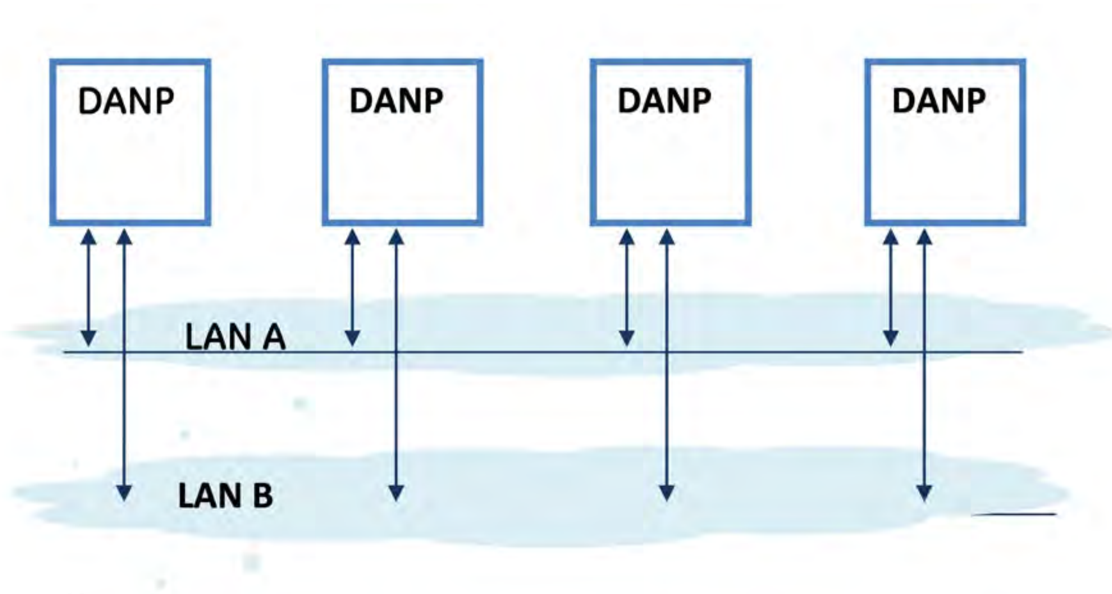

Figure G-3: Example of PRP Redundant Network

Under normal circumstances both frames reach their destination and one of them is sent up the OSI stack to the destination application, while the second one is discarded. If an error occurs in one of the networks and traffic is prevented from flowing on that path, connectivity is still be provided through the other network to ensure continuous communication. However, care must be taken when designing the two LANs, so that no single point of failure (such as a common power supply) is encountered, as such scenarios can bring down both LANs simultaneously.

PRP uses specialized nodes called doubly attached nodes (DANPs) for handling the duplicated frames. DANPs devices have an additional module at the link layer level, called the Link Redundancy Entity (LRE). LRE is responsible for duplicating frames and adding the specific PRP trailer when sending the frames out on the LAN, as well as making decisions on received frames as to which one is sent up the OSI stack to the application layer and which one is discarded. In essence LRE is responsible for making PRP transparent to the higher layers of the stack. There is a second type of specialized device used in PRP networks, called RedBox, with the role of connecting Single Attached Nodes (SANs) to a redundant network.

R650 relays implement only the DANP functionality. The RedBox functionality is not implemented.

The original standard IEC 62439-3 (2010) was amended to align PRP with the High availability Seamless Redundancy (HSR) protocol. To achieve this, the original PRP was modified at the cost of losing compatibility with the PRP 2010 version. The revised standard IEC 62439-3 (2012) is commonly referred to as PRP-1, while the original standard is PRP-0. The R650 relays support only PRP-1.

PRP can be enabled in configuration through a setting available on the network configuration menu (Product Setup? Communication Settings? Network (Ethernet), REDUNDANCY, which already has the capability of enabling Failover redundancy. When REDUNDANCY is set to PRP, the ports dedicated for PRP operate in redundant mode.

The rights associated with configuring PRP follow the security requirements for network configuration.

PRP management through SNMP MIB is not supported, as R650 doesn't currently support SNMP for configuration. Settings and actual values are only available through the front panel and through EnerVista.

The PRP solution to implement must ensure that performance requirements stated in IEC 61850-5 Clause 13 are still met. It is specified under Clause 13 (Message performance requirements) that messages of type 1A must meet the performance class P2/3, which is 3ms (See 3.7.1.1).

G.1.2 HSR

HSR defines a redundancy protocol for high availability in substation automation networks, based on PRP principles, provides the property of zero recovery time, typically used in ring topology but applicable to any topology.

In the R650 relay, HSR is implemented in devices with communication option number K (for Fiber; 100 Base Fx) and M (for cooper; Base 100 Tx). A frame is sent over both ports. A destination should receive, in the fault-free state, two identical frames within a certain time skew, forward the first frame to the application and discard the second frame when (and if) it comes. A sequence number is used to recognize such duplicates.

In contrast to PRP (IEC 62439-3- Clause 4), with which it shares the operating principle, HSR nodes are arranged into a ring, which allows the network to operate without dedicated switches, since every node is able to forward frames from port to port. HSR originally meant "High-availability Seamless Ring", but HSR is not limited to a simple ring topology.

Redundant connections to other HSR rings and to PRP networks are possible.

G.2 RSTP (IEEE 802.1D-2004) and daisy chain

G.2.1 RSTP description

The Rapid Spanning Tree Protocol (RTSP), like STP, was designed to avoid loops in an Ethernet network. Rapid Spanning Tree Protocol (RSTP) (IEEE 802.1w) is an evolution of the Spanning Tree Protocol (STP) (802.1d standard) and provides for faster spanning tree convergence after a topology change.

G.2.2 RSTP concepts

The IEEE 802.1d Spanning Tree Protocol (STP) was developed to allow the construction of robust networks that incorporate redundancy while pruning the active topology of the network to prevent loops. While STP is effective, it requires that frame transfer must halt after a link outage until all bridges in the network are sure to be aware of the new topology.

Using STP (IEEE 802.1d) recommended values, this period lasts 30 seconds. The Rapid Spanning Tree Protocol (IEEE 802.1w) is a further evolution of the 802.1d Spanning Tree Protocol. It replaces the settling period with an active handshake between switches (bridges) that guarantees topology information to be rapidly propagated through the network. RSTP converges in less than one second. RSTP also offers a number of other significant innovations. These include:

- Topology changes in STP must be passed to the root bridge before they can be propagated to the network. Topology changes in RSTP can be originated from and acted upon by any designated switch (bridge), leading to more rapid propagation of address information
- STP recognizes one state - blocking for ports that should not forward any data or information. RSTP explicitly recognizes two states or blocking roles - alternate and backup port including them in computations of when to learn and forward and when to block
- STP relays configuration messages received on the root port going out of its designated ports. If an STP switch (bridge) fails to receive a message from its neighbor it cannot be sure where along the path to the root a failure occurred. RSTP switches (bridges) generate their own configuration messages, even if they fail to receive one from the root bridge. This leads to quicker failure detection
- RSTP offers edge port recognition, allowing ports at the edge of the network to forward frames immediately after activation while at the same time protecting them against loops
- An improvement in RSTP allows configuration messages to age more quickly preventing them from “going around in circles” in the event of a loop RSTP has three states. They are discarding, learning and forwarding.

The discarding state is entered when the port is first taken into service. The port does not learn addresses in this state and does not participate in frame transfer. The port looks for STP traffic in order to determine its role in the network. When it is determined that the port plays an active part in the network, the state changes to learning. The learning state is entered when the port is preparing to play an active member of the network. The port learns addresses in this state but does not participate in frame transfer. In a network of RSTP switches (bridges) the time spent in this state is usually quite short. RSTP switches (bridges) operating in STP compatibility mode spend between 6 to 40 seconds in this state. After 'learning' the bridge places the port in the forwarding state. While in this state the port both learn addresses and participates in frame transfer while in this state. The result of these enhanced states is that the IEEE 802.1d version of spanning tree (STP) can take a fairly long time to resolve all the possible paths and to select the most efficient path through the network. The IEEE 802.1w Rapid reconfiguration of Spanning Tree significantly reduces the amount of time it takes to establish the network path. The result is reduced network downtime and improved network robustness. In addition to faster network reconfiguration, RSTP also implements greater ranges for port path costs to accommodate the higher connection speeds that are being implemented.
Proper implementations of RSTP (by switch vendors) is designed to be compatible with IEEE 802.1d STP. GE recommends that you employ RSTP or STP in your network.

G.2.3 Use in meshed networks

One great strength of RSTP is its support for all kinds of meshed topologies. The resulting flexibility regarding the installation is a clear advantage over the stringent restrictions that are imposed by ring protocols such as MRP and ring installations. However, this flexibility harbors one great disadvantage, namely the reconfiguration time, which for an interconnected network depends – among other things – on the complexity of the network topology and the location in the network at which the failure occurred. Since RSTP is a decentralized protocol, it may also provoke highly unpredictable race conditions in the establishment of new communications paths, particularly when choosing a new root bridge. This gives rise to network reconfiguration times that can be estimated only very roughly, and this does restrict the use of RSTP, particularly in meshed networks. In the case of meshed networks with very little complexity (such as ring networks with two or three additional loops or subrings), a detailed analysis can make it possible to determine upper limits, but these always need to be worked out individually. Unlike with the protocols MRP, HSR and PRP, it is not possible to make a general statement.

G.2.4 Daisy chain

A daisy chain is an interconnection of devices where each device is connected in series to the next.

With an Ethernet daisy-chain redundancy selected, the R650 has two Ethernet ports and it is working as an Ethernet unmanaged switch. The two Ethernet ports are used for connecting each device to the ports of its two neighboring devices.

Each device in the daisy chain forwards the message until it reaches the destination.

Ports A and B use the same MAC (physical device) address and operate by chaining one device with the next one.

Note that it is important not to create a loop in this topology. Both ends of the chain can be connected to different networks. The device operates only with one IP address through these 2 ports.

G.3 Link loss alert (LLA)

G.3.1 LLA

(Link Loss Alert) operation: The operation of ports A and B are as follows:

Ports A and B use port A's MAC and IP address settings while port B is in standby mode in that it does not actively communicate on the Ethernet network but monitors its link.

G.3.2 LLA priority

If this setting is set to enabled, the port A has the priority. If PORTA's LLA detects a problem with the link, communications is switched to Port B. Port B is, in effect, acting as a redundant or backup link to the network for port A.

G.3.3 LLA timeout

This setting is active only when the LLA PRIORITY is set to ENABLED. When the link on primary port is detected again after it fails, there is LLA TIMEOUT (ms) monitoring time for the health of the network. During this time, the secondary port remains active. If primary network is healthy for more than LLA TOIMEOUT value, the switch over to primary port is automatic.

If the setting LLA PRIORITY is enabled:

- The primary port is port A while secondary (redundant) port is port B.
- The primary port is always used if available.
- If the link on primary port is lost switch over to secondary port occurs immediately.
- When the link on primary port is detected again, there is a monitoring timeout (LLA TIMEOUT) for the health of the network. After that period the communication switch over to primary port automatically.

If the setting LLA PRIORITY is disabled:

- There is no priority, therefore there is no primary port. The communication switch over from one Port to the other occurs when the link fails.
- In this case the LLA TIMEOUT setting does not act.

R650 Recloser Controller

Appendix H: Factory default configuration

H.1 Factory default settings

Product Setup > Communication Settings > Serial Ports					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Baud rate for COM1	COM1 Baud Rate	19200	N/A	[300 : 115200]	
Baud rate for COM2	COM2 Baud Rate	19200	N/A	[300 : 115200]	
Parity for COM1	COM1 Parity	NONE	N/A	[NONE:ODD:EVEN]	
Parity for COM2	COM2 Parity	NONE	N/A	[NONE:ODD:EVEN]	

Product Setup > Communication Settings > Network (Ethernet)					
Ethernet A > Ethernet B > Ethernet E					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
1st octet of IP address	IP Address Oct1	0	N/A	[0 : 255]	
2nd octet of IP address	IP Address Oct2	0	N/A	[0 : 255]	
3rd octet of IP address	IP Address Oct3	0	N/A	[0 : 255]	
4th octet of IP address	IP Address Oct4	0	N/A	[0 : 255]	
1st octet of Netmask	Netmask Oct1	0	N/A	[0 : 255]	
2nd octet of Netmask	Netmask Oct2	0	N/A	[0 : 255]	
3rd octet of Netmask	Netmask Oct3	0	N/A	[0 : 255]	
4th octet of Netmask	Netmask Oct4	0	N/A	[0 : 255]	

Product Setup > Communication Settings > Network (Ethernet)					
forest run school Redundancy					
Function permission	REDUNDANCY MODE	INDEPENDENT	N/A	[INDEPENDENT; LLA; PRP; HSR; RSTP; DAISY_CHAIN]	
Establish priority for Port A	LLA Priority	DISABLED	N/A	[ENABLED; DISABLED]	
Switch over time from port B to port A	LLA Timeout	5000	N/A	[0 : 600000]	
Switch (bridge) priority value	RSTP BRIDGE PRIORITY	32768	N/A	[0 : 61440]	
determine which ports are used for forwarding	RSTP PORT A PRIORITY	128	N/A	[0 : 240]	
assigned port cost value used for the switch	RSTP PORT A PATHCOST	200000	N/A	[0 : 2000000]	
Determine which ports are used for forwarding	RSTP PORT B PRIORITY	128	N/A	[0 : 240]	
Assigned port cost value used for the switch	RSTP PORT B PATHCOST	200000	N/A	[0 : 2000000]	

Product Setup > Communication Settings > Modbus Protocol					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Slave address for COM1	Modbus Address COM1	254	N/A	[1 : 255]	
Slave address for COM2	Modbus Address COM2	254	N/A	[1 : 255]	
Modbus port number for Modbus TCP/IP	Modbus Port Number	502	N/A	[0 : 65535]	

Product Setup > Communication Settings > DNP3 Slave					
DNP3 Slave 1 > DNP3 Slave 2 > DNP3 Slave 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Communications port assigned to the DNP protocol	Physical Port	NONE	N/A	[COM1:COM2:NETWORK]	
DNP slave address	Address	255	N/A	[0 : 65534]	
1st Octect of IP address of DNP master 1	IP Addr Client1 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 1	IP Addr Client1 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 1	IP Addr Client1 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 1	IP Addr Client1 Oct4	0	N/A	[0 : 255]	
1st Octect of IP address of DNP master 2	IP Addr Client2 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 2	IP Addr Client2 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 2	IP Addr Client2 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 2	IP Addr Client2 Oct4	0	N/A	[0 : 255]	
1st Octect of IP address of DNP master 3	IP Addr Client3 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 3	IP Addr Client3 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 3	IP Addr Client3 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 3	IP Addr Client3 Oct4	0	N/A	[0 : 255]	
1st Octect of IP address of DNP master 4	IP Addr Client4 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 4	IP Addr Client4 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 4	IP Addr Client4 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 4	IP Addr Client4 Oct4	0	N/A	[0 : 255]	
1st Octect of IP address of DNP master 4	IP Addr Client5 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 4	IP Addr Client5 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 4	IP Addr Client5 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 4	IP Addr Client5 Oct4	0	N/A	[0 : 255]	

TCP/UDP port number for DNP over Ethernet	TCP/UDP Port	20000	N/A	[0 : 65535]	
Unsolicited responses permission	Unsol Resp Function	DISABLED	N/A	[DISABLED – ENABLED]	
Time out to confirm an unsolicited response	Unsol Resp TimeOut	5	1 s	[0 : 60]	
Number of retransmissions of an unsol resp w/o confirmation	Unsol Resp Max Ret	10	N/A	[0 : 255]	
Address to which all unsolicited responses are sent	Unsol Resp Dest Adr	200	N/A	[0 : 65519]	
Scale for currents	Current Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Scale for voltages	Voltage Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Product Setup > Communication Settings > DNP3 Slave (CONT.)					
DNP3 Slave 1 > DNP3 Slave 2 > DNP3 Slave 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Scale for power	Power Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Scale for energy	Energy Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Other Scale factor	Other Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Default deadband for Current Analog Input points to trigger unsolicited responses	Current Deadband	30000	N/A	[0 : 65535]	
Default deadband for Voltage Analog Input points to trigger unsolicited responses	Voltage Deadband	30000	N/A	[0 : 65535]	
Default deadband for Power Analog Input points to trigger unsolicited responses	Power Deadband	30000	N/A	[0 : 65535]	
Default deadband for Energy Analog Input points to trigger unsolicited responses	Energy Deadband	30000	N/A	[0 : 65535]	
Default deadband for Other Analog Input points to trigger unsolicited responses	Other Deadband	30000	N/A	[0 : 65535]	
Size (in bytes) for message fragmentation	Msg Fragment Size	240	1 byte	[30 : 2048]	
Product Setup > Communication Settings > DNP3 Slave (CONT.)					
DNP3 Slave 1 > DNP3 Slave 2 > DNP3 Slave 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Size customization and change of DNP Binary Inputs point list	Binary Input Block 1	CTL EVENTS 1-16	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 2	CTL EVENTS 17-32	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 3	CTL EVENTS 33-48	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 4	CTL EVENTS 49-64	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 5	CTL EVENTS 65-80	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 6	CTL EVENTS 81-96	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 7	CTL EVENTS 97-112	N/A	[See DNP note2]	

Size customization and change of DNP Binary Inputs point list	Binary Input Block 8	CTL EVENTS 113-128	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 9	SWITCHGEAR 1-8	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 10	SWITCHGEAR 9-16	N/A	[See DNP note2]	
Default Analog Map permission	Default Analog Map	ENABLED	N/A	[ENABLED; DISABLE]	
DNP Analog Input Points point list	Analog Input Point 0	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 1	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 2	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 3	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 4	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 5	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 6	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 7	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 8	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 9	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 10	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 11	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 12	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 13	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 14	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 15	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 16	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 17	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 18	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 19	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 20	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 21	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 22	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 23	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 24	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 25	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 26	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 27	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 28	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 29	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 30	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 31	End of list	N/A		

DNP Notes	
Note 1: Scale Factor	Note that a scale factor of 0.1 is equivalent to a multiplier of 10 (i.e. the value is 10 times
Note 2: Binary Input Block Selection:	[NOT USED, CTL EVENTS 1-16, CTL EVENTS 17-32, CTL EVENTS 33-48,CTL EVENTS 49-64, CTL EVENTS 65-80, CTL EVENTS 81-96, CTL EVENTS 97-112, CTL EVENTS 113-128, SWITCHGEAR

Product Setup > Communication Settings > IEC 870-5-104					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Enable or disable the protocol operation	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Listening TCP port in the relay	TCP Port	2404	N/A	[0 : 65535]	
Address in the ASDU header	Common Addr of ASDU	255	N/A	[0 : 65535]	
Number of seconds for instantaneous metering	Cyclic Meter Period	0	1 s	[0 : 3600]	
Synchronization Event	Synchronization Event	0	0 N/A	[0 : 3600]	
1st Octect of IP address of 104 master 1	IEC104 NET1 CLI1 OCTET1	0	N/A	[0 : 255]	
2nd Octect of IP address of 104 master 1	IEC104 NET1 CLI1 OCTET2	0	N/A	[0 : 255]	
3nd Octect of IP address of 104 master 1	IEC104 NET1 CLI1 OCTET3	0	N/A	[0 : 255]	
4th Octect of IP address of 104 master 1	IEC104 NET1 CLI1 OCTET4	0	N/A	[0 : 255]	
1st Octect of IP address of 104 master 2	IEC104 NET1 CLI2 OCTET1	0	N/A	[0 : 255]	
2nd Octect of IP address of 104 master 2	IEC104 NET1 CLI2 OCTET2	0	N/A	[0 : 255]	
3nd Octect of IP address of 104 master 2	IEC104 NET1 CLI2 OCTET3	0	N/A	[0 : 255]	
4th Octect of IP address of 104 master 2	IEC104 NET1 CLI2 OCTET4	0	N/A	[0 : 255]	
Enable or disable the protocol operation	Function 2	DISABLED	N/A		
Listening TCP port in the relay	TCP Port 2	2404	N/A	[0 : 65535]	
Address in the ASDU header	Common Addr of ASDU 2	255	N/A	[0 : 65535]	
1st Octect of IP address of 104 master 1	IEC104 NET2 CLI1 OCTET1	0	N/A	[0 : 255]	
2nd Octect of IP address of 104 master 1	IEC104 NET2 CLI1 OCTET2	0	N/A	[0 : 255]	

Product Setup > Communication Settings > IEC 870-5-104 (CONT.)					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
3nd Octect of IP address of 104 master 1	IEC104 NET2 CLI1 OCTET3	0	N/A	[0 : 255]	
4th Octect of IP address of 104 master 1	IEC104 NET2 CLI1 OCTET4	0	N/A	[0 : 255]	
1st Octect of IP address of 104 master 2	IEC104 NET2 CLI2 OCTET1	0	N/A	[0 : 255]	
2nd Octect of IP address of 104 master 2	IEC104 NET2 CLI2 OCTET2	0	N/A	[0 : 255]	
3nd Octect of IP address of 104 master 2	IEC104 NET2 CLI2 OCTET3	0	N/A	[0 : 255]	
4th Octect of IP address of 104 master 2	IEC104 NET2 CLI2 OCTET4	0	N/A	[0 : 255]	
IEC104 SCALE CURRENT	IEC104 SCALE CURRENT	1		[0,00001; 0,0001; 0,001; 0,01; 0,1; 1; 10; 100; 1000; 10000]	
IEC104 SCALE VOLTAGE	IEC104 SCALE VOLTAGE	1			
IEC104 SCALE POWER	IEC104 SCALE POWER	1			

IEC104 SCALE ENERGY	IEC104 SCALE ENERGY	1			
IEC104 SCALE OTHER	IEC104 SCALE OTHER	1			
IEC104 DEADBAND CURRENT	IEC104 DEADBAND CURRENT	30000		[0 : 65535]	
IEC104 DEADBAND VOLTAGE	IEC104 DEADBAND VOLTAGE	30000		[0 : 65535]	
IEC104 DEADBAND POWER	IEC104 DEADBAND POWER	30000		[0 : 65535]	
IEC104 DEADBAND ENERGY	IEC104 DEADBAND ENERGY	30000		[0 : 65535]	
IEC104 DEADBAND OTHER	IEC104 DEADBAND OTHER	30000		[0 : 65535]	
IEC104 IOA BINARIES	IEC104 IOA BINARIES	1000		[0 : 65535]	
IEC104 IOA DOUBLE POINTS	IEC104 IOA DOUBLE POINTS	1500		[0 : 65535]	
IEC104 IOA ANALOGS	IEC104 IOA ANALOGS	2000		[0 : 65535]	
IEC104 IOA COUNTERS	IEC104 IOA COUNTERS	4000		[0 : 65535]	
IEC104 IOA COMMANDS	IEC104 IOA COMMANDS	3000		[0 : 65535]	
IEC104 IOA ANALOG PARAMETERS	IEC104 IOA ANALOG PARAMETERS	5000		[0 : 65535]	

IEC 870-5-104 Notes	
Note 1: Cyclic Meter Period	0 value means no spontaneous metering

Product Setup > Communication Settings > SNTP					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Port used	UDP port	123	1	[1 : 65535]	
IP Address OCT 1	Server IP Oct 1	0	1	[1 : 255]	
IP Address OCT 2	Server IP Oct 2	0	1	[1 : 255]	
IP Address OCT 3	Server IP Oct 3	0	1	[1 : 255]	
IP Address OCT 4	Server IP Oct 4	0	1	[1 : 255]	

Product Setup > Communication Settings > PTP 1588					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	PTP FUNCTION	DISABLE		[DISABLE; ENABLE]	
Port A, B Path Delay Adder	PORTA DELAY ADDER	0		ns [0 : 60000]	
Port A Path Delay Asymmetry	PORTA DELAY ASYM	0		ns [-1000 : 1000]	
Port B Path Delay Adder	PORTB DELAY ADDER	0		ns [0 : 60000]	
Port B Path Delay Asymmetry	PORTB DELAY ASYM	0		ns [-1000 : 1000]	
Strict Power Profile	STRICT POWER PROFILE	DISABLED		DISABLED/ENABLED	
PTP domain number	PTP DOMAIN NUMBER	0		[0 : 255]	
PTP VLAN Priority	PTP VLAN PRIORITY	4		[0 : 7]	
PTP VLAN Identification	PTP VLAN ID	0		[0 : 4095]	

Reference time defining the origin of a time scale is termed the epoch.	PTP EPOCH	UTC SINCE 2000		UTC SINCE 2000; UTC SINCE 1970; UTC SINCE 1900	

Product Setup > Communication Settings > Routing					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
1st octet of Gateway	Default RT GWY Oct1	0	1	[0 : 255]	
2nd octet of Gateway	Default RT GWY Oct2	0	1	[0 : 255]	
3nd octet of Gateway	Default RT GWY Oct3	0	1	[0 : 255]	
4th octet of Gateway	Default RT GWY Oct4	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT1 IP Oct1	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT1 IP Oct2	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT1 IP Oct3	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT1 IP Oct4	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT1 Mask Oct1	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT1 Mask Oct2	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT1 Mask Oct3	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT1 Mask Oct4	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT1 GWY Oct1	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT1 GWY Oct2	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT1 GWY Oct3	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT1 GWY Oct4	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT2 IP Oct1	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT2 IP Oct2	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT2 IP Oct3	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT2 IP Oct4	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT2 Mask Oct1	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT2 Mask Oct2	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT2 Mask Oct3	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT2 Mask Oct4	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT2 GWY Oct1	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT2 GWY Oct2	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT2 GWY Oct3	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT2 GWY Oct4	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT3 IP Oct1	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT3 IP Oct2	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT3 IP Oct3	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT3 IP Oct4	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT3 Mask Oct1	0	1	[0 : 255]	

sets the IP mask associated with the route	Static RT3 Mask Oct2	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT3 Mask Oct3	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT3 Mask Oct4	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT3 GWY Oct1	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT3 GWY Oct2	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT3 GWY Oct3	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT3 GWY Oct4	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT4 IP Oct1	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT4 IP Oct2	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT4 IP Oct3	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT4 IP Oct4	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT4 Mask Oct1	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT4 Mask Oct2	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT4 Mask Oct3	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT4 Mask Oct4	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT4 GWY Oct1	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT4 GWY Oct2	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT4 GWY Oct3	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT4 GWY Oct4	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT5 IP Oct1	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT5 IP Oct2	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT5 IP Oct3	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT5 IP Oct4	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT5 Mask Oct1	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT5 Mask Oct2	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT5 Mask Oct3	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT5 Mask Oct4	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT5 GWY Oct1	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT5 GWY Oct2	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT5 GWY Oct3	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT5 GWY Oct4	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT6 IP Oct1	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT6 IP Oct2	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT6 IP Oct3	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT6 IP Oct4	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT6 Mask Oct1	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT6 Mask Oct2	0	1	[0 : 255]	

sets the IP mask associated with the route	Static RT6 Mask Oct3	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT6 Mask Oct4	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT6 GWY Oct1	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT6 GWY Oct2	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT6 GWY Oct3	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT6 GWY Oct4	0	1	[0 : 255]	
SETPOINT > Product Setup > Modbus User Map					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Address 00 for Modbus user map	Address 00	0	N/A	[0000 : FFFF]	
Address 01 for Modbus user map	Address 01	0	N/A	[0000 : FFFF]	
	...	...		...	
Address 254 for Modbus user map	Address 254	0	N/A	[0000 : FFFF]	
Address 255 for Modbus user map	Address 255	0	N/A	[0000 : FFFF]	
SETPOINT > PRODUCT SETUP > FAULT REPORT					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Positive sequence impedance module	Pos Seq Module	3.00	0.01 Ohm	[0.01 : 250.00]	
Positive sequence impedance angle	Pos Seq Angle	75	1 Deg	[25 : 90]	
Zero sequence impedance module	Zero Seq Module	9.00	0.01 Ohm	[0.01 : 750.00]	
Zero sequence impedance angle	Zero Seq Angle	75	1 Deg	[25 : 90]	
Line length	Line Length	100.0	0.1	[0.0 : 2000.0]	
Display fault on HMI	Show Fault On HMI	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	
CT Direction	CT Direction	REVERSE	NA	REVERSE; FORWARD	
Setpoint > Product Setup > Oscillography					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function Permission	Function	ENABLED	N/A	[DISABLED – ENABLED]	
Prefault	Trigger Position	30	1%	[5 : 95]	
Samples per cycle	Samples/Cycle	64	N/A	[4 – 8 – 16 –32 – 64]	
Maximum number of oscillos	Max. Number Osc.	4	1 oscillo	[1 : 20]	
Automatic oscillography overwrite	Automatic Overwrite	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Product Setup > Data Logger					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Data logger Rate	Data Logger Rate	1 s	N/A	[1 s, 5 min, 10 min, 15 min, 20 min, 30 min, 60 min.]	
Data Logger analog channels X	Data Logger Chnl X	None	N/A	[1 to 16]	

Setpoint > Product Setup > Demand					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Demand Function	DISABLED	N/A	[DISABLED – ENABLED]	
Demand method for current values	CRNT Demand Method	THERMAL EXPONENTIAL	N/A	[BLOCK INTERVAL -	
				ROLLING DEMAND -	
				THERMAL EXPONENTIAL]	
Demand method for Power values	POWER Demand Method	THERMAL EXPONENTIAL	N/A	[BLOCK INTERVAL -	
				ROLLING DEMAND -	
				THERMAL EXPONENTIAL]	
Demand interval	Demand Interval	5 Minutes	N/A	[5 – 10 – 15 – 20– 30–60]	
Trigger Enabled	Trigger Enabled	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Product Setup > Time Settings					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Local time zone offset Universal Coodinated Time	LOC. TIME OFFS. UTC	0	1	[-24,0 : 24,0]	
To follow DST rules	DAYLIG. SAVINGS TIME	DISABLED	NA	[DISBLED; ENABLED]	
Set the start month of the DST	DST START MONTH	MAR	MON TH	January to December	
Set the start weekday of the DST	DST START WEEKDAY	SUNDAY	DAY	Monday to Sunday	
Set the start day instance	DST START DAY INST	LAST	NA	First; Second; Third; Fourth; Last	
Set the starting hour of the DST	DST START HOUR	2	1	[0 : 23]	
Set the Stop month of the DST	DST STOP MONTH	OCT	Mont h	January to December	
Set the stop weekday of the DST	DST STOP WEEKDAY	SUNDAY	Day	Monday to Sunday	
Set the stop day instance	DST STOP DAY INST	LAST	NA	First; Second; Third; Fourth; Last	
Set the stop hour of the DST	DST STOP HOUR	2	1	[0 : 23]	
IRIG-B local time	IRIG-B LOCAL TIME	OFF	NA	[ON; OFF]	
Function permission	IRIGB Function	DISABLED	NA	ENABLLED; DISABLED	
Stablish the sync priority	PTP IRIGB Priority	PTP-1588	NA	PTP-1588; IRIG_B	

Setpoint > System Setup > General Settings					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Device Name	Device Name	R650_1	N/A	[Max. 16 ASCII characters]	
Nominal Frequency	Nominal Frequency	50 Hz	Hz	[50-60]	
Phase Rotation	Phase Rotation	ABC	N/A	[ABC – ACB]	
Voltage Set Reference	Voltage Set Reference	Load Side (VLx)	0.1	[Load Side (VLx); Source Side (VBx)]	
Frequency Reference	Frequency Reference	VI	N/A	[VI-VII-VIII]	
Primary Meter Units	Primary Meter Units	100.0	0.1	[1.0 : 250.0]	
Snapshot Events generation	Snapshot Events	50 Hz	Hz	[50-60]	

Setpoint > System Setup > Current Sensing					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Phase CT Primary	Phase CT Primary	250.0 A	0.1 A	[0.1 : 6000.0]	
Phase CT Secondary	Phase CT Secondary	1 A	N/A	[0.1 A; 5 A]	
Ground CT Primary	Ground CT Primary	50.0 A	0.1 A	[1.0 : 6000.0]	
Ground CT Secondary	Ground CT Secondary	1 A	N/A	[0.2 A; 1 A; 5 A]	
Sensitive Ground CT Primary	Stv Gnd CT Primary	3.0 A	0.1 A	[1.0 : 6000.0]	
Sensitive Ground CT Secondary	Stv Gnd CT Secondary	0.2 A	N/A	[0.2 A]	

Setpoint > System Setup > Source Voltage Sensing					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Source VT Ratio	Source VT Ratio	1		[1 : 10000]	
Voltage Rated Secondary	Voltage Rated Secondary	8.0 (*) 100.0	0.1 V (*) 0.1 V	[0.5 ; 10.0] (*) [1.0 ; 250.0]	
Phase Angle (*)	Phase Angle (*)	0.0 º	0.1 º	[0.0 º: 359.9º]	
Phase VT Connection	Phase VT Connection	WYE	N/A	[WYE – DELTA]	
Sensor 1 Magnitude Correction (*)	Sensor 1 Magnitude Correction (*)	0.0% fo	0.1% fo	[-15.0: 15.0]	
Sensor 1 Phase Angle Correction (*)	Sensor 1 Phase Angle Correction (*)	0.0 º	0.1 º	[0.0 º: 359.9º]	
Sensor 2 Magnitude Correction(*)	Sensor 2 Magnitude Correction(*)	0.0% fo	0.1% fo	[-15.0: 15.0]	
Sensor 2 Phase Angle Correction (*)	Sensor 2 Phase Angle Correction (*)	0.0 º	0.1 º	[0.0 º: 359.9º]	
Sensor 3 Magnitude Correction (*)	Sensor 3 Magnitude Correction (*)	0.0% fo	0.1% fo	[-15.0: 15.0]	
Sensor 3 Phase Angle Correction (*)	Sensor 3 Phase Angle Correction (*)	0.0 º	0.1 º	[0.0 º: 359.9º]	

(*) This setting is only available for LEA voltage sensor types.

Setpoint > System Setup > Load Voltage Sensing					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Source VT Ratio	Source VT Ratio	1		[1 : 10000]	
Voltage Rated Secondary	Voltage Rated Secondary	8.0 (*) 100.0	0.1 V (*) 0.1 V	[0.5 ; 10.0] (*) [1.0 ; 250.0]	
Phase Angle (*)	Phase Angle (*)	0.0 º	0.1 º	[0.0 º: 359.9º]	
Phase VT Connection	Phase VT Connection	WYE	N/A	[WYE – DELTA]	
Sensor 1 Magnitude Correction (*)	Sensor 1 Magnitude Correction (*)	0.0% fo	0.1% fo	[-15.0: 15.0]	
Sensor 1 Phase Angle Correction (*)	Sensor 1 Phase Angle Correction (*)	0.0 º	0.1 º	[0.0 º: 359.9º]	
Sensor 2 Magnitude Correction(*)	Sensor 2 Magnitude Correction(*)	0.0% fo	0.1% fo	[-15.0: 15.0]	
Sensor 2 Phase Angle Correction (*)	Sensor 2 Phase Angle Correction (*)	0.0 º	0.1 º	[0.0 º: 359.9º]	
Sensor 3 Magnitude Correction (*)	Sensor 3 Magnitude Correction (*)	0.0% fo	0.1% fo	[-15.0: 15.0]	
Sensor 3 Phase Angle Correction (*)	Sensor 3 Phase Angle Correction (*)	0.0 º	0.1 º	[0.0 º: 359.9º]	

(*) This setting is only available for LEA voltage sensor types.

Setpoint > System Setup > Miscellaneous					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Relay Out of Service	Relay Out of Service	ENABLED	N/A	[DISABLED – ENABLED]	
Local/Remote Blocked	Local/Remote Blocked	OFF	N/A	[ON -OFF]	
Active Language	Active Language	0	N/A	[0;1]	

Setpoint > System Setup > Flex Curves					
Flex Curves A > Flex Curves B > Flex Curves C > Flex Curves D					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Values for reset points 0.00 pkp	Time 0.00xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]	
Values for reset points 0.05 pkp	Time 0.05xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]	
...	...	...	0.001 s	[0.000 : 65.535]	
Values for reset points 0.97 pkp	Time 0.97xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]	
Values for reset points 0.98 pkp	Time 0.98xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]	
Values for operation points 1.03 pkp	Time 1.03xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]	
Values for operation points 1.05 pkp	Time 1.05xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]	
...	...	...	0.001 s	[0.000 : 65.535]	
Values for operation points 19.50 pkp	Time 19.50xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]	
Values for operation points 20.00 pkp	Time 20.00xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]	

Setpoint > System Setup > Breaker > Reclose/Breaker					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
RECLOSE TYPE	RECLOSE TYPE	THREE PHASE	N/A	[1 : 10000]	
MAX. OPENINGS 1 HOUR	MAX. OPENINGS 1 HOUR	1	N/A	[1 ; 60]	
RECLOSE WEAR MONITOR FUNCTION	RECLOSE WEAR MONITOR FUNCTION	DISABLED	N/A	[ENABLED ; DISABLED]	

RECLOSE WEAR MONITOR ALARM	RECLOSE WEAR MONITOR ALARM	100.0		[20.0 : 100.0]	
INTERRUPTING DUTY CURRENT 1	INTERRUPTING DUTY CURRENT 1	2.00	0.01 kA	[0 : 999.99]	
INTERRUPTING DUTY CURRENT 3	INTERRUPTING DUTY OPERATIONS 1	44	1	[0: 65000]	
INTERRUPTING DUTY OPERATIONS 3	INTERRUPTING DUTY CURRENT 2	6.00	0.01 kA	[0 : 999.99]	
MAX. NUMBER OF OPENINGS	INTERRUPTING DUTY OPERATIONS 2	56	1	[0: 65000]	
MAX. INTERRUPTING KA	INTERRUPTING DUTY CURRENT 3	12.00	0.01 kA	[0 : 999.99]	
STATISTIC INTEGRATION NUMBER	INTERRUPTING DUTY OPERATIONS 3	16	1	[0: 65000]	
SNAPSHOT EVENTS	MAX. NUMBER OF OPENINGS	10000	1	[0: 65000]	
Setpoint > System Setup > Breaker > Switchgear					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Number of inputs used with the switchgear	CONTACTS	NONE	N/A	[NONE, 52A, 52B, 52A+B]	
Maximum time to detect an opening failure event	OPENING TIME	0	1 ms	[0 : 30000]	
Maximum time to detect a closing failure event	CLOSING TIME	0	1 ms	[0 : 30000]	
Status of the 52a input of the recloser/ breaker	CONTACT A	N/A		Configured from PLC logic	
Status of the 52b input of the recloser/ breaker	CONTACT B	N/A		Configured from PLC logic	
Issues an open command when asserted	OPENING INIT	N/A		Configured from PLC logic	
Issues a close command when asserted	CLOSING INIT	N/A		Configured from PLC logic	
Blocks open commands	BLOCK OPEN	N/A		Configured from PLC logic	
Blocks close commands	BLOCK CLOSE	N/A		Configured from PLC logic	
Setpoint > Protection Elements > Phase Current >					
> Phase TOC High > Phase TOC High 1 > Phase TOC High 2 > Phase TOC High 3					
> Phase TOC Low > Phase TOC Low 1 > Phase TOC Low 2 > Phase TOC Low 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	1.00	0.01 x CT	[0.5 : 20.00]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Voltage Restraint	Voltage Restraint	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Phase Current >					
> Phase IOC High > Phase IOC High 1 > Phase IOC High 2 > Phase IOC High 3					
> Phase IOC Low > Phase IOC Low 1 > Phase IOC Low 2 > Phase IOC Low 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	1.00	0.01 x CT	[0.05 : 20.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Phase Current > Phase Directional >					
Phase Directional 1> Phase Directional 2 > Phase Directional 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Torque Angle	MTA	45	1 Deg	[-90 : +90]	
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]	
Block logic	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]	
Polarization voltage threshold	Pol V Threshold	0.10	0.01 x VT	[0 : 1.25]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	
Voltage Memory	Voltage Memory	0,00 s	0,01 s	[0,00 : 3,00]	

Setpoint > Protection Elements > Phase Current > Thermal Model >					
Thermal Model 1 > Thermal Model 2 > Thermal Model 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Heating constant	Heat Time Constant	6.0	0.1 min	[3.0 : 600.0]	
Cooling constant	Cool Time Constant	2.00	0.01 x Heat Time Ct.	[1.00 : 6.00]	
Pickup level	Pickup Level	1.00	0.01 x CT	[0.05 : 20.00]	
Alarm level	Alarm Level	80.0	0.10%	[1.0 : 110.0]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Neutral Current > Neutral TOC					
Neutral TOC 1> Neutral TOC 2 > Neutral TOC 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	1.00	0.01 x CT	[0.05 : 20.00]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	

Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Neutral Current > Neutral IOC					
Neutral IOC 1 > Neutral IOC 2 > Neutral IOC 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	1.00	0.01 x CT	[0.05 : 20.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Neutral Current > Neutral Directional >					
Neutral Directional 1 > Neutral Directional 2 > Neutral Directional 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]	
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]	
Polarization type	Polarization	VO	N/A	[V_0 – I_P – V_0+I_P – V_0*I_P]	
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]	
Polarization voltage threshold	Pol V Threshold	0.10	0.01 x VT	[0.00 : 1.25]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Ground Current > Ground TOC					
Ground TOC 1 > Ground TOC 2 > Ground TOC 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	1.00	0.01 x CTg	[0.05 : 20.00]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Ground Current > Ground IOC					
Ground IOC 1 > Ground IOC 2 > Ground IOC 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	1.00	0.01 x CTg	[0.05 : 20.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Ground Current > Ground Directional >					
Ground Directional 1 > Ground Directional 2 > Ground Directional 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]	
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]	
Polarization type	Polarization	VO	N/A	[V_0 – I_P – V_0+I_P – V_0*I_P]	
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]	
Polarization voltage threshold	Pol V Threshold	10	1 V	[0 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Sensitive Ground Current > Sensitive Ground TOC					
Sensitive Ground TOC 1 > Sensitive Ground TOC 2 > Sensitive Ground TOC 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	0.050	0.001 A	[0.005 : 16.000]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Sensitive Ground Current > Sensitive Ground IOC					
Sensitive Ground IOC 1 > Sensitive Ground IOC 2 > Sensitive Ground IOC 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	0.100	0.001 A	[0.005 : 16.000]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Sensitive Ground Current > Isolated Ground IOC					
Isolated Ground IOC 1 > Isolated Ground IOC 2 > Isolated Ground IOC 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
High Voltage level	Vh Level	0.20	0.001 x VT	[0.02 : 4.00]	
Low Current level	Il LEVEL	0.005	0.001 x CTg	[0.005 : 4.00]	
Low Voltage level	Vl LEVEL	0.02	0.001 x VT	[0.02 : 4.00]	
High Current level	Ih LEVEL	0.025	0.001 x CTg	[0.005 : 4.00]	
Operation time	Delay	0.00	0.01 s	[0.00 : 900.00]	
Deviation time to instantaneous	Time to inst	0.00	0.01 s	[0.00 : 900.00]	

Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Sensitive Ground Current > Sensitive Ground Directional > Sensitive Ground Directional 1 > Sensitive Ground Directional 2 > Sensitive Ground Directional 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]	
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]	
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]	
Polarization voltage threshold	Pol V Threshold	10	1 V	[0 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Negative Sequence Current > Negative Sequence TOC > Negative Sequence TOC 1 > Negative Sequence TOC 2 > Negative Sequence TOC 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	1.00	0.01 x CT	[0.05 : 20.00]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Voltage Elements > Phase UV > Phase UV 1 > Phase UV 2 > Phase UV 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input mode	Mode	PHASE-PHASE	N/A	[PHASE-PHASE, PHASE-GROUND]	
Pickup Level	Pickup Level	0.10	0.01 x VT	[0.02 : 1.25]	
Curve shape	Curve	DEFINITE TIME	N/A	[DEFINITE TIME – INVERSE TIME]	
Time Dial	Delay	10.00	0.01 s	[0.00 : 900.00]	
Minimum Voltage Threshold	Minimum Voltage	0	0.01 x VT	[0 : 1.25]	
Operation logic	Logic	ANY PHASE	N/A	[ANY PHASE – TWO PHASES – ALL PHASES]	
Supervision by breaker status	Supervised by 52	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Voltage Elements > Phase OV > Phase OV 1 > Phase OV 2 > Phase OV 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup Level	Pickup Level	1.25	0.01 x VT	[0.02 : 1.25]	
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Operation logic	Logic	ANY PHASE	N/A	[ANY PHASE – TWO PHASES – ALL PHASES]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Voltage Elements > >Neutral OV High > Neutral OV High 1 > Neutral OV High 2 > Neutral OV High 3 >Neutral OV Low > Neutral OV Low 1 > Neutral OV Low 2 > Neutral OV Low 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup Level	Pickup Level	1.25	0.01 x VT	[0.02 : 1.25]	
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > voltage elements > Negative Sequence OV > Negative Sequence OV 1 > Negative Sequence OV 2 > Negative Sequence OV 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup Level	Pickup Level	1.25	0.01 x VT	[0.02 : 1.25]	
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Power > Forward Power Forward Power 1 > Forward Power 2 > Forward Power 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Block from offline	Blk Time After Close	0.00	0.01 s	[0.00 : 900.00]	
Pickup level for stage 1	Stage 1 Tap	10.00	0.01MW	[0.00 : 10000.00]	
Trip time for stage 1	Stage 1 Time	60.00	0.01 s	[0.00 : 900.00]	
Pickup level for stage 2	Stage 2 Tap	20.00	0.01MW	[0.00 : 10000.00]	
Trip time for stage 2	Stage 2 Time	60.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Power > Directional Power>					
Directional Power 1 > Directional Power 2 > Directional Power 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Block from offline	Blk Time After Close	0.00	0.01 s	[0.00 : 900.00]	
Directional Angle for stage 1	Dir Power Angle 1	0.00	0.01 Deg	[0.00 : 359.99]	
Pickup level for stage 1	Stage 1 Tap	10.00	0.01M W	[-10000.00 : 10000.00]	
Trip time for stage 1	Stage 1 Time	60.00	0.01 s	[0.00 : 900.00]	
Directional Angle for stage 2	Dir Power Angle 2	0.00	1 Deg	[0.00 : 359.99]	
Pickup level for stage 2	Stage 2 Tap	20.00	0.01M W	[-10000.00 : 10000.00]	
Trip time for stage 2	Stage 2 Time	60.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Power					
WATT GND FLT 1 > WATT GND FLT 2 > WATT GND FLT 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED-ENABLED]	
Supervision minimum voltage	Voltage Pickup Level	0.02	0.01 x VT	[0.02 : 1.00]	
Source of operating current.	Current selection	IN	N/A	[IN-IG]	
Pickup Level for Overcurrent	OC Pickup Level	0.050	0.001 x CT	[0.002 : 0.400]	
Pickup Delay for Overcurrent	OC Pickup Delay	0,2	0.01 s	[0.00 : 600.00]	
Pickup Level for operating Power	Power Pickup	0.10	0.001 x CTVT	[0.001 : 1.200]	
Max torque angle	MTA	0	1 Deg	[0 : 360]	
Pickup Delay for Operating Power	Power Pickup Delay	0,2	0.01 s	[0.00 : 600.00]	
Curve shape	Curve	DEFINITE TIME	N/A	[DEFINITE TIME - INVERSE TIME - USER CURVE A - USER CURVE B - USER CURVE C - USER CURVE D]	
Multiplier	Multiplier	1	0.01 s	[0.02 : 2.00]	
Snapshot event generation	Snapshot Event	DISABLED	N/A	[DISABLED-ENABLED]	
Setpoint > Protection Elements > Miscellaneous > Broken Conductor					
Broken Conductor 1 > Broken Conductor 2 > Broken Conductor 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Tap Level in percentage of I2/I1	Tap	20	0.10%	[20.0 : 100.0]	
Trip Time	Trip Delay	60	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	
Current Inhibition Level setting	Operation Threshold	0.05	0.01 x CT	[0 : 1.00]	

Setpoint > Control Elements > Setting Group					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Setting Grouping Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Active Group	Active Group	GROUP 1	N/A	[GROUP 1 – GROUP 2 – GROUP 3]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Control Elements > Underfrequency					
Underfrequency 1 > Underfrequency 2 > Underfrequency 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	49.50	0.01 Hz	[20.00 : 65.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Minimum voltage threshold	Minimum Voltage	0.10	0.01 x VT	[0.05 : 1.25]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Control Elements > Overfrequency					
Overfrequency 1 > Overfrequency 2 > Overfrequency 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	50.50	0.01 Hz	[20.00 : 65.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Minimum voltage threshold	Minimum Voltage	0.10	0.01 x VT	[0.05 : 1.25]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Control Elements > Synchrocheck					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Dead source voltage level	Dead Source Level	0.10	0.01 x VT (S)	[0 : 1.25]	
Live source voltage level	Live Source Level	0.10	0.01 x VT (S)	[0.03 : 1.25]	
Dead load voltage level	Dead Load Level	0.10	0.01 x VT (L)	[0 : 1.25]	
Live load voltage level	Live Load Level	0.10	0.01 x VT (L)	[0.03 : 1.25]	
Voltage Difference	Max Volt Difference	0.10	0.01 x VT (L)	[0.02 : 1.25]	
Angle Difference	Max Angle Difference	10.0	0.1 Deg	[2.0 : 80.0]	
Frequency Slip	Max Freq Difference	20	10 mHz	[10 : 5000]	

Breaker Closing time	Time	0.50	0.01 s	[0.01 : 600.00]	
Dead Load – Dead Source Function permission	Dead Load – Dead Source Function	DISABLED	N/A	[DISABLED – ENABLED]	
Live Load – Dead Source Function permission	Live Load – Dead Source Function	DISABLED	N/A	[DISABLED – ENABLED]	
Dead Load – Live Source Function permission	Dead Load – Live Source Function	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Control Elements > Autoreclose					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Number of shots	Max Number Shots	1	N/A	[1 : 4]	
Dead time 1	Dead Time 1	0.00	0.01 s	[0.00 : 900.00]	
Dead time 2	Dead Time 2	0.00	0.01 s	[0.00 : 900.00]	
Dead time 3	Dead Time 3	0.00	0.01 s	[0.00 : 900.00]	
Dead time 4	Dead Time 4	0.00	0.01 s	[0.00 : 900.00]	
Reclaim time or reset lockout delay	Reclaim Time	0.00	0.01 s	[0.00 : 900.00]	
Reset Time	Reset Time	0.00	0.01 s	[0.00 : 900.00]	
Halt Time	Halt Time	0.00	0.01 s	[0.00 : 900.00]	
Cond. Permission	Cond. Permission	DISABLED	N/A	[DISABLED – ENABLED]	
Cond. Time	Cond. Time	0.0	0.01 s	[0.00 : 900.00]	
Lockout Type	Lockout Type	AUTOMATIC	N/A	[MANUAL – AUTOMATIC]	
Coor. Time	Coor. Time	0.0	0.01 s	[0.00 : 900.00]	
Reset Shot Time	Reset Shot Time	0.00	0.01 s	[0.00 : 900.00]	
Sync Shots Counter	Sync Shots Counter	DISABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Control Elements > Breaker failure					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function Permission	FUNCTION	DISABLED	N/A	[DISABLED – ENABLED]	
TRIP MODE	TRIP MODE	SINGLE POLE	N/A	[SINGLE POLE – THREE POLE]	
Current Supervision	CURRENT SUPV	ENABLED	N/A	[DISABLED – ENABLED]	
PH Current Supervision	PH CURRENT SUPV	1.00	0.01 x CT	[0.05 : 20.00]	
GND Current Supervision	GND CURRENT SUPV	1.00	0.01 x CTg	[0.05 : 20.00]	
SGND Current Supervision	SGND CURRENT SUPV	1.00	0.01 x CTg	[0.05 : 20.00]	
RETRIP TIME DELAY	RETRIP TIME DELAY	0.20	0.01 s	[0.00 : 999.99]	
PH HISET PKP LEVEL	PH HISET PKP LEVEL	5.00	0.01 x CT	[0.05 : 20.00]	
GND HISET PKP LEVEL	GND HISET PKP LEVEL	5.00	0.01 x CTg	[0.05 : 20.00]	
SGND HISET PKP LEVEL	SGND HISET PKP LEVEL	5.00	0.01 x CTg	[0.05 : 20.00]	
HISET 1 POLE DELAY	HISET 1 POLE DELAY	2.00	0.01 s	[0.00 : 999.99]	
HISET 3 POLE DELAY	HISET 3 POLE DELAY	0.50	0.01 s	[0.00 : 999.99]	
PH LOSET PKP LEVEL	PH LOSET PKP LEVEL	2.00	0.01 x CT	[0.05 : 20.00]	
GND LOSET PKP LEVEL	GND LOSET PKP LEVEL	2.00	0.01 x CTg	[0.05 : 20.00]	

SGND LOSET PKP LEVEL	SGND LOSET PKP LEVEL	2.00	0.01 x CTg	[0.05 : 20.00]	
LOSET 1 POLE DELAY	LOSET 1 POLE DELAY	5.00	0.01 s	[0.00 : 999.99]	
LOSET 3 POLE DELAY	LOSET 3 POLE DELAY	1.00	0.01 s	[0.00 : 999.99]	
2ND STAGE DELAY	2ND STAGE DELAY	5.00	0.01 s	[0.00 : 999.99]	
INTERNAL ARC PICKUP LEVEL	INTERNAL ARC PICKUP LEVEL	0.10	0.01 x CT	[0.05 : 30.00]	
INTERNAL ARC PICKUP DELAY	INTERNAL ARC PICKUP DELAY	10.00	0.01 s	[0.00 : 999.99]	
WITHOUT current element time delay	BF W/O CURRENT DELAY	10.00	0.01 s	[0.00 : 999.99]	
Snapshot event generation	SNAPSHOT EVENTS	DISABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Control Elements > VT Fuse Failure)					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > PULSE COUNTERS					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Pulse counter enabling setting	CntPulses Enabled X	DISABLED	N/A	[DISABLED – ENABLED]	
Name of the pulse counter	CntPulses Name X	Pulse Counter 1	N/A	N/A	
Multiplier factor for the pulse counter	CntPulses Factor X	1.000	0.001	[0.000 : 65000.000]	
Overflow value for the pulse counter	CntPulses Overflow X	65535	1	[0 : 1000000]	
Board selection for the pulse counter	CntPulses Board Origin X	F	N/A	[F,G,H,I]	
Input index inside the selected board	CntPulses Input Origin X	1	1	[1 : 32]	
Note: X is the pulse counter index, up to 8.					

SETPOINT > CONTROL ELEMENTS > ANALOG COMPARATORS					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Generic Analog Function Permission	Analog Function	DISABLED	N/A	[DISABLED – ENABLED]	
Generic Snapshot Events Generation	Analog Snapshot Events	DISABLED	N/A	[DISABLED – ENABLED]	
Analog Input Value Selection	Analog Input X	None	N/A	[All available analog values]	
Analog Maximum Threshold Value	Analog Maximum X	1.000	0.001	[-100000.000 : 100000.000]	
Analog Minimum Threshold Value	Analog Minimum X	1.000	0.001	[-100000.000 : 100000.000]	
Analog Delay for Activation Signal	Analog Delay X	0.00	0.01 s	[0.00 : 900.00]	
Analog Hysteresis for the Deadband	Analog Hysteresis X	1.0	0.1	[0.0 : 50.0]	
Analog Direction for Activation Inside or Outside the Deadband	Analog Direction X	OUT	N/A	[IN-OUT]	
Note: X is the analog comparator index, up to 20					

SETPOINT > CONTROL ELEMENTS > DIGITAL COUNTERS					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	DigCnt 1 Function	DISABLED	NA		
Digital Counter 1 name	DigCnt 1 Name		NA		

Digital counter 1 Preset	DigCnt 1 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 1 Compare	DigCnt 1 Compare	0	1	[-2147483648 : 2147483647]	
Function permission	DigCnt 2 Function	DISABLED	NA		
Digital Counter 2 name	DigCnt 2 Name		NA		
Digital counter 2 Preset	DigCnt 2 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 2 Compare	DigCnt 2 Compare	0	1	[-2147483648 : 2147483647]	
Function permission	DigCnt 3 Function	DISABLED	NA		
Digital Counter 3 name	DigCnt 3 Name		NA		
Digital counter 3 Preset	DigCnt 3 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 3 Compare	DigCnt 3 Compare	0	1	[-2147483648 : 2147483647]	
Function permission	DigCnt 4 Function	DISABLED	NA		
Digital Counter 4 name	DigCnt 4 Name		NA		
Digital counter 4 Preset	DigCnt 4 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 4 Compare	DigCnt 4 Compare	0	1	[-2147483648 : 2147483647]	
Function permission	DigCnt 5 Function	DISABLED	NA		
Digital Counter 5 name	DigCnt 5 Name		NA		
Digital counter 5 Preset	DigCnt 5 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 5 Compare	DigCnt 5 Compare	0	1	[-2147483648 : 2147483647]	
Function permission	DigCnt 6 Function	DISABLED	NA		
Digital Counter 6 name	DigCnt 6 Name		NA		
Digital counter 6 Preset	DigCnt 6 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 6 Compare	DigCnt 6 Compare	0	1	[-2147483648 : 2147483647]	
Function permission	DigCnt 7 Function	DISABLED	NA		
Digital Counter 7 name	DigCnt 7 Name		NA		
Digital counter 7 Preset	DigCnt 7 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 7 Compare	DigCnt 7 Compare	0	1	[-2147483648 : 2147483647]	
Function permission	DigCnt 8 Function	DISABLED	NA		
Digital Counter 8 name	DigCnt 8 Name		NA		
Digital counter 8 Preset	DigCnt 8 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 8 Compare	DigCnt 8 Compare	0	1	[-2147483648 : 2147483647]	
Snapshot Event Generation	Snapshot Events	ENABLED	NA	[ENABLED; DISABLED]	
SETPOINT > CONTROL ELEMENTS > COLD LOAD PICK UP					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Cold Load Function	DISABLED	NA	[ENABLED; DISABLED]	

Cold Load Pickup Outage Time	Cold Outage Time	20	min	[1 : 1000]	
Cold Load Pickup Blocking Time	Cold Blocking Time	5	s	[1 : 1000]	
Snapshot Event Generation	Cold Load Events	ENABLED	NA	[ENABLED; DISABLED]	
SETPOINT > CONTROL ELEMENTS > CURRENT TRANSFORMER FAILURE					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function Permission	Function Permission	DISABLED	N/A	[DISABLED – ENABLED]	
Neutral Current PKP	3I0 Current PKP	0.10	0.01 x CT	[0.05 : 2.00]	
Neutral Voltage Inhibit	3V0 Voltage Inhibit	0.10	0.01 x VT	[0 : 1.25]	
GND Current Inhibit	GND Current Inhibit	0.005	0.01 x CTg	[0.05 : 2.00]	
SGND Current Inhibit	SGND Current Inhibit	0.005	0.001	[0.005-1.000]	
Time Delay	Time Delay	0.00	0.01	[0.00 -600.00]	
Snapshot events	Snapshot events	DISABLED	N/A	ENABLED/DISABLED	
Function Permission	Function Permission	DISABLED	N/A	[DISABLED – ENABLED]	
SETPOINT > CONTROL ELEMENTS > 2ND HARMONIC INHIBIT					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Second harmonic pickup	2ND HRMC PICKUP	1	1%	[1- 40.00]	
Second harmonic delay	2ND HRMC DELAY	0.00	0.1s	[0.00-600.00]	
Minimum secondary current to operate	MINIMUM. CURRENT	0.05	0.01 x CT	[0.05-2.00]	
Phase affected to operate	PHASES FOR OPERATION	ANY ONE	N/A	[ANY ONE- ANY TWO- ALL THREE- AVERAGE]	
Snapshot events	Snapshot events	DISABLED	N/A	[DISABLED – ENABLED]	
Setpoint > Inputs/Outputs > Contact I/O >					
Board F > Board G >board h>board j					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
I/O board type (available only for CIO modules)	I/O Board Type_**X**	NONE	N/A	[NONE, 16 INP + 8OUT, 8 INP + 8OUT + SUPV 32 INP 16 INP + 8 ANA]	
Input activation voltage threshold Group A	Voltage Threshold A_**X**	80	1 V	[10 : 230]	
Input activation voltage threshold Group B	Voltage Threshold B_**X**	80	1 V	[10 : 230]	
Input activation voltage threshold Group C	Voltage Threshold C_**X**	80	1 V	[10 : 230]	
Input activation voltage threshold Group D	Voltage Threshold D_**X**	80	1 V	[10 : 230]	
Debounce time for Group A	Debounce Time A_**X**	15	1 ms	[1 : 50]	
Debounce time for Group B	Debounce Time B_**X**	15	1 ms	[1 : 50]	
Debounce time for Group C	Debounce Time C_**X**	15	1 ms	[1 : 50]	
Debounce time for Group D	Debounce Time D_**X**	15	1 ms	[1 : 50]	
Input type	Input Type_**X**_CC**Y** (CC**Y**)	POSITIVE	N/A	[POSITIVE-EDGE, NEGATIVE-EDGE, POSITIVE, NEGATIVE]	
Input signal time delay	Delay Input Time_**X**_CC**Y** (CC**Y**)	0	1 ms	[0 : 60000]	

Output logic type	Output Logic_**X**_0**Z**	POSITIVE	N/A	[POSITIVE, NEGATIVE]	
Output type	Output Type_**X**_0**Z**	NORMAL	N/A	[NORMAL, PULSE, LATCH]	
Output pulse length	Pulse Output Time_**X**_0**Z**	10000	1 ms	[0 : 60000]	
Analog Inputs Range	Range_**X**_0**Z**	NONE	N/A	[NONE, -1 to 0mA, 0 to 1 mA, -1 to 1 mA, 0 to 5 mA, 0 to 10 mA]	
Minimum Value	Min_Value_**X**_0**Z**	0.00	0.01	[-9999.99 : 9999.99]	
Maximum Value	Max_Value_**X**_0**Z**	0.00	0.01	[-9999.99 : 9999.99]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Note 2: Description of X, Y and Z in input/output boards			
X	F, G, H or J, the I/O board name, depending on the Relay model.		
	F and G are internal Relay boards, and H and J are additional boards available in CIO modules (remote Bus CAN I/O module)		
For the I/O board selection in the relay model:	I/O BOARD TYPE		
	ASSOCIATED DIGIT	ENERVISTA 650 SETUP BOARD SETTINGS	BOARD TYPE
	0	NONE	None
	1	16 INP+ 8 OUT	Mixed
	2	8 INP +8 OUT +SUPV	Supervision
	4	32 INP	32 digital inputs
	5	16 INP + 8 ANA	16 digital inputs + 8 analog inputs
CC**Y**	Is the name used for inputs in I/O boards		
	Mixed, 16 digital inputs: CC1....CC16		
	Supervision: 8 digital inputs: CC1,..., CC8		
	32 INP: 32 digital inputs; CC1,...,CC32		
0**Z**	Is the name used for the different outputs in I/O boards, 8 outputs available for any of the two types of board (01,...., 08)		

Setpoint > inputs/outputs > remote comms					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Remote comms selection	Remote Comms	NONE	N/A	[NONE – GSSE – GOOSE]	
SETTING DESCRIPTION FOR GSSE					
Remote comms selection	Remote Comms	GSSE	N/A	[NONE – GSSE – GOOSE]	
Device Identification	650 ID	R650	N/A		
Hold time signal send by the transmiting device	Hold Time	10000	1 ms	[1000 : 60000]	
Snapshot Events Generation	Snapshot Events Remote Out	DISABLED	N/A	[DISABLED – ENABLED]	
Remote Device Description	Remote Device X	Remote Device X	N/A		
Bit Pair Selection	Bit Pair X	None	N/A	[DNA-1 to DNA-32 – UserSt-1 to UserSt-64]	
Default Value Selection	Default Value X	OFF	N/A	[OFF – ON – LATEST OFF – LATEST ON]	

SETTING DESCRIPTION FOR GoOSE					
Remote comms selection	Remote Comms	GOOSE	N/A	[NONE – GSSE – GOOSE]	
Default Value Selection	Default Value X	OFF	N/A	[OFF – ON – LATEST OFF – LATEST ON]	
Note: X is the Remote Device index, up to 32					

LIST OF TIME OVERCURRENT CURVES AVAILABLE IN R650
IEEE extremely/very/moderately inverse
IEC Curve A/B/C/Long-Time Inverse/ Short-Time Inverse
IAC extremely/very/normally/moderately inverse
ANSI extremely/very/normally/moderately inverse
I2t
Definite time
Rectifier curve
User Curve - FlexCurve™ A/B/C/D

GE
Grid Solutions

R650 Recloser Controller

Appendix I: Miscellaneous

I.1 GE Multilin warranty

WARRANTY

For products shipped as of 1 October 2013, GE warrants most of its GE manufactured products for 10 years. For warranty details including any limitations and disclaimers, see our Terms and Conditions at https://www.gegridsolutions.com/multilin/warranty.htm

For products shipped before 1 October 2013, the standard 24-month warranty applies

I.2 Revision History

MANUAL P/N	RELEASE DATE
1601-0707-A1	January 2018

I.2.1 Major Updates

R650 A1 - Initial release