MiCOM P847B&C

Technical Manual

Phasor Measurement Unit

Platform Hardware Version: K
Platform Software Version: 72
Publication Reference: P847BC/EN M/B

GRID

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CONTENTS

INTRODUCTION

CHAPTER 1

1 FOREWORD

This technical manual provides a functional and technical description of Alstom Grid's P847B&C, as well as a comprehensive set of instructions for using the device.

1.1 Target Audience

This manual is aimed towards all professionals charged with installing, commissioning, maintaining, troubleshooting, or operating any of the products in the product range. This includes installation and commissioning personnel as well as system, protection and measurement engineers who will be responsible for operating the product.

The level at which this manual is written assumes that installation and commissioning engineers have knowledge of handling electronic equipment and that system, protection and measurement engineers have a thorough knowledge of phasor measurement based systems and associated equipment.

1.2 Special Terms

Due to the technical nature of this manual, many special terms, abbreviations and acronyms are used throughout the manual. Some of these terms are well-known industry-specific terms while others may be special product-specific terms used by Alstom Grid. A glossary at the back of this manual provides a description of all special terms used throughout the manual.

1.3 Manual Structure

The manual consists of several chapters, each consisting of several sections and sub-sections.

The manual consists of the following chapters:

- Chapter 1: Introduction
- Chapter 2: Safety Information
- Chapter 3: Technical Specifications
- Chapter 4: Physical Description
- Chapter 5: Hardware & Software Design
- Chapter 6: Configuration
- Chapter 7: Communications
- Chapter 8: Redundant Ethernet
- Chapter 9: Settings and Records
- Chapter 10: Operation
- Chapter 11: Application Examples
- Chapter 12: Programmable Scheme Logic (PSL) Editor
- Chapter 13: PSL Schemes
- Chapter 14: Installation
- Chapter 15: Commissioning Instructions
- Chapter 16: Maintenance & Troubleshooting
- Chapter 17: Symbols and Glossary

- Chapter 18: Wiring Diagrams
- Appendix A: Commissioning Records

2 INTRODUCING PHASOR MEASUREMENT

Electrical power systems are becoming ever more complex and consequently ever more difficult to manage. This is due to various reasons, such as deregulation of the power industry, increasing market requirements for high quality reliable electricity and the increased energy supply from renewable sources such as wind farms, providing unpredictable quantities of energy to the grid. Grid instability is a major concern in the industry, and a means of accurately measuring and comparing the amplitude, frequency and phase angles at different parts of the grid, in real time, is becoming essential to anticipate problems and take necessary control actions. Further, the grids of different countries and areas that used to be autonomous are becoming more interconnected. This provides huge advantages for the trans-boundary distribution of power, but presents a range of energy management problems. Phasor Measurement Units (PMUs) have been shown to be a suitable technology in helping to manage this increased grid complexity.

A PMU is a device that can accurately measure the magnitude, frequency, and phase of power system components of voltage or current, in real time and in relation to a geographically independent time reference. Typically these measurements are then communicated using a standard protocol (IEEE C37.118-2005) to a central Phasor Data Concentrator (PDC) or other processing tool for system analysis.

2.1 The P847 Range

The P847 is a PMU that is designed to acquire and communicate phasor data in compliance with the IEEE C37.118-2005 standard.

The P847 is available in three models: Model A, Model B and Model C.

- Model A provides PMU functionality as well as a range of backup protection functions.
- Model B provides PMU functionality with extra CTs and extended I/O but with no backup protection.
- Model C provides PMU functionality with extra CTs and further extended I/Os but also without backup protection.

Note: Models B and C do not provide backup protection

The features of the three variants are summarized below.

Model v. Feature	P847 Model A	P847 Model B	P847 Model C
Case	60TE	80TE	80TE
Digital inputs	8	16	24
Relay outputs	8	8	24
Voltage inputs	3 (1 x 3-phase set only)	3 (1 x 3-phase set or 3 x individual)	3 (1 x 3-phase set or 3 x individual)
Current inputs	4 (1 x 3-phase set + 1 ground fault input)	4 x 3-phase set, or 12 individual	4 x 3-phase set, or 12 individual
Redundant Ethernet	No	Yes	Yes
Backup protection	Yes	No	No
Sensitive Earth Fault	Yes	No	No

Table 1: Model variant features

Note: This type of product needs to be supplied with highly accurate timing signals. These can be provided by using the P594 timing synchronization unit.

2.2 The P847 Model B and C

The rest of this technical manual describes the P847 Models B and C only. These models are intended for use where extensive PMU functionality is required, with a wide selection of input and output possibilities, and where backup protection is not required.

Models B and C are housed in 80TE cases. They provide three voltage connections and twelve current connections.

Model B provides sixteen digital inputs and eight relay outputs. Model C provides twenty-four digital inputs and twenty-four relay outputs.

Models B and C also feature redundant Ethernet connectivity.

3 FEATURES AND FUNCTIONS

The device provides the following features.

- Synchrophasor measurements
- Selectable phasor reporting rate
- Selectable filter length
- Communication in accordance with IEEE C37.118-2005 (TCP/IP or UDP/IP over Ethernet)
- IRIG-B time stamping
- GPS 1 PPS phasor synchronization
- Optically isolated digital inputs (opto-inputs)
- Relay output contacts
- Dual rated 1 A and 5 A CT inputs
- Multiple password access control levels
- Sequence of Events records (SOE)
- Disturbance recorder
- Graphical programmable scheme logic (PSL)
- Programmable hotkeys (2)
- Control inputs
- Programmable allocation of digital inputs and outputs
- Fully customizable menu texts
- Power-up diagnostics and continuous self-monitoring.

4 COMPLIANCE

The unit has undergone extensive testing and certification processes to demonstrate compatibility with target markets. Table 2 summarizes a list of standards with which the device is compliant. A detailed description of these criteria can be found in the *Technical Specifications* chapter.

Condition	Compliance
EMC compliance (Europe)	2004/108/EC (demonstrated by EN50263:2000)
EMC	EN50263, IEC 60255-22-1/2/3/4, IEC 61000-4-5/6/8/9/10, EN61000-4-3/18, IEEE/ANSI C37.90.1/2, ENV50204, EN55022
Product safety (Europe)	2006/95/EC (demonstrated by EN60255-27:2005)
Product Safety (North America)	UL/CL File No. UL/CUL E202519
R&TTE Compliance (Europe)	99/5/EC
Environmental conditions	IEC 60068-2-1/30/60/78
Power supply interruption	IEC 60255-11, IEC 61000-4-11
Type tests for Insulation, creepage distance and clearances, high voltage dielectric withstand, and impulse voltage withstand	IEC 60255-27:2005
Enclosure protection	IEC 60529:1992 – IP10, IP30, IP52
Mechanical robustness	IEC 60255-21-1/2/3
Communications	IEC 61850, DNP3
Synchrophasor communications	IEEE C37.118-2005

Table 2: Compliance standards

5 APPLICATION OVERVIEW

5.1 PMU-specific functionality

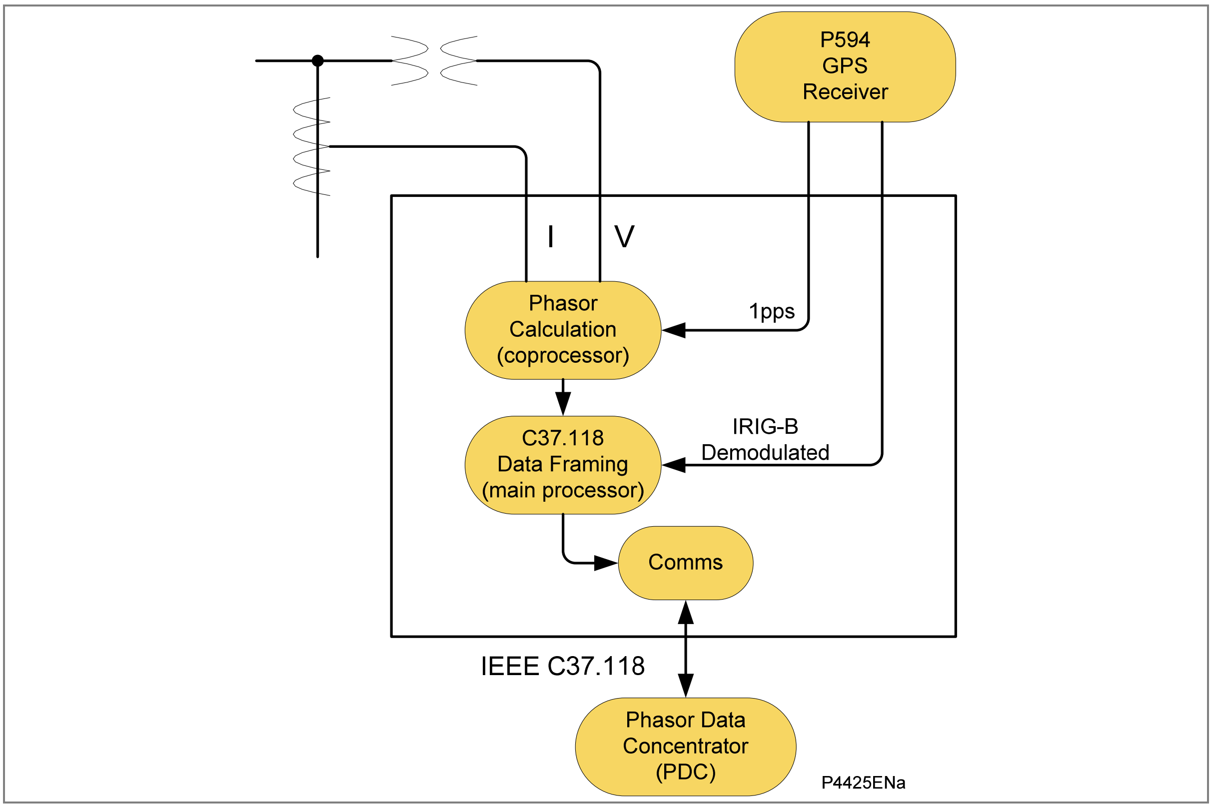


Figure 1: Functional Overview

6 ORDERING OPTIONS

Variants Order No.	P847
Model	
Phasor Measurement Unit	
Nominal auxiliary voltage	
24 - 48 Vdc	1
48 - 110 Vdc (40 - 100 Vac)	2
110 - 250 Vdc (100 - 240 Vac)	3
In/Vn rating	
1n = 1 A/5 A : Vn = 100 - 120 Vac, 4 CT & 3 VT (60TE)	1
1n = 1 A/5 A : Vn = 100 - 120 Vac, 12 CT & 3 VT (80TE)	2
Hardware options	
Ethernet (100 Mbps) plus IRIG-B (De-modulated)	B
Redundant Ethernet Self-Healing Ring + Demodulated IRIG-B	H
Redundant Ethernet Rapid Spanning Tree Protocol + Demodulated IRIG-B	K
Redundant Ethernet Dual Homing Star + Demodulated IRIG-B	M
Product Options	
8 Inputs & 8 Outputs + Backup Protection (60TE)	A
16 Inputs & 8 Outputs (80TE)	B
24 Inputs & 24 Outputs (80TE)	C
Protocol options	
K-Bus	1
IEC 61850 + Courier via rear RS485 port	6
DNP3.0 Over Ethernet with Courier rear port K-Bus/RS485 protocol	8
Mounting	
Flush / Panel mounting	M
19" Rack mounting (80TE only)	N
Language	
English, French, German, Spanish	0
English, French, German, Russian	5
Chinese, English or French via HMI, with English or French only via Communications port	C
Software version	
Date and application dependant	**
Customer specific options	
Standard version	0
Customer version	A
Hardware version	
K = XCPU2	K

SAFETY INFORMATION

CHAPTER 2

1 CHAPTER OVERVIEW

The Safety Information chapter provides information for the safe handling of the equipment. You must be familiar with information contained in this chapter before unpacking, installing, commissioning, or servicing the equipment.

The chapter contains the following sections

2 HEALTH AND SAFETY

The information in this chapter is intended to ensure that equipment is properly installed and handled in order to maintain it in a safe condition and to keep personnel safe at all times.

Personnel associated with the equipment must also be familiar with the contents of this Safety Information chapter as well as the Safety Guide (SFTY/4L M).

When electrical equipment is in operation, dangerous voltages will be present in certain parts of the equipment. Improper use of the equipment and failure to observe warning notices will endanger personnel.

Only qualified personnel may work on or operate the equipment. Qualified personnel are individuals who:

- Are familiar with the installation, commissioning, and operation of the equipment and the system to which it is being connected.
- Are familiar with accepted safety engineering practices and are authorized to energize and de-energize equipment in the correct manner.
- Are trained in the care and use of safety apparatus in accordance with safety engineering practices
- Are trained in emergency procedures (first aid).

Although the documentation provides instructions for installing, commissioning and operating the equipment, it cannot cover all conceivable circumstances nor include detailed information on all topics. In the event of questions or problems, do not take any action without proper authorization. Please contact the appropriate Alstom Grid technical sales office and request the necessary information.

3 SYMBOLS

Throughout this chapter you may come across the following symbols. You will also see these symbols on parts of the equipment.

	Caution: refer to equipment documentation. Failure to do so could result in damage to the equipment
	Caution: Risk of electric shock
	Ground terminal (In some countries, known as the Earth terminal)
	Protective ground terminal

4 INSTALLATION, COMMISSIONING AND SERVICING

4.1 General Safety Guidelines

4.1.1 Lifting Hazards

Plan carefully, identify any possible hazards and determine whether the load needs to be moved at all. Look at other ways of moving the load to avoid manual handling. Use the correct lifting techniques and Personal Protective Equipment to reduce the risk of injury.

Many injuries are caused by:

- Lifting heavy objects
- Lifting things incorrectly
- Pushing or pulling heavy objects
- Using the same muscles repetitively.

Follow the Health and Safety at Work, etc Act 1974, and the Management of Health and Safety at Work Regulations 1999.

4.1.2 Electrical Hazards

All personnel involved in installing, commissioning, or servicing of this equipment must be familiar with the correct working procedures.

Consult the equipment documentation before installing, commissioning, or servicing the equipment.

Always use the equipment in a manner specified by the manufacturer. Failure to do will jeopardize the protection provided by the equipment.

Removal of equipment panels or covers may expose hazardous live parts, which must not be touched until the electrical power is removed. Take extra care when there is unlocked access to the rear of the equipment.

Before working on the terminal strips, the equipment must be isolated.

A suitable protective barrier should be provided for areas with restricted space, where there is a risk of electric shock due to exposed terminals.

Disconnect power before disassembling. Disassembly of the equipment may expose sensitive electronic circuitry. Take suitable precautions against electrostatic voltage discharge (ESD) to avoid damage to the equipment.

Where fiber optic communication devices are fitted, these should not be viewed directly. Optical power meters should be used to determine the operation or signal level of the device.

Insulation testing may leave capacitors charged up to a hazardous voltage. At the end of each part of the test, the voltage should be gradually reduced to zero, to discharge capacitors, before the test leads are disconnected.

Equipment operating conditions

The equipment should be operated within the specified electrical and environmental limits.

Cleaning

The equipment may be cleaned using a lint free cloth dampened with clean water, when no connections are energized. Contact fingers of test plugs are normally protected by petroleum jelly, which should not be removed.

4.2 UL/CSA/CUL Requirements

Equipment intended for rack or panel mounting is for use on a flat surface of a Type 1 enclosure, as defined by Underwriters Laboratories (UL).

To maintain compliance with UL and CSA/CUL, the equipment should be installed using UL/CSA-recognized parts for: connection cables, protective fuses, fuse holders and circuit breakers, insulation crimp terminals, and replacement internal batteries.

For external fuse protection, a UL or CSA Listed fuse must be used. The listed protective fuse type is: Class J time delay fuse, with a maximum current rating of 15 A and a minimum DC rating of 250 V dc (for example type AJT15).

Where UL/CSA listing of the equipment is not required, a high rupture capacity (HRC) fuse type with a maximum current rating of 16 Amps and a minimum dc rating of 250 V dc may be used (for example Red Spot type NIT or TIA.

4.3 Equipment Connections

Beware! Terminals exposed during installation, commissioning and maintenance may present a hazardous voltage unless the equipment is electrically isolated.

M4 (#8) clamping screws of heavy duty terminal block connectors used for CT and VT wiring must be tightened to a nominal torque of 1.3 Nm.

M3.5 (#6) clamping screws of medium duty terminal block connectors used for binary I/O and power supply wiring must be tightened to a nominal torque of 0.8 Nm.

Pin terminal screws of terminal block connectors used for field wiring must be tightened to a nominal torque of 0.25 Nm.

Always use insulated crimp terminations for voltage and current connections.

Always use the correct crimp terminal and tool according to the wire size.

Watchdog (self-monitoring) contacts are provided to indicate the health of the device. Alstom Grid strongly recommends that you hardwire these contacts into the substation's automation system, for alarm purposes.

4.4 Protection Class 1 Equipment Requirements

Ground the equipment with the supplied PCT (Protective Conductor Terminal).

Do not remove the PCT.

The PCT is sometimes used to terminate cable screens. Always check the PCT’s integrity after adding or removing such functional ground connections.

Use a locknut or similar mechanism to ensure the integrity of M4 stud-connected PCTs.

The recommended minimum PCT wire size is 2.5 mm² for countries whose mains supply is 230 V (e.g. Europe) and 3.3 mm² for countries whose mains supply is 110 V (e.g. North America). This may be superseded by local or country wiring regulations.

The PCT connection must have low-inductance and be as short as possible.

All connections to the equipment must have a defined potential. Connections that are pre-wired, but not used, should be grounded when binary inputs and output relays are isolated. When binary inputs and output relays are connected to a common potential, unused, pre-wired connections should be connected to the common potential of the grouped connections.

4.5 Pre-energization Checklist

Check voltage rating/polarity (rating label/equipment documentation).

Check CT circuit rating (rating label) and integrity of connections.

Check protective fuse or miniature circuit breaker (MCB) rating.

Check integrity of the PCT connection.

Check voltage and current rating of external wiring, ensuring it is appropriate for the application.

4.6 Peripheral Circuitry

Do not open the secondary circuit of a live CT since the high voltage produced may be lethal to personnel and could damage insulation. The secondary of the line CT should be shorted before opening any connections to it.

Note: For most equipment with ring-terminal connections, the threaded terminal block for current transformer termination has automatic CT shorting on removal of the module. Therefore external shorting of the CTs may not be required. Check the equipment documentation first to see if this applies.

Where external components, such as resistors or voltage dependent resistors (VDRs), are used, these may present a risk of electric shock or burns, if touched.

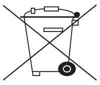
Take extreme care when using external test blocks and test plugs such as the MMLG, MMLB and MiCOM ALSTOM P990, as hazardous voltages may be exposed. CT shorting links must be in place before inserting or removing MMLB test plugs, to avoid potentially lethal voltages.

4.7 Upgrading/Servicing

Modules, PCBs, or expansion boards must not be inserted into or withdrawn from the equipment while energized, as this may result in damage to the equipment. Hazardous live voltages would also be exposed, thus endangering personnel.

5 DECOMMISSIONING AND DISPOSAL

Before decommissioning, isolate completely the equipment power supplies (both poles of any dc supply). The auxiliary supply input may have capacitors in parallel, which may still be charged. To avoid electric shock, the capacitors should be safely discharged via the external terminals prior to decommissioning.



Avoid incineration or disposal to water courses. The equipment should be disposed of in a safe, responsible, in an environmentally friendly manner, and if applicable, in accordance with country-specific regulations.

TECHNICAL SPECIFICATIONS

CHAPTER 3

1 CHAPTER OVERVIEW

This chapter contains a list of all the various technical specifications for this device. These will generally include electrical, mechanical and thermal specifications for the equipment, details of electrical and signaling protocols used on any interfaces, terminals and ratings as well as compliance with any standards and Electromagnetic Compatibility.

This chapter consists of the following sections:

2 INTERFACES

2.1 IRIG-B (De-modulated)

IRIG-B Interface (De-modulated)	
Use	External clock synchronization signal
Standard	IRIG 200-98 format B00X
Connector	BNC
Cable type	50 Ohm coaxial
Isolation	Isolation to SELV level
Input signal	TTL level
Input impedance at dc	10 k ohms
Accuracy	< +/- 1s per day

2.2 1PPS GPS input

1PPS GPS input	
Use	1 PPS time signal from GPS
Standard	Proprietary (needs connection to P594)
Connector	IEC 874-10 BFOC 2.5 –(ST®) (Just 1 for Rx)
Fiber type	Multimode 50/125 µm or 62.5/125 µm
Accuracy	Maximum absolute error between the actual GPS time and the rising edge of the 1PPS signal: better then ±50 ns
Wavelength	850 nm

2.3 Download/Monitor port

Front parallel port	
Use	For firmware downloads or monitor connection
Standard	Compatible with IEEE1284-A
Connector	25 pin D-type female connector
Isolation	Isolation to ELV level
Protocol	Proprietary
Constraints	Maximum cable length 3 m

2.4 Rear serial port

Rear serial port	
Use	For SCADA communications (multi-drop)
Standard	EIA(RS)485
Connector	General purpose block, M4 screws (2 wire)
Cable	Screened twisted pair (STP)
Supported Protocols	Courier
Isolation	Isolation to ELV level
Constraints	Maximum cable length 1000 m

2.5 Rear Ethernet port (copper)

Rear Ethernet port (copper)	
Main Use	IEEE C37.118 synchrophasor communications
Alternative Use	IEC 61850
Standard	IEEE 802.3 10BaseT/100BaseTX
Connector	RJ45
Cable type	Screened twisted pair (STP)
Isolation	1.5 kV
Supported Protocols	IEEE C37.118, IEC 61850
Constraints	Maximum cable length 100 m

2.6 Rear Ethernet port (fiber including redundancy option)

Rear Ethernet port (fiber)	
Main Use	IEEE C37.118 synchrophasor communications
Alternative Use	IEC 61850 or DNP3 SCADA communications
Connector	IEC 874-10 BFOC 2.5 –(ST®) (1 each for Tx and Rx)
Standard	IEEE 802.3 100 BaseFX
Fiber type	Multimode 50/125 µm or 62.5/125 µm
Supported Protocols	IEEE C37.118, IEC 61850, DNP3.0
Optional Redundancy Protocols Supported	Rapid spanning tree protocol (RSTP) Self-healing protocol (SHP) Dual homing protocol (DHP)
Wavelength	1300 nm

2.7 100 Base FX Transmitter characteristics

Parameter	Sym	Min.	Typ.	Max.	Unit
Output Optical Power BOL 62.5/125 µm NA = 0.275 Fiber EOL	PO	-19 -20	-16.8	-14	dBm avg.
Output Optical Power BOL 50/125 µm NA = 0.20 Fiber EOL	PO	-22.5 -23.5	-20.3	-14	dBm avg.
Optical Extinction Ratio				10 -10	% dB
Output Optical Power at Logic “0” State	PO (“0”)			-45	dBm avg.

Conditions: T_A = 0°C to 70°C, VCC = 4.75 V to 5.25 V

2.8 100 Base FX Receiver characteristics

Parameter	Sym	Min.	Typ.	Max.	Unit
Input Optical Power Minimum at Window Edge	PIN Min. (W)		-33.5	–31	dBm avg.
Input Optical Power Minimum at Eye Center	PIN Min. (C)		-34.5	-31.8	Bm avg.
Input Optical Power Maximum	PIN Max.	-14	-11.8		dBm avg.

Conditions: T_A = 0°C to 70°C, VCC = 4.75 V to 5.25 V

3 MEASUREMENTS AND RECORDING

3.1 Phasor Measurement Accuracy

Phasor Measurement Accuracy	
Total Vector Error (TVE)	< 1% (typically)
Reference conditions	Fn ±5 Hz

3.2 Phasor Reporting Rates

Phasor Reporting Rates	
Reporting rates for 60 Hz	10, 12, 15, 20, 30, 60 frames per second - settable
Reporting rates for 50 Hz	10, 25, 50 frames per second - settable

3.3 General

General Measurement Accuracy	
General measurement accuracy	Typically ±1%, but ±0.5% between 0.2 - 2 In/Vn
Current	0.05 to 3 In ±1.0% of reading
Voltage	0.05 to 2 Vn ±1.0% of reading
Power (W)	0.2 to 2 Vn and 0.05 to 3 In ±5.0% of reading at unity power factor
Reactive power (Vars)	0.2 to 2 Vn to 3 In ±5.0% of reading at zero power factor
Apparent power (VA)	0.2 to 2 Vn 0.05 to 3 In ±5.0% of reading
Energy (Wh)	0.2 to 2 Vn 0.2 to 3 In ±5.0% of reading at zero power factor
Phase	0° to 360° ±0.5%
Frequency	45 to 65 Hz ±0.025 Hz

3.4 Disturbance Records

Disturbance Records Measurement Accuracy	
Maximum record duration	10.5 s
No of records	Typically a minimum of 50 records at 1.5 seconds (no of records dependent on record duration setting)
Magnitude and relative phases accuracy	±5% of applied quantities
Duration accuracy	±2%
Trigger position accuracy	±2% (minimum Trigger 100 ms)

3.5 Event and Maintenance Records

Event and Maintenance Records	
Record location	The most recent records are stored in battery-backed memory
Viewing method	Front panel display or S1 Studio
Extraction method	Extracted via the communication port
Number of Event records	Up to 512 time tagged event records
Number of Maintenance Records	Up to 10

Note: *The P847 models B&C do not have any protection elements and with the default PSL schemes fitted will not generate any fault records. As it may be possible to trigger fault records if the PSL is changed, however, information on the fault recorder and associated functionalities is included for completeness.*

4 STANDARDS COMPLIANCE

4.1 EMC Compliance: 2004/108/EC

Compliance with the European Commission Directive on EMC is demonstrated using a Technical File.

Compliance with EN50263:2000 was used to establish conformity.

4.2 Product Safety: 2006/95/EC:

Compliance with the European Commission Low Voltage Directive (LVD) is demonstrated using a Technical File.

Compliance with EN 60255-27: 2005 was used to establish conformity:

4.3 R&TTE Compliance

Radio and Telecommunications Terminal Equipment (R&TTE) directive 99/5/EC.

Conformity is demonstrated by compliance to both the EMC directive and the Low Voltage directive, to zero volts.

4.4 UL/CUL Compliance

Canadian and USA Underwriters Laboratory

File Number E202519

5 MECHANICAL SPECIFICATIONS

5.1 Physical Parameters

Physical Measurements	
Case Type	80TE (Models B & C)
Weight	15.5 kg
Dimensions in mm (w x h x l) (80TE case)	413.2 x 177 x 270 (with secondary cover fitted)
Mounting	Front of panel flush mounting

5.2 Enclosure Protection: IEC 60529:1992

Enclosure Protection	
Against dust and dripping water (front face)	IP52 as per IEC 60529:1999
Protection for sides of the case	IP30 as per IEC 60529:1999
Protection for rear of the case	IP10 as per IEC 60529:1999

5.3 Mechanical Robustness

Mechanical Robustness	
Vibration test per IEC 60255-21-1:1996	Response: class 2, Endurance: class 2
Shock and bump immunity per IEC 60255-21-2:1995	Shock response: class 2, Shock withstand: class 1, Bump withstand: class 1
Seismic test per IEC 60255-21-3: 1995	Class 2

6 TERMINALS

6.1 AC Current and Voltage Measuring Inputs

AC Current and Voltage Measuring Inputs	
Use	For CT and VT inputs
Terminal Location	Located on heavy duty (black) terminal block, at rear
Connection type	Threaded M4 terminals, for ring lug connection
Protection	CT inputs have integral safety shorting, upon removal of the terminal block

6.2 General Input/Output Terminals

General Input/Output Terminals	
Use	For power supply, opto-inputs, output contacts and RP1 rear communications
Terminal Location	Located on general purpose (grey) blocks, at rear
Connection type	Threaded M4 terminals, for ring lug connection

6.3 Case Protective Ground Connection

Case Protective Ground Connection	
Use	For case protective ground only
Terminal Location	Two stud connections at rear
Connection type	Threaded M4 terminals
Special conditions	Must be grounded for safety. Minimum earth wire size 2.5 mm^2

7 RATINGS

7.1 AC Measuring Inputs

AC Measuring Inputs	
Nominal frequency	50 and 60 Hz (settable)
Operating range	45 to 65 Hz
Phase rotation	ABC

7.2 AC Current

AC Current	
Nominal current (In)	1 A and 5 A dual rated
Nominal burden per phase	< 0.2 VA at In
AC current thermal withstand	Continuous: 4*In, 10 s: 30*In, 1 s: 100*In linear to 64*In (non-offset ac current)

AC Voltage	
Nominal voltage	100 to 120 V phase-phase
Nominal burden per phase	< 0.02 VA at Vn
Thermal withstand	Continuous: 2*Vn, 10 s: 2.6*Vn

7.3 Auxiliary voltage (Vx)

Auxiliary voltage (Vx)	
Ordering options	Type 1: 24-48 V dc, Type 2: 48-110 V dc + 40-100 V ac, Type 3: 110-250 V dc + 100-240 V ac
Operating range, type 1	19 to 65 V dc
Operating range, type 2	37 to 150 V dc, 32 to 110 V ac
Operating range, type 3	87 to 300 V dc, 80 to 265 V ac
Ripple	<12% for a dc supply (compliant with IEC 60255-11:1979)

7.4 Field Output Voltage

Field Output Voltage	
Voltage	48 V dc regulated
Current limit	112 mA maximum output

7.5 Nominal burden

Nominal burden	
Quiescent burden	11 W
Additions for energized binary inputs	Per opto input: 0.09 W (24 to 54 V), 0.12 W (110/125 V), 0.19 W (220/120 V)
Additions for energized binary outputs	Per energized output relay: 0.13 W

7.6 Power-up

Power-up	
Time to power up	< 11 s
Battery Backup	Mounting: Front panel, Type: ½ AA, 3.6 V Lithium Thionyl Chloride Battery
Battery Type	Type: ½ AA, 3.6 V Lithium Thionyl Chloride Battery (SAFT advanced: LS14250)
Battery Life	>10 years (based on 90% energization time)

7.7 Power Supply Interruption

Power Supply Interruption	
Standard	IEC 60255-11:2008
Vx = 24 – 48 V dc Quiescent / half load	20 ms at 24 V 50 ms at 36 V 100 ms at 48 V
Vx = 24 – 48 V dc Full load	20 ms at 24 V 50 ms at 36 V 100 ms at 48 V
Vx = 48 – 100 V dc Quiescent / half load	20 ms at 36 V 50 ms at 60 V 100 ms at 72 V 200 ms at 110 V
Vx = 24 – 48 V dc Full load	20 ms at 36 V 50 ms at 60 V 100 ms at 85 V 200 ms at 110 V
Vx = 110 – 250V dc Quiescent / half load	50 ms at 110 V 100 ms at 160 V 200 ms at 210 V
Vx = 110 – 250 V dc Full load	20 ms at 85 V 50 ms at 98 V 100 ms at 135 V 200 ms at 174 V
Vx = 40 – 100 V ac Quiescent / half load	50 ms at 27 V for 100% voltage dip
Vx = 40 – 100 V ac Full load	10 ms at 27 V for 100% voltage dip
Vx = 100 – 240 V ac Quiescent / half load	50 ms at 80 V for 100% voltage dip

Power Supply Interruption	
Vx = 100 – 240 V ac Full load	50 ms at 80 V for 100% voltage dip

Maximum loading = all digital inputs/outputs energized
Quiescent or 1/2 loading = 1/2 of all digital inputs/outputs energized

7.8 Output Contacts

Standard Contacts	
Use	General purpose relay outputs for signaling, tripping and alarming
Rated voltage	300 V
Maximum continuous current	10 A
Short duration withstand carry	30 A for 3 s, 250 A for 30 ms
Make and Break, dc resistive	50 W
Make and Break, dc inductive	62.5 W (L/R = 50 ms)
Make and Break, ac resistive	2500 VA resistive (cos ϕ = unity)
Make and Break, ac inductive	2500 VA inductive (cos ϕ = 0.7)
Make and Carry, dc resistive	30 A for 3 s, 10000 operations (subject to the above limits)
Make, Carry and break, dc resistive	4 A for 1.5 s, 10000 operations (subject to the above limits)
Make, Carry and break, dc inductive	0.5 A for 1 s, 10000 operations (subject to the above limits)
Make, Carry and break ac resistive	30 A for 200 ms, 2000 operations (subject to the above limits)
Make, Carry and break ac inductive	10 A for 1.5 s, 10000 operations (subject to the above limits)
Loaded contact	1000 operations min.
Unloaded contact	10000 operations min.
Operate time	< 5 ms
Reset time	< 5 ms

7.9 Watchdog Contacts

Watchdog Contacts	
Use	Non-programmable contacts for relay healthy/relay fail indication
Breaking capacity, dc resistive	30 W
Breaking capacity, dc inductive	15 W (L/R = 40 ms)
Breaking capacity, ac inductive	375 VA inductive (cos ϕ = 0.7)

7.10 Fiber defect connector (watchdog relay – redundant Ethernet version)

Fiber Defect Contacts	
Use	Non-programmable contacts for Ethernet fiber healthy/fail indication
Connection method	Phoenix cage type retention
Rated voltage	250 Vac
Rated continuous current	5 A
Make current	Max. 30 A and carry for 3 s
Breaking capacity AC	1500 VA resistive (cos ϕ = unity) 1500 VA inductive (cos ϕ = 0.5)

Fiber Defect Contacts	
Breaking capacity, DC	50 W, 250 Vdc resistive 25 W, inductive (L/R = 40 ms)

7.11 Opto-isolated digital inputs

Opto-isolated digital inputs (opto-inputs)	
Rated nominal voltage	24 to 250 V dc
Operating range	19 to 265 V dc
Withstand	300 V dc
Options	The opto-inputs with programmable voltage thresholds may be energized from the 48 V field voltage, or the external battery supply

7.12 Nominal pick-up and reset thresholds:

Nominal Battery voltage	Logic levels: 60-80% DO/PU	Logic Levels: 50-70% DO/PU
24/27 V	Logic 0 < 16.2 V : Logic 1 > 19.2 V	Logic 0 <12.0 V : Logic 1 > 16.8
30/34	Logic 0 < 20.4 V : Logic 1 > 24.0 V	Logic 0 < 15.0 V : Logic 1 > 21.0 V
48/54	Logic 0 < 32.4 V : Logic 1 > 38.4 V	Logic 0 < 24.0 V : Logic 1 > 33.6 V
110/125	Logic 0 < 75.0 V : Logic 1 > 88.0 V	Logic 0 < 55.0 V : Logic 1 > 77.0 V
220/250	Logic 0 < 150 V : Logic 1 > 176.0 V	Logic 0 < 110.V : Logic 1 > 154.0 V

7.13 Recognition time

Recognition time	
With half-cycle ac immunity filter removed	< 2 ms
With filter on	<12 ms

Note: *Opto-inputs operated with filtering removed are more susceptible to EM interference and precautions should be taken to minimize pickup on the external wiring.*

8 ENVIRONMENTAL CONDITIONS

8.1 Ambient Temperature Range

Ambient Temperature Range	
Compliance	IEC 60068-2-1: 2007 and 60068-2-2: 2007
Operating temperature range (96 hours)	-40°C to +85°C (-40°F to +185°F)
Storage and transit temperature range	-40°C to +85°C (-40°F to +185°F)

8.2 Ambient Humidity Range

Ambient Humidity Range	
Compliance	IEC 60068-2-78: 2001 and IEC 60068-2-30: 2005
Durability	56 days at 93% relative humidity and +40°C
Damp heat cyclic	six (12 + 12) hour cycles, 93% RH, +25 to +55°C

8.3 Corrosive Environments

Corrosive Environments	
Compliance	IEC 60068-2-60: 1995, Part 2, Test Ke, Method (class) 3
Industrial corrosive environment/poor environmental control, mixed gas flow test	21 days exposure to elevated concentrations of H_2S, NO_2, Cl_2 and SO_2 at 75% relative humidity and +30°C

9 TYPE TESTS

9.1 Insulation

Insulation	
Compliance	IEC 60255-27: 2005
Insulation resistance	> 100 MΩ at 500 V dc (Using only electronic/brushless insulation tester)

9.2 Creepage Distances and Clearances

Creepage Distances and Clearances	
Compliance	IEC 60255-27: 2005
Pollution degree	3
Overvoltage category	III
Impulse test voltage	5 kV

9.3 High Voltage (Dielectric) Withstand

High Voltage (Dielectric) Withstand	
IEC Compliance	IEC 60255-27: 2005
Between all independent circuits	2 kV ac rms for 1 minute
Between independent circuits and protective earth conductor terminal	2 kV ac rms for 1 minute
Between all case terminals and the case earth	2 kV ac rms for 1 minute
Across open watchdog contacts	1 kV ac rms for 1 minute
Across open contacts of changeover output relays	1 kV ac rms for 1 minute
Between all D-type EIA(RS)232 contacts and protective earth	1 kV ac rms for 1 minute
Between all screw-type EIA(RS)485 contacts and protective earth	1 kV ac rms for 1 minute
ANSI/IEEE Compliance	ANSI/IEEE C37.90-1989
Across open contacts of normally open output relays	1.5 kV ac rms for 1 minute
Across open contacts of normally open changeover output relays	1 kV ac rms for 1 minute
Across open watchdog contacts	1 kV ac rms for 1 minute

9.4 Impulse Voltage Withstand Test

Impulse Voltage Withstand Test	
Compliance	IEC 60255-27: 2005
Between all independent circuits	Front time: 1.2 µs, Time to half-value: 50 µs, Peak value: 5 kV, 0.5 J
Between terminals of all independent circuits	Front time: 1.2 µs, Time to half-value: 50 µs, Peak value: 5 kV, 0.5 J
Between all independent circuits and protective earth conductor terminal	Front time: 1.2 µs, Time to half-value: 50 µs, Peak value: 5 kV, 0.5 J

Exceptions: *EIA(RS)232 ports and EIA(RS485) ports and normally-open output contacts*

.

10 ELECTROMAGNETIC COMPATIBILITY (EMC)

10.1 1 MHz Burst High Frequency Disturbance Test

1 MHz Burst High Frequency Disturbance Test	
Compliance	IEC 60255-22-1: 2007 2008, Class III
Common-mode test voltage	2.5 kV
Differential test voltage	1.0 kV

Exception: *EIA(RS)232 ports*

10.2 100 kHz Damped Oscillatory Test

100 kHz Damped Oscillatory Test	
Compliance	EN61000-4-18: 2006: Level 3, 100 kHz and 1 MHz
Common-mode test voltage	2.5 kV
Differential mode test voltage	1.0 kV

10.3 Immunity to Electrostatic Discharge

Immunity to Electrostatic Discharge	
Compliance	IEC 60255-22-2: 1996 Class 3 and Class 4,
Class 4 Condition	15 kV discharge in air to user interface, display, and exposed metalwork
Class 3 Condition 1	8 kV discharge in air to all communication ports
Class 3 Condition 2	6 kV point contact discharge to any part of the front of the product

10.4 Electrical Fast Transient or Burst Requirements

Electrical Fast Transient or Burst Requirements	
Compliance	IEC 60255-22-4: 2002 and EN61000-4-4:2004. Test severity Class III and IV
Applied to auxiliary supply and all other inputs except for EIA(RS)232)	Amplitude: 2 kV, burst frequency 5 kHz (class III)
Applied to auxiliary supply and all other inputs except for EIA(RS)232)	Amplitude: 4 kV, burst frequency 2.5 kHz (class IV)
Applied directly to auxiliary	Amplitude: 4 kV, burst frequency 5 kHz (class IV)

10.5 Surge Withstand Capability

Surge Withstand Capability	
Compliance	IEEE/ANSI C37.90.1: 2002
Condition 1	4 kV fast transient and 2.5 kV oscillatory applied common mode and differential mode to opto inputs (filtered), output relays, CTs, VTs, power supply, field voltage
Condition 2	4 kV fast transient and 2.5 kV oscillatory applied common mode to communications, IRIG-B

10.6 Surge Immunity Test

Surge Immunity Test	
Compliance	IEC 61000-4-5: 2005 Level 4
Pulse duration	Time to half-value: 1.2/50 µs
Between all groups and protective earth conductor terminal	Amplitude 4 kV
Between terminals of each group	Amplitude 2 kV

Exception: EIA(RS)232 ports

10.7 Immunity to Radiated Electromagnetic Energy

Immunity to Radiated Electromagnetic Energy	
Compliance	IEC 60255-22-3: 2000, Class III
Frequency band	80 MHz to 1 GHz
Spot tests at	80, 160, 450, 900 MHz
Test field strength	10 V/m
Test using AM	1 kHz / 80%
Compliance	IEEE/ANSI C37.90.2: 2004
Frequency band	80 MHz to 1 GHz
Waveform	1 kHz 80% am and am pulse modulated
Field strength	35 V/m

10.8 Radiated Immunity from Digital Communications

Radiated Immunity from Digital Communications	
Compliance	EN61000-4-3: 2002, Level 4
Frequency bands	800 to 960 MHz, 1.4 to 2.0 GHz
Test field strength	30 V/m
Test using AM	1 kHz / 80%

10.9 Radiated Immunity from Digital Radio Telephones

Radiated Immunity from Digital Radio Telephones	
Compliance	IEC 6100-4-3: 2002
Frequency bands	900 MHz and 1.89 GHz
Test field strength	10 V/m

10.10 Immunity to Conducted Disturbances Induced by Radio Frequency Fields

Immunity to Conducted Disturbances Induced by Radio Frequency Fields	
Compliance	IEC 61000-4-6: 1996, Level 3
Frequency bands	150 kHz to 80 MHz
Test disturbance voltage	10 V

10.11 Magnetic Field Immunity

Magnetic Field Immunity	
Compliance	IEC 61000-4-8: 1994 Level 5 IEC 61000-4-9/10: 1993 Level 5
IEC 61000-4-8 test	100 A/m applied continuously, 1000 A/m applied for 3 s
IEC 61000-4-9 test	1000 A/m applied in all planes
IEC 61000-4-10 test	100 A/m applied in all planes at 100 kHz/1 MHz with a burst duration of 2 s

10.12 Conducted Emissions

Conducted Emissions	
Compliance	EN 55022: 1998
Test 1	0.15 - 0.5 MHz, 79 dBμV (quasi peak) 66 dBμV (average)
Test 2	0.5 – 30 MHz, 73 dBμV (quasi peak) 60 dBμV (average)

10.13 Radiated Emissions

Radiated Emissions	
Compliance	EN 55022: 1998
Test 1	30 – 230 MHz, 40 dBμV/m at 10 m measurement distance
Test 2	230 – 1 GHz, 47 dBμV/m at 10 m measurement distance

PHYSICAL DESCRIPTION

CHAPTER 4

1 CHAPTER OVERVIEW

The Physical Description chapter describes the physical implementation of the product. It does not describe the functionality, just the physical attributes of the housing and the boards which are used to build the product.

A full description of the functionality of the products is provided in the subsequent chapters.

The chapter contains the following sections:

2 HOUSING VARIANTS

The MiCOM ALSTOM Px40 series products are intelligent electronic devices for the substation environment (IEDs). They are implemented in a range of case sizes and types. There are two main housing categories: standalone and rack-mounted. Each product can be implemented in either case type.

Case dimensions for industrial products usually follow modular measurement units based on rack sizes. These are: U for height and TE for width, where:

- 1U = 1.75" = 44.45 mm
- 1TE = 0.2 inches = 5.08 mm

The Px40 series products are available in rack-mount or standalone versions. All products are nominally 4U high to allow mounting in an IEC 60297 compliant 19” rack. The height of the front panels are such that no significant gaps can be seen when they are mounted one above another in the rack.

The case width depends on the product type and its hardware options. There are three different case widths for the Px40 series: 40TE, 60TE and 80TE.

The widths in millimeters for these case variants are shown in Table 1.

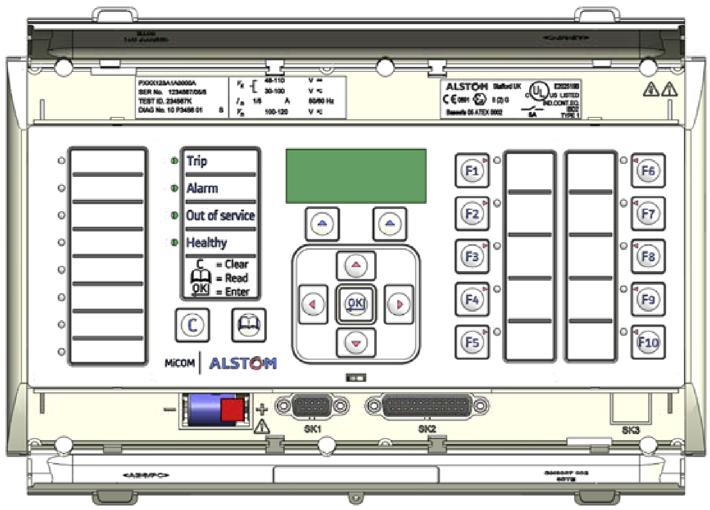
Case width (TE)	Case width (mm)	Case width (inches)
40TE	203.2	8
60TE	304.8	12
80TE	406.4	16

Table 1: Case Widths

The cases are pre-finished steel with a conductive covering of aluminum and zinc. This provides good grounding at all joints, providing a low impedance path to earth that is essential for performance in the presence of external noise.

3 FRONT PANEL

Figure 1 shows the front panel of a typical 60TE unit. The front panels of the products based on 40TE and 80TE cases have a lot of commonality, and differ only in the number of hotkeys and user-programmable light-emitting diodes (LEDs). The hinged covers at the top and bottom of the front panel are shown open. An optional transparent front cover physically protects the front panel.



P4520ENb

Figure 1: Front panel (60TE)

The front panel of the unit comprises the following:

A top compartment with a hinged cover
This compartment contains labels for the:

- Serial number
- Current and voltage ratings.

A bottom compartment with a hinged cover
This compartment contains:

- A compartment for a 1/2 AA size backup battery (used for the real time clock and event, fault, and disturbance records).
- A 9-pin female D-type front port for an EIA(RS)232 serial connection to a PC.
- A 25-pin female D-type parallel port for monitoring internal signals and downloading high-speed local software and language text.

An alphanumeric liquid crystal display (LCD)
The LCD is a monochrome display with resolution 16 characters by 3 lines.

A Keypad

The keypad consists of the following keys:

4 arrow keys to navigate the menus	
An enter key for executing the chosen option	
A clear key for clearing the last command	
A read key for viewing larger blocks of text (arrow keys now used for scrolling)	
2 hot keys for scrolling through the default display and for control of setting groups	

Function keys  **to** 

Depending on the model, up to ten programmable function keys are available for custom use.

The function keys are associated with programmable LEDs for local control. Factory default settings associate specific functions with these direct-action keys and LEDs, but by using programmable scheme logic, you can change the default functions of the keys and LEDs to fit specific needs.

Control inputs and circuit breaker operation to control setting groups.

Fixed Function LEDs

The fixed-function LEDs on the left-hand side of the front panel indicate the following conditions.

- Trip (Red) switches ON when the IED issues a trip signal.
- Alarm (Yellow) flashes when the IED registers an alarm. This may be triggered by a event or maintenance record. The LED flashes until the alarms have been accepted (read), then changes to constantly ON. When the alarms are cleared, the LED switches OFF.
- Out of service (Yellow) is ON when the IED's main functions are unavailable.
- Healthy (Green) is ON when the IED is in correct working order, and should be ON at all times. It goes OFF if the unit's self-tests show there is an error in the hardware or software. The state of the healthy LED is reflected by the watchdog contacts at the back of the unit.

Programmable Alarm LEDs

Depending on the model, the unit has up to eight RED programmable LEDs (numbers 1 to 8), which are used for alarm indications.

Programmable Function LEDs

Depending on the model, the unit has up to ten further programmable LEDs (F1 to F10) to show the status of the function keys. All of the programmable LEDs on the unit are tri-color and can be set to RED, YELLOW or GREEN.

Note: The trip LED is not used in the default application of the P847 B&C

4 REAR PANEL

The Px40 series is of a modular construction, most of the internal workings being implemented on boards and modules, which fit into slots. Some of the boards (the non-communication boards) plug into terminal blocks, which are bolted onto the rear of the unit. The rear panel consists of these terminal blocks, plus the rears of the communications boards.

The back panel cut-outs and slot allocations vary according to the product and the type of boards and terminal blocks needed to populate the case. Figure 2 shows the rear views of an 80TE case populated with various boards.

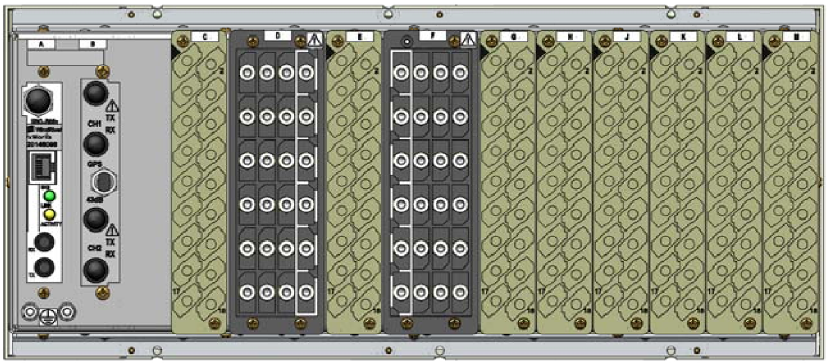


Figure 2: Rear view of populated 80TE case

Note:	*This diagram is just an example and does not show the exact product described in this manual. It also does not show the full range of available boards, just a typical arrangement.*

Not all slots are the same size. The slot width depends on the type of board or terminal block. For example, heavy duty (HD) terminal blocks, as required for an analog input board, require a wider slot size than Medium duty (MD) terminal blocks. The board positions are not interchangeable. Each slot is designed to house a particular type of board. Again this is model-dependent.

There are four types of terminal block: RTD/CLIO input, heavy duty, medium duty, and MiDOS. The terminal blocks are fastened to the rear panel using slotted screws on the RTD/CLIO input blocks and crosshead screws on the heavy duty, medium duty, and MiDOS blocks. See Figure 3.

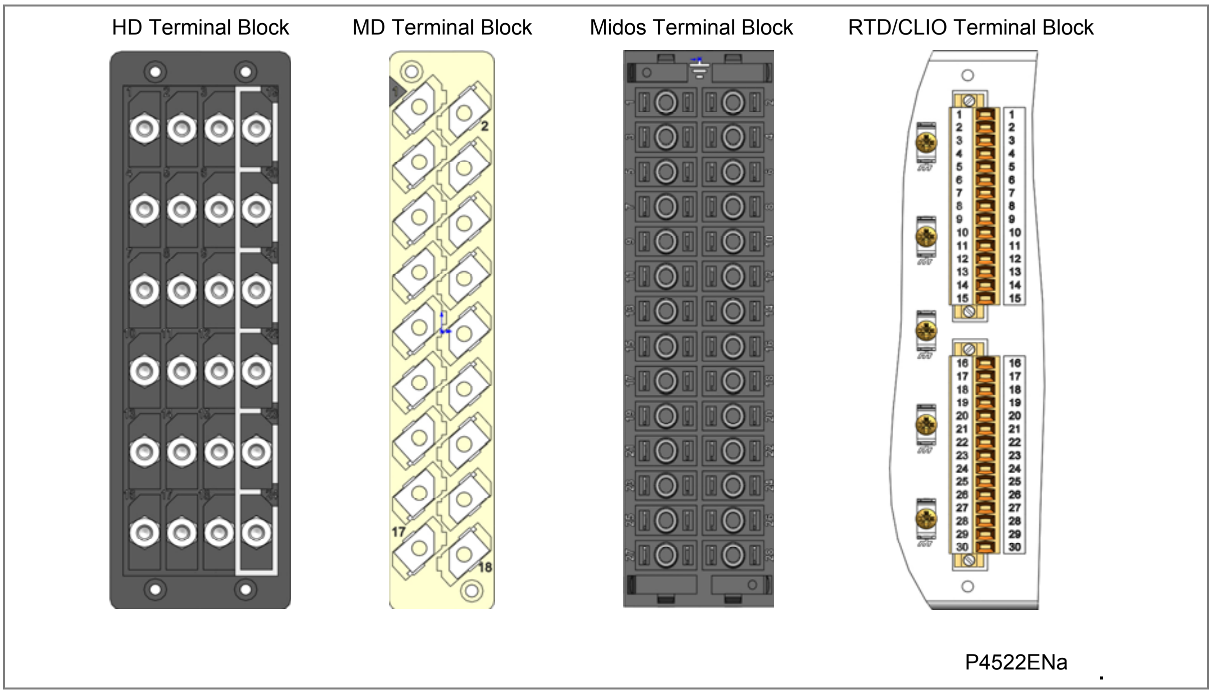


Figure 3: Terminal block types

> *Note: The P847models B and C do not use RTD/CLIO terminal blocks*

5 BOARDS AND MODULES

Figure 4 shows an exploded view of a typical IED. As can be seen, each product and its variants comprise a selection of boards and sub-assemblies, depending on the chosen configuration.

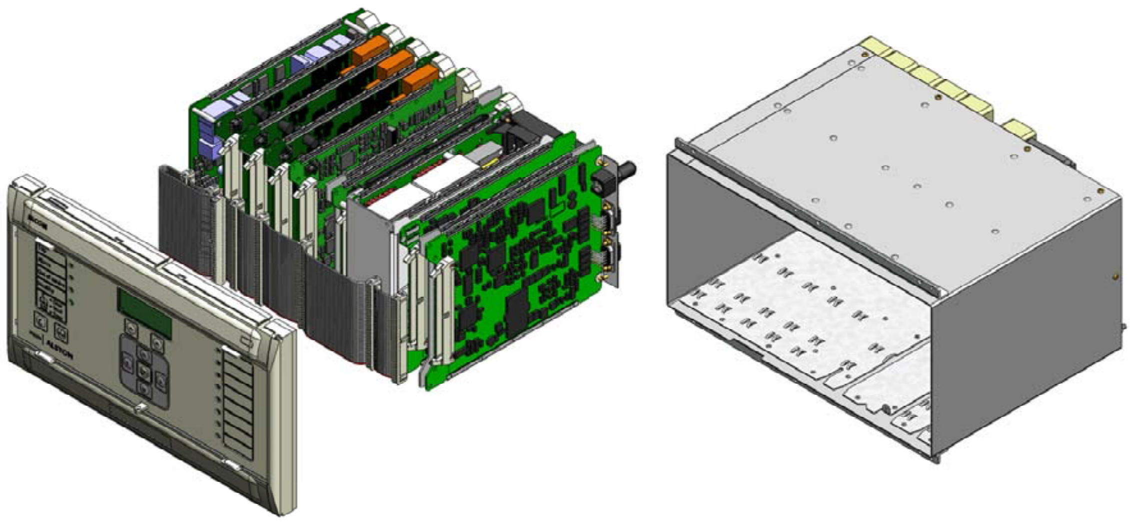


Figure 4: Exploded view of IED

A sub-assembly consists of two or more boards connected together physically (bolted together with spacers) and electrically (via electrical connectors). It may also have other special requirements such as being encased in a metal housing for shielding against electromagnet radiation.

An example of a sub-assembly is shown in Figure 5. The sub-assembly shown here is an Analog Input Module consisting of the input current and voltage transformers, together with the analog input board.

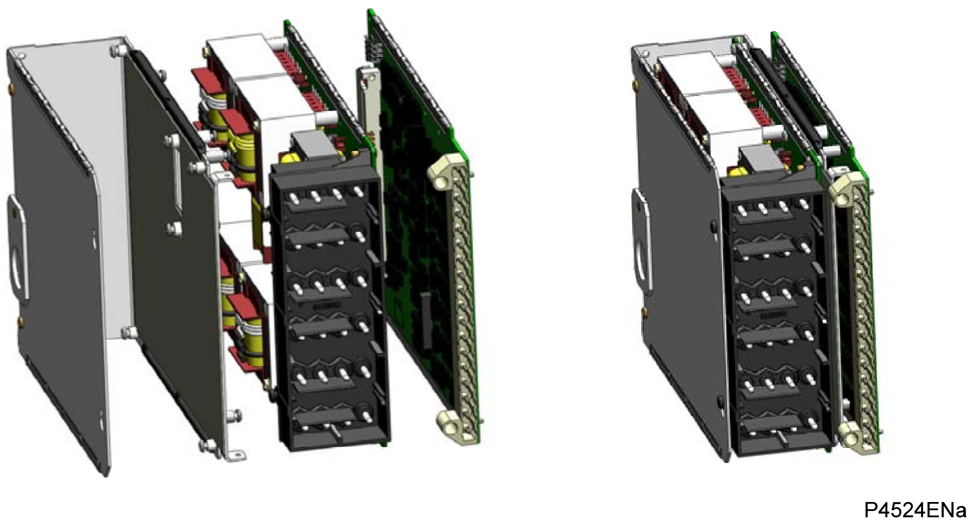


Figure 5: Typical sub-assembly

Boards are designated by a part number beginning with ZN, whereas preassembled sub-assemblies are designated with a part number beginning with GN. For example, the GN49001 is a sub-assembly consisting of a transformer board ZN68001 coupled together with the analog input board ZN67001 and the opto-input board ZN17012.

Note: Sub-assemblies, which are put together at the IED production stage, do not have a separate part number. This is why the power supply module, which consists of a power supply board and a relay output board, does not have a GN part number.

Table 2 , Table 3 and Table 4 show the available boards and sub-assemblies for the P847B&C.

The exact choice of boards depends on the particular variant ordered.

Board or Sub-assembly	Part Number	Model B	Model C
Main Processor Board	ZN0041 001	●	●
Power Supply Module: 24/54 V DC	ZN0021 001 *1	●	●
Power Supply Module: 48/125 V DC	ZN0021 002 *1	●	●
Power Supply Module: 110/250 V DC	ZN0021 003 *1	●	●
Relay Output Board	ZN0019 001	●	●
Input module sub-assembly	GN0499 001*2	●	●
Input module sub-assembly	GN0499 003*2	●	●
Opto Input Board	ZN0017 012 *3		●
GPS Time Sync Board	ZN0020 001	●	●
Ethernet (100 Base-Fx) with Demodulated IRIG-B	ZN0049 003*4	●	●
Redundant Ethernet - SHP With Demodulated IRIG-B	ZN0071 002 *4	●	●
Redundant Ethernet - RSTP With Demodulated IRIG-B	ZN0071 006 *4	●	●
Redundant Ethernet - DHP With Demodulated IRIG-B	ZN0071 008 *4	●	●

Table 2: Available boards and subassemblies

Notes:

**[1] One of the three assemblies are used*
**[2] Multiple assemblies may be used per IED if required*
**[3] Opto-input expansion for model C*
**[4] One of the four boards are used*

PCB	Part number	Model B	Model C
Analog Input Board	ZN0067 001	●	●
Transformer Board with 9 CTs and 2 VTs	ZN0068 001	●	●

Table 3: GN0499 001 sub-assembly breakdown

PCB	Part number	Model B	Model C
Analog Input Board	ZN0067 001	●	●
Transformer Board with 3 CTs and 2 VTs	ZN0068 003	●	●

Table 4: GN0499 003 sub-assembly breakdown

The boards and modules use multi-point grounding to improve the immunity to external noise and minimize the effect of circuit noise. Ground planes are used on boards to reduce impedance paths and spring clips are used to ground the module metalwork.

Heavy duty terminal blocks and/or MiDOS terminal blocks are used at the rear of the unit for the current and voltage signal connections. Medium duty terminal blocks are used for the digital logic input signals, the output relay contacts, the power supply and the rear communication port.

Inside the unit, the PCBs plug into the connector blocks at the rear, and can be removed from the front of the unit only

The following sections provide a brief description of the boards in these tables. This section describes the physical hardware only. A full description of the board functionality is given in the *Hardware and Software Design* chapter.

6 BOARD DESCRIPTIONS

6.1 Main Processor Board ZN0041 001

The processor board performs all calculations and controls the operation of all other modules in the IED. The processor board also contains and controls the user interfaces (LCD, LEDs, keypad and communication interfaces). This board is the only board that does not fit into one of the slots. It resides in the front panel and is connected to the rest of the system via an internal ribbon cable.

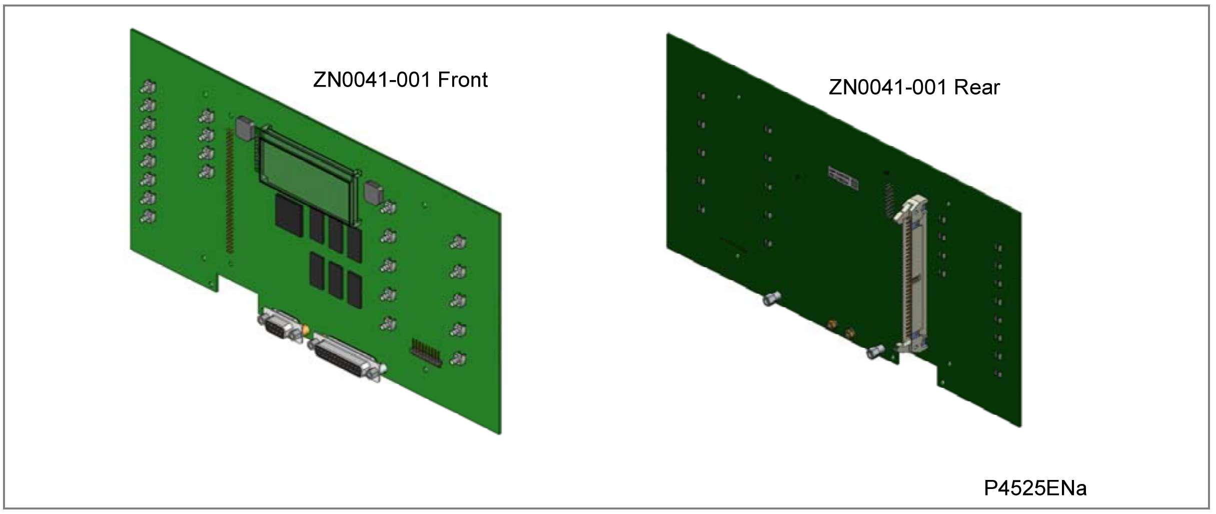


Figure 6: Main processor board

6.2 Power Supply Board ZN0021

The power supply board provides power to the unit. There are three different boards to choose from depending on what voltage level you require. It also provides the EIA(RS)485 electrical connection for the rear communication port.

The power supply board is sandwiched together with the relay output board ZN0019 001 to form a complete module.

There are three versions of this board:

- ZN0021 001: 24/54 V DC
- ZN0021 002: 48/125 V DC
- ZN0021 003: 110/250 V DC

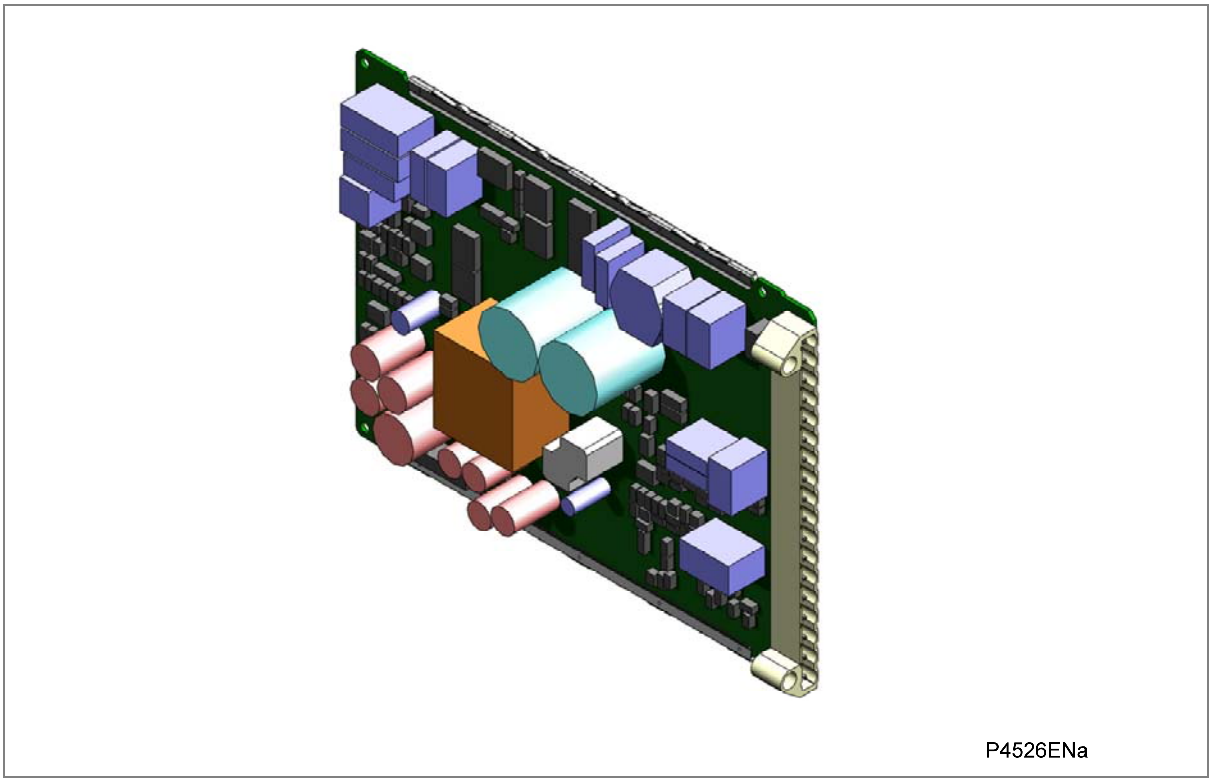


Figure 7: Power supply board

The power supply module's board connector plugs into a medium duty terminal block sliding in from the front of the unit to the rear. This terminal block is always positioned on the left hand side of the unit looking from the front.

Power is applied to pins 1 and 2 of the terminal block, where:

Pin 1 is negative and Pin 2 is positive. The pin numbers are clearly marked on the terminal block as show in Figure 8.

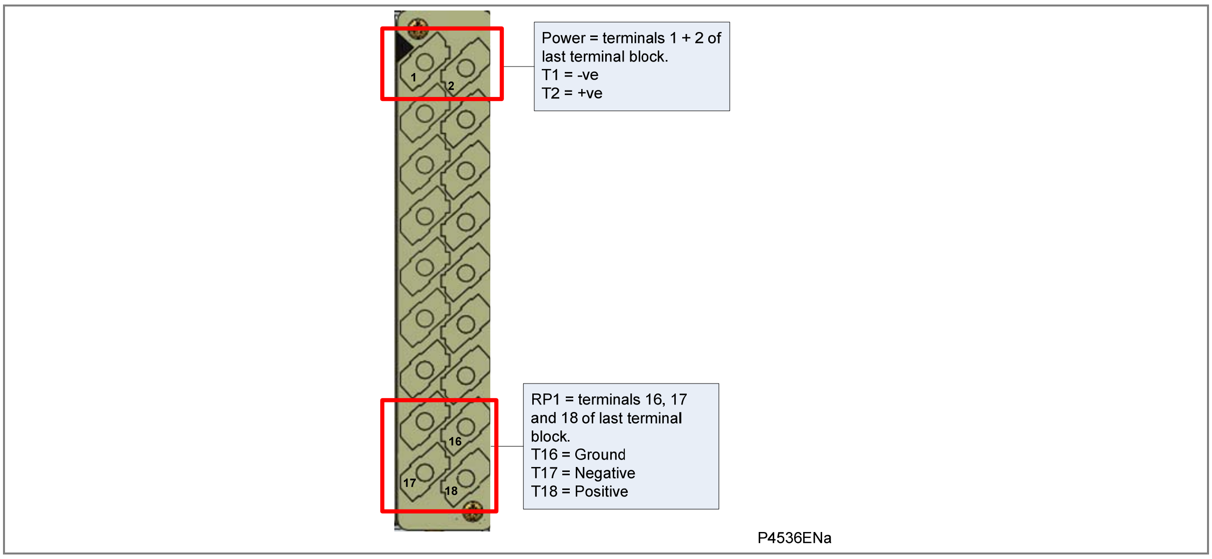


Figure 8: Power supply terminal block

6.3 Relay Output Board ZN0019 001

This output relay board provides eight relays (6 'normally open' contacts and two 'changeover' contacts). The output relays can drive any circuit requiring logical inputs such as circuit breakers, blocking signals, and PSL schemes.

The relay output board can be provided together with the power supply board as a complete module, or independently for the purposes of relay output expansion.

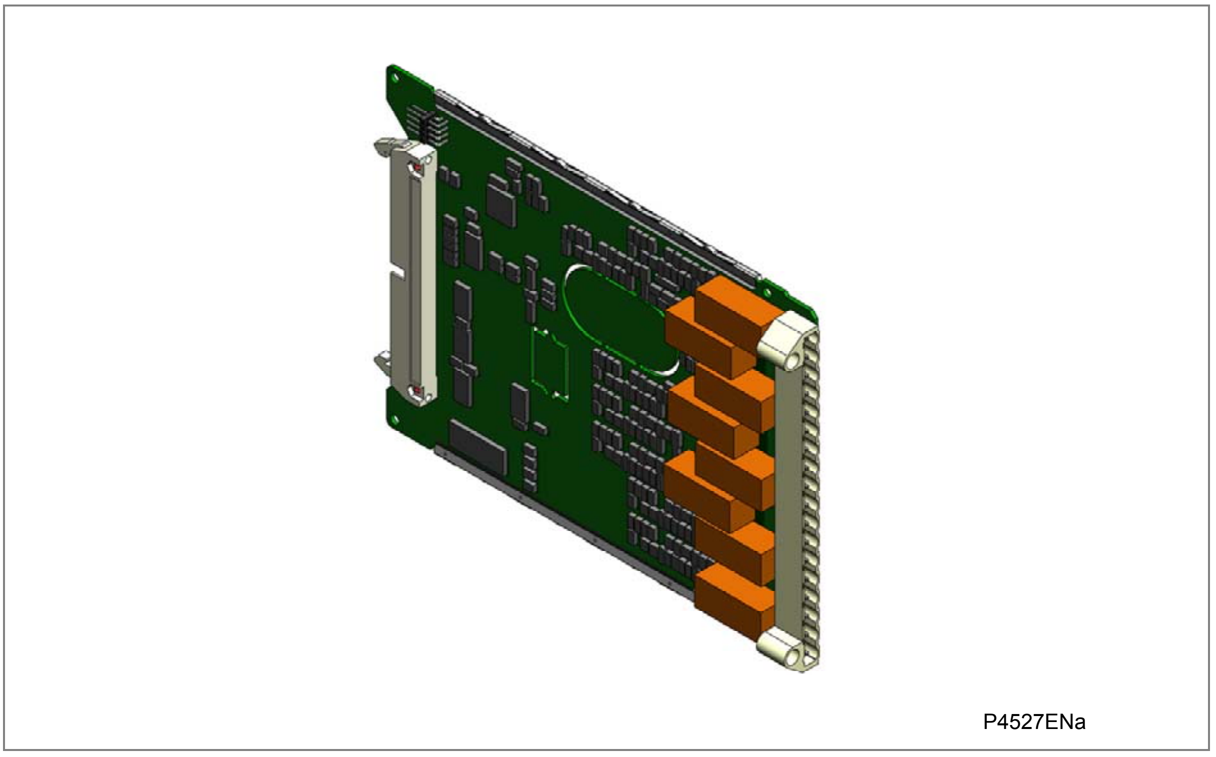


Figure 9: Relay output board

6.4 Analog Input Board ZN0067 001

The analog input board is used to convert the analog signals delivered by the current and voltage transformers into digital quantities used by the IED. This analog input board also has on-board opto-input circuitry, providing eight optically-isolated digital inputs (opto-inputs) and associated noise filtering and buffering. These opto-inputs are presented to the user by means of a MD terminal block, which will be situated to the right of the MiDOS terminal block presenting the analog inputs.

This board is connected physically and electrically to a transformer board to form a complete input module.

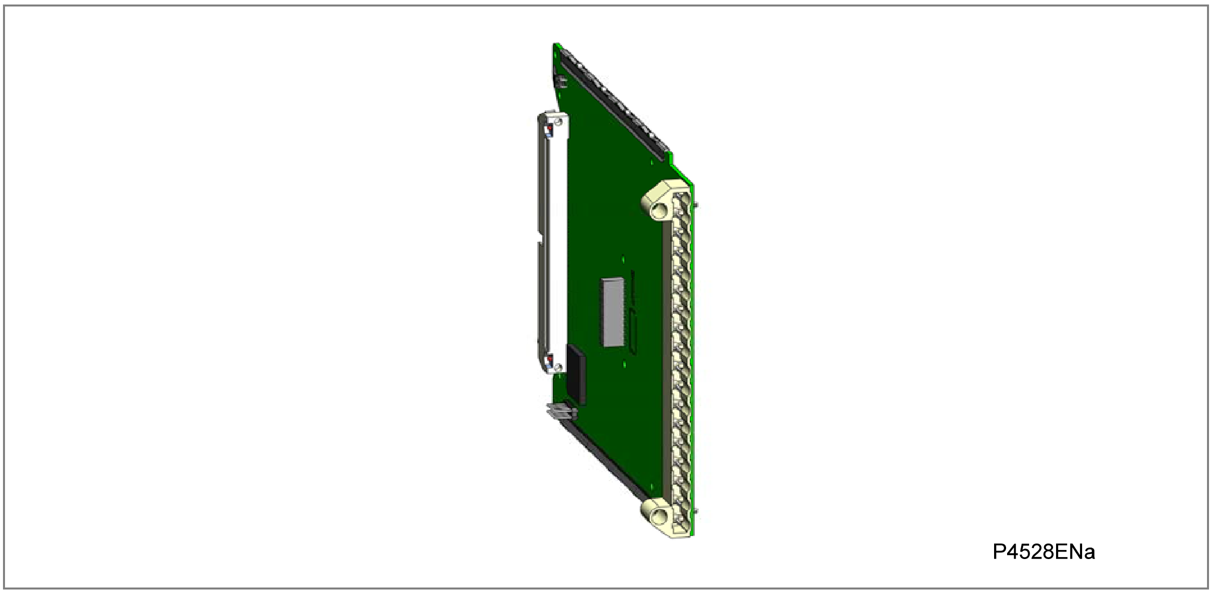


Figure 10: Analog input board

6.5 Transformer Board ZN0068

This transformer board provides up to 9 Current transformers and 2 voltage transformers. It is connected physically and electrically with the analog input board to form the input module. The CT and VT inputs are presented to a MiDOS terminal block.

The board may be populated with different numbers of transformers. For the P847B&C, two boards are available as follows:

- ZN0068 001: Populated with 9 Current transformers and 2 voltage transformers
- ZN0068 003: Populated with 3 Current transformers and 2 voltage transformers

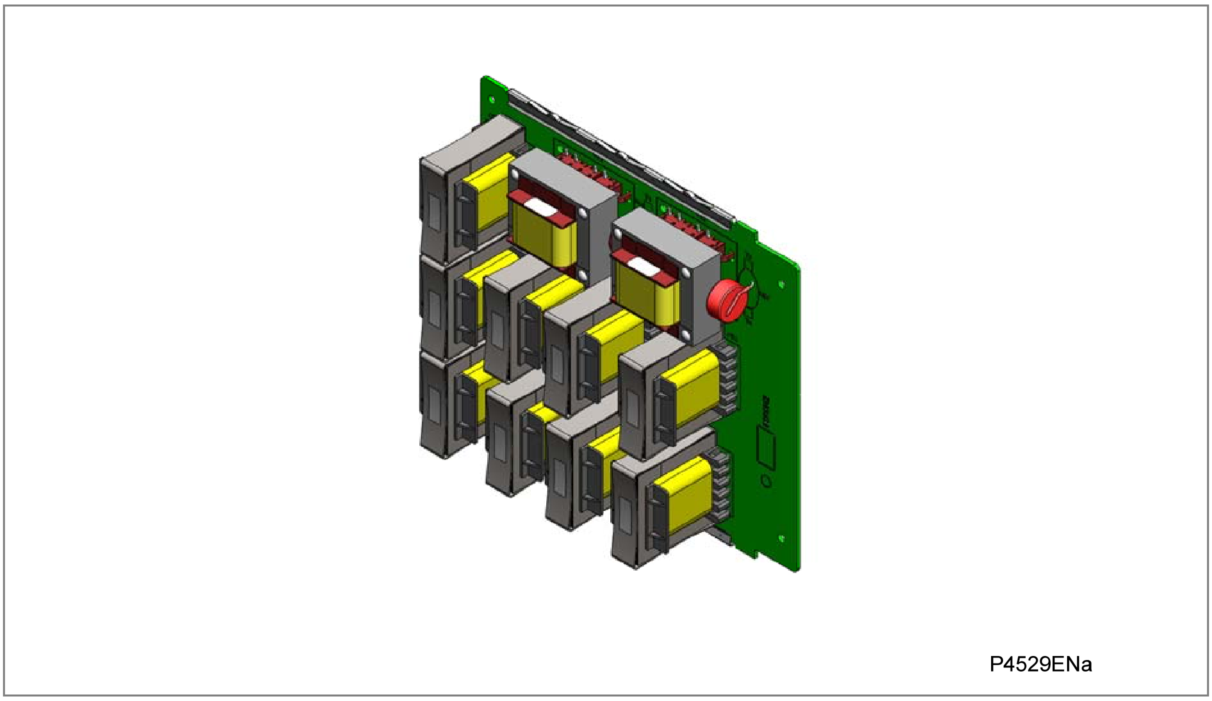
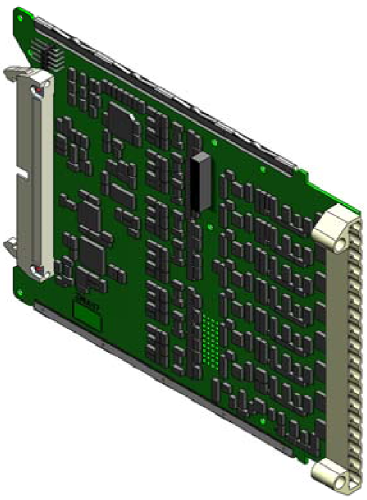


Figure 11: Typical transformer board

6.6 Opto-Input Board ZN0017 012

This opto-input board contains eight opto-isolated digital inputs. There are many variants of the ZN0017, because the board can host a variety of input functionality including analog-to-digital (A/D) input circuitry. The ZN0017 012 is a standalone opto-input board with the A/D circuitry part left unpopulated.

The opto inputs are presented to a MD terminal block.

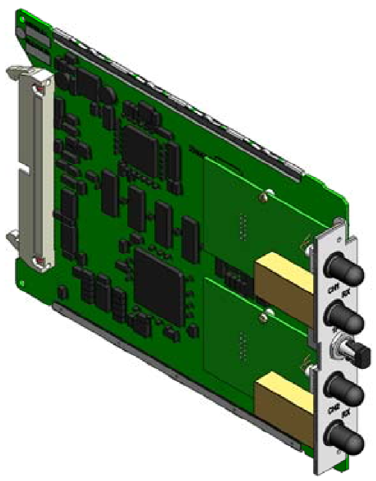


P4530ENa

Figure 12: Opto-input board

6.7 GPS Time Synchronization Board ZN0020 001

The GPS Time Synchronization board handles the GPS one pulse per second input (1 PPS), which is delivered by a fiber optic cable presented to the ST connector at the rear of the unit.

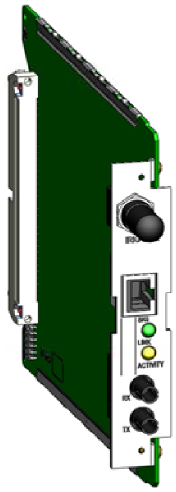


P4531ENa

Figure 13: Typical GPS time synchronization board

6.8 Ethernet with Demodulated IRIG-B Board ZN0049 003

This is a communications board that provides a standard 100-Base Ethernet interface in addition to a demodulated IRIG interface. IRIG-B provides a timing reference for the unit. The IRIG B signal is connected to the board with a BNC connector on the back of the relay. For the Ethernet connection, this board supports one electrical copper connection and one fiber-pair connection.



P4532ENa

Figure 14: Ethernet + IRIG-B board

6.9 Redundant Ethernet with Demodulated IRIG-B ZN0071

This board provides dual redundant Ethernet (supported by two fiber pairs) together with an IRIG-B interface for timing.

Alstom Grid supply six different board variants depending on the redundancy protocol and the type of IRIG-B signal (demodulated or modulated). The available redundancy protocols are:

- SHP (Self healing Protocol)
- RSTP (Rapid Spanning Tree Protocol)
- DHP (Dual Homing Protocol)

All boards further support a three-way wired connector for fiber failure alarming.

The P847B&C requires demodulated IRIG-B, and so there are three relevant variants for this model, as follows:

- ZN0071 002: Demodulated IRIG-B running RSTP
- ZN0071 006: Demodulated IRIG-B running SHP
- ZN0071 008: Demodulated IRIG-B running DHP

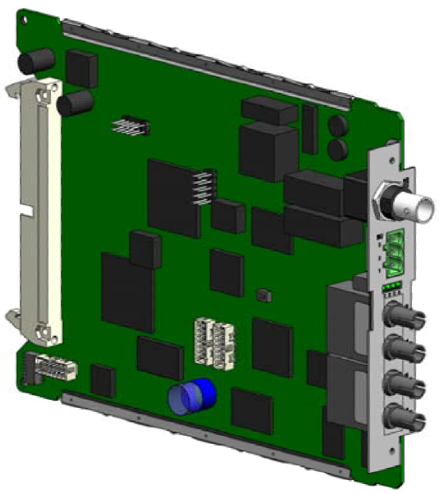


Figure 15: Redundant Ethernet board

HARDWARE AND SOFTWARE DESIGN

CHAPTER 5

1 CHAPTER OVERVIEW

This chapter describes the general design of the products specified in this manual. Some of the elements described are not distinguishable to the user, and the distinction is made purely for the purposes of explanation, and not all products are equipped with all functionality described.

The chapter contains the following sections:

2 HARDWARE DESIGN

This chapter describes the hardware electronic design of the unit. It does not go into much detail about the physical description of the unit. For this, please see the Physical Description chapter.

The unit's hardware is based on a modular design philosophy and is made up of several modules drawn from a standard range.

The hardware modules present in the unit are as follows:

- Processor board
- Power supply module comprising power supply board and output relay board
- Transformer board(s)
- Analog Input board(s) including opto-isolated digital inputs (opto-inputs)
- Co-processor board with GPS time synchronization
- Ethernet and IRIG-B board

Note: Additional input boards and output relay boards may be fitted according to the model and options selected.

All modules are connected by a parallel data and address bus, which allows the processor board to send and receive information to and from the other modules as required. There is also a serial data bus for conveying sampled data from the input module to the processors. Figure 1 shows the modules and the flow of information between them.

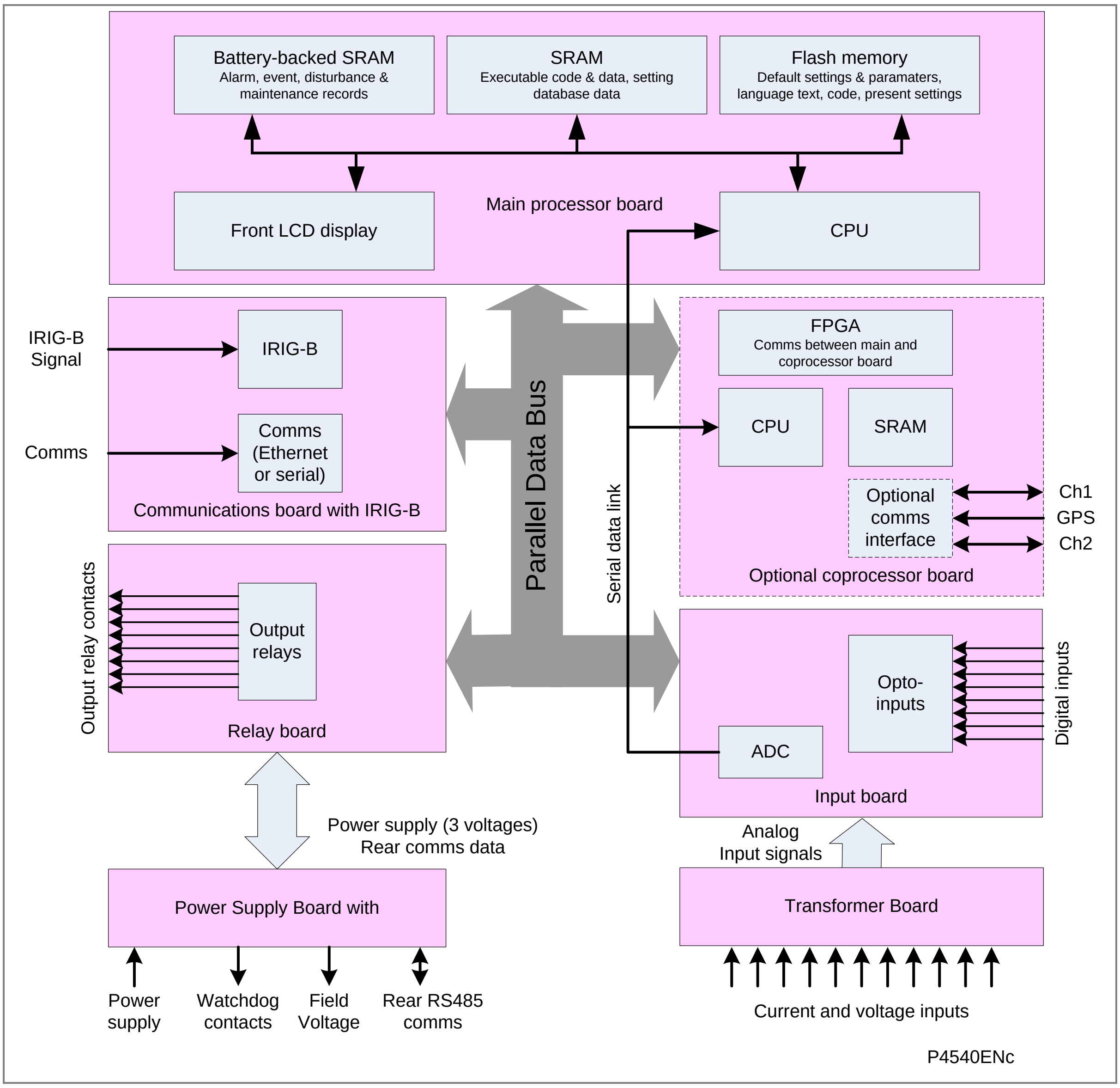


Figure 1: Functional diagram

The following sections provide further details about the components and modules making up the hardware design.

2.1 Main Processor Board / Front Panel

The Px40 products are based around a floating point, 32-bit Digital Signal Processor (DSP). This processor controls the data communication and user interfaces including the operation of the liquid crystal display (LCD), keypad and light-emitting diodes (LEDs).

The processor board resides directly behind the front panel. The LCD and LEDs are mounted on the processor board along with the front panel communication ports. All serial communication is handled using a Field Programmable Gate Array (FPGA).

The memory provided on the main processor board is split into two categories, volatile and non-volatile: the volatile memory is fast access SRAM which is used for the storage and execution of the processor software, and data storage as required during the processor's calculations. The non-volatile memory is sub-divided into 2 groups:

- Flash memory for non-volatile storage of software code, text and configuration data including the present setting values
- Battery-backed SRAM for the storage of disturbance, event and maintenance record data.

The front panel consists of a membrane keypad with tactile dome keys, an LCD and 22 LEDs mounted on an aluminum backing plate

2.2 Power Supply Board

The power supply board contains the power supply unit. It also contains an RS485 communication interface and Watchdog contacts.

One of three different configurations of the power supply board can be fitted to the unit. This will be specified at the time of order and depends on the supply voltage that will be connected to it. The three options are as follows:

Nominal dc range	Nominal ac range
24/54 V	DC only
48/125 V	30/100 V rms
110/250 V	100/240 V rms

Table 1: Power supply options

The power supply outputs are used to provide isolated power supply rails to the various modules within the unit. Three voltage levels are used by the unit's modules:

- 5.1 V for all of the digital circuits
- ±16 V for the analog electronics such as on the input board
- 22 V for driving the output relay coils.

All power supply voltages including the 0 V earth line are distributed around the unit by means of the 64-way ribbon cable.

An additional 48 V supply is provided by the power supply board for the field voltage. This is brought out to terminals on the back of the unit so that it can be used to drive the optically isolated digital inputs.

The power supply board incorporates inrush current limiting. This limits the peak inrush current, during energization, to approximately 10 A.

The RS485 interface is used with the relay's rear communication port to provide communication using the Courier protocol. The RS485 hardware supports half-duplex communication and provides optical isolation of the serial data being transmitted and received. All internal communication of data from the power supply board is conducted through the output relay board connected to the parallel bus.

The watchdog facility provides two output relay contacts, one normally open and one normally closed which are driven by the processor board. These are driven by the main processor board and indicate the unit's state of health.

2.3 Relay Output Board

The relays are driven from the 22 V power supply line. The relays' state is written to or read from using the parallel data bus. More output contacts can be provided by using further output relay boards. Each additional board provides a further four or eight output relays, depending on the board type chosen.

2.4 Input Module

The input module electronics comprises two printed circuit boards (PCBs); the transformer board and the analog input board. The transformer board contains the voltage and current transformers, which isolate and scale the analog input signals delivered by the system transformers. The analog input board contains the analog-to-digital (A/D) conversion and digital processing circuitry, as well as eight digital optically isolated inputs (opto-inputs). A full description of the physical implementation of this module is provided in the Physical Description chapter.

The two boards making up the input module are shown in Figure 2 .

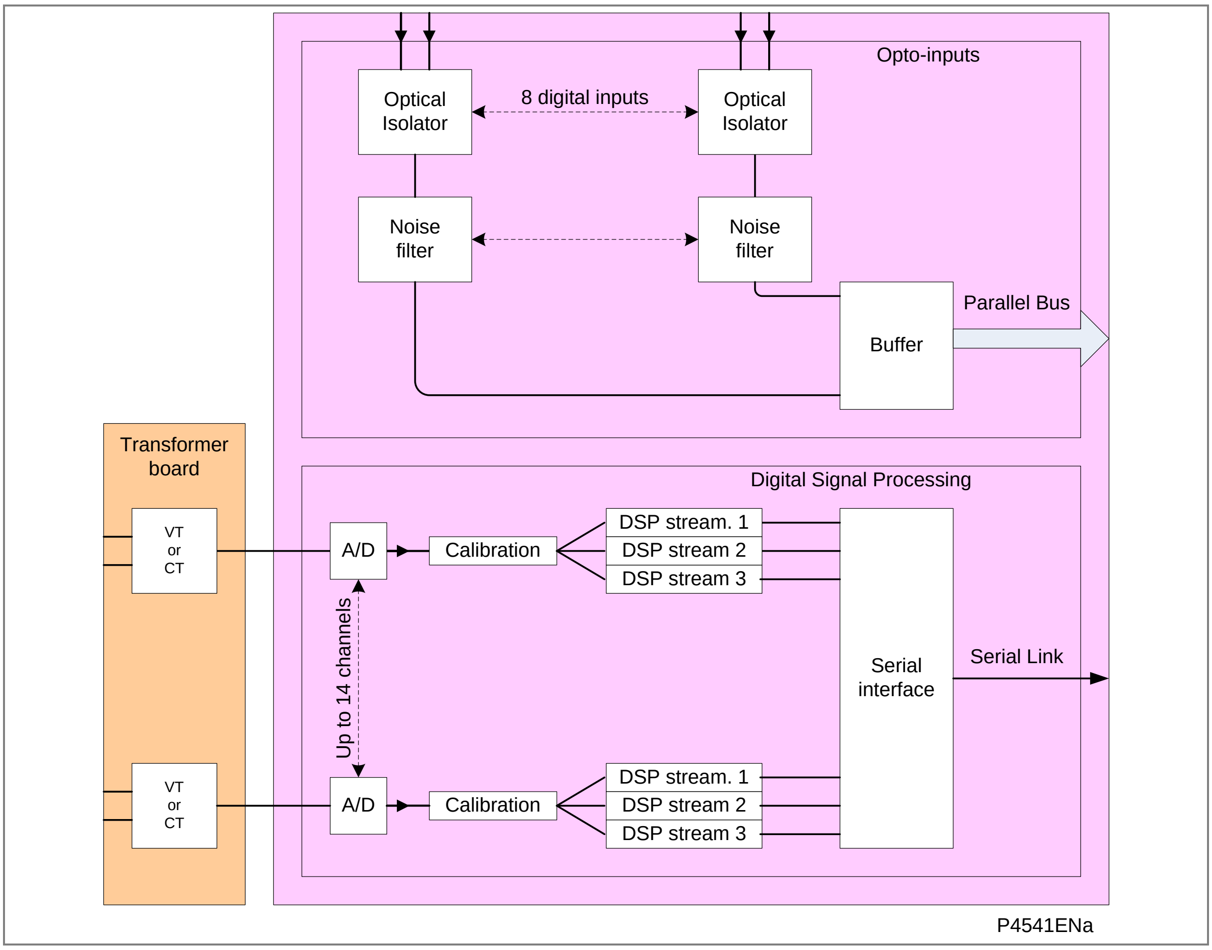


Figure 2: Input Module Circuitry

Transformer Inputs

The transformer board hosts the current and voltage transformers, which are used to step down the currents and voltages originating from the power systems' current and voltage transformers, to levels that can be used by the unit's electronic circuitry. In addition to this, the on-board CT and VT transformers provide electrical isolation between the unit and the power system. Up to 11 transformers (9 CT + 2 VT) can be populated on one transformer board.

The current inputs will accept either 1 A or 5 A nominal current. The nominal voltage input is 110 V.

The CT and VT secondary windings provide differential input signals to the analog input board to reduce noise.

Shorting Links

These automatically short the current transformer circuits before they are broken when the board is removed

A/D Conversion

The analog signals delivered by the system current and voltage transformers are first scaled and isolated using current and voltage transformers on the transformer board. The signals are then fed into A/D converters. The outputs of the A/D converters are fed into digital signal processing circuitry before being transmitted to the rest of the unit's circuitry on the serial data link.

Digital Processing

There are three separate filtering streams for each channel. In each stream, the incoming signals are filtered according to a specific filter characteristic, the filtered signals are then re-sampled (at the rate demanded by the application) before being transmitted to the main processor board and, where fitted, the coprocessor board.,

Each input is individually calibrated and compensated in software. The calibration coefficients are stored in non-volatile memory. These are used by the processor board(s) to correct for any amplitude or phase errors introduced by the transformers and analog circuitry.

Opto-isolated inputs

The other function of the input board is to read in the digital inputs. As with the analog inputs, the digital inputs must be electrically isolated from the power system. This is achieved by means of the 8 on-board optical isolators for connection of up to 8 digital signals. The digital signals are passed through an optional noise filter before being buffered and presented to the unit’s processing boards in the form of a parallel data bus.

This selectable filtering allows the use of a pre-set filter of ½ cycle which renders the input immune to induced power-system noise on the wiring. Although this method is secure it can be slow, particularly for inter-tripping. This can be improved by switching off the ½ cycle filter in which case one of the following methods to reduce ac noise should be considered.

- Use double pole switching on the input
- Use screened twisted cable on the input circuit.

The opto-isolated logic inputs can be programmed for the nominal battery voltage of the circuit of which they are a part, allowing different voltages for different circuits such as signaling and tripping. They can also be programmed to 60% - 80% or 50% - 70% pickup to dropoff ratio of the nominal battery voltage in order to satisfy different operating constraints.

The threshold levels are as follows:

Nominal Battery voltage	Logic levels: 60-80% DO/PU	Logic Levels: 50-70% DO/PU
24/27 V	Logic 0 < 16.2 V : Logic 1 > 19.2 V	Logic 0 <12.0 V : Logic 1 > 16.8 V
30/34	Logic 0 < 20.4 V : Logic 1 > 24.0 V	Logic 0 < 15.0 V : Logic 1 > 21.0 V
48/54	Logic 0 < 32.4 V : Logic 1 > 38.4 V	Logic 0 < 24.0 V : Logic 1 > 33.6 V
110/125	Logic 0 < 75.0 V : Logic 1 > 88.0 V	Logic 0 < 55.0 V : Logic 1 > 77.0 V
220/250	Logic 0 < 150. V : Logic 1 > 176.0 V	Logic 0 < 110.V : Logic 1 > 154.0 V

Table 2: Opto-input thresholds

The lower value eliminates fleeting pickups that may occur during a battery earth fault, when stray capacitance may present up to 50% of battery voltage across an input.

2.5 Coprocessor with GPS Time Synchronization

The global positioning satellite system (GPS) is used as the source of the accurate time synchronization needed for synchrophasors applications. GPS time synchronization hardware is situated on a coprocessor board. This is a separate plug-in board, which normally occupies slot B next to the Ethernet card. The coprocessor is the same as that used on the main processor board. The board has provision for fast access (zero wait state) SRAM for use with both program and data memory storage. This memory can be accessed by the main processor board through the parallel bus, and this route is used at power-on to download the software for the coprocessor from the flash memory on the main processor board. Further communication between the two processor boards is achieved using a memory mapped FPGA interface and the shared SRAM. The serial bus carrying the sample data is also connected to the coprocessor board, using the processor’s built-in serial port, as on the main processor board.

The GPS one pulse per second input (1PPS) is delivered from an associated P594 unit to the GPS time sync interface by a fiber optic cable presented to the ST connector at the rear of the unit.

2.6 Ethernet Connectivity and IRIG-B Time Synchronization

Ethernet and IRIG-B connectivity are provided on the same board, fitted into slot A.

IRIG-B

Demodulated IRIG-B is used to provide an accurate timing reference, which can be used wherever an IRIG-B signal is available. The timing information is used to synchronize the relay’s internal real-time clock to an accuracy of 1 ms. The internal clock is then used for the time tagging of the event maintenance and disturbance records.

Ethernet

The unit can be fitted with standard Ethernet or Redundant Ethernet. Redundant Ethernet is described in the Redundant Ethernet chapter and is not further described here.

When using standard Ethernet, the ports may be either fiber optic or metallic. When using redundant Ethernet, the ports are always fiber optic.

The 100 Mbps Fiber Optic ports use ST® type connectors and are suitable for 1300 nm multi-mode fiber type.

Metallic ports use RJ45 type connectors. When using metallic Ethernet, it is important to use Shielded Twisted Pair (STP) or Foil Twisted Pair (FTP) cables, to shield the Ethernet communications against electromagnetic interference. The RJ45 connector at each end of the cable must be shielded, and the cable shield must be connected to this RJ45 connector shield, so that the shield is grounded to the case. Both the cable and the RJ45 connector at each end of the cable must be Category 5 minimum.

> *Note:* *We recommend that you limit each metallic Ethernet cable to a maximum length of 3 m and confine it to one bay.*

The physical layout of both types of Ethernet card is shown in Figure 3. Further details are available in the Physical Description chapter.

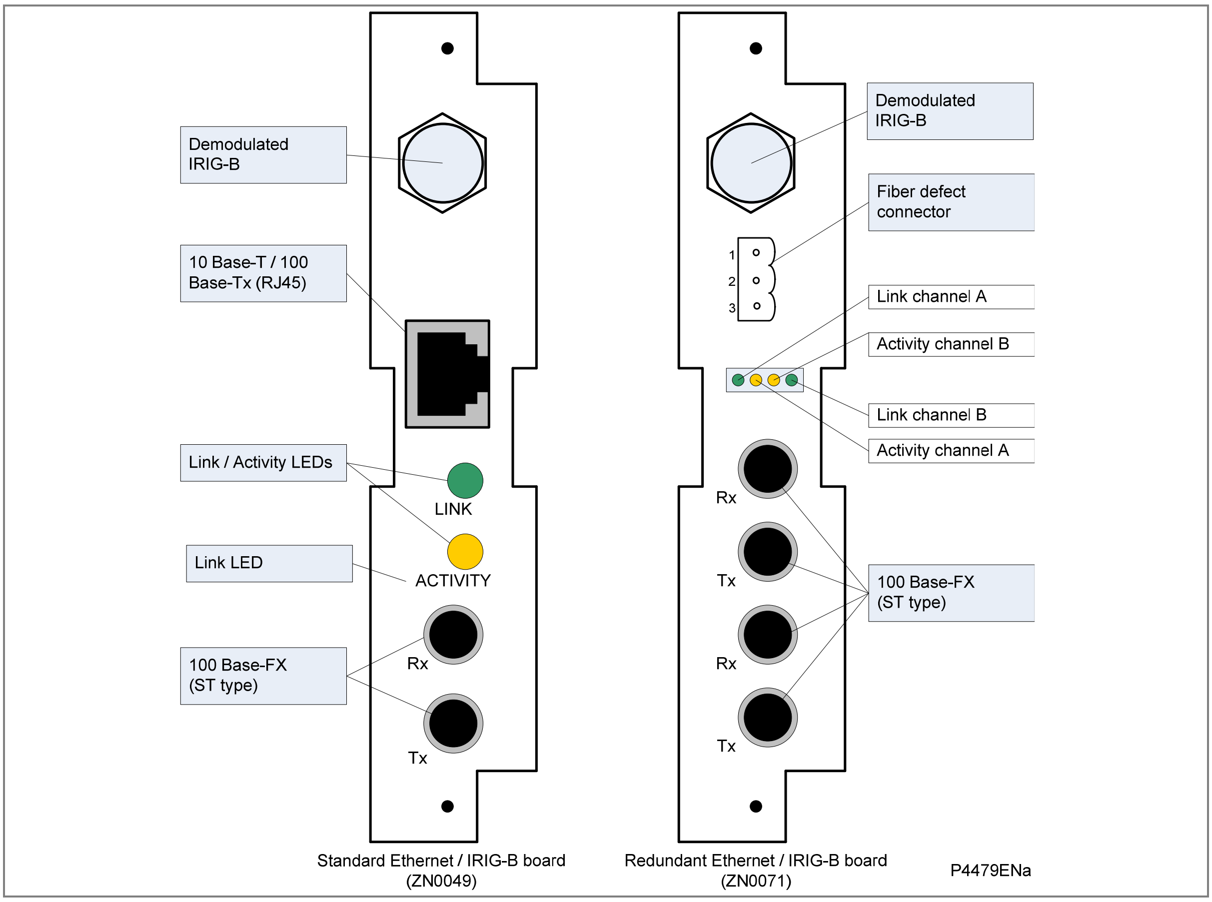


Figure 3: Standard and redundant Ethernet / IRIG-B boards

2.7 Internal Communication Buses

The unit has two internal buses for the communication of data between different modules. The main bus is a parallel link that is part of a 64-way ribbon cable. The ribbon cable carries the data and address bus signals in addition to control signals and all power supply lines. Operation of the bus is driven by the main processor board that operates as a master while all other modules within the unit are slaves.

The second bus is a serial link that is used exclusively for communicating the digital sample values from the input module to the main processor and coprocessor boards. The DSP processor has a built-in serial port that is used to read the sample data from the serial bus. The serial bus is also carried on the 64-way ribbon cable.

3 SERIAL COMMUNICATION PORTS

3.1 Front Serial Port (SK1)

The front communication port is situated under the bottom hinged cover. It is a 9-pin female D-type connector, providing RS232 serial data communication. This port is intended for temporary connection during testing, installation and commissioning, etc. It is not intended to be used for permanent SCADA communications. This port supports the Courier communication protocol only. Courier is the communication protocol developed by Alstom Grid to allow communication with its range of protection equipment, and between the device and the Windows-based S1 Studio support software package.

You can connect the unit to a PC with a serial cable up to 15 m in length.

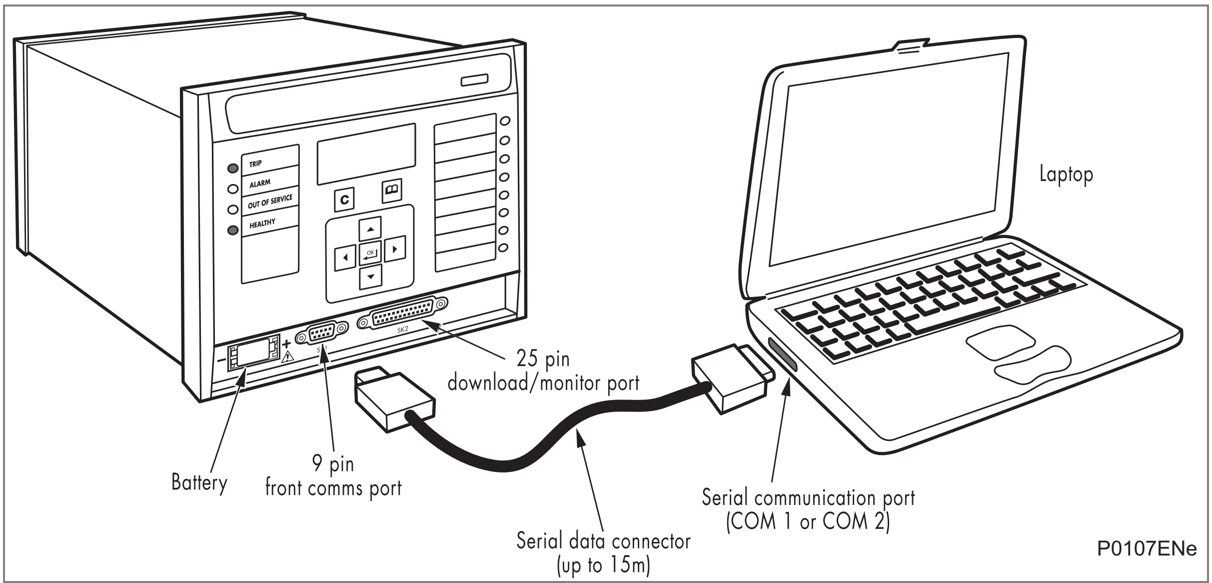


Figure 4: Front port connection

The port pin-out follows the standard for Data Communication Equipment (DCE) device with the following pin connections on a 9-pin connector.

Pin number	Description
2	Tx Transmit data
3	Rx Receive data
5	0 V Zero volts common

Table 3: DCE 9-pin serial port connections

The unit should be connected to one of the serial communication ports on the PC. PCs follow the standard for Data Terminal Equipment (DTE) with the following pin connections:

Pin number	25-way	9-way	Description
2	3	2	Rx Receive data
3	2	3	Tx Transmit data
5	7	5	0 V Zero volts common

Table 4: DTE 9-pin and 25-pin port connections

You must use the correct serial cable, or the communication will not work. A straight-through serial cable is required, connecting pin 2 to pin 2, pin 3 to pin 3, and pin 5 to pin 5.

Once the physical connection from the unit to the PC is made, the PC's communication settings must be set to match those of the IED. The following table shows the unit's communication settings for the front port.

Protocol	Courier
Baud rate	19,200 bps
Courier address	1
Message format	11 bit - 1 start bit, 8 data bits, 1 parity bit (even parity), 1 stop bit

Table 5: RS232 communication settings

The inactivity timer for the front port is set at 15 minutes. This controls how long the unit maintains its level of password access on the front port. If no messages are received on the front port for 15 minutes, any password access level that has been enabled is cancelled.

The front communication port supports the Courier protocol for one-to-one communication. It is designed to be used for installing, commissioning or maintaining the unit and is not intended for permanent connection. Since this interface is not used to link the unit to a substation communication system, the following Courier features of are not used:

- Automatic Extraction of Event Records:
  - The Courier Status byte does not support the Event flag
  - The Send Event or Accept Event commands are not implemented
- Automatic Extraction of Disturbance Records:
  - The Courier Status byte does not support the Disturbance flag
- Busy Response Layer:
  - The Courier Status byte does not support the Busy flag; the only response to a request is the final data
- Fixed Address:
  - The address of the front courier port is always 1; the Change Device address command is not supported.
- Fixed Baud Rate:
  - 19200 bps

Note: Although automatic extraction of event and disturbance records is not supported, this data can be manually accessed using the front port.

3.2 Front Parallel Port (SK2)

This is a 25 pin D-type port. This port is used for commissioning, downloading firmware updates and menu text editing.

3.3 Rear Serial Port RP1

RP1 is a three-terminal serial communications port. It is intended for use with a permanently wired connection to a remote control center. The physical connectivity is achieved using three screw terminals; two for the signal connection, and the third for the earth shield of the cable. These are located on pins 16, 17 and 18 of the power supply board, which is usually the card on the far right looking from the rear. The interface can be selected between RS485 and K-bus. When the K-Bus option is selected, the two signal connections are not polarity conscious.

Note:	*The polarity independent K-bus can only be used for the Courier data protocol. The polarity conscious MODBUS, IEC 60870-5-103 and DNP3.0 protocols, if specified, need RS485.*

The rear serial port is shown in Figure 5. The pin assignments are as follows:

- Pin 16: Ground shield
- Pin 17: Negative signal
- Pin 18: Positive signal

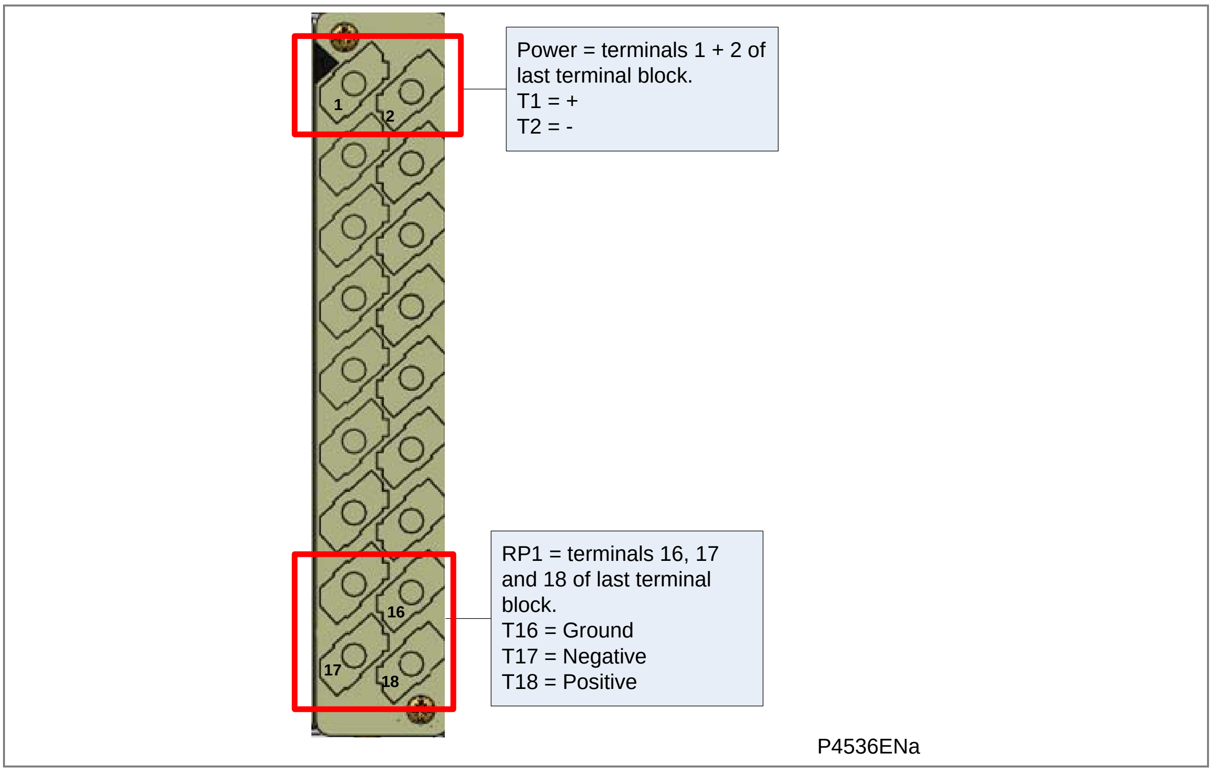


Figure 5: Power supply terminal block

4 SOFTWARE DESIGN

The unit's software can be conceptually categorized into several elements as follows:

- The real-time operating system
- The system services software
- The platform software
- The synchrophasor software
- The disturbance recorder software

These elements are not distinguishable to the user, and the distinction is made purely for the purposes of explanation.

4.1 Real-Time Operating System

The software is split into tasks; the real-time operating system is used to schedule the processing of the tasks to ensure that they are processed in the time available and in the desired order of priority. The operating system is also responsible in part for controlling the communication between the software tasks through the use of operating system messages.

4.2 System Services Software

The system services software provides the interface between the unit's hardware and the higher-level functionality of the platform software and the protection & control software. For example, the system services software provides drivers for items such as the LCD display, the keypad and the remote communication ports, and controls the boot of the processor and downloading of the processor code into SRAM from Flash memory at power up.

4.3 Platform Software

The platform software has three main functions:

- To control the logging of records generated by the software, including alarms, events and maintenance records
- To store and maintain a database of all of the settings in non-volatile memory
- To provide the internal interface between the Settings database and each of the unit's user interfaces.

Record Logging

The logging function is used to store all alarms, events and maintenance records. The records are stored in battery-backed SRAM to provide a non-volatile log of what has happened. The unit maintains three logs:

- Alarms (96) – check number
- Event records (512)
- Maintenance records (10)

The logs are maintained on a first in first out basis, such that the oldest record is overwritten with the newest record. The platform software is responsible for logging of a maintenance record in the event of a unit failure. This includes errors that have been detected by the platform software itself or errors that are detected by the system services or the software.

Settings Database

The settings database contains all the settings and data. This includes the synchrophasor, disturbance recorder, and control & support settings. The settings are stored in non-volatile memory. The platform software manages the settings database, ensuring that only one user interface can modify the settings at any one time. This is necessary to avoid conflict between different parts of the software during a setting change.

Changes to settings are first written to a 'scratchpad' in the SRAM memory. These settings will not be written to non-volatile memory immediately. This is because a batch of such changes should not be activated one by one, but in a complete scheme. Once the complete scheme has been stored in SRAM, the batch of settings can be committed to the non-volatile memory where they will become active.

If a setting change affects the protection & control task, the database notifies the affected features of the new values.

Warning: Settings should not be applied individually but in a complete scheme.

Database Interface

Another function of the platform software is to implement the interface between the unit's various user interfaces and the database. The settings and measurements database must be accessible from all of the user interfaces to allow read and modify operations. The platform software presents the data in the appropriate format for each user interface.

4.4 Synchrophasor Software

All of the processing of the synchrophasors is performed on the co-processor board.

The co-processor takes the frequency-tracked samples at 48 samples per cycle from the input board and converts these to phasors. The length of the filter applied to derive the phasors is selected based on the output frame rate and the desired performance, in accordance with the IEEE C37.118 standard.

The 1pps fiber input provides the reference for phasor synchronization. If the 1pps signal is not present when the unit powers up, generation of synchrophasors will be suppressed until a valid 1pps signal is received. Thereafter, if the 1pps signal fails, the co-processor board will maintain an output signal, but with an alarm to indicate degraded performance.

4.5 Control Scheduling

After initialization at start-up, the tasks on the main processor board are suspended until the co-processor board has started. If the co-processor board fails, the task automatically starts after six analog samples have been received. In normal operation the task is restarted by the co-processor 16 times per cycle.

4.5.1 Acquisition of Samples

The acquisition of samples on the main processor board is controlled by a 'sampling function' which is called by the system services software and takes each set of new samples from the input module and stores them in a two-cycle buffer. These samples are also stored concurrently by the co-processor.

4.5.2 Signal Processing

The sampling function provides filtering of the digital input signals from the opto-isolators and frequency tracking of the analog signals.

The frequency tracking of the analog input signals is achieved by a recursive Fourier algorithm which is applied to one of the input signals, and works by detecting a change in the signal's measured phase angle. The calculated value of the frequency is used to modify the sample rate being used by the input module to achieve a constant sample rate of 48 samples per cycle of the power waveform. The value of the frequency is also stored for use by the protection and control task.

When the protection and control task is re-started by the sampling function, it calculates the Fourier components for the analogue signals. The Fourier components are calculated using a one-cycle, 48 sample Discrete Fourier Transform (DFT). The DFT is always calculated using the last cycle of samples from the 2-cycle buffer, so the most recent data is used.

The DFT extracts the power frequency fundamental component from the signal and produces the magnitude and phase angle of the fundamental in rectangular component format. The DFT provides an accurate measurement of the fundamental frequency component, as well as effective filtering of harmonic frequencies and noise. This is in addition to the hardware anti-alias filtering provided in the input module.

The samples from the input module are used, in an unprocessed form, by the disturbance recorder, for recording waveforms and calculating true current, voltage and power rms values for metering purposes.

4.5.3 Programmable Scheme Logic

The Programmable Scheme Logic (PSL) allows you to configure an individual protection scheme to suit your own application. This is achieved with programmable logic gates and delay timers. The PSL is part of the Protection Setting Group.

The input to the PSL is any combination of digital input signals from the opto-isolators on the input board, the outputs of the protection elements (for example, protection starts and trips) and the outputs of the fixed protection scheme logic. The fixed scheme logic provides the unit’s standard protection schemes. The PSL itself consists of software logic gates and timers. The logic gates can be programmed to perform a range of different logic functions and can accept any number of inputs. The timers are used either to create a programmable delay or to condition the logic outputs, such as to create pulses of fixed duration. The outputs of the PSL are the LEDs on the front panel and the output contacts at the rear of the unit

The execution of the PSL logic is event driven. Only the part of the PSL logic that is affected by the initiating input change is processed. This reduces the amount of processing time used by the PSL. The protection and control software updates the logic delay timers and checks for a change in the PSL input signals every time it runs.

This system provides flexibility to allow you to create your own scheme logic design. However, it also means that the PSL can be configured into a very complex system. Because of this, the PSL can only be implemented using the PC support package S1 Studio.

When a PSL file is to be transferred from the PSL editor in S1 Studio to the unit, you can specify the Group to which it is downloaded together with a 32-character reference description. This PSL reference is shown in the **Grp1 PSL Ref** cell in the **PSL DATA** menu. The download date and time and file checksum for each of the group’s PSL file is also shown in the cells **Date/Time** and **Grp 1 PSL ID**. The PSL data can be used to indicate whether a PSL has been changed and thus be useful in providing information for version control of PSL files.

The default PSL Reference description is **Default PSL** followed by the model number, for example, “Default PSL PXXX??????0yy0?” where XXX refers to the product and yy refers to the software version. This is the same for all setting groups since the default PSL is the same for all groups. Since the LCD display (bottom line) only has space for 16 characters the display must be scrolled to see all 32 characters of the PSL Reference description.

The default date and time is loaded into non-volatile memory

Note:	*The PSL DATA column information is visible using the front panel interface or over the Courier communications protocol.*

4.5.4 Event Recording

A change in any digital input signal causes an event record to be created. These events are generated by the software and immediately time stamped before being buffered in a fast area of memory to avoid compromising the unit's main function. They are then transferred to battery-backed SRAM for non-volatile storage. It is possible for the fast buffer to overflow under avalanche conditions. If this occurs, a maintenance record is generated to indicate this loss of information.

4.5.5 Disturbance Recorder

The disturbance recorder operates as a separate task from the protection and control task. It can record the waveforms of up to 12 calibrated analog channels, plus the values of up to 32 digital signals. The recording time is user selectable up to a maximum of 50 seconds. The disturbance recorder is supplied with data by the protection and control task once per cycle, and collates the received data into the required length disturbance record. The disturbance records can be extracted using S1 Studio, which can also store the data in COMTRADE format, allowing the use of other packages to view the recorded data.

CONFIGURATION

CHAPTER 6

1 OVERVIEW

Each product has different configuration parameters according to the functions it has been designed to perform. There is, however, a common methodology used across the entire Px40 product series to set these parameters.

This chapter describes a summary of this common methodology.

This chapter consists of the following sections:

2 CONFIGURATION USING THE PANEL HMI

2.1 Menu Structure

Settings, records and measurements are stored inside the intelligent electronic device (IED) in non-volatile memory in a local database. When using the Human Machine Interface (HMI) it is convenient to visualize the menu navigation as a table. Each setting in the menu is known as a cell, which is accessed by reference to a row and column address. Each row and column is assigned 2-digit hexadecimal numbers, resulting in a unique 4-digit cell address for every item in the database. The main menu groups are allocated columns and the items within the groups are allocated rows, meaning a particular item within a particular group is a cell.

The settings are arranged so that each column contains all related settings, for example all of the disturbance recorder settings are in the same column.

The horizontal arrows on the keypad navigate between columns, whilst the vertical arrows navigate between the individual settings of the chosen column

Table 1 provides an example of the menu structure.

SYSTEM DATA	VIEW RECORDS	MEASUREMENTS 1	…
Language	"Select Event [0...n]"	IA Magnitude	…
Password	Menu Cell Ref	IA Phase Angle	…
Sys Fn Links	Time & Date	IB Magnitude	…
…	…	…	…

Table 1: Menu structure

The first three column headers are common throughout the entire Px40 series. However the rows within each of these column headers may differ according to the product type. Many of the column headers are the same for all products within the Px40 series. However there is no guarantee that the addresses will be the same for a particular column header.

2.2 Setting Categories

There are three categories of menu settings:

- Control and Support Settings
- Disturbance Recorder Settings
- Protection Settings

One of two different methods is used to change a setting depending on which category the setting falls into. Control and support settings are stored and used by the unit immediately after they are entered.

For protection settings and disturbance recorder settings, the IED stores the new setting values in a temporary ‘scratchpad’ memory. Once the new settings have been confirmed, the device activates all the new settings together. This provides extra security so that several setting changes, made in a group of protection settings, all take effect at the same time. The following paragraphs provide more detail about these setting categories.

Note: The P847 models B and C do not have protection settings.

2.2.1 Control and Support Settings

These are general settings that apply across all groups. Many of these settings are also common across the Px40 series of products. The control and support settings include:

- IED configuration settings
- VT ratio settings
- Reset LEDs
- Password and language settings
- Communications settings
- Measurement settings
- Event record settings
- User interface settings
- Commissioning settings

Table 2 shows a list of the column headers for the Control and Support Settings for the PX40 product series.

Note: Not all categories are applicable to all products.

Column header	Description
SYSTEM DATA	This contains general configuration options.
VIEW RECORDS	The device records and time tags events and stores them in non-volatile (battery backed up) memory. This lets you establish the sequence of events that occurred following a particular power condition, switching sequence etc. When the available space is exhausted, the oldest event is automatically overwritten by the new one. The event records are available for viewing either via the LCD front panel or remotely via the communications ports (courier versions only). The View Records setting range lets you view these records.
MEASUREMENTS 1	This lets you define the measurement quantities, which may include various Magnitudes, Phase Angles, RMS values and Frequencies.
DATE AND TIME	This displays the date and time as well as the battery condition.
CONFIGURATION	This lets you enable/disable or show/hide the general configuration options for this device. Examples of such settings include the activation of Groups, CT/VT ratios, inputs/outputs, labels and function keys.
CT AND VT RATIOS	This lets you set different primary and secondary, CT and VT ratings.
RECORD CONTROL	This lets you enable/disable the reporting of various events that support all setting changes.
DISTURB RECORDER	This lets you define recording times and trigger positions for a disturbance recorder as well as assign any available analogue channels or digital inputs to be monitored.
MEASURE'T SETUP	This lets you define how measurement settings are displayed, whether they are displayed as primary or secondary quantities, how monitoring periods are defined and how distance units are selected.
COMMUNICATIONS	This lets you view communications protocols, addresses, baud rates, timers, codes and statuses on the rear communications ports which use SCADA.

Column header	Description
COMMISSION TESTS	This lets you set the status of the opto-isolated inputs, output relay contacts, internal digital data bus (DDB) signals and define which user-programmable LEDs are to be monitored. Additionally you can test the operation of the output contacts, user-programmable LEDs and, where available, the auto-reclose cycles.
OPTO CONFIG	This lets you define the opto-input configuration settings, including setting nominal voltage values for each opto-input, setting filters to reduce wiring noise as well as pick-up and drop-off characteristics for the opto-inputs.
CONTROL INPUTS	This lets you define how any control input labels are set.
CTRL I/P CONFIG	This lets you assign any of the pre-existing Control Inputs to a Hotkey.
FUNCTION KEYS	This lets you enable/disable function keys, and to create/edit function key labels.
IED CONFIGURATOR	This lets you view IEC 61850 configuration information such as communication settings and configuration names/revisions
CTRL I/P LABELS	This allows you to set the input labels - this being the text which is displayed when a control input is accessed by the hotkey menu.

Table 2: Control and Support column headers

2.2.2 Disturbance Recorder Settings

The disturbance recorder settings include the record duration and trigger position, selection of analog and digital signals to record, and the signal sources that trigger the recording.

2.3 Password Protection

The menu structure contains three levels of access. The level of access that is enabled determines which of the settings can be changed and is controlled by two different passwords. The levels of access are summarized in Table 3.

Access level	Operations enabled
Level 0 No password required	Read access to all settings, alarms and event records
Level 1 Password 1 or 2 required	As level 0 plus: Control commands such as Reset of alarm conditions. Reset LEDs. Clearing of event records.
Level 2 Password 2 required	As level 1 plus: All other settings

Table 3: Password access levels

Each of the two passwords is 4 characters of upper case text. The factory default for both passwords is AAAA. Each password can be changed once it has been correctly entered. To enter a password, either use the prompt when you attempt a setting change, or select; System data > Password from the menu. The access level is independently enabled for each interface, therefore if level 2 access is enabled for the rear communication port, the front panel access remains at level 0, unless the relevant password is entered at the front panel.

The access level, enabled by the password, times out independently for each interface after a period of inactivity and reverts to the default level. If you lose or forget the passwords, contact Alstom Grid with the unit’s serial number and an emergency password will be supplied.

To establish the current level of access enabled for an interface, select System data > Access level. The IED is supplied with a default access level of 2, so no password is required to change any of the settings. It is also possible to set the default menu access level to either level 0 or level 1, preventing write access without the correct password. You set the default menu access level in System data > Password control.

Note: This setting can only be changed when level 2 access is enabled.

2.4 Simplifying the Unit Configuration

The unit is a multi-function device that supports numerous control and communication features. To simplify the setting of the unit, there is a configuration settings column, which can be used to enable or disable many of the unit's functions. The settings associated with any disabled function do not appear in the menu. To disable a function, change the relevant cell in the Configuration column from Enabled to Disabled.

2.5 Navigating the Panel HMI

Using the HMI, you can:

- Display and modify all settings
- View the digital I/O signal status
- Display measurements
- Reset alarm records
- Clear event records

The keypad provides full access to the device functionality by means of a range of menu options. The information is displayed on the LCD.

Note: As the LCD display has a resolution of 16 characters by 3 lines, some of the information is condensed mnemonic form.

The cursor keys are used to navigate the menus. These keys have an auto-repeat function if held down continuously. This can be used to speed up both setting value changes and menu navigation. The longer the key is held pressed, the faster the rate of change or movement.

Figure 1 shows how to navigate the menu items in the form of a menu navigation map.

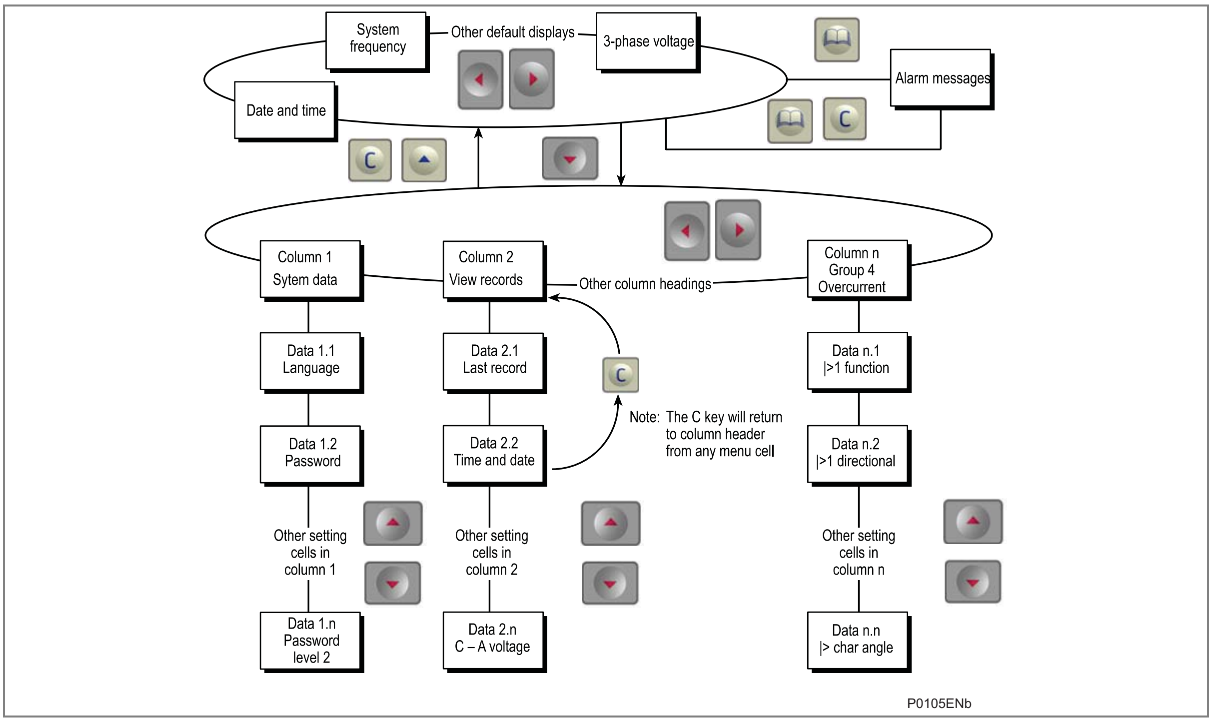


Figure 1: Menu Navigation

Use the four arrow keys to browse the menu, following the structure shown in Figure 1

1. Starting at the default display, press the  key to show the first column heading.
2. Use the  and  keys to select the required column heading.
3. Use the  and  keys to view the setting data in the column.
4. To return to the column header, either hold the  key down or press the  key once. It is only possible to move across columns at the column heading level.
5. To return to the default display, press the  key or the  key from any of the column headings. If you use the auto-repeat function of the  key, you cannot go straight to the default display from one of the column cells because the auto-repeat stops at the column heading.

2.6 Default Display and Menu Time-out

The display contains default text, which always reverts back after a timeout period. The following items can be selected:

- Date and Time
- Unit Description (user defined)
- Plant Reference (user defined)
- System Frequency
- 3 phase Voltage

- Access Level

The default display options are at the top of the display hierarchy. It is possible to choose the default display by using the left and right cursor keys. This allows you to see what options are available.

If there is no keypad activity for the 15 minute timeout period, the default display reverts to that stored in the settings, and the LCD backlight switches off. If this happens, any setting changes that have not been confirmed are lost and the original setting values are maintained.

You can change the default display by selecting **Measure't. setup** > **default display**.

2.7 Alarm Display Px40

If Alarms are present, this will override the default display until the alarms are cleared.

Whenever the unit has an un-cleared alarm (such as control alarm) the default display is replaced by the text **Alarms present**.

You can enter the menu structure from the default display, even if the display shows the **Alarms present** message.

2.8 Password Entry

1. When a password is required to edit a setting, an **Enter password** prompt appears.

```
ENTER PASSWORD
Level 1
* * * *
```

2. A flashing cursor shows which character field of the password can be changed. Press the up or down cursor keys to change each character between A and Z.
3. Use the left and right cursor keys to move between the character fields of the password. Press the Enter key to confirm the password.

   If you enter an incorrect password, the display reverts to **Enter password**. Upon entering a valid password a message then appears indicating that the password is correct and if so what level of access has been unlocked. If this level is sufficient to edit the selected setting, the display returns to the setting page to allow the edit to continue. If the correct level of password has not been entered, the password prompt page appears again.
4. To escape from this prompt press the Clear key. Alternatively, enter the password using **System data** > **Password**. If the keypad is inactive for 15 minutes, the password protection of the front panel user interface reverts to the default access level.
5. To manually reset the password protection to the default level, select **System data > Password**, then press the clear key instead of entering a password.

2.9 Reading and Clearing of Alarms

One or more alarm messages appear on the default display and the yellow alarm LED flashes. The alarm messages can either be self-resetting or latched, in which case they must be cleared manually.

1. To view the alarm messages, press the Read key. When all alarms have been viewed but not cleared, the alarm LED changes from flashing to constantly ON.
2. Scroll through the pages using the Read key. When all pages have been viewed, the following prompt appears.

```
Press Clear To
Reset Alarms
```

3. To clear all alarm messages, press the Clear key. To return to the display showing alarms and leave the alarms uncleared, press the Read key.
4. Depending on the password configuration settings, you may need to enter a password before the alarm messages can be cleared.
5. When all alarms are cleared, the yellow alarm LED switches OFF; also the red trip LED switches OFF if it was switched ON after a trip.

To speed up the procedure, enter the alarm viewer using the Read key, then press the clear key. Press the Clear key again to move straight to the alarm reset prompt, then press the Clear key again to clear all alarms.

2.10 Setting Changes

1. To change the value of a setting, go to the relevant cell in the menu, then press the Enter key to change the cell value. A flashing cursor on the LCD shows that the value can be changed. You may be prompted for a password first.
2. To change the setting value, press the up and down cursor keys. If the setting to be changed is a binary value or a text string, select the required bit or character to be changed using the left and right cursor keys.
3. Press Enter to confirm the new setting value or the Clear key to discard it. The new setting is automatically discarded if it is not confirmed in 15 seconds
4. For protection group settings and disturbance recorder settings, the changes must be confirmed before they are used. To do this, when all required changes have been entered, return to the column heading level and press the up arrow. Before returning to the default display, the following prompt appears.

```
Update Settings?
ENTER or CLEAR
```

5. Press **Enter** to accept the new settings or press the Clear key to discard the new settings.

> ***Note**: If the menu time-out occurs before the setting changes have been confirmed, the setting values are also discarded.*

Control and support settings are updated immediately after they are entered, without the **Update Settings** prompt.

2.11 Navigating the Hotkey Menu

1. To access the hotkey menu from the default display, press the key directly below the HOTKEY text on the LCD.
2. Once in the Hotkey menu, use the left and right cursor keys to scroll between the available options, then use the hotkeys to control the function currently displayed. If neither of the cursor keys is pressed within 20 seconds of entering a hotkey sub menu, the unit reverts to the default display.
3. Press Clear key to return to the default menu from any page of the hotkey menu.

The layout of a typical page of the Hotkey menu is as follows:

- The top line shows the contents of the previous and next cells for easy menu navigation
- The center line shows the function
- The bottom line shows the options assigned to the direct access keys

The functions available in the hotkey menu are listed in the following sections.

Note: In the P847 models B&C only the control inputs can be controlled by hotkeys

2.11.1 Control Inputs

The control inputs are user-assignable functions (USR ASS).

Use the **CTRL I/P CONFIG** column to configure the number of **USR ASS** shown in the hotkey menu. To set or reset the chosen inputs, use the HOTKEY menu.

For more information see the Control Inputs section in the Operation chapter of this manual.

3 CONFIGURATION USING S1 STUDIO

S1 Studio is application software specifically designed to interface with Alstom Grid IEDs. This section provides a brief overview of S1 Studio and is intended to get you up and running.

For more detailed documentation, please refer to the demo included with the S1 STUDIO software package and the online help system.

3.1 Platform Requirements

S1 Studio requires the following hardware platform.

Minimum

- 1 GHz processor
- 256 MB RAM
- Windows™ XP
- Resolution 800 x 600 (256 colors)
- 1 GB free hard disk space

Recommended

- 2 GHz processor
- 1 GB RAM
- WindowsTM XP
- Resolution 1024 x 768
- 5 GB free hard disk space

Note: Support for Windows 7 is currently undergoing testing

3.2 Connecting to the Unit using S1 Studio

This section is intended as a quick start guide to using S1 Studio and assumes you have a copy installed on your PC. See the S1 Studio program online help for more detailed information.

4. Make sure the correct serial cable is properly connected between the port on the front panel of the unit and the PC.
5. To start S1 Studio, select Programs > Alstom Grid > S1 Studio > S1 Studio.
6. Click the **Quick Connect** tab and select Create a New System.
7. Check the Path to System file is correct, then enter the name of the system in the Name field. If you wish to add a brief description of the system, use the Comment field.
8. Click **OK**.
9. Select the device type.
10. Select the communications port.
11. Once connected, select the language for the settings file, the device name, then click **Finish**. The configuration is updated.
12. In the Studio Explorer window, select **Device > Supervise Device…** to control the unit functions directly.

3.3 Off-line use of S1 Studio

S1 Studio can also be used as an off-line tool to prepare settings, without access to the unit.

1. If creating a new system, in the Studio Explorer, select **Create new system**. Then right click the new system and select **New substation**.
2. Right-click the new substation and select **New voltage level**.
3. Right-click the new voltage level and select **New bay**.
4. Right-click the new bay and select New device. You can add a device at any level, whether it is a system, substation, voltage or bay.
5. Select a device type from the list, and enter the unit type. Click **Next**.

> *Note: If the device type you want doesn't appear in the list, you will have to import a device data model. Refer to section 3.4 for details.*

6. Enter the full model number and click **Next**.
7. Select the Language and Model, then click **Next**.
8. Enter a unique device name, then click **Finish**.
9. Right-click the Settings folder and select New File. A default file 000 is added.
10. Right-click file **000** and select click Open. You can then edit the settings.

See the S1 Studio program online help for more information.

3.4 Importing Device Data Models

To use S1 Studio as an off-line tool to prepare settings etc., it is necessary to install the data models for the products that you wish to work with. Data models are installed using the Data Model Manager.

1. Before running the Data Model Manager, you must close S1 Studio.
2. To start the Data Model Manager, select Programs > Alstom Grid > S1 Studio > Data Model Manager.
3. You will be prompted to add data models. A dialog provides a list of locations from where the data models are to be retrieved. Normally the data model will be downloaded from the Alstom Grid ftp site since this will contain the most up-to-date models.

> *Note: Each product version has a number of data models, all of which are large, and hence download times can be lengthy. We recommend that you select only the data models you need in order to keep download times reasonable.*

4. You must now re-start S1 Studio to use the new data models.

4 CONFIGURING THE ETHERNET INTERFACE

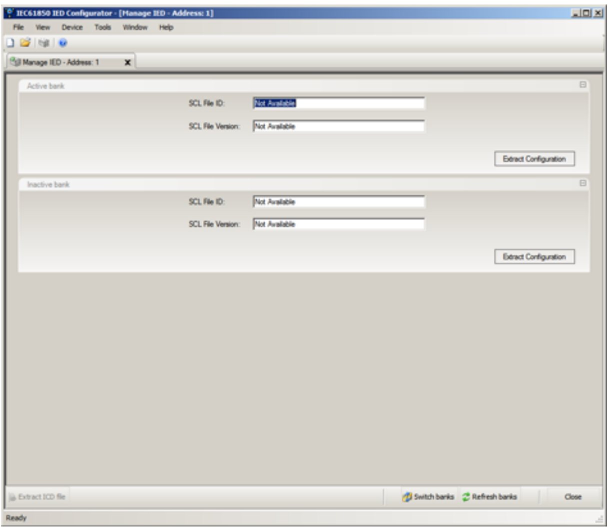
The way in which you configure the Ethernet interface depends on the particular type of interface you have. If you have a DNP3.0 interface you use the menu of the product HMI. Otherwise you should use the IED configurator tool in S1 Studio. If you have a redundant Ethernet version, please refer to the "Redundant Ethernet" chapter.

To launch S1 Studio you need to connect to the front serial port.

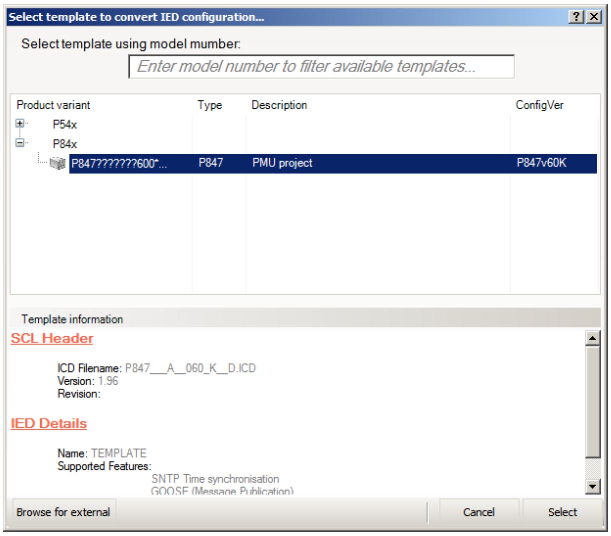
4.1 Configuring the Ethernet Interface – IEC 61850

From S1 Studio:

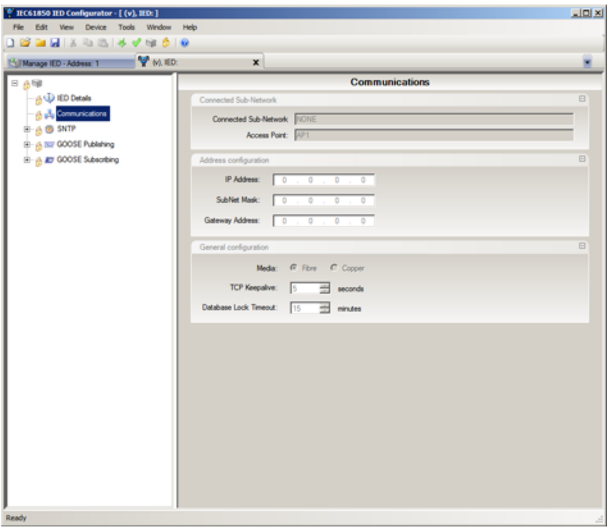
1. Select Tools > IEC61850 IED Configurator
2. Select Device > Manage IED
3. Select Px40
4. Enter the address of the IED you want to manage (this will always be '1' if you are connected via the front port)
5. Click Next. The following screen appears



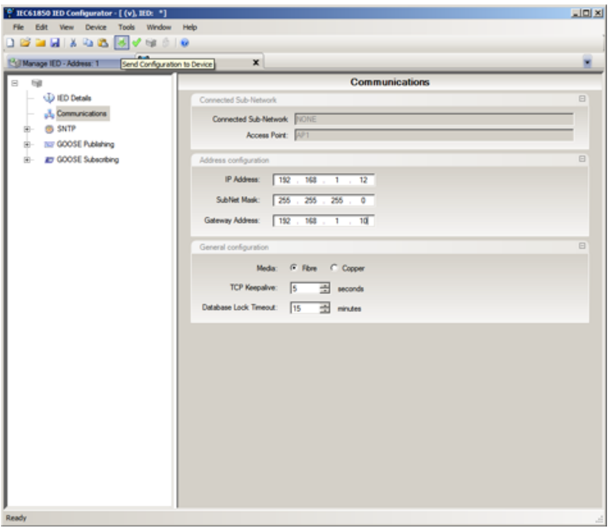
6. Select Extract Configuration, Active Bank



7. Select the model. The IP address data is then revealed:



8. To change the address values, select View > Enter Manual Editing Mode
9. Enter the required IP configuration and select the green download button:



The Ethernet interface should now be configured.

4.2 Configuring the Ethernet Interface – other models

Other models are set using the IED configurator as per the IEC 61850 devices.

5 TIME SYNCHRONIZATION

The MiCOM ALSTOM P847 Phasor Measurement Unit requires accurate time synchronization via an IRIG-B input as well as a one-pulse-per-second fiber optic input in order to output synchronized Phasor data. This can be achieved by using it in conjunction with a MiCOM ALSTOM P594 time synchronizing unit. The P594 provides a one-pulse-per-second fiber optic signal for the precise alignment of the synchrophasors as well as an IRIG-B input for time synchronization. Both the P847 and the P594 can be set to compensate for the difference between local time and Universal Time Co-ordinated (UTC). In order that the compensation is not applied twice, in P847 applications, the associated P594 should be set so that no UTC offset correction is applied.

COMMUNICATIONS

CHAPTER 7

1 OVERVIEW

The MiCOM ALSTOM Px40 series supports SCADA communications based on two communications technologies: Serial and Ethernet. Serial communications has been around for a long while, and there are many substations still using this method. Ethernet is a more modern medium and all modern substation communications are based on this technology. It is therefore necessary to support both of these communication technologies.

Further information can be obtained from the following sources. These are available on request.

- R6509 K-Bus Interface Guide
- R6510 IEC 60870 Interface Guide
- R6511 Courier Protocol
- R6512 Courier User Guide

This chapter consists of the following sections:

2 ETHERNET COMMUNICATION

Several different types of Ethernet board are available for use depending on the chosen model. The available boards and their features are described in the *Physical Description* chapter of this manual.

Fiber optic connection is recommended for permanent connections in a substation environment, as it offers advantages in terms of noise rejection. The fiber optic port provides 100 Mbps communication and uses type BFOC2.5 (ST) connectors. Fibers should be suitable for 1300 nm transmission and be multimode 50/125 µm or 62.5/125 µm.

The unit can also be connected to either a 10Base-T or a 100Base-TX Ethernet hub using the RJ45 port. The port automatically senses which type of hub is connected. Due to noise and interference reasons, this connection type is recommended for short-term connections over a short distance.

Table 1 shows the signals and pins on the RJ45connector.

Pin	Signal name	Signal definition
1	TXP	Transmit (positive)
2	TXN	Transmit (negative)
3	RXP	Receive (positive)
4	-	Not used
5	-	Not used
6	RXN	Receive (negative)
7	-	Not used
8	-	Not used

Table 1: Ethernet signals

Note: *For models equipped with redundant Ethernet connections the product must be partially dismantled to set the fourth octet of the second IP address. Please see separate chapter for details.*

3 SERIAL COMMUNICATION

The physical layer protocols that are used for serial communications for SCADA purposes are:

- EIA(RS)232 (often abbreviated to RS232)
- EIA(RS)485 (often abbreviated to RS485)
- K-Bus

The protocols are similar. RS485 is very similar to RS232, but is better able to cope with long cables and daisy-chaining. K-Bus is very similar to RS485, but the signals applied across two terminals are not polarized.

It is important to note that these are not data protocols. They only describe the physical characteristics required for two devices to communicate with each other. Full descriptions of these physical layer protocols are available from a number of sources including the published standards.

3.1 EIA(RS)232 bus

The EIA(RS)-232 interface uses the IEC 60870-5 FT1.2 frame format.

The IED supports an IEC 60870-5 FT1.2 connection on the front-port. This is intended for temporary local connection and is not suitable for permanent connection. This interface uses a fixed baud rate, 11-bit frame, and a fixed device address.

EIA(RS)-232 interfaces are polarized.

3.2 EIA(RS)485 bus

The RS485 two-wire connection provides a half-duplex, fully isolated serial connection to the IED. The connection is polarized but there is no agreed definition of which terminal is which. If the master is unable to communicate with the product, and the communication parameters match, then it is possible that the two-wire connection is reversed.

The RS485 bus must be terminated at each end with 120 Ω 0.5 Watt terminating resistors between the signal wires.

The RS485 standard requires that each device be directly connected to the actual bus. Stubs and tees are expressly forbidden. Loop bus and Star topologies are not part of the RS485 standard and are also forbidden.

Two-core screened cable is recommended. The final cable specification is dependent on the application, although a multi-strand 0.5 mm2 per core is normally adequate. The total cable length must not exceed 1000 m. It is important to avoid circulating currents, which can cause noise and interference, especially when the cable runs between buildings. For this reason, the screen should be continuous and connected to ground at one end, normally at the master connection point.

The RS485 signal is a differential signal and there is no signal ground connection. If a signal ground connection is present in the bus cable then it must be ignored. At no stage must this be connected to the cables screen or to the product’s chassis. This is for both safety and noise reasons.

It may be necessary to bias the signal wires to prevent jabber. Jabber occurs when the signal level has an indeterminate state because the bus is not being actively driven. This can occur when all the slaves are in receive mode and the master is slow to turn from receive mode to transmit mode. This may be because the master is waiting in 'Receive' mode, in a high impedance state, until it has something to transmit. Jabber causes the receiving device(s) to miss the first bits of the first character in the packet, which results in the slave rejecting the message and consequentially not responding. Symptoms of this are poor response times (due to retries), increasing message error counters, erratic communications, and in the worst case, complete failure to communicate.

Biasing requirements

Biasing requires that the signal lines be weakly pulled to a defined voltage level of about 1 V. There should only be one bias point on the bus, which is best situated at the master connection point. The DC source used for the bias must be clean to prevent noise being injected. Figure 1 shows a typical biasing arrangement.

> *Note: Some devices may (optionally) be able to provide the bus bias, in which case external components will not be required.*

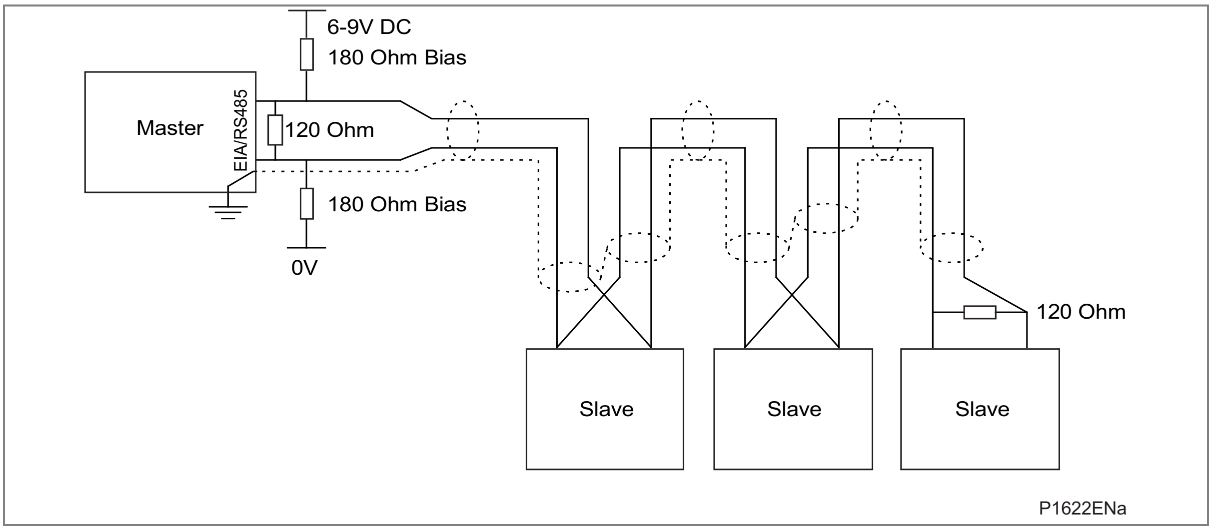


Figure 1: RS485 bus biasing arrangements

It is possible to use the product's field voltage output (48 V DC) to bias the bus using values of 2.2 k Ω (½W) as bias resistors instead of the 180 Ω resistors shown in the above diagram.

> *Note: The following warnings apply:*

- It is extremely important that the 120 Ω termination resistors are fitted. Otherwise the bias voltage may be excessive and may damage the devices connected to the bus.
- As the field voltage is much higher than that required, Alstom Grid cannot assume responsibility for any damage that may occur to a device connected to the network as a result of incorrect application of this voltage.
- Ensure the field voltage is not used for other purposes, such as powering logic inputs, because noise may be passed to the communication network.

3.3 K-Bus

K-Bus is a robust signaling method based on RS485 voltage levels. K-Bus incorporates message framing, based on its own frame format, and uses a 64 kbps synchronous HDLC protocol with FM0 modulation to increase speed and security.

The rear interface is used to provide a permanent connection for K-Bus and allows multi drop connection. Although K-Bus is based on EIA(RS)-485 voltage levels, it is not possible to use a standard EIA(RS)-232 to EIA(RS)-485 converter to convert IEC 60870-5 FT1.2 frames to K-Bus. Also it is not possible to connect K-Bus to an EIA(RS)-485 computer port. A protocol converter, such as the KITZ101, should be used for this purpose. Please consult Alstom Grid for information regarding the specification and supply of KITZ devices).

Each spur of the K-Bus twisted pair wiring can be up to 1000 m in length and have up to 32 connected IEDs. The K-Bus twisted pair connection is unpolarized.

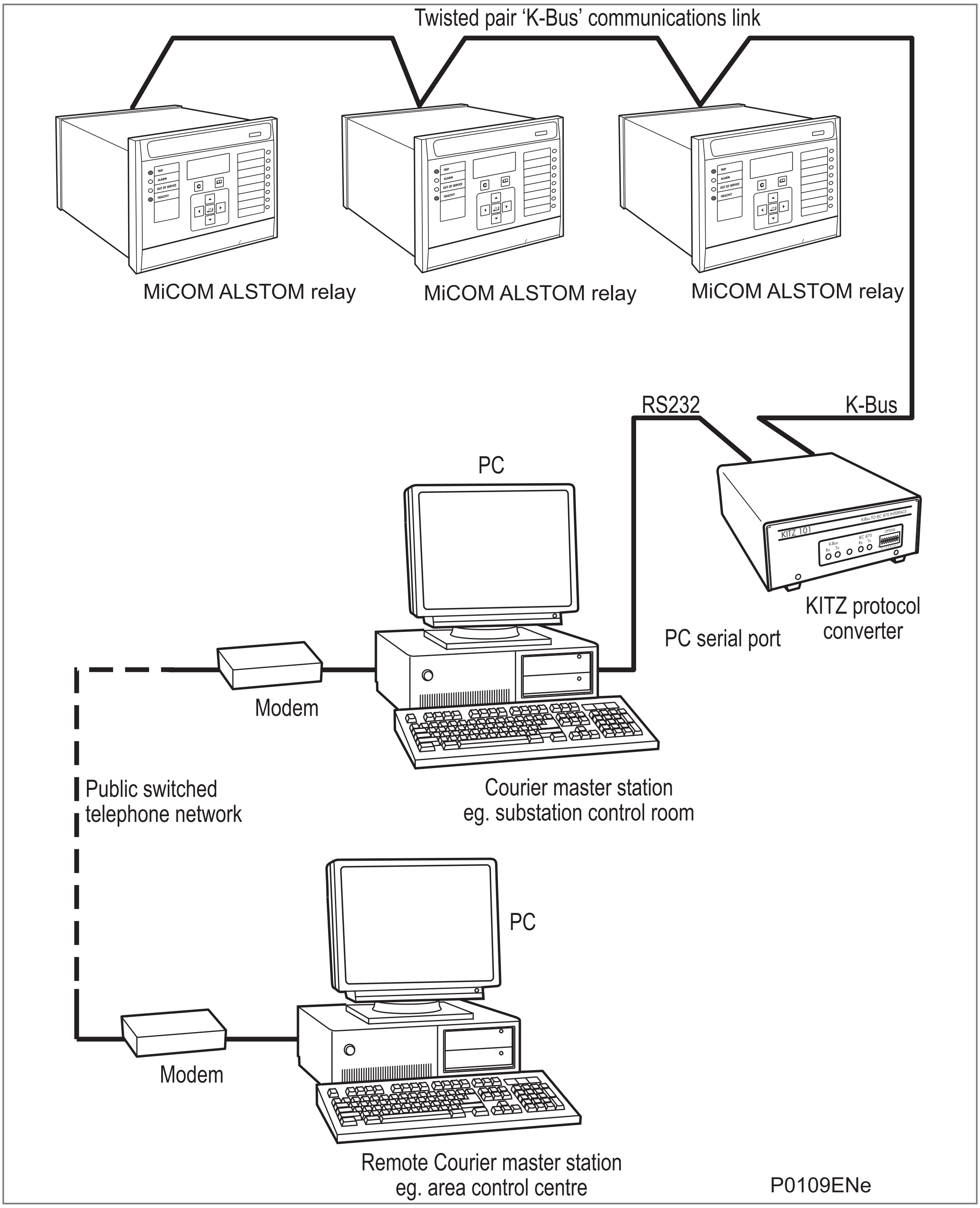


Figure 2: Remote communication using K-Bus example

4 AVAILABLE DATA PROTOCOLS

The Px40 series supports a wide range of protocols to make them applicable to many industries and applications. The exact data protocols supported by a particular product depend on its chosen application, but the following table gives a list of the data protocols that are typically available.

Data Protocol	Layer 1 protocol	Description
Courier	K-Bus, RS232 and RS485	Standard for SCADA communications developed by Alstom Grid.
MODBUS	RS232 and RS485	Standard for SCADA communications developed by Modicon.
IEC 60870-5 CS103	RS485 only	IEC standard for SCADA communications
DNP 3.0	RS485 and Ethernet	Standard for SCADA communications developed by Harris. Used mainly in North America.
IEC 61850	Ethernet only	New IEC standard for substation automation. Facilitates interoperability.
IEEE C37.118 Interface	Ethernet only	Standard for defining synchrophasors and their communication.

Table 2: SCADA data protocols

The relationship of these protocols to the lower level physical layer protocols is shown in Figure 3.

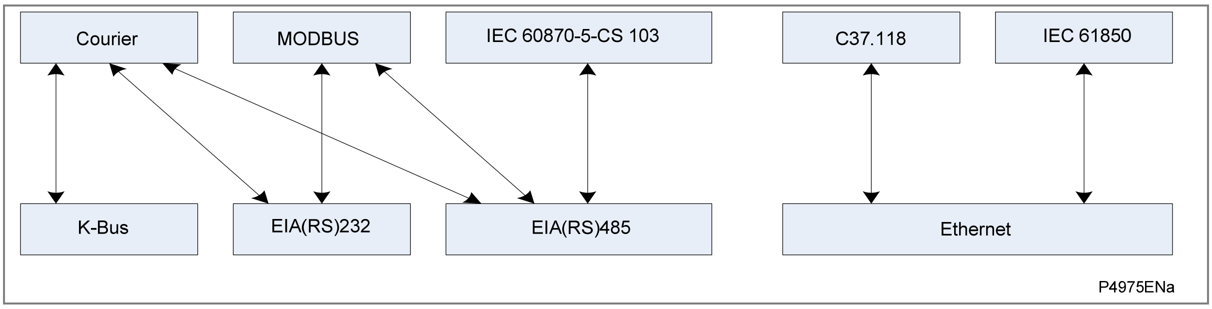


Figure 3: SCADA data protocols

5 IEEE C37.118-2005

As well as defining synchrophasors, the IEEEC37.118-2005 standard also specifies how the communications of this synchrophasor information is to be implemented. The parts of the standard relevant to the SCADA communications interface are summarized in this section, but you should read the standard itself if you require further details.

Four message types are described in the standard:

- Data
- Configuration
- Header
- Command

The “Configuration”, “Header” and “Command” types are used to setup the communications and the Data type carries the actual information. All frames have a similar structure. The Data Frame format is shown in Table 3.

Field function	Field size (bytes)
Message synchronization	2
Frame size definition	2
PMU ID code*	2
Real time timing information	8
Status information	2
Phasor data values	Typically 120
System frequency measurement	2
Rate of change of system frequency	2
Digital data values	2
Frame checksum	2
Total	Typically 144

Table 3: Data Frame format

**Note* *The PMU ID code is set to uniquely associate the synchrophasor values to the P847 PMU responsible for producing them.*

5.1 C37.118 Data Rate

The rate at which the frames are sent is defined by the standard and described by two settings:

For 50 Hz operation the frame repetition rate can be set to 10, 25 or 50 frames per second

For 60 Hz operation the frame repetition rate can be set to 10, 12, 15, 20, 30, or 60 frames per second.

5.2 Bandwidth calculations

For a typical application with a frame length of 144 bytes and a repetition rate of 60 per second, the minimum bandwidth requirement for these raw frames is 8640 bytes per second.

In addition to the raw data frames, there is an overhead associated with the layer 3 and 4 protocols as follows:

In addition to the raw data frames, there is an overhead associated with the layer 3 and 4 protocols as follows:

TCP/IP

- TCP 24 bytes per frame
- IP 20 bytes per frame
- MAC 18 bytes per frame

Therefore 62 bytes of data per frame is the required TCP/IP overhead.

UDP/IP

- Source port 2 bytes
- Destination Port 2 bytes
- UDP length 2 bytes
- UDP checksum 2 bytes
- IP 20 bytes per frame

Therefore 28 bytes of data per frame is the required UDP/IP overhead.

As the C37.118 frame contains 144 bytes, the total number of bytes per frame is 206 for TCP and 172 for UDP.

The resulting bandwidth of the maximum frame rate is thus:

- 1648 * 50 = 82.4 kbps for a maximum frame rate of 50 frames per second (TCP)
- 1648 * 60 = 98.88 kbps for a maximum frame rate of 60 frames per second (TCP)
- 1376 * 50 = 68.8 kbps for a maximum frame rate of 50 frames per second (UDP)
- 1376 * 60 = 82.56 kbps for a maximum frame rate of 60 frames per second (UDP)

So for the worst case condition (60 x C37.118 frames per second over TCP/IP), the maximum theoretical number of PMUs is as follows:

- 10000/98.88 = 101 for a 10 Mbps network
- 100000/98.88 = 1011 for a 100 Mbps network

This assumes of course an ideal traffic free network, and that all 30 channels are selected.

5.3 Mapping C37.118 to Ethernet

The P847 supports the transmission of synchrophasor information over Ethernet communications only which must be configured appropriately.

The phasor data frames presented in the preceding sections can be mapped to either transmission control protocol (TCP) or user datagram protocol (UDP) according to preference. TCP is a connection-oriented protocol. It manages message acknowledgement, re-transmission and time out. As such it can be considered to be reliable and ordered, but carrying overheads. UDP is a simpler protocol that broadcasts messages from the transmitter without checking the state of the receiver. As such it can be considered unreliable and not ordered, but lean. The choice will come down to the specific requirements of the application.

> ***Note:*** *UDP is a stateless protocol so the order of packets is not guaranteed. In addition to this, once a connection is established and transmission of phasor data initiated, the transmission will not stop until the IED receives the* ***stop transmission*** *command from the client phasor data concentrator (or the interface is reconfigured).*

The TCP or UDP mapped messages are written to and read from using standard IP input output functions. These functions apply a numerical identifier for the data structures of the terminals of the communications. The terminal is referred to as a port and the numerical identifier is called the port number. The port number needs to be set to align with the recipient data concentrator.

The selection of TCP or UDP, and the setting of the port number are found under the Communications settings column of the P847. As default the port numbers are 4712 for TCP, and 4713 for UDP as per the recommendations of C37.118.

Other settings that are required are; the IP address, subnet mask, and gateway address. Unless the P847 is equipped with DNP3 over Ethernet communications, these are set using the IED configurator (IEC 61850 IED Configurator) tool which is resident in the S1 Studio software package. In the case of a P847 equipped with DNP3 over Ethernet communications, the settings for these are found in the Communications settings column of the menu.

> *Note: The P847 must have started to receive a valid one pulse per second synchronizing signal before it will start transmitting C37.118 frames.*

6 COURIER

Courier is a proprietary communication protocol. Courier uses a standard set of commands to access a database of settings and data in the IED. This allows a master to communicate with a number of slave devices. The application-specific elements are contained in the database rather than in the commands used to interrogate it, meaning that the master station does not need to be preconfigured.

Courier can be used with three physical layer protocols: K-Bus, EIA(RS)232 or EIA(RS)485. Refer to section 2 for details on these.

6.1 Supported command set

The following Courier commands are supported:

- Protocol Layer
  - Reset Remote Link
  - Poll Status
  - Poll Buffer*
- Low Level Commands
  - Send Event*
  - Accept Event*
  - Send Block
  - Store Block Identifier
  - Store Block Footer
- Menu Browsing
  - Get Column Headings
  - Get Column Text
  - Get Column Values
  - Get Strings
  - Get Text
  - Get Value
  - Get Column Setting Limits
- Setting Changes
  - Enter Setting Mode
  - Preload Setting
  - Abort Setting
  - Execute Setting
  - Reset Menu Cell
  - Set Value
- Control Commands
  - Select Setting Group
  - Change Device Address*
  - Set Real Time

Note: Commands marked with an asterisk (*) are not supported through the front Courier port.

6.2 Courier database

The Courier database is two-dimensional. Each cell in the database is referenced by a row and column address. Both the column and the row can take a range from 0 to 255 (0000 to FFFF Hexadecimal. Addresses in the database are specified as hexadecimal values, for example, 0A02 is column 0 A (10 decimal) row 02. Associated settings or data are part of the same column. Row zero of the column has a text string to identify the contents of the column and to act as a column heading.

The Menu Databases contain the complete database definition. This information is also presented in the Settings chapter of this technical manual.

6.3 Setting changes

Courier provides two mechanisms for making setting changes. Either method can be used for editing any of the settings in the database.

Method 1

This uses a combination of three commands to perform a settings change:

First, enter **Setting** mode: This checks that the cell is settable and returns the limits.

1. Preload Setting: This places a new value into the cell. This value is echoed to ensure that setting corruption has not taken place. The validity of the setting is not checked by this action.
2. Execute Setting: This confirms the setting change. If the change is valid, a positive response is returned. If the setting change fails, an error response is returned.
3. Abort Setting: This command can be used to abandon the setting change.

This is the most secure method. It is ideally suited to on-line editors because the setting limits are extracted before the setting change is made. However, this method can be slow if many settings are being changed because three commands are required for each change.

Method 2

The **Set Value** command can be used to change a setting directly. The response to this command is either a positive confirm or an error code to indicate the nature of a failure. This command can be used to implement a setting more rapidly than the previous method, however the limits are not extracted. This method is therefore most suitable for off-line setting editors such as S1 Studio, or for issuing preconfigured control commands.

6.4 Settings categories

There are two categories of settings for the P847B&C:

- Control and support settings
- Disturbance recorder settings

Changes made to the control and support settings are implemented immediately and stored in non-volatile memory. Changes made to the Disturbance recorder settings are stored in a ‘scratchpad’ memory and are not immediately implemented. These need to be committed by writing to the **Save Changes** cell in the CONFIGURATION column

6.5 Setting transfer mode

To transfer all of the settings to or from the unit, use the Setting Transfer cell (location BF03) in the COMMS SYS DATA column. When this cell is set to 1, all of the settings are made visible. Any setting changes made in this mode are stored in scratchpad memory, *including control and support* *settings*. When the cell is set back to 0, all setting changes are verified and committed to non-volatile memory.

6.6 Event extraction

You can extract events either automatically (rear Courier port only) or manually (either Courier port). For automatic extraction, all events are extracted in sequential order using the standard Courier event mechanism. This includes maintenance data if appropriate. The manual approach allows you to select events or maintenance data as desired.

6.6.1 Automatic event extraction

This method is intended for continuous extraction of event information as it is produced. It is only supported through the rear Courier port.

When new event information is created, the **Event** bit is set in the **Status** byte. This indicates to the Master device that event information is available. The oldest, non-extracted event can be extracted from the IED using the **Send Event** command. The IED responds with the event data, which is either a Courier Type 0 or Type 3 event. The Type 3 event is used for maintenance records.

Once an event has been extracted, the **Accept Event** command can be used to confirm that the event has been successfully extracted. When all events have been extracted, the **Event** bit is reset. If there are more events still to be extracted, the next event can be accessed using the **Send Event** command as before.

For further information, please refer to publication R6512

6.6.2 Manual event record extraction

The VIEW RECORDS column (location 01) of the database is used for manual viewing of event and maintenance records. The contents of this column depend on the nature of the record selected. You can select events by event number and directly select a maintenance record by number.

Event Record selection (Select Event cell: 0101)

This cell can be set to a value between 0 to 249 to select from 250 stored events. 0 selects the most recent record and 249 the oldest stored record. For simple event records, (Type 0) cells 0102 to 0105 contain the event details. A single cell is used to represent each of the event fields. If the event selected is a maintenance record (Type 3), the remainder of the column contains the additional information.

Maintenance Record Selection (Select Maint cell: 01F0)

This cell can be used to select a maintenance record using a value between 0 and 4.

If this column is used to extract event information, the number associated with a particular record changes when a new event occurs.

Event types

The IED generates events under the following circumstances:

- Change of state of output contact
- Change of state of opto-input
- Alarm condition
- Setting change
- Password entered/timed-out
- Maintenance record (Type 3 Courier Event)

Event format

The IED returns the following fields when the Send Event command is invoked:

- Cell reference
- Time stamp
- Cell text
- Cell value

The Menu Database documents contain tables of possible events, and shows how the contents of the above fields are interpreted. Maintenance records return a Courier Type 3 event, which contains the above fields plus two additional fields:

- Event extraction column
- Event number

These events contain additional information, which is extracted from the IED using the RECORDER EXTRACTION column. Row 01 of the RECORDER EXTRACTION column contains a **Select Record** setting that allows maintenance record to be selected. This setting should be set to the event number value returned in the record. The extended data can be extracted from the IED by uploading the text and data from the column.

6.7 Disturbance record extraction

The stored disturbance records are accessible in a compressed format through the Courier interface. The records are extracted using the RECORDER EXTRACTION column (B4).

The **Select Record** cell can be used to select the record to be extracted. Record 0 is the oldest non-extracted record. Older records which have been already been extracted are assigned positive values, while younger records are assigned negative values. To help automatic extraction through the rear port, the IED sets the **Disturbance** bit of the **Status** byte, whenever there are non-extracted disturbance records.

Once a record has been selected, using the above cell, the time and date of the record can be read from the **Trigger Time** cell (B402). The disturbance record can be extracted using the block transfer mechanism from cell B40B. The file extracted from the IED is in a compressed format. To decompress this file, you need to use S1 Studio to save the disturbance record in the COMTRADE format.

6.8 Programmable scheme logic settings

The programmable scheme logic (PSL) settings can be uploaded from and downloaded to the IED using the block transfer mechanism (see chapter 12 of the Courier User Guide).

The following cells are used to perform the extraction:

- **Domain** cell (B204): Used to select either PSL settings (upload or download) or PSL configuration data (upload only)
- **Sub-Domain** cell (B208): Used to select the Protection Setting Group to be uploaded or downloaded.
- **Version** cell (B20C): Used on a download to check the compatibility of the file to be downloaded.
- **Transfer Mode** cell (B21C): Used to set up the transfer process.
- **Data Transfer** cell (B120) : Used to perform upload or download.

The programmable scheme-logic settings can be uploaded and downloaded to and from the IED using this mechanism. S1 Studio must be used to edit the settings. S1 Studio also performs checks on the validity of the settings before they are transferred to the IED.

6.9 Configuring the IED for Courier

Once the physical connection is made, configure the IED's communication settings using the keypad and LCD user interface.

4. In the IED menu, select the Configuration column, then check that the Comms. settings cell is set to Visible.
5. Select the Communications column. Only two settings apply to the rear port using Courier, the IED's address and the inactivity timer. Synchronous communication is used at a fixed baud rate of 64 kbits/s.
6. Move down the Communications column from the column heading to the first cell down. This shows the communication protocol.

```
RP1 Protocol
Courier
```

7. The next cell down the column controls the address of the IED. Since up to 32 IEDs can be connected to one K-Bus spur, as shown in Figure 2, each IED must have a unique address so that messages from the master control station are accepted by one IED only. Courier uses an integer between 0 and 254 for the IED address that is set with this cell. It is important that no two IEDs have the same Courier address. The Courier address is then used by the master station to communicate with the IED.

```
RP1 Address
1
```

8. The next cell down controls the inactivity timer. The inactivity timer controls how long the IED waits without receiving any messages on the rear port before it reverts to its default state, including revoking any password access that was enabled. For the rear port this can be set between 1 and 30 minutes

```
RP1 Inactiv Timer
10.00 mins.
```

9. The next cell down controls the physical media used for the communication. The default setting is to select the copper electrical EIA(RS)-485 connection. If the optional fiber optic connectors are fitted to the IED, this setting can be changed to Fiber optic. This cell is also invisible if a second rear comms. port is fitted because it is mutually exclusive to the fiber optic connectors.

```
RP1 Physical link
Copper
```

10. .As an alternative to running Courier over K-Bus, Courier over EIA(RS)-485 can be selected. The next cell down indicates the status of the hardware.

```
RP1 Card status
EIA(RS)-232 OK
```

11. The next cell allows you to configure the port for EIA(RS)-485 or K-Bus.

```
RP1 Port config.
EIA(RS)-232
```

12. If using EIA(RS)-485, the next cell selects the communication mode. The choice is either IEC 60870 FT1.2 for normal operation with 11-bit modems, or 10-bit no parity.

```
RP1 Comms. Mode
IEC60870 FT1.2
```

13. If using EIA(RS)-485, the next cell down controls the baud rate. For K-Bus the baud rate is fixed at 64 kbits/second between the IED and the KITZ interface at the end of the IED spur. Courier communications is asynchronous. Three baud rates are supported by the IED, 9600 bits/s, 19200 bits/s and 38400 bits/s.

```
RP1 Baud rate
19200
```

If you modify disturbance recorder settings using an on-line editor such as PAS&T, you must confirm them. To do this, from the Configuration column select the Save changes cell. Off-line editors such as S1 Studio do not need this action for the setting changes to take effect.

7 IEC 61850

IEC 61850 is the international standard for Ethernet-based communication in substations. It enables integration of all protection, control, measurement and monitoring functions within a substation, and additionally provides the means for interlocking and inter-tripping. It combines the convenience of Ethernet with the security that is so essential in substations today.

7.1 Benefits of IEC 61850

The standard provides:

- Standardized models for IEDs and other equipment within the substation
- Standardized communication services (the methods used to access and exchange data)
- Standardized formats for configuration files
- Peer-to-peer communication

The standard adheres to the requirements laid out by the ISO OSI model and thus provides complete vendor interoperability and flexibility on the transmission types and protocols used. This includes mapping of data onto Ethernet, which is becoming more and more widely used in substations, in favor of RS485. Using Ethernet in the substation offers many advantages, most significantly including:

- Ethernet allows high-speed data rates (currently 100 Mbps, rather than 10’s of kbps or less used by most serial protocols)
- Ethernet provides the possibility to have multiple clients
- Ethernet is an open standard in every-day use
- There is a wide range of Ethernet-compatible products that may be used to supplement the LAN installation (hubs, bridges, switches)

7.2 IEC 61850 Interoperability

A major benefit of IEC 61850 is interoperability. IEC 61850 standardizes the data model of substation IEDs, which allows interoperability between products from multiple vendors.

An IEC 61850-compliant device does not mean that it is interchangeable, but does mean that it is interoperable. You cannot simply replace one product with another, however the terminology is pre-defined and anyone with prior knowledge of IEC 61850 should be able very quickly integrate a new device without the need for mapping of all of the new data. IEC 61850 will inevitably bring improved substation communications and interoperability, at a lower cost to the end user.

7.3 The IEC 61850 data model

The data model of any IEC 61850 IED can be viewed as a hierarchy of information, whose nomenclature and categorization is defined and standardized in the IEC 61850 specification.

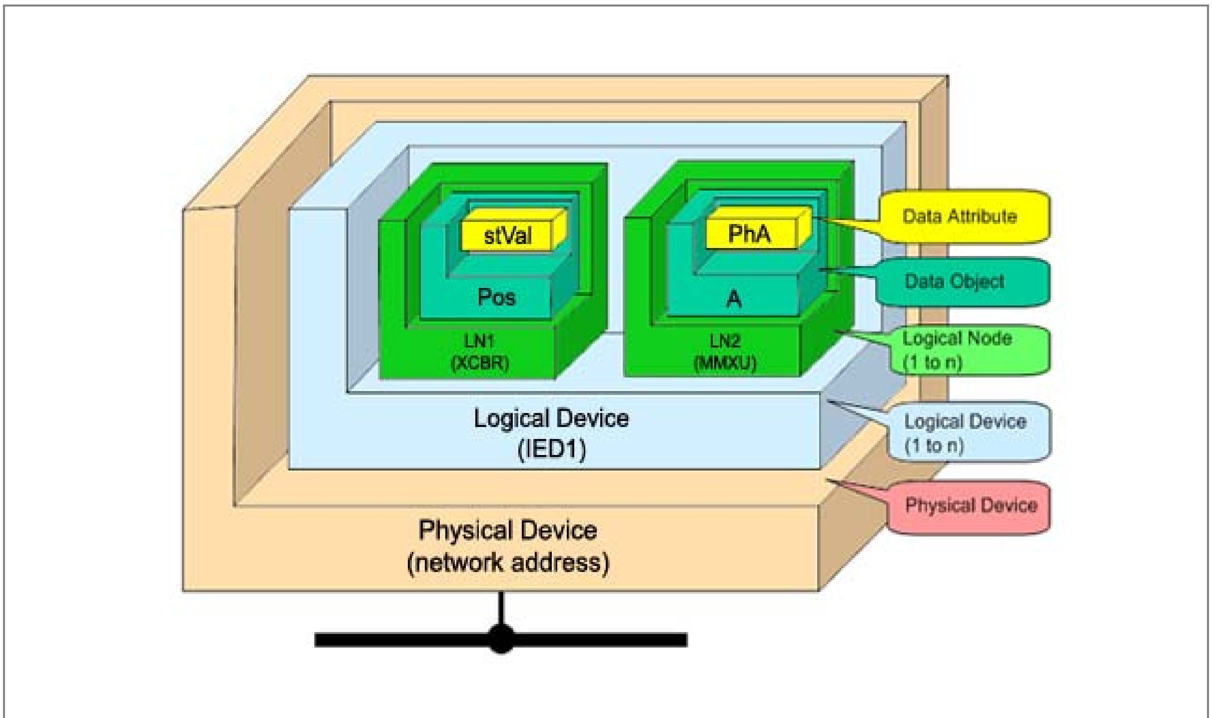


Figure 4: Data model layers in IEC 61850

The levels of this hierarchy can be described as follows:

Layer	Description
Physical Device	Identifies the actual IED within a system. Typically the device's name or IP address can be used (for example Feeder_1 or 10.0.0.2
Logical Device	Identifies groups of related Logical Nodes within the Physical Device. For the MiCOM ALSTOM IEDs, 5 Logical Devices exist: Control, Measurements, Protection, Records, System
Wrapper/Logical Node Instance	Identifies the major functional areas within the IEC 61850 data model. Either 3 or 6 characters are used as a prefix to define the functional group (wrapper) while the actual functionality is identified by a 4 character Logical Node name suffixed by an instance number.
	For example, XCBR1 (circuit breaker), MMXU1 (measurements), FrqPTOF2 (overfrequency protection, stage 2)
Data Object	This next layer is used to identify the type of data you will be presented with. For example, Pos (position) of Logical Node type XCBR
Data Attribute	This is the actual data (measurement value, status, description, etc.). For example, stVal (status value) indicating actual position of circuit breaker for Data Object type Pos of Logical Node type XCBR

Table 4: Data Frame format

7.4 IEC 61850 in MiCOM ALSTOM IEDs

In the IEDs, IEC 61850 is implemented by use of a separate Ethernet card. This card manages the majority of the IEC 61850 implementation and data transfer to avoid any impact on the performance of the protection.

In order to communicate with an IEC 61850 IED on Ethernet, it is necessary only to know its IP address. This can then be configured into either:

- An IEC 61850 client (or master), for example a PACiS computer (MiCOM ALSTOM C264)
- An HMI
- An MMS browser, with which the full data model can be retrieved from the IED, without any prior knowledge of the IED

The IEDs IEC 61850 compatible interface standard provides capability for:

- Read access to measurements
- All measurements are refreshed once per second.
- Generation of un-buffered reports on change of status or measurement
- Support for time synchronization over an Ethernet link. (Time synchronization is supported using SNTP (Simple Network Time Protocol), which is used to synchronize the internal real time clock of the IEDs).
- GOOSE peer-to-peer communication
- GOOSE communications of statuses.
- Disturbance record extraction by file transfer. The record is extracted as an ASCII format COMTRADE file.

Note: Setting changes are not supported in the current IEC 61850 implementation. Currently these setting changes are carried out using S1 Studio Settings & Records program. You can use the front port serial connection of the IED as before, or if preferred, an Ethernet connection.

7.5 IEC 61850 configuration

IEC 61850 allows IEDs to be directly configured from a configuration file. The IED's system configuration capabilities are determined from an **IED Capability Description** file (ICD), supplied with the product. By using ICD files from the products to be installed, you can design, configure and even test (using simulation tools), a substation's entire protection scheme before the products are even installed into the substation.

To help with this process, S1 Studio provides an IED Configurator tool, which allows the pre-configured IEC 61850 configuration file to be imported and transferred to the IED. As well as this, you can manually create configuration files for IEDs, based on their original IED capability description (ICD file).

Other features include:

- The extraction of configuration data for viewing and editing.
- A sophisticated error checking sequence to validate the configuration data before sending to the IED.

> *Note: To help the user, some configuration data is available in the **IED CONFIGURATOR** column, allowing read-only access to basic configuration data.*

7.6 IEC 61850 Configuration banks

To help version management and minimize down-time during system upgrades and maintenance, the IEDs have incorporated a mechanism consisting of multiple configuration banks. These configuration banks fall into two categories:

- Active Configuration Bank
- Inactive Configuration Bank

Any new configuration sent to the IED is automatically stored in the inactive configuration bank, therefore not immediately affecting the current configuration.

When the upgrade or maintenance stage is complete, the IED Configurator tool can be used to transmit a command, which authorizes activation of the new configuration contained in the inactive configuration bank. This is done by switching the active and inactive configuration banks. The capability of switching the configuration banks is also available using the **IED CONFIGURATOR** column of the HMI.

The SCL Name and Revision attributes of both configuration banks are also available in the **IED CONFIGURATOR** column of the HMI.

7.7 IEC 61850 Network connectivity

Configuration of the IP parameters and SNTP time synchronization parameters is performed by the IED Configurator tool. If these parameters are not available using an SCL file, they must be configured manually.

As the IP addressing will be completely detached and independent from any public network, it is up to the company's system administrator to establish the IP addressing strategy. Every IP address on the network must be unique. This applies to all devices on the network. Duplicate IP addresses will result in conflict and must be avoided. The IED will check for a conflict on every IP configuration change and at power up. An alarm will be raised if an IP conflict is detected.

The IED can be configured to accept data from other networks using the **Gateway** setting. If multiple networks are used, the IP addresses must be unique across networks.

7.8 The IEC 61850 data model of IEDs

The data model naming adopted in the IEDs has been standardized for consistency. Hence the Logical Nodes are allocated to one of the five Logical Devices, as appropriate, and the wrapper names used to instantiate Logical Nodes are consistent between Px30 and Px40 IEDs.

The data model is described in the Model Implementation Conformance Statement (MICS) document, which is available as a separate document if required.

7.9 The IEC 61850 communication services of IEDs

The IEC 61850 communication services which are implemented in the IEDs are described in the Protocol Implementation Conformance Statement (PICS) document, which is available as a separate document if required.

7.10 IEC 61850 Peer-to-peer (GSSE) communications

The implementation of IEC 61850 Generic Substation Event (GSSE) enables faster communication between IEDs offering the possibility for a fast and reliable system-wide distribution of input and output data values. The GSSE model uses multicast services to deliver event information. Multicast messaging means that messages are broadcast to all the devices on the network by using the broadcast address. It is also known as a publisher-subscriber system. When a device detects a change in one of its monitored status points it publishes a new message. Any device that is interested in the information subscribes to the data it contains.

> ***Note:*** *Multicast messages cannot be routed across networks without specialized equipment.*

Each new message is re-transmitted at configurable intervals, to counter for possible corruption due to interference, and collisions, thus ensuring delivery. In practice, the parameters controlling the message transmission cannot be calculated. Time must be allocated to the testing of GSSE schemes before or during commissioning, in just the same way a hardwired scheme must be tested.

7.10.1 Mapping GOOSE messages to virtual inputs

Each GOOSE signal contained in a subscribed GOOSE message can be mapped to any of the 32 virtual inputs within the PSL. The virtual inputs allow the mapping to internal logic functions for protection control, directly to output contacts or LEDs for monitoring. All published GOOSE signals are BOOLEAN values

An IED can subscribe to all GOOSE messages but only the following data types can be decoded and mapped to a virtual input:

- BOOLEAN
- BSTR2
- INT16
- INT32
- INT8
- UINT16
- UINT32
- UINT8

7.10.2 IEC 61850 GOOSE configuration

All GOOSE configuration is performed using the IED Configurator tool available in the S1 Studio Support Software.

All GOOSE publishing configuration can be found under the **GOOSE Publishing** tab in the configuration editor window. All GOOSE subscription configuration parameters are under the **External Binding** tab in the configuration editor window.

Settings to enable GOOSE signaling and to apply Test Mode are available using the HMI.

7.11 Ethernet functionality

Settings relating to a failed Ethernet link are available in the **COMMUNICATIONS** column of the IED's HMI.

7.11.1 Ethernet disconnection

IEC 61850 **Associations** are unique and made between the client and server. If Ethernet connectivity is lost for any reason, the associations are lost, and will need to be re-established by the client. The IED has a **TCP_KEEPALIVE** function to monitor each association, and terminate any which are no longer active.

7.11.2 Loss of power

The IED allows the re-establishment of associations without disrupting the IED's operation, even after its power has been removed. As the IED acts as a server in this process, the client must request the association. Uncommitted settings are cancelled when power is lost, and reports requested by connected clients are reset. The client must re-enable these when it next creates the new association to the IED.

REDUNDANT ETHERNET

CHAPTER 8

1 OVERVIEW

The term redundancy can be a little misleading, as it implies that something may not be needed. If the term is qualified such that it reads “Redundancy is any resource that would not be needed if there were no failures”, it becomes clear what redundancy means in the context of IT systems, or indeed any other industrial system. Redundancy is transparent backup. It is required where failure cannot be tolerated, and is thus required in critical applications such as substation automation. Redundancy acts as an insurance policy, providing an alternative system in the event that one system fails.

Industrial network failure can be disastrous. Redundancy provides increased security and reliability, but also devices can be added to or removed from the network without network downtime.

The Redundant Ethernet Board (REB) designed for the Px40 series assures "bumpless" redundancy at the intelligent electronic device (IED) level.

This chapter describes the REB in detail and consists of the following sections:

2 HARDWARE DESCRIPTION

Ethernet redundancy can be implemented in many different ways. Alstom Grid provides six boards to cover various requirements. Each board combines Ethernet communications, with IRIG-B timing functionality.

There is a choice of three embedded protocols for the Ethernet communications, and two types of IRIG-B, hence there is a choice of six boards:

PCB	Part number
Self-Healing Protocol (SHP) with modulated IRIG-B	ZN0071 001
Self-Healing Protocol (SHP) with demodulated IRIG-B	ZN0071 002
Rapid Spanning Tree Protocol (RSTP) with modulated IRIG-B	ZN0071 005
Rapid Spanning Tree Protocol (RSTP) with demodulated IRIG-B	ZN0071 006
Dual Homing Protocol (DHP) with modulated IRIG-B	ZN0071 007
Dual Homing Protocol (DHP) with demodulated IRIG-B	ZN0071 008

Table 1: Model variant features

All Ethernet connections are made with 1300 nm multi mode 100BaseFx fiber optic Ethernet ports (ST® connector).

The boards support both IEC 61850 and DNP3.0 over Ethernet.

Note: SHP and DHP are Alstom Grid proprietary Protocols providing extremely fast recovery time. These boards offer compatibility with C264-SWR202 and MiCOM ALSTOM H35x multi-mode switches.

The REB is fitted into Slot A of the IED, which is the optional communications slot. Each Ethernet board has two MAC addresses, one for the managed embedded switch and one for the IED.

The MAC address of the IED is printed on the rear panel of the IED. The MAC address of the embedded switch is printed on the board

For information concerning installation, refer to the installation chapter of this manual and the Best Practice document GP02 Ethernet Wiring.

Figure 1 and Table 1, Table 2, Table 3 and Table 4 provide details about the board and its connectors.

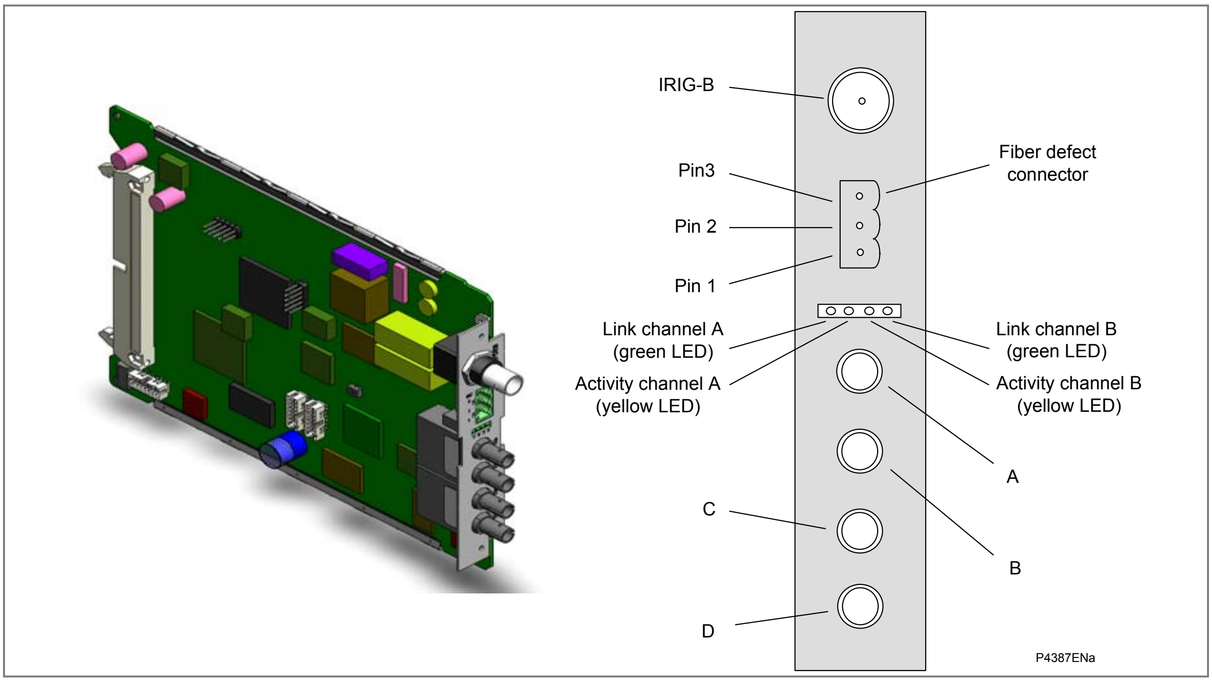


Figure 1: REB connectors

Fiber Defect Connector (Watchdog Relay)

Pin	Closed	Open
1-2	Link fail Channel 1 (A)	Link ok Channel 1 (A)
2-3	Link fail Channel 2 (B)	Link ok Channel 2 (B)

Table 2: Fiber Defect Connector (Watchdog Relay)

LEDs

LED	Function	On	Off	Flashing
Green	Link	Link ok	Link broken	
Yellow	Activity	SHP running		RSTP or DHP traffic

Table 3: LED functionality

Optical Fiber Connectors

Connector	DHP	RSTP	SHP
A	RXA	RX1	RP
B	TXA	TX1	ES
C	RXB	RX2	RS
D	TXB	TX2	EP

Table 4: Optical fiber connector functionality

3 REDUNDANCY PROTOCOLS

There are three redundancy protocols available:

- RSTP (Rapid Spanning Tree Protocol)
- SHP (Self-Healing Protocol)
- DHP (Dual Homing Protocol)

3.1 Rapid Spanning Tree Protocol (RSTP)

RSTP is a standard used to quickly reconnect a network fault by finding an alternative path, allowing loop-free network topology. Although RSTP can recover network faults quickly, the fault recovery time depends on the number of devices and the topology. The recovery time also depends on the time taken by the devices to determine the root bridge and compute the port roles (discarding, learning, forwarding). The devices do this by exchanging Bridge Protocol Data Units (BPDUs) containing information about bridge IDs and root path costs. See the IEEE 802.1D 2004 standard for further information.

The Px4x REB uses the RSTP protocol (802.1w), so a Px4x can attach onto a network as shown in Figure 2.

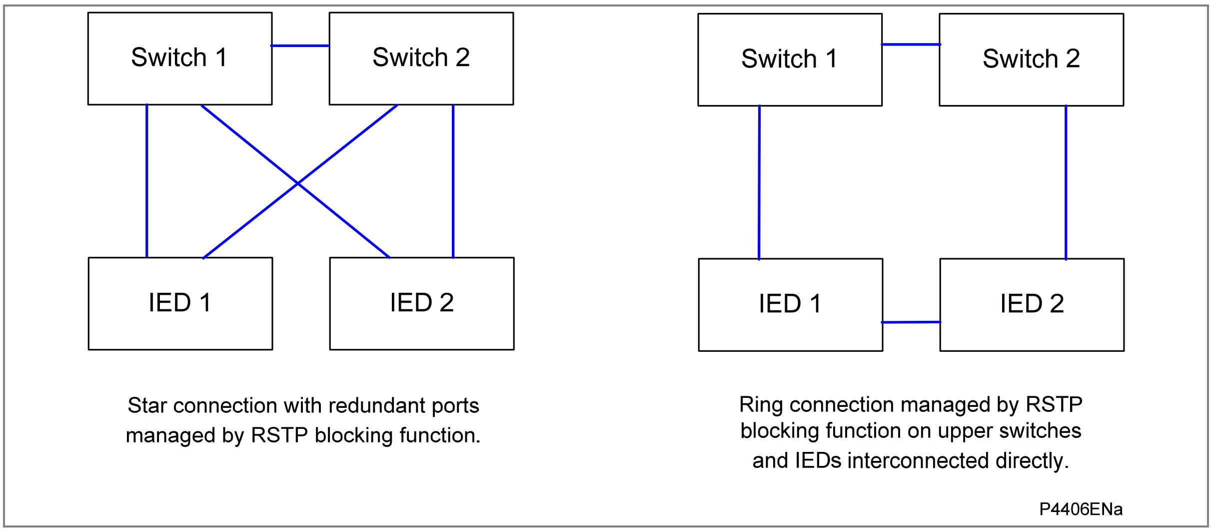


Figure 2: Px4x attached to a redundant Ethernet star or ring circuit

The RSTP solution is based on open standards. It is therefore compatible with other Manufacturers' IEDs that use the RSTP protocol. The RSTP recovery time is typically 300 ms but it increases with network size. However, the Alstom Grid DHP solution and Alstom Grid SHP solution respond to the constraints of critical time applications such as the GOOSE messaging of IEC 61850.

3.2 Self-Healing Protocol (SHP)

SHP is applied to double-ring network topologies. When a fiber is broken, both end stations detect the break. Using both the primary and redundant networks the ring is automatically reclosed.

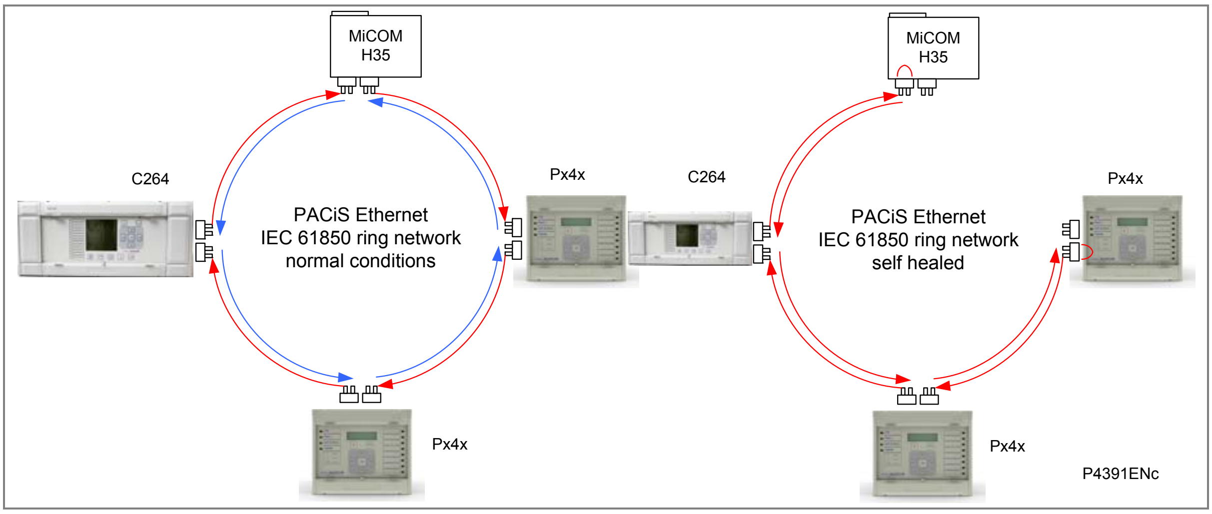


Figure 3: MiCOM ALSTOM products in a self-healing ring

The devices shown in the diagram are repeaters with a standard 802.3 Ethernet switch plus the Self-Healing Manager (SHM). Figure 4 shows the internal architecture of such a device.

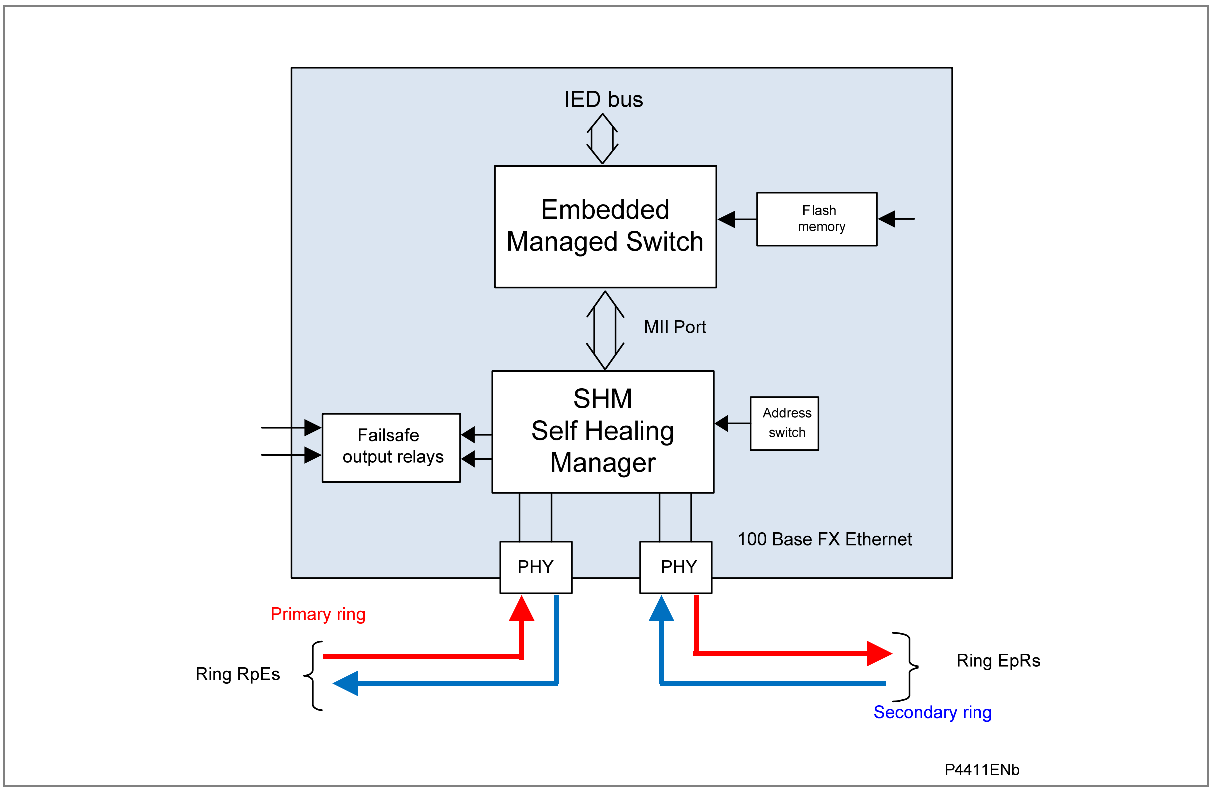


Figure 4: Internal architecture of Redundant Ethernet facility

The SHM functions manage the ring. If the fiber optic connection between two devices is broken, the network continues to run correctly.

Normally the Ethernet packets travel on the primary fiber in the same direction, and only a checking frame (4 octets) is sent every 5 µs on the secondary fiber in the opposite direction.

If the link goes down, both SHMs immediately start the network self-healing. At one side of the break, received messages are no longer sent to the primary fiber but are sent to the secondary fiber. On the other side of the break, messages received on the secondary fiber are sent to the primary fiber and the new topological loop is closed in less than 1 ms.

It is therefore possible to extend the number of devices, or the size of a sub-station network, without stopping the network. The loop is opened and it self heals, then new equipment is connected and it self heals again, closing the loop.

To increase the reliability some specific mechanisms are used:

- The quality of transmission is monitored. Each frame (Ethernet packet or checking frame) is controlled by the SHM. If a large error rate is detected, the self healing starts and the fault is eliminated.
- Even if there is no traffic in the primary link, the secondary link is still supervised by sending out checking frames every 5 µs.

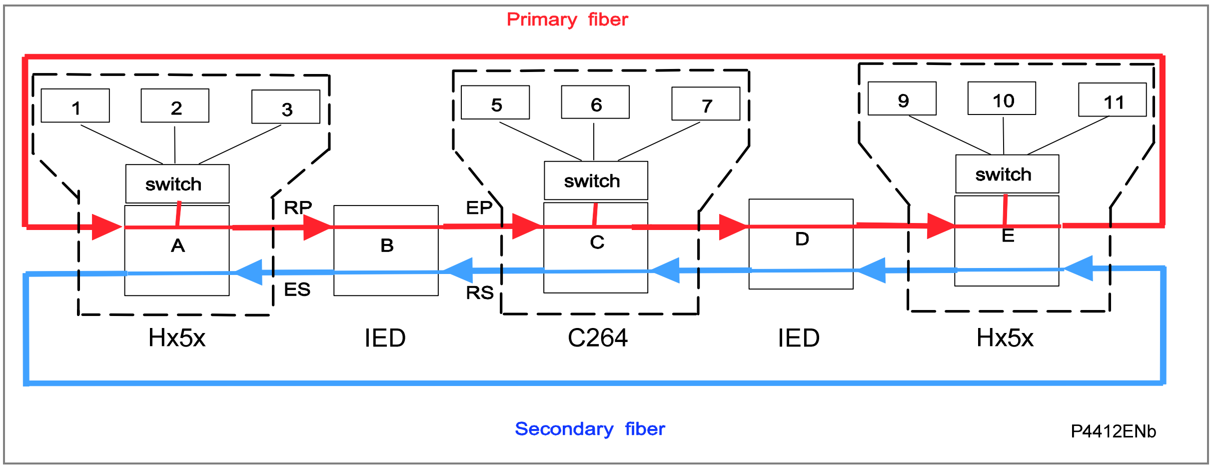


Figure 5: Nominal redundant Ethernet ring architecture

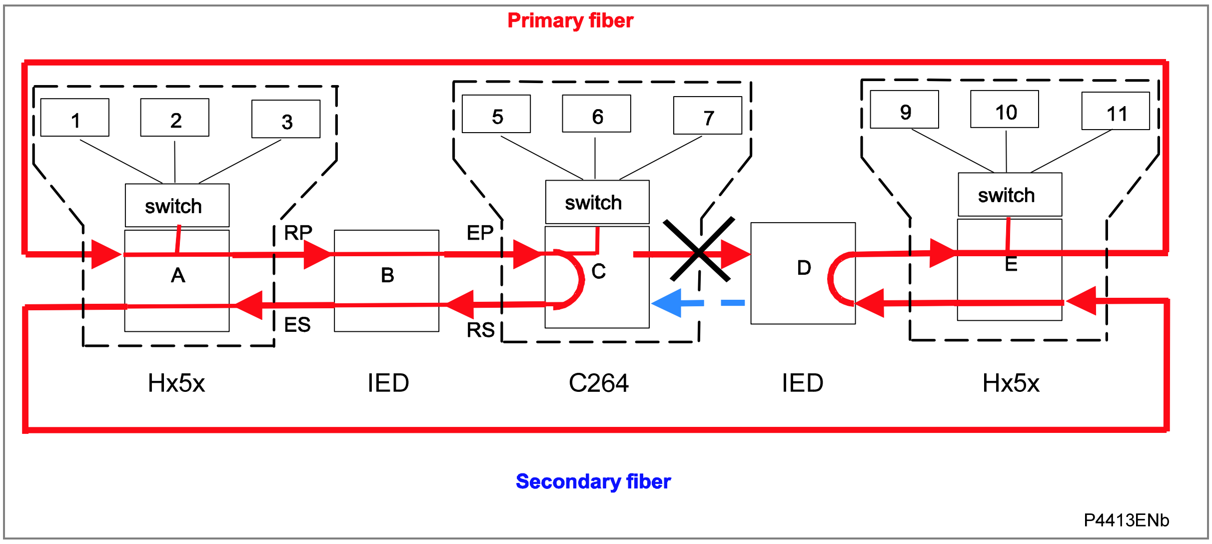


Figure 6: Ethernet ring architecture after failure

3.3 Dual-Homing Protocol (DHP)

The Dual Homing Manager (DHM) functions manage the double star. If the optical fiber connection between two devices is broken, the network continues to operate correctly.

The DHM handles topologies where a device is connected to two independent networks. One is the main link, the other is the backup. Both are active at the same time.

In sending mode, packets from the device are sent by the DHM to the two networks. In receive mode, the duplicate discard principle is used. This means that when both links are up, the MiCOM ALSTOM H16x receives the same Ethernet frame twice. The DHM transmits the first frame received to upper layers for processing, and the second frame is discarded. If one link is down, the frame is sent through the link, received by the device, and passed to upper layers for processing.

Alstom Grid's DHM fulfils automation requirements by delivering a very fast recovery time for the entire network (less than 1 ms).

To increase reliability some specific mechanisms are used:

- Each frame carries a sequence number which is incremented and inserted into both frames.
- Specific frames are used to synchronize the discard mechanism.

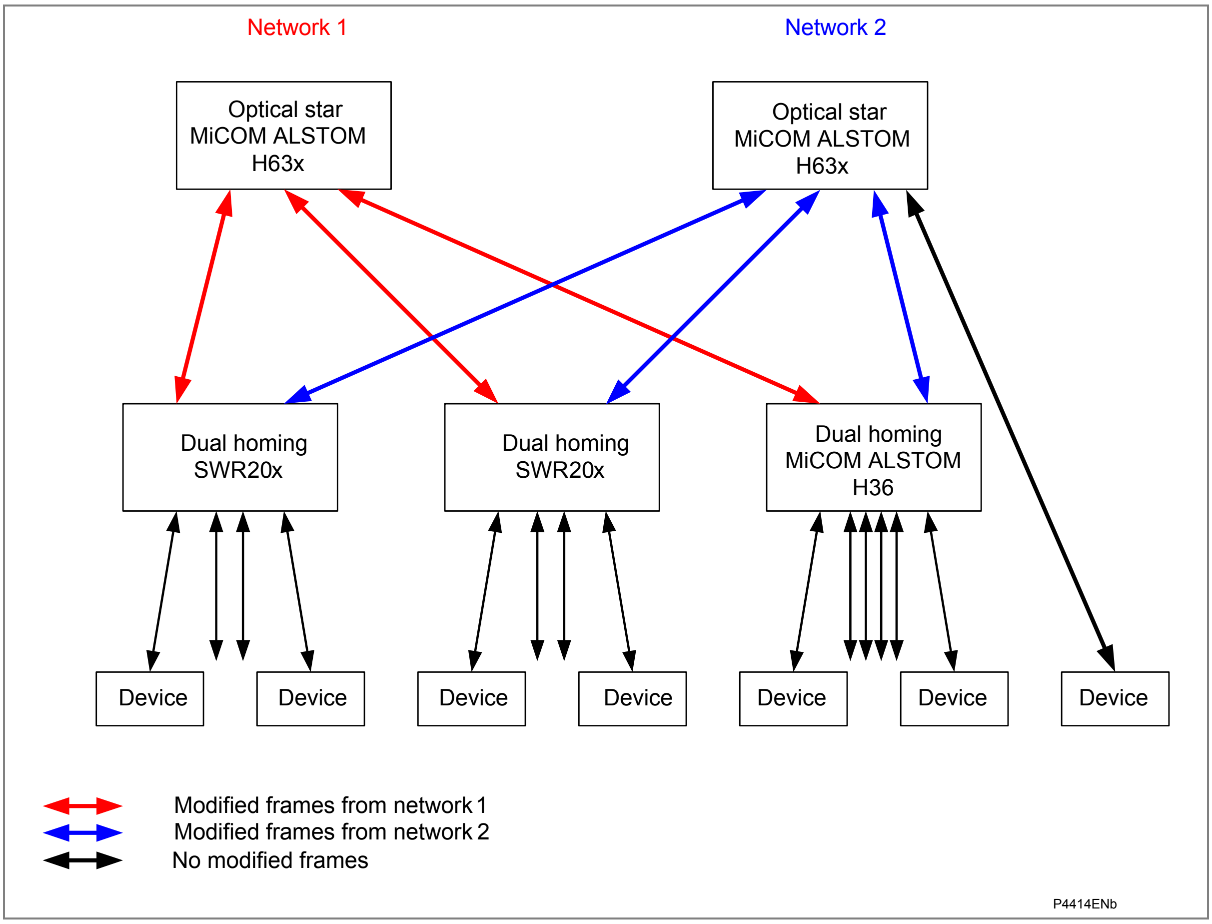


Figure 7: Dual homing mechanism

The H36x is a repeater with a standard 802.3 Ethernet switch, plus the DHM. Figure 8 shows the internal architecture of such a device.

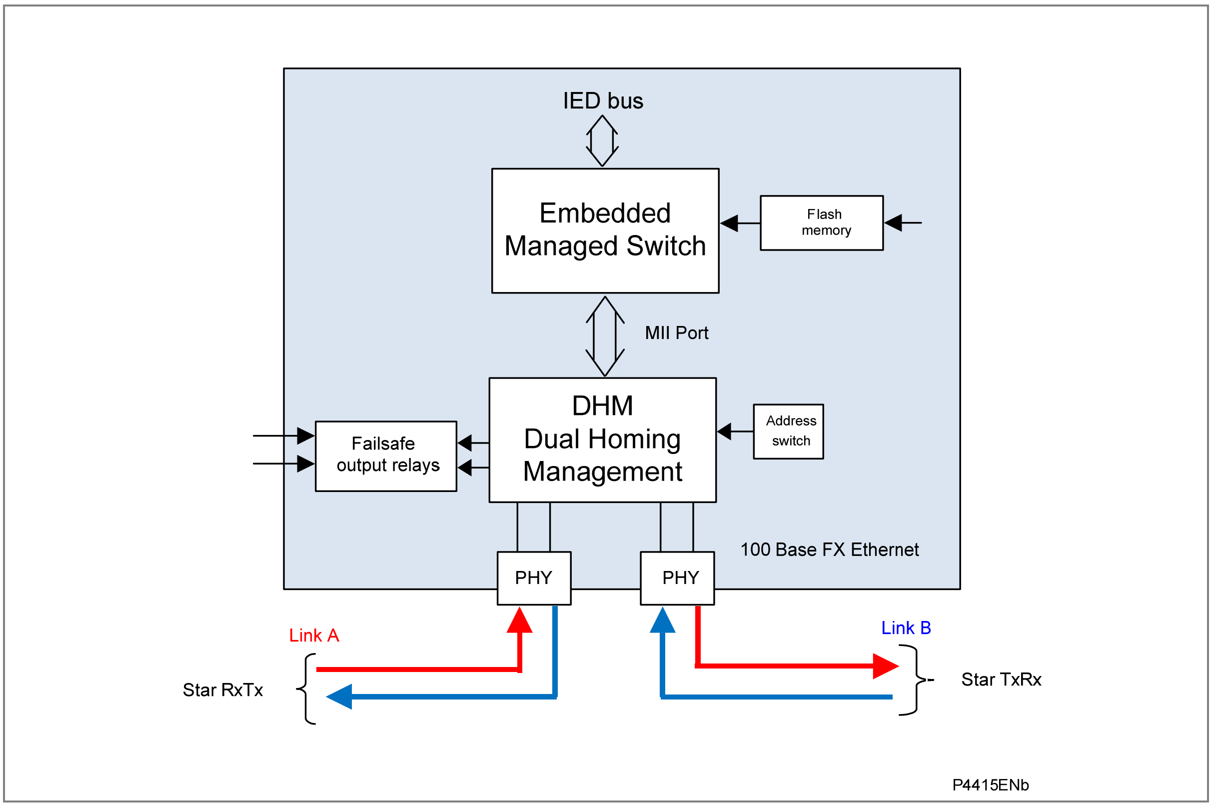


Figure 8: Internal architecture

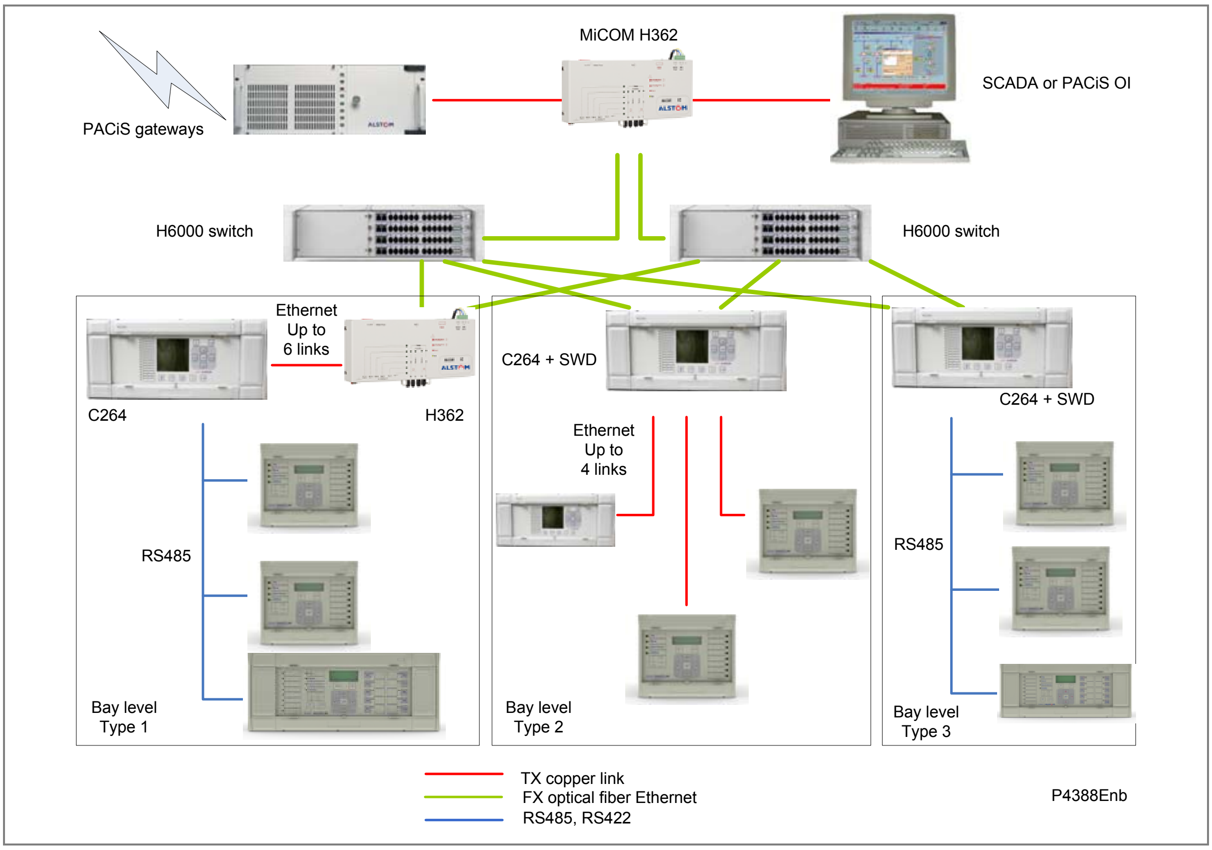


Figure 9: Application of Alstom Grid dual homing star at substation level

3.4 Generic Functions for all Redundant Ethernet Boards

The following apply to all three redundant Ethernet protocols (RSTP, SHP and DHP).

3.4.1 Ethernet 100Base Fx

The fiber optic ports are full duplex 100 Mbps ST connectors.

3.4.2 Forwarding

The MiCOM ALSTOM products switches support store and forward mode. The switch forwards messages with known addresses to the appropriate port. The messages with unknown addresses, the broadcast messages and the multicast messages are forwarded out to all ports except the source port. MiCOM ALSTOM switches do not forward error packets, 802.3x pause frames or local packets.

3.4.3 Priority tagging

802.1p priority is enabled on all ports.

3.4.4 Simple Network Management Protocol (SNMP)

Simple Network Management Protocol (SNMP) is a network protocol designed to manage devices in an IP network. SNMP uses a Management Information Base (MIB) that contains information about parameters to supervise. The MIB format is a tree structure, with each node in the tree identified by a numerical Object Identifier (OID). Each OID identifies a variable that can be read or set using SNMP with the appropriate software. The information in the MIB is standardized.

Each system in a network (workstation, server, router, bridge, and so forth) maintains an MIB that reflects the status of the managed resources on that system, such as the version of the software running on the device, the IP address assigned to a port or interface, the amount of free hard drive space, or the number of open files. The MIB does not contain static data, but is instead an object-oriented, dynamic database that provides a logical collection of managed object definitions. The MIB defines the data type of each managed object and describes the object.

The SNMP-related branches of the MIB tree are located in the internet branch, which contains two main types of branches:

Public branches (mgmt=2), which are defined by the Internet Engineering Task Force (IETF) RFCs, are the same for all SNMP-managed devices.

Private branches (private=4), which are assigned by the Internet Assigned Numbers Authority (IANA), are defined by the companies and organizations to which these branches are assigned.

The following figure shows the structure of the SNMP MIB tree. There are no limits on the width and depth of the MIB tree.

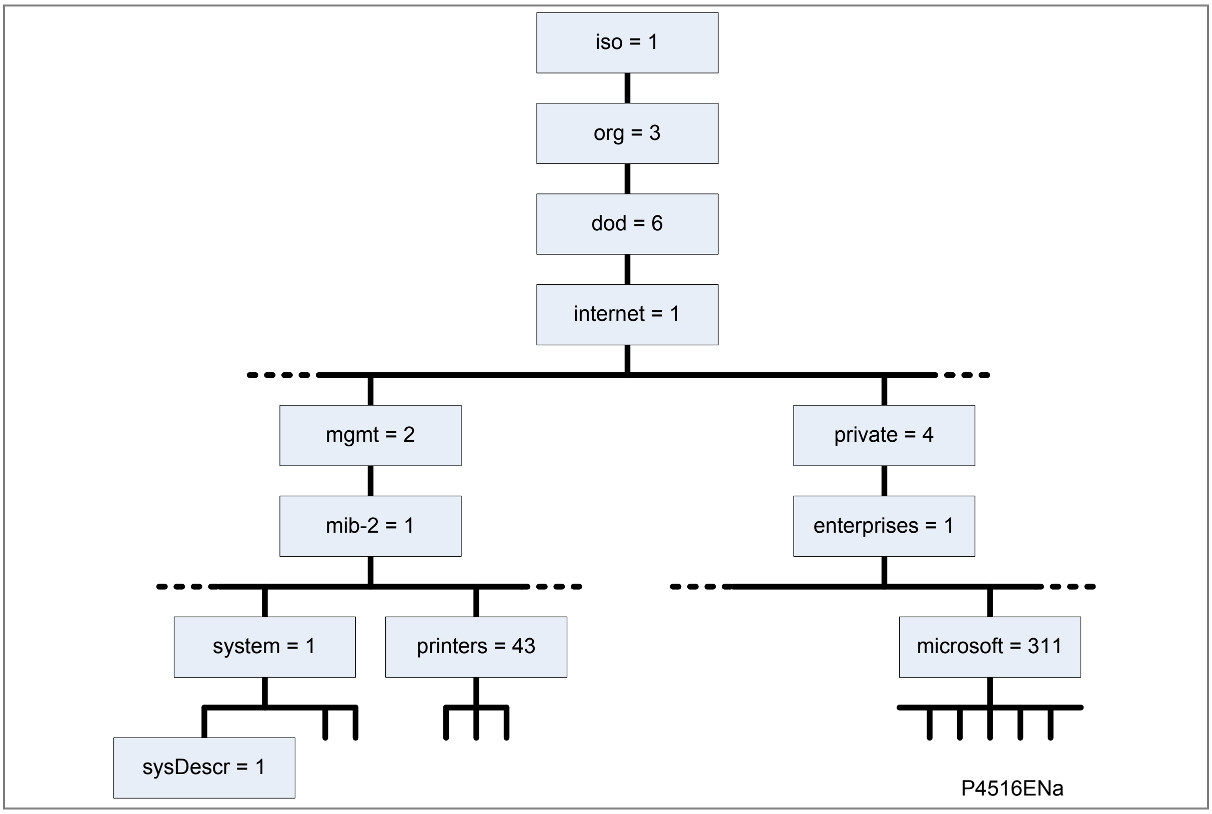


Figure 10: MIB tree structure

Immediately beneath the root of the MIB tree, International Organization for Standardization (iso), is the Organization (org) branch, followed by Department of Defense (dod), and then Internet (internet). Management (mgmt), the main public branch, defines network management parameters common to devices from all vendors. Underneath the Management branch is MIB-II (mib-2), and beneath this are branches for common management functions such as system management, printers, host resources, and interfaces.

The private branch of the MIB tree contains branches for large organizations, organized under the enterprises branch. This is not applicable to Alstom Grid.

Redundant Ethernet board MIB Structure

The Alstom Grid MIB uses three types of OID:

- sysDescr
- sysUpTime
- sysName.

These are shown shaded in Table 5:

Address												Name
0												CCITT
	1											ISO
		3										Org
			6									DOD
				1								Internet
					2							mgmt
						1						Mib-2

Address												Name
							1					sys
								1				sysDescr
								3				sysUpTime
								4				sysName
Remote Monitoring												
							16					RMON
								1				statistics
									1			etherstat
										1		etherStatsEntry
											9	etherStatsUndersizePkts
											10	etherStatsOversizePkts
											12	etherStatsJabbers
											13	etherStatsCollisions
											14	etherStatsPkts64Octets
											15	etherStatsPkts65to127Octets
											16	etherStatsPkts128to255Octets
											17	etherStatsPkts256to511Octets
											18	etherStatsPkts512to1023Octets

Table 5: REB MIB Structure

Various SNMP client software tools can be used with the product range. Alstom Grid recommends using an SNMP MIB browser, which can perform the basic SNMP operations such as GET, GETNEXT, RESPONSE.

To access the network using SNMP, use the IP address of the embedded switch in the REB.

4 CONFIGURATION

An IP address is a logical address assigned to devices in a computer network that uses the Internet Protocol (IP) for communication between nodes. IP addresses are stored as binary numbers but they are represented using Decimal Dot Notation, whereby four sets of decimal numbers are delimited by dots as follows:

`XXX.XXX.XXX.XXX`

For example: `10.86.254.85`

An IP address within a network is usually associated with a subnet mask that defines which network the device resides. A subnet mask takes the same form of an IP address.

For example: `255.255.255.0`

A full explanation of IP addressing and subnet masking is beyond the scope of this guide. Further information is available on application.

Both the IED and the REB each have their own IP address. Figure 11 shows the IED as IP1 and the REB as IP2.

Note: IP1 and IP2 are different but use the same subnet mask.

The switch IP address must be configured through the network.

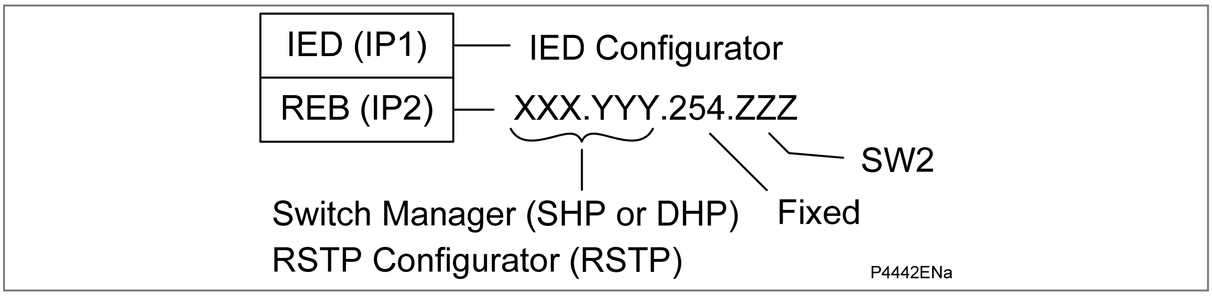


Figure 11: IED and REB IP address configuration

4.1 Configuring the IED IP address

The IP address of the IED is configured using the IED Configurator software in S1 Studio.

For IEC 61850, the IED IP address is set using the IED Configurator.

For DNP3 over Ethernet, the IED IP address is managed directly through the DNP3 file.

There are 126 addresses available, which are configurable in the last octet. These are within the range 128 to 254 decimal, which is equivalent 80 to FE hexadecimal, or 10000000 to 11111110 binary.

*Note: In the IED Configurator, set the port type to **Copper**, not **Fiber**.*

4.2 Configuring the Board IP Address

The IP address of the REB is configured in both software and hardware, as shown in Figure 11. Therefore this must be configured before connecting the IED to the network to avoid an IP address conflict.

4.2.1 Configuring the First Two Octets of the Board IP Address

If using SHP or DHP, the first two octets are configured using Switch Manager or an SNMP MIB browser. An H35 (SHP) or H36 (DHP) network device is needed in the network to configure the Px40 redundant Ethernet board IP address using SNMP.

If using Rapid Spanning Tree Protocol (RSTP), the first two octets are configured using the RSTP Configurator software tool (see section 4.3) or using an SNMP MIB browser (see section 3.4.4).

4.2.2 Configuring the Third Octet of the Board IP Address

The third octet is fixed at 254 (FE hex, 11111110 binary, regardless of the protocol.

4.2.3 Configuring the Last Octet of the Board IP Address

The last octet is configured using board address switch SW2 on the board. It is necessary to first remove the IED front cover to gain access to the board address switch.

Caution This hardware configuration should ideally take place before the unit is installed.

1. Refer to the safety section of the IED.
2. Switch off the IED. Disconnect the power and all connections.
3. Before the front cover is removed take precautions to prevent electrostatic discharge damage, according to the ANSI/ESD-20.20 -2007 standard.
4. Wear a 1 MΩ earth strap and connect it to the ground (earth) point on the back of the IED. See Figure 12.

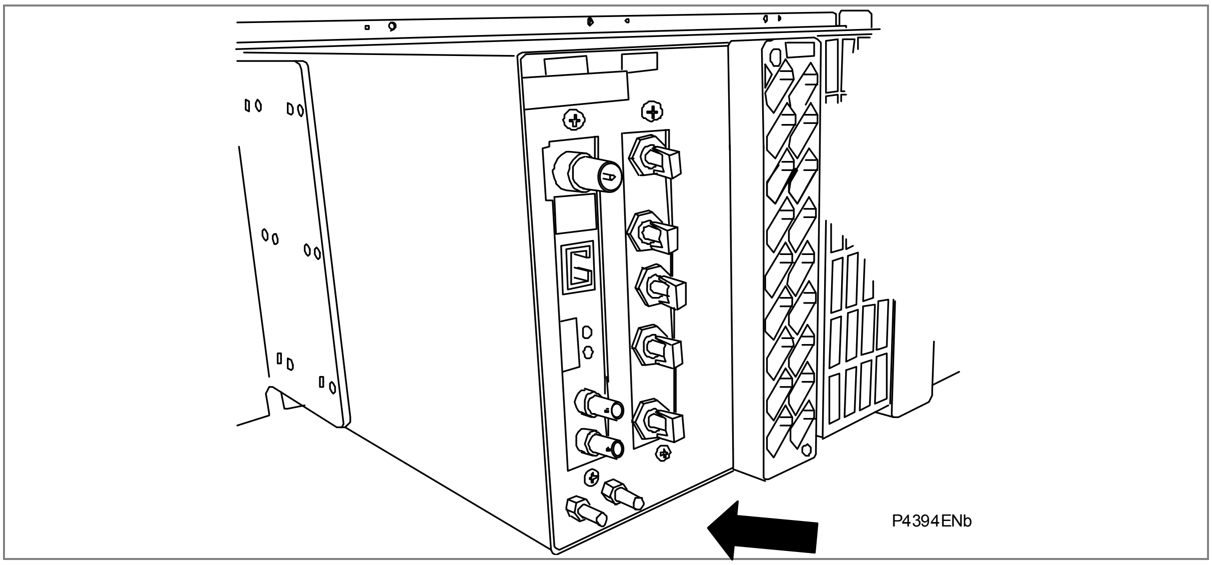


Figure 12: IED earth (ground) point

5. Lift the upper and lower flaps. Remove the six screws securing the front panel and pull the front panel outwards.

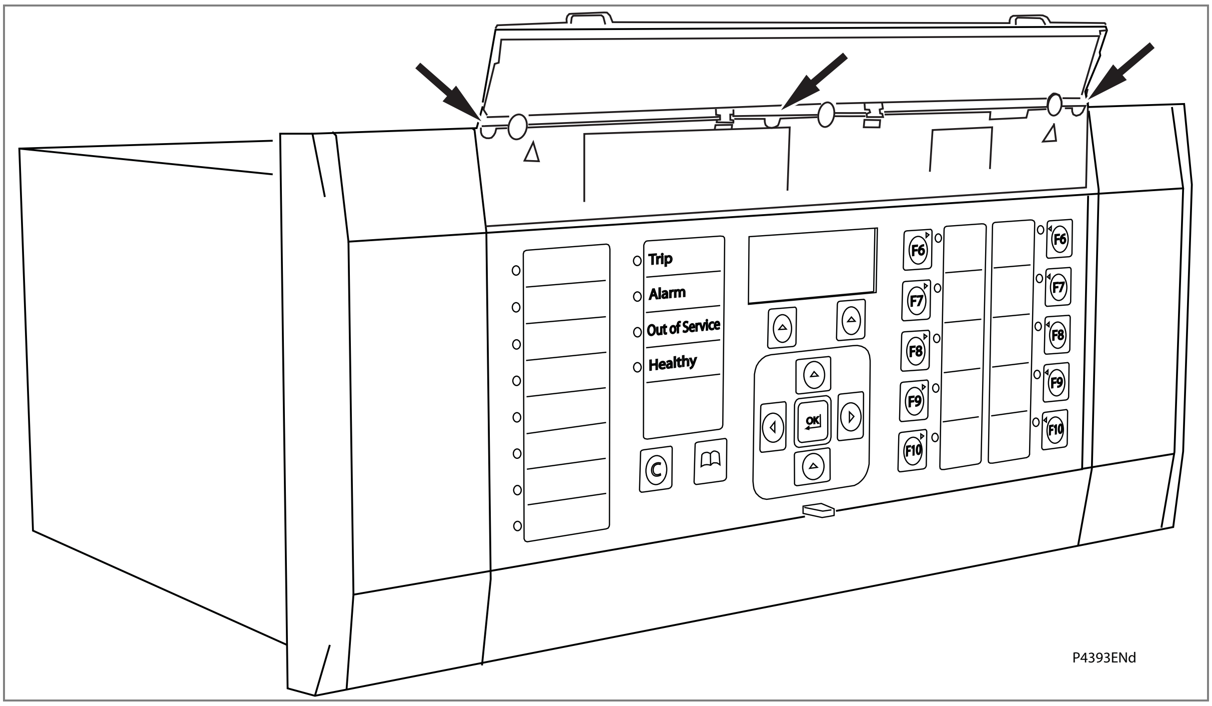


Figure 13: IED front panel

6. Press the levers either side of the connector to disconnect the ribbon cable from the front panel.

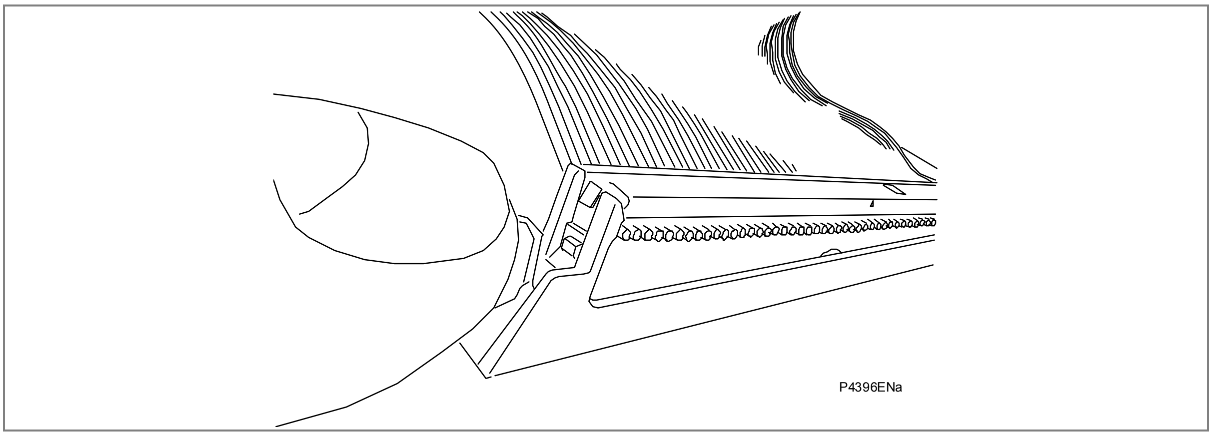


Figure 14: Ribbon cable connector

7. You now have access to the address switches on the dual Ethernet board.

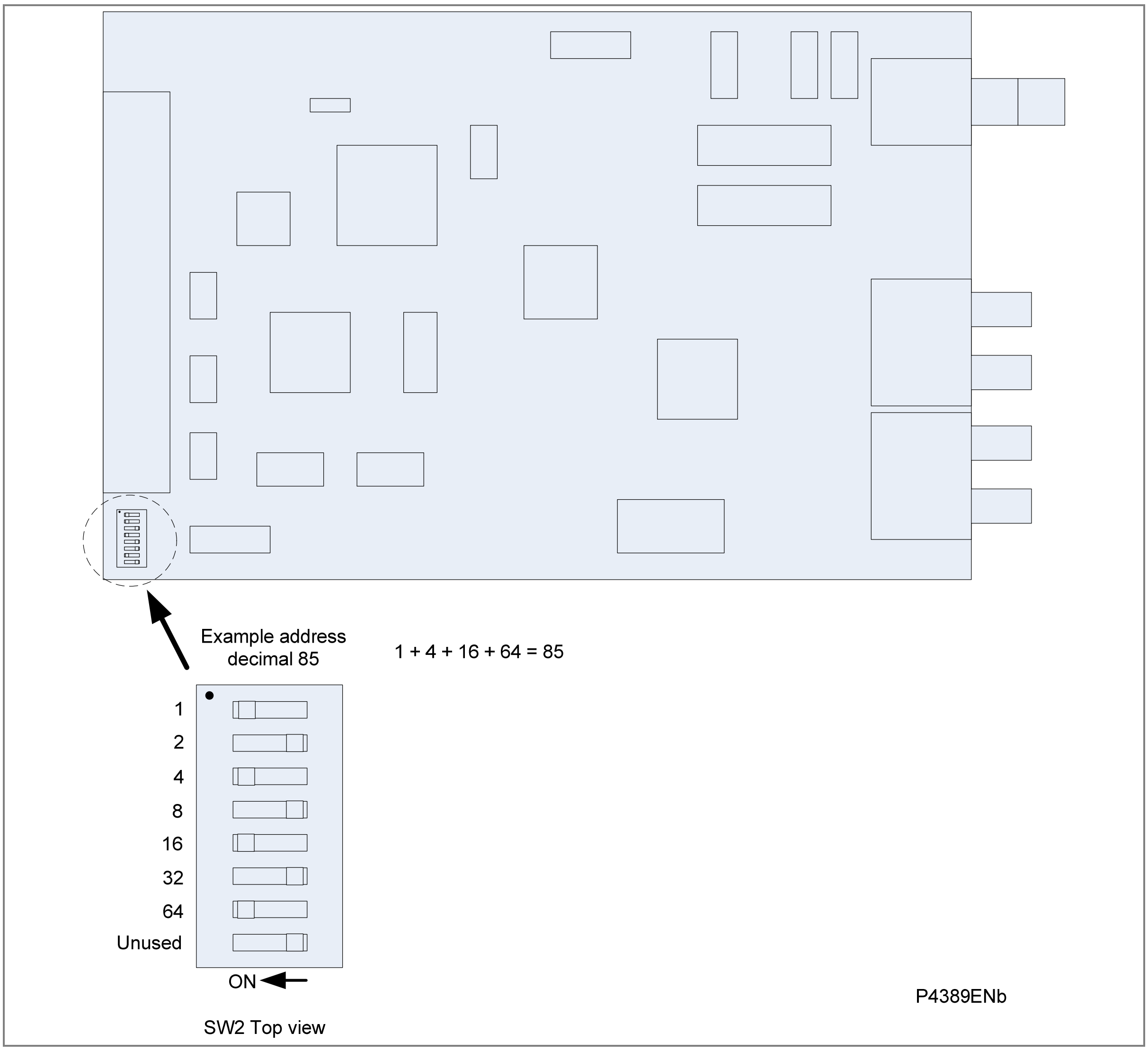


Figure 15: Dual Ethernet board address switches (SW2)

8. Set the last octet of the board IP address by setting the DIP switches.
9. Once you have set the IP address, reassemble the relay, following the above instructions in the reverse order.

Caution **Take care not to damage the pins of the ribbon cable connector on the front panel when reinserting the ribbon cable.**

4.3 RSTP Configurator Software

If you are using RSTP, you will need the RSTP configurator software. This is available from Alstom Grid on request.

The RSTP Configurator software is used to identify a device, configure the IP address, configure the SNTP IP address and configure RSTP settings.

4.3.1 Connecting the IED to a PC

This connection is done through an Ethernet switch or through a media converter. See Figure 16.

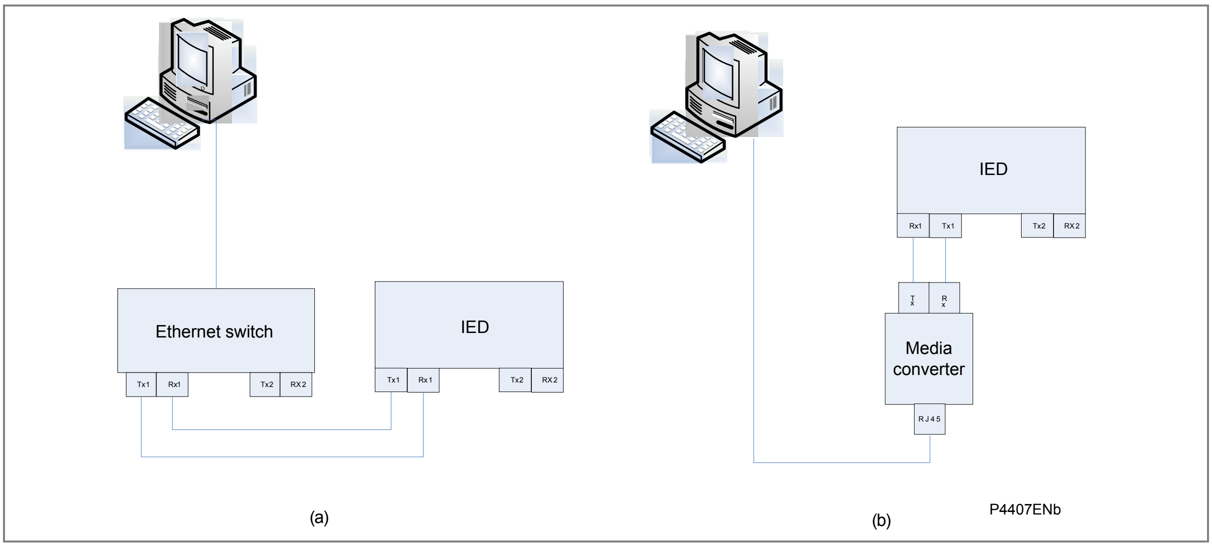


Figure 16: Connection using (a) an Ethernet switch and (b) a media converter

4.3.2 Installing RSTP Configurator

1. Double click **WinPcap_4_0.exe** to install WinPcap.
2. Double click Alstom Grid-RSTP Configurator.msi to install the RSTP Configurator.
3. The setup wizard appears. Click **Next** and follow the on-screen instructions to run the installation.

4.3.3 Starting the RSTP Configurator

1. To start the RSTP Configurator, select **Programs** > **RSTP Configurator** > **RSTP Configurator**.
2. The Login screen appears. For user mode login, enter the **Login name** as **User** and click **OK** with no password.
3. If the login screen does not appear, check all network connections.
4. The main window of the RSTP Configurator appears. The **Network Board** drop-down list shows the Network Board, IP Address and MAC Address of the PC in which the RSTP Configurator is running.

4.3.4 Device Identification

To configure the REB, go to the main window and click **Identify Device**.

> *Note: Due to the time needed to establish the RSTP protocol, it is necessary to wait 25 seconds between connecting the PC to the IED and clicking the **Identify Device** button.*

The REB connected to the PC is identified and its details are listed.

- Device address
- MAC address

- Version number of the firmware
- SNTP IP address
- Date & time of the real-time clock, from the board.

4.3.5 IP Address Configuration

1. To change the network address component of the IP address, go to the main window and click the **IP Config** button.

   The Device setup screen appears. The first three octets of the board IP address can be configured. Note: the last octet is set using the DIP switches (SW2) next to the ribbon connector.
2. Enter the required board IP address and click **OK**.

   The board network address is updated and displayed in the main window.

4.3.6 SNTP IP Address Configuration

1. To Configure SNTP server IP address, go to the main window and click the **SNTP Config** button. The **Device setup** screen appears.
2. Enter the required SNTP MAC and server IP address, then click **OK**.

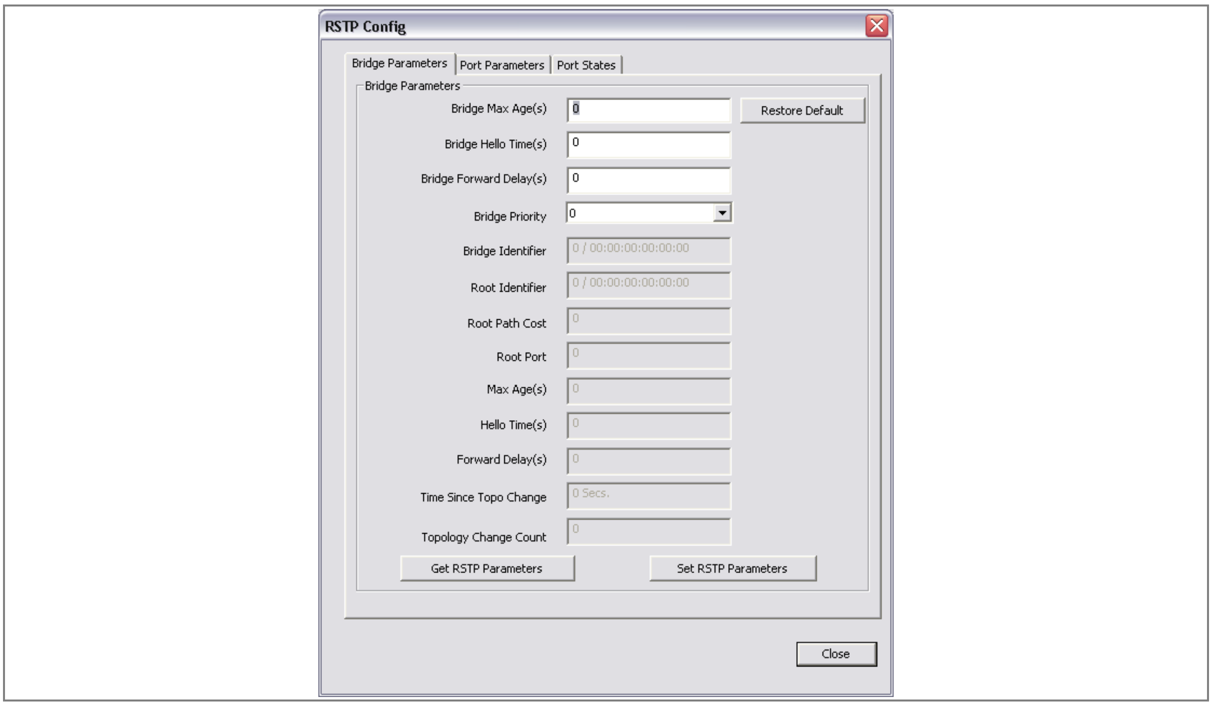
   The updated SNTP server IP address appears in the main screen.

4.3.7 Equipment

1. To view the MAC addresses learned by the switch, go to the main window and click the **Identify Device** button. The selected device MAC address then appears highlighted.
2. Click the **Equipment** button. The list of MAC addresses learned by the switch and the corresponding port number are displayed.

4.3.8 RSTP Configuration

1. To view or configure the RSTP Bridge Parameters, go to the main window and click the device address to select the device. The selected device MAC address appears highlighted.
2. Click the **RSTP Config** button. The RSTP Config screen appears.



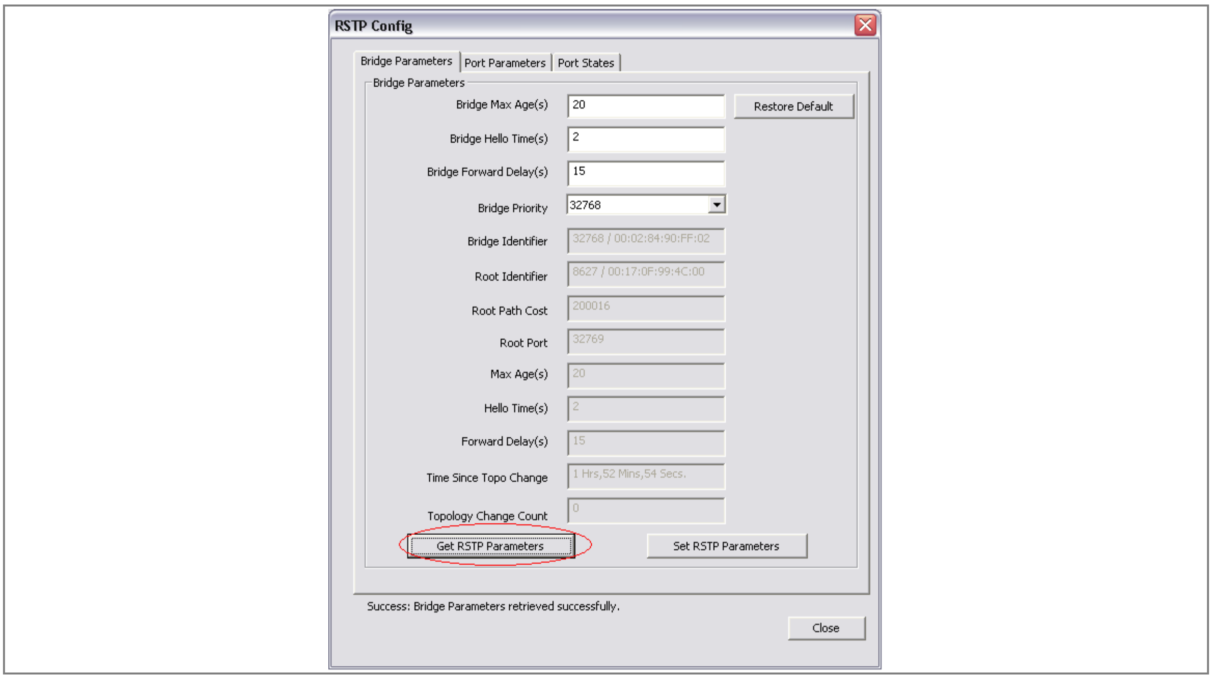
3. To view the available parameters in the board that is connected, click the **Get RSTP Parameters** button.
4. To set the configurable parameters such as **Bridge Max Age**, **Bridge Hello Time**, **Bridge Forward Delay**, and **Bridge Priority**, modify the parameter values and click **Set RSTP Parameters**.

S.No	Parameter	Default value (second)	Minimum value (second)	Maximum value (second)
1	Bridge Max Age	20	6	40
2	Bridge Hello Time	2	1	10
3	Bridge Forward Delay	15	4	30
4	Bridge Priority	32768	0	61440

Table 6: RSTP configuration parameters range and default values

Bridge Parameters

1. To read the RSTP bridge parameters from the board, go to the main window and click the device address to select the device. The **RSTP Config** window appears and the default tab is **Bridge Parameters**.
2. Click the **Get RSTP Parameters** button. This displays all the RSTP bridge parameters from the Ethernet board.

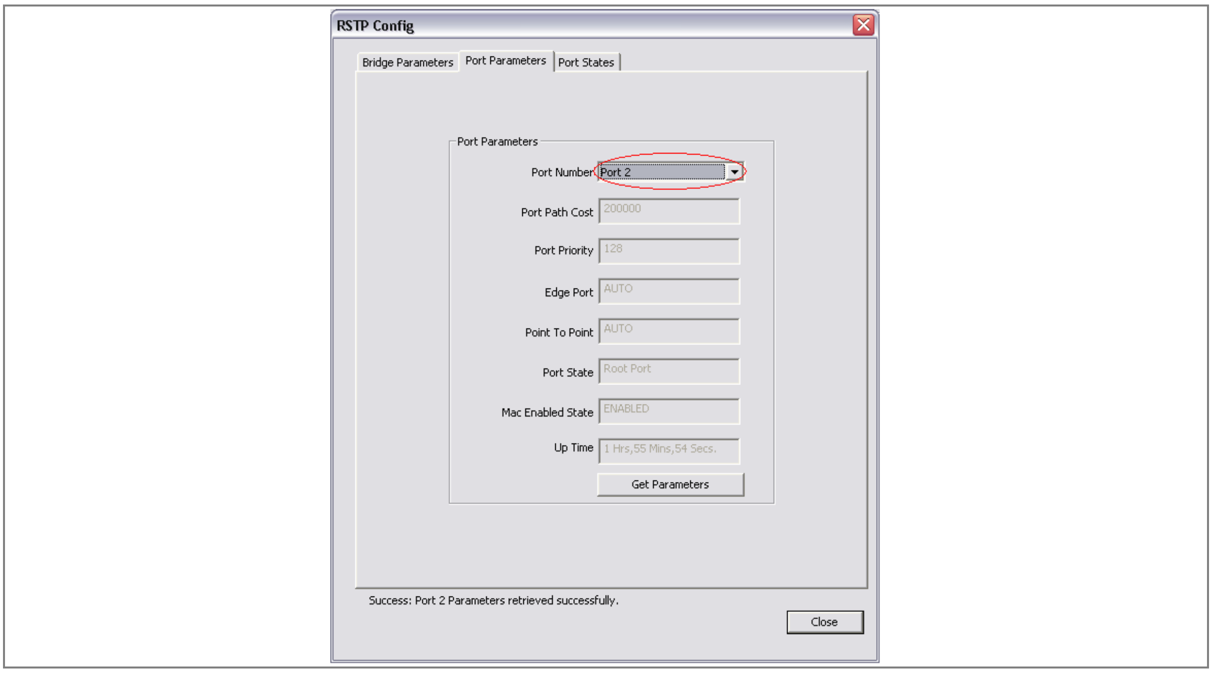


3. To modify the RSTP parameters, enter the values according to Table 6 and click **Set RSTP Parameters**.
4. To restore the default values, click **Restore Default** and click **Set RSTP Parameters**.
5. The grayed parameters are read-only and cannot be modified.

Port Parameters

This function is useful if you need to view the parameters of each port.

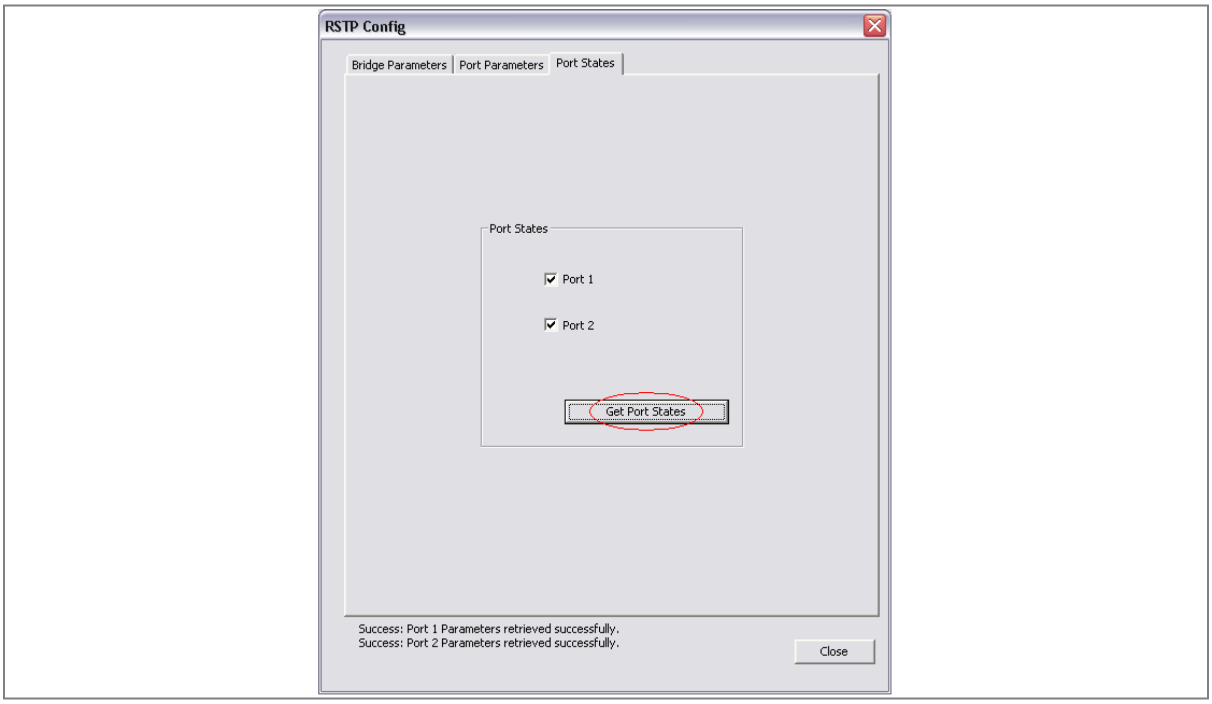
1. From the main window, click the device address to select the device and the **RSTP Config** window appears.
2. Select the **Port Parameters** tab, then click **Get Parameters** to read the port parameters.
3. Alternatively, select the port numbers to read the parameters.



Port States

This is used to see which ports of the board are enabled or disabled.

1. From the main window, click the device address to select the device. The **RSTP Config** window appears.
2. Select the **Port States** tab then click the **Get Port States** button. This lists the ports of the Ethernet board. A tick shows they are enabled.



5 COMMISSIONING

5.1 SHP Ring Connection

Connect Es to Rs and Ep to Rp until it makes a ring, as shown in Figure 17.

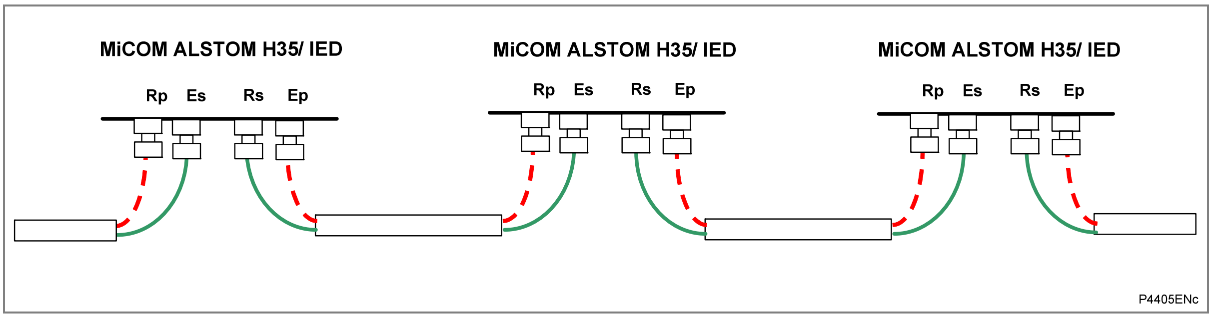


Figure 17: Dual Ethernet ring connections

5.2 DHP Star Connection

Connect Tx to Rx and Rx to Tx on each device until it makes a star, as shown in the following diagram.

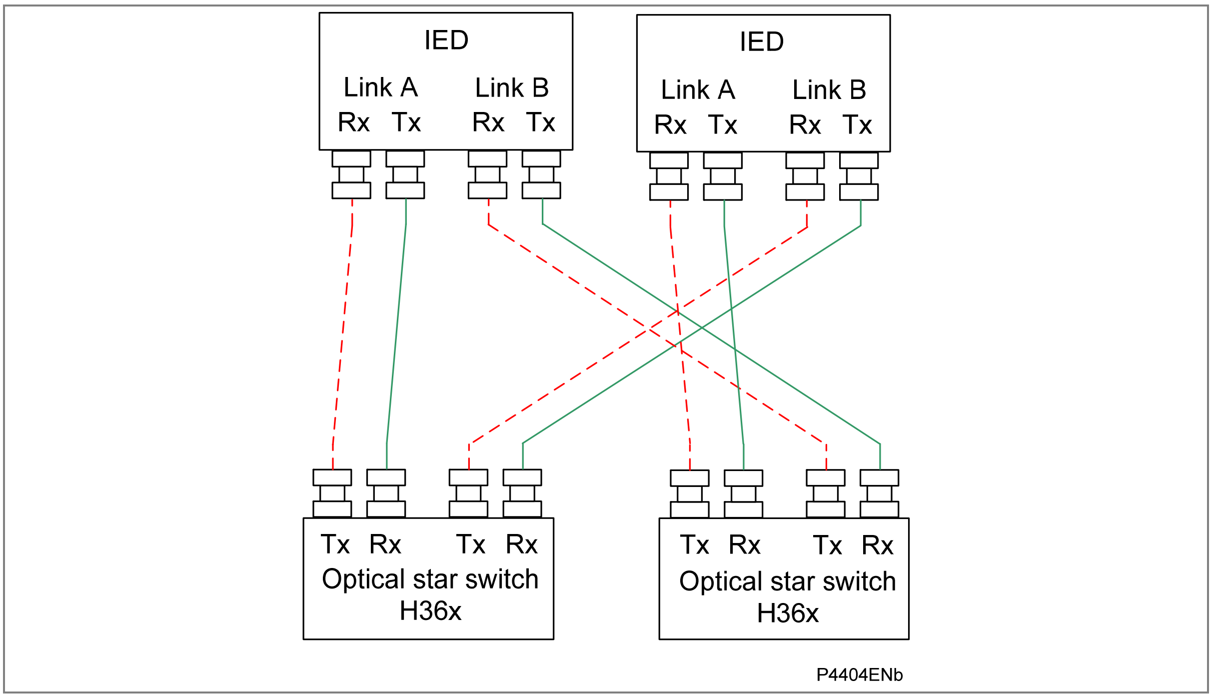


Figure 18: Dual Ethernet star connections

5.3 RSTP Ring Connection

Figure 19 shows the Px4x IEDs (Px4x – IED 1 to IED N) using RSTP REBs connected in a ring topology.

This topology can have one or more RSTP-enabled Ethernet switches to interface with another network or control center. The Ethernet switch is an RSTP-enabled switch with a higher number of ports.

The Ethernet switch, which is connected to the controlling PC, should be configured as the root bridge, as shown in Figure 19. The bridge priority of the Ethernet switch should be configured to the minimum value in the network

The maximum number of IEDs that can be connected in the ring network depends on the Max Age parameter configured in the root bridge (see Figure 21).

The Max Age parameter can be varied from 6 to 40 seconds.

If Max Age = 6 seconds, the minimum number of IEDs in the ring is 6 - 1 = 5.

If Max Age = 40 seconds, the maximum number of IEDs in the ring is 40 - 1 = 39.

Therefore the number of IEDs that can be connected in the ring can vary from 5 to 39.

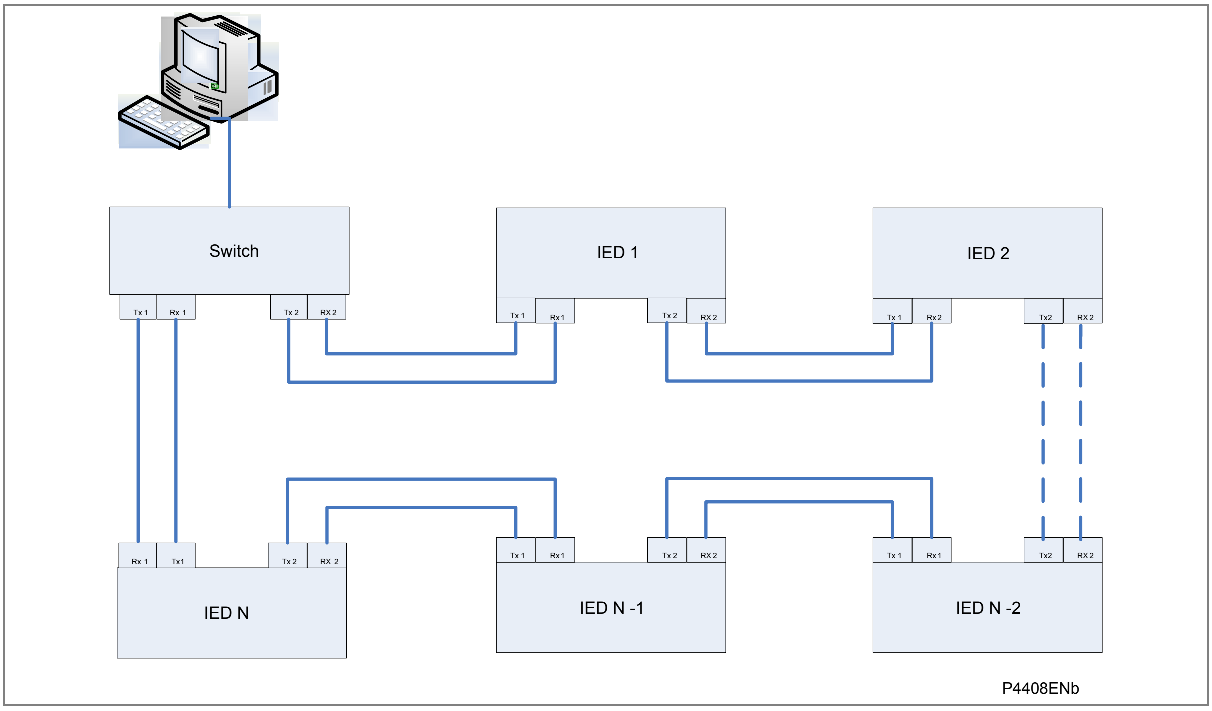


Figure 19: Dual Ethernet ring topology

5.4 RSTP Star Connection

Figure 20 shows the Px4x IEDs (Px4x – IED 1 to IED N) using RSTP REBs connected in a star topology.

This topology can have one or more RSTP-enabled Ethernet switches to interface with other networks, control centers, or Px4x IEDs. The Ethernet switch is an RSTP-enabled switch with a greater number of ports.

The Ethernet switch, which is connected to the controlling PC, should be configured as the root bridge, as shown in Figure 21. The bridge priority of the Ethernet switch should be configured to the minimum value in the network.

The Px4x IEDs are placed at two hop distance from the root bridge, therefore the Max Age parameter has no impact on star topology.

The maximum number of IEDs that can be connected in the star network depends on the number of ports available in the Ethernet switch, provided that the hop count from the root bridge is less than the Max Age parameter.

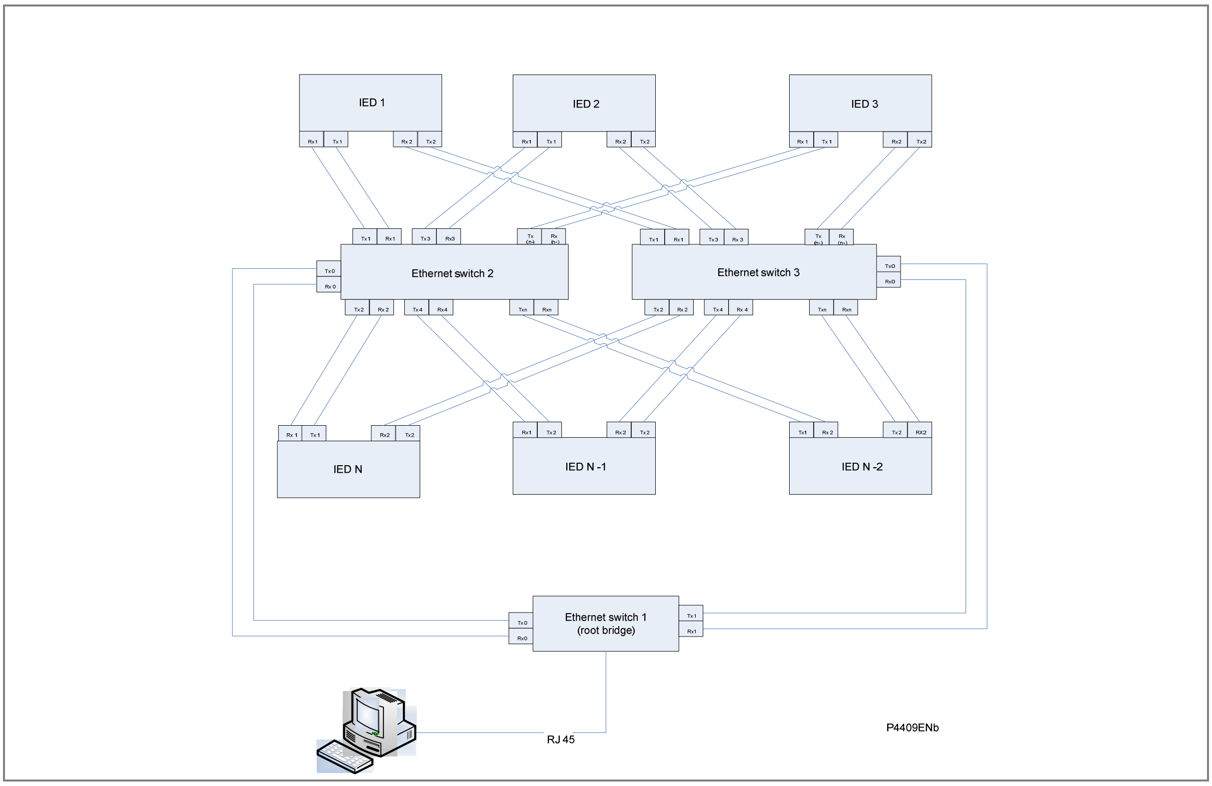


Figure 20: Dual Ethernet star topology

5.5 Large RSTP Networks Combining Star and Ring

Figure 21 shows a star of four rings. Each ring is connected to the root bridge. The root bridge is a high-end RSTP-enabled bridge with the number of ports required. The devices A1, A2…Anmax, B1, B2…Bnmax, C1, C2…Cnmax, D1, D2…Dnmax, represent the RSTP REBs.

The maximum number of boards that can be connected in single ring in an RSTP-enabled network depends on the Max Age parameter. The hop count from the root bridge can not be greater than the Max Age parameter.

The maximum number of RSTP bridges in a ring is given by

Nmax = (Max Age – 1)

Where:

Nmax = maximum number of devices in a ring

Max Age = Max Age value configured in the root bridge.

Assuming the default value of Max Age as 20 seconds in the topology shown in Figure 21 , the maximum number of devices that can be connected in ring A is 19.

If Max Age is configured as 40 seconds, the maximum number of IEDs that can be connected in the network is (40-1) = 39. According to the IEEE 802.1D 2004 standard, the maximum value for the Max Age parameter is limited to 40. To use the maximum number of IEDs in the ring, the following configuration should be used.

Max Age	*40 seconds*
Forward Delay	*30 seconds*
Hello Time	*2 seconds*
Bridge Priority	*As required by the end user.*

The IEEE 802.1D 2004 standard defines the relation between Max Age and Forward Delay as:

*2 * (Forward Delay – 1.0 seconds) >= Max Age*

To have the maximum number of nodes in the RSTP network, the number of rings can be increased, depending on the number of ports available in the root bridge.

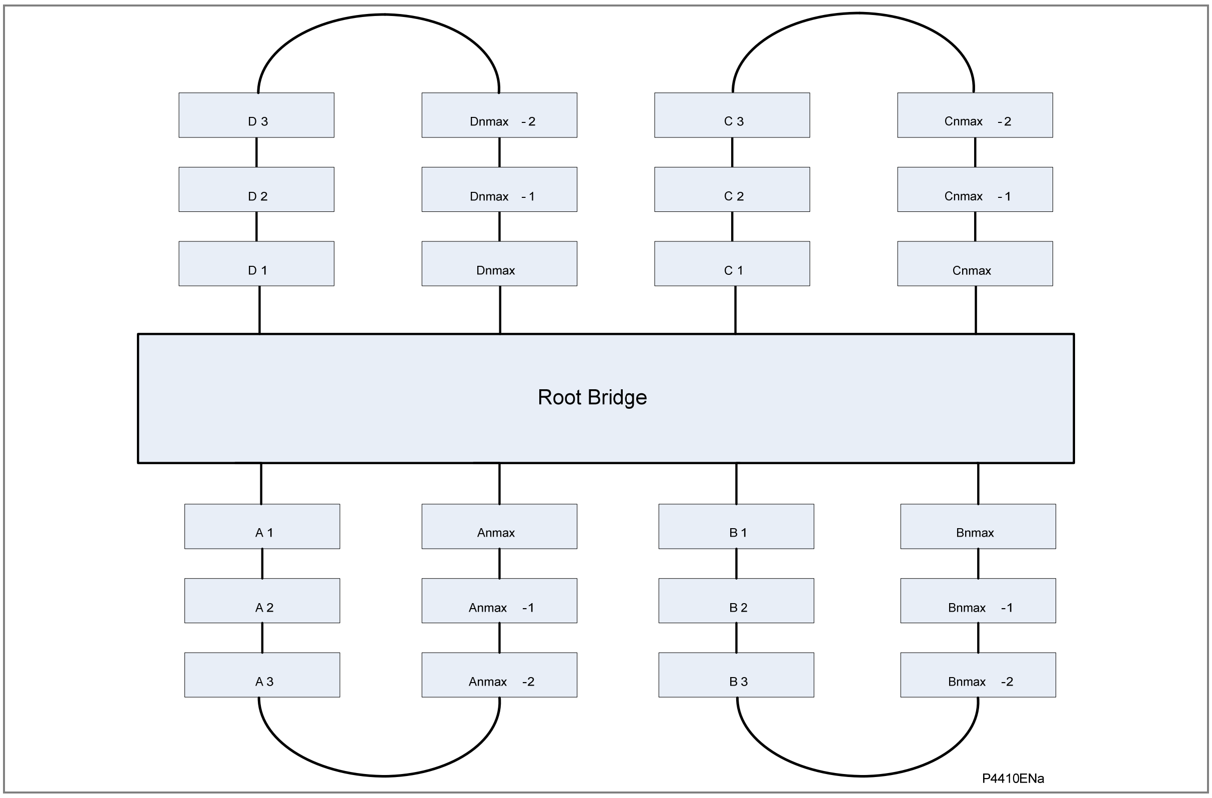


Figure 21: Combined RSTP star and ring topology

SETTINGS AND RECORDS

CHAPTER 9

1 OVERVIEW

The P847B&C phasor measurement unit (PMU) is an intelligent electronic device (IED) that must be configured to the system and application using appropriate settings. The IED is supplied preconfigured with factory default settings, but you need to set the parameters according to your application. The IED also supplies measurements of system parameters, which are not settable.

This chapter contains tables and descriptions of all the unit's settings and measurement parameters. It consists of the following sections:

2 SETTINGS DESCRIPTIONS

Due to the complex functionality of the unit, it contains a large number of settings, which can be configured using the buttons and the liquid crystal display (LCD) on the front panel of the unit, or by the supplied application software, which can be accessed by connecting the unit to a PC. These settings are arranged in a hierarchical menu structure.

When configuring the PMU to the application, the settings can be considered to be in five parts:

- Configuration Settings
- PMU Settings
- Protection Group Settings
- Control and Support Settings
- Disturbance Recorder Settings

The sequence in which the settings descriptions are given reflects the above structure.

2.1 Configuration Settings

The P847B&C PMU is a multi-function device that supports numerous control, monitoring, recording and communication features. To simplify the setting of the unit, there is a group of general configuration settings, which can be used to enable or disable many of its functions. If a function is disabled, the settings associated with that function are not shown in the menu.

This **Configuration** column is also used to control which of the four settings groups is selected as active through the **Active Settings** cell. A setting group can be disabled in the **Configuration** column, provided it is not the present active group. Also if a setting group is disabled in the **Configuration** menu, it cannot be set as the active group.

It is possible to copy the contents of one of the setting groups to that of another group. To do this, set the **Copy from** cell to the setting group to be copied then set the **Copy to** cell to the protection group where the copy is to be placed. The copied settings are initially placed in the temporary scratchpad and are only used after they have been confirmed.

COURIER TEXT	Col	Row	Default Setting	Available Setting
Description				
CONFIGURATION	9	0		
The Configuration column contains all the general configuration options				
Restore Defaults	9	1	No Operation	No operation, All settings, Setting Group 1, Setting Group 2, Setting Group 3, Setting Group 4
Setting to restore a setting group to factory default settings.				
Setting Group	9	2	Select via Menu	Select via Menu, Select via PSL
Select an Settings group				
Active Settings	9	3	Group 1	Group 1, Group 2, Group 3, Group 4
Displays the active settings group				
Save Changes	9	4	No Operation	No Operation, Save, Abort
Copy From	9	5	Group 1	Group 1, Group 2, Group 3, Group 4
Choose to copy from any of the given settings group				
Copy To	9	6	No Operation	No Operation, Group 1, Group 2, Group 3, Group 4
Choose to copy to any of the given settings group				

COURIER TEXT	Col	Row	Default Setting	Available Setting
Description				
Setting Group 1	9	7	Enabled	Enabled, Disabled
Settings Group 1				
Setting Group 2	9	8	Disabled	Enabled, Disabled
Settings Group 2				
Setting Group 3	9	9	Disabled	Enabled, Disabled
Settings Group 3				
Setting Group 4	9	0A	Disabled	Enabled, Disabled
Settings Group 4				
Control Input	9	2F	Visible	Invisible, Visible
Sets the Control Inputs menu to visible				
Control I/P Config	9	35	Visible	Invisible, Visible
Sets the Control Input Configuration menu to visible				
Ctrl I/P Labels	9	36	Visible	Invisible, Visible
Sets the Control Input Labels menu to visible				
Direct Access	9	39	Visible	Enabled, Disabled, Hotkey Only
Defines what controls are available using the direct access keys - Enabled (Hotkey and CB Control functions) / Hotkey Only (Control Inputs and Setting group selection) / CB Cntrl Only (CB open/close)				
Function Key	9	50	Visible	Invisible, Visible
Sets the Function Key menu to visible				
LCD Contrast	9	FF	10	0 to 31 step 1
Sets the LCD Contrast				

Table 1: General configuration settings

2.2 PMU configuration

The PMU configuration settings are associated with the presentation of synchrophasor information. These settings are in the menu item PMU CONFIG and ensure that data are transmitted in accordance with IEEE C37.118.

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
PMU CONFIG	2A	0	0	0
This Column contains settings for configuring the PMU functionality				
Device ID Code	2A	1	1	1 to 65534 step 1
Unique identifier for the PMU used for both sending and receiving messages				
Datarate Select	2A	2	50 per second	10, 25 or 50 per second
This setting controls the number of messages sent upstream per second when the system frequency is 50Hz.				
Datarate Select	2A	3	60 per second	10, 12,15, 20, 30 or 60 per second
This setting controls the number of messages sent upstream per second when the system frequency is 60Hz.				
Phasor Format	2A	4	Polar (Mag/Ang)	Rectangular, Polar
The setting controls the format in which the vector measurements are transmitted. If the setting is Rectangular , real and imaginary parts of the vectors are transmitted else the vector is transmitted as magnitude and angle				
Filter Length	2A	5	13	1, 3, 5, 7 or 13
This setting controls the length of the filter used for PMU measurements. A larger filter length translates to better harmonic rejection but slower response to magnitude and phase changes				

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
AngleCorr Status	2A	6	Disabled	Enabled, Disabled
This is the global setting that enables or disables angle correction on all channels				
Freq/Rocof Fmt	2A	7	Floating Point	Floating Point, Integer
This setting controls whether the data format of frequency and rate of change of frequency in PMU data frames is IEEE floating point or 16-bit integer				
Phasor Data Fmt	2A	8	Floating Point	Floating Point, Integer
This setting controls whether the data format of all phasors in PMU data frames is IEEE floating point or 16-bit integer				
Mag. Corr Status	2A	0A	Disabled	Enabled, Disabled
This is the global setting that enables or disables magnitude correction on all channels				
VA	2A	10	Enabled	Enabled, Disabled
Enables or disables the transmission of GPS synchronized A phase voltage measurement				
VA Vctr Grp Cor	2A	11	0	-180° to 180° step 30°
This is the angular shift applied to VA phasor in PMU data streams related to power transformer vector group				
VA Ang Correct	2A	12	0	-10° to +10° step 0.01°
This is to correct any phase angle error of VA phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
VA Mag Correct	2A	13	1	0.9 to 1.1 step 0.001
This is to correct any Magnitude error of VA phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
VB	2A	14	Enabled	Enabled, Disabled
Enables or disables the transmission of GPS synchronized B phase voltage measurement				
VB Vctr Grp Cor	2A	15	0	-180° to 180° step 30°
This is the angular shift applied to VB phasor in PMU data streams related to power transformer vector group				
VB Ang Correct	2A	16	0	-10° to +10° step 0.01°
This is to correct any phase angle error of VB phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
VB Mag Correct	2A	17	1	0.9 to 1.1 step 0.001
This is to correct any Magnitude error of VB phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
VC	2A	18	Enabled	Enabled, Disabled
Enables or disables the transmission of GPS synchronized C phase voltage measurement				
VC Vctr Grp Cor	2A	19	0	-180° to 180° step 30°
This is the angular shift applied to VC phasor in PMU data streams related to power transformer vector group				
VC Ang Correct	2A	1A	0	-10° to +10° step 0.01°
This is to correct any phase angle error of VC phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
VC Mag Correct	2A	1B	1	0.9 to 1.1 step 0.001
This is to correct any Magnitude error of VC phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
V1	2A	1C	Enabled	Enabled, Disabled
Enables or disables the transmission of GPS synchronized positive sequence voltage measurement				
V2	2A	20	Enabled	Enabled, Disabled
Enables or disables the transmission of GPS synchronized negative sequence voltage measurement				
V0	2A	24	Enabled	Enabled, Disabled
Enables or disables the transmission of GPS synchronized zero sequence voltage measurement				

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
IA	2A	28	Enabled	Enabled, Disabled
Enables or disables the transmission of GPS synchronized A phase current measurement				
IA Vctr Grp Cor	2A	29	0	-180° to 180° step 30°
This is the angular shift applied to IA phasor in PMU data streams related to power transformer vector group				
IA Ang Correct	2A	2A	0	15° to 15° step 0.01°
This is to correct any phase angle error of IA phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
IA Mag Correct	2A	2B	1	0.9 to 1.1 step 0.001
This is to correct any Magnitude error of IA phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
IB	2A	2C	Enabled	Enabled, Disabled
Enables or disables the transmission of GPS synchronized B phase current measurement				
IB Vctr Grp Cor	2A	2D	0	-180° to 180° step 30°
This is the angular shift applied to IB phasor in PMU data streams related to power transformer vector group				
IB Ang Correct	2A	2E	0	15° to 15° step 0.01°
This is to correct any phase angle error of IB phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
IB Mag Correct	2A	2F	1	0.9 to 1.1 step 0.001
This is to correct any Magnitude error of IB phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
IC	2A	30	Enabled	Enabled, Disabled
Enables or disables the transmission of GPS synchronized C phase current measurement				
IC Vctr Grp Cor	2A	31	0	-180° to 180° step 30°
This is the angular shift applied to IC phasor in PMU data streams related to power transformer vector group				
IC Ang Correct	2A	32	0	-10° to +10° step 0.01°
This is to correct any phase angle error of IC phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
IC Mag Correct	2A	33	1	0.9 to 1.1 step 0.001
This is to correct any Magnitude error of IC phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
I1	2A	34	Enabled	Enabled, Disabled
This cell enables or disables the transmission of GPS synchronized positive sequence current measurement				
I2	2A	38	Enabled	Enabled, Disabled
This cell enables or disables the transmission of GPS synchronized negative sequence current measurement				
I0	2A	3C	Enabled	Enabled, Disabled
This cell enables or disables the transmission of GPS synchronized zero sequence current measurement				
IA2	2A	40	Enabled	Enabled, Disabled
Enables or disables the transmission of GPS synchronized A phase current measurement				
IA2 Vctr Grp Cor	2A	41	0	-180° to 180° step 30°
This is the angular shift applied to IA2 phasor in PMU data streams related to power transformer vector group				
IA2 Ang Correct	2A	42	0	-10° to +10° step 0.01°
This is to correct any phase angle error of IA2 phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
IA2 Mag Correct	2A	43	1	0.9 to 1.1 step 0.001
This is to correct any Magnitude error of IA2 phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
IB2	2A	44	Enabled	Enabled, Disabled
Enables or disables the transmission of GPS synchronized B phase current measurement				
IB2 Vctr Grp Cor	2A	45	0	-180° to 180° step 30°
This is the angular shift applied to IB2 phasor in PMU data streams related to power transformer vector group				
IB2 Ang Correct	2A	46	0	-10° to +10° step 0.01°
This is to correct any phase angle error of IB2 phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
IB2 Mag Correct	2A	47	1	0.9 to 1.1 step 0.001
This is to correct any Magnitude error of IB2 phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
IC2	2A	48	Enabled	Enabled, Disabled
Enables or disables the transmission of GPS synchronized C phase current measurement				
IC2 Vctr Grp Cor	2A	49	0	-180° to 180° step 30°
This is the angular shift applied to IC2 phasor in PMU data streams related to power transformer vector group				
IC2 Ang Correct	2A	4A	0	-10° to +10°° step 0.01°
This is to correct any phase angle error of IC2 phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
IC2 Mag Correct	2A	4B	1	0.9 to 1.1 step 0.001
This is to correct any Magnitude error of IC2 phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
I1_2	2A	4C	Enabled	Enabled, Disabled
This cell enables or disables the transmission of GPS synchronized positive sequence current measurement				
I2_2	2A	50	Enabled	Enabled, Disabled
This cell enables or disables the transmission of GPS synchronized negative sequence current measurement				
I0_2	2A	54	Enabled	Enabled, Disabled
This cell enables or disables the transmission of GPS synchronized zero sequence current measurement				
IA3	2A	58	Enabled	Enabled, Disabled
Enables or disables the transmission of GPS synchronized A phase current measurement				
IA3 Vctr Grp Cor	2A	59	0	-180° to 180° step 30°
This is the angular shift applied to IA3 phasor in PMU data streams related to power transformer vector group				
IA3 Ang Correct	2A	5A	0	-10° to +10° step 0.01°
This is to correct any phase angle error of IA3 phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
IA3 Mag Correct	2A	5B	1	0.9 to 1.1 step 0.001
This is to correct any Magnitude error of IA3 phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
IB3	2A	5C	Enabled	Enabled, Disabled
Enables or disables the transmission of GPS synchronized B phase current measurement				
IB3 Vctr Grp Cor	2A	5D	0	-180° to 180° step 30°
This is the angular shift applied to IB3 phasor in PMU data streams related to power transformer vector group				
IB3 Ang Correct	2A	5E	0	-10° to +10° step 0.01°
This is to correct any phase angle error of IB3 phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
IB3 Mag Correct	2A	5F	1	0.9 to 1.1 step 0.001
This is to correct any Magnitude error of IB3 phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
IC3	2A	60	Enabled	Enabled, Disabled
Enables or disables the transmission of GPS synchronized C phase current measurement				
IC3 Vctr Grp Cor	2A	61	0	-180° to 180° step 30°
This is the angular shift applied to IC3 phasor in PMU data streams related to power transformer vector group				
IC3 Ang Correct	2A	62	0	-10° to +10° step 0.01°
This is to correct any phase angle error of IC3 phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
IC3 Mag Correct	2A	63	1	0.9 to 1.1 step 0.001
This is to correct any Magnitude error of IC3 phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
I1_3	2A	64	Enabled	Enabled, Disabled
This cell enables or disables the transmission of GPS synchronized positive sequence current measurement				
I2_3	2A	68	Enabled	Enabled, Disabled
This cell enables or disables the transmission of GPS synchronized negative sequence current measurement				
I0_3	2A	6C	Enabled	Enabled, Disabled
This cell enables or disables the transmission of GPS synchronized zero sequence current measurement				
IA4	2A	70	Enabled	Enabled, Disabled
Enables or disables the transmission of GPS synchronized A phase current measurement				
IA4 Vctr Grp Cor	2A	71	0	-180° to 180° step 30°
This is the angular shift applied to IA4 phasor in PMU data streams related to power transformer vector group				
IA4 Ang Correct	2A	72	0	-10° to +10° step 0.01°
This is to correct any phase angle error of IA4 phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
IA4 Mag Correct	2A	73	1	0.9 to 1.1 step 0.001
This is to correct any Magnitude error of IA4 phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
IB4	2A	74	Enabled	Enabled, Disabled
Enables or disables the transmission of GPS synchronized B phase current measurement				
IB4 Vctr Grp Cor	2A	75	0	-180° to 180° step 30°
This is the angular shift applied to IB4 phasor in PMU data streams related to power transformer vector group				
IB4 Ang Correct	2A	76	0	-10° to +10° step 0.01°
This is to correct any phase angle error of IB4 phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
IB4 Mag Correct	2A	77	1	0.9 to 1.1 step 0.001
This is to correct any Magnitude error of IB4 phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
IC2	2A	78	Enabled	Enabled, Disabled
Enables or disables the transmission of GPS synchronized C phase current measurement				
IC4 Vctr Grp Cor	2A	79	0	-180° to 180° step 30°
This is the angular shift applied to IC4 phasor in PMU data streams related to power transformer vector group				
IC4 Ang Correct	2A	7A	0	-10° to +10° step 0.01°
This is to correct any phase angle error of IC4 phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				
IC4 Mag Correct	2A	7B	1	0.9 to 1.1 step 0.001
This is to correct any Magnitude error of IC4 phasor in PMU data streams that may be introduced by any other part of the system connection such as current transformers and voltage transformers				

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
I1_4	2A	7C	Enabled	Enabled, Disabled
This cell enables or disables the transmission of GPS synchronized positive sequence current measurement				
I2_4	2A	80	Enabled	Enabled, Disabled
This cell enables or disables the transmission of GPS synchronized negative sequence current measurement				
I0_4	2A	84	Enabled	Enabled, Disabled
This cell enables or disables the transmission of GPS synchronized zero sequence current measurement				
Dig Enable	2A	C0	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Any element in the G32 digital lookup table
Selects which of the 32 digital signals are enabled and transmitted in the PMU data frame				
Digital Input 1	2A	C1	DDB_OPTO_ISOLATOR_1	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 2	2A	C2	DDB_OPTO_ISOLATOR_2	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 3	2A	C3	DDB_OPTO_ISOLATOR_3	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 4	2A	C4	DDB_OPTO_ISOLATOR_4	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 5	2A	C5	DDB_OPTO_ISOLATOR_5	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 6	2A	C6	DDB_OPTO_ISOLATOR_6	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 7	2A	C7	DDB_OPTO_ISOLATOR_7	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 8	2A	C8	DDB_OPTO_ISOLATOR_8	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 9	2A	C9	DDB_OPTO_ISOLATOR_9	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 10	2A	CA	DDB_OPTO_ISOLATOR_10	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 11	2A	CB	DDB_OPTO_ISOLATOR_11	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 12	2A	CC	DDB_OPTO_ISOLATOR_12	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 13	2A	CD	DDB_OPTO_ISOLATOR_13	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 14	2A	CE	DDB_OPTO_ISOLATOR_14	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 15	2A	CF	DDB_OPTO_ISOLATOR_15	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 16	2A	D0	DDB_OPTO_ISOLATOR_16	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 17	2A	D1	DDB_OUTPUT_RELAY_1	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 18	2A	D2	DDB_OUTPUT_RELAY_2	Any element in the G32 digital lookup table

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 19	2A	D3	DDB_OUTPUT_RELAY_3	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 20	2A	D4	DDB_OUTPUT_RELAY_4	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 21	2A	D5	DDB_OUTPUT_RELAY_5	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 22	2A	D6	DDB_OUTPUT_RELAY_6	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 23	2A	D7	DDB_OUTPUT_RELAY_7	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 24	2A	D8	DDB_OUTPUT_RELAY_8	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 25	2A	D9	DDB_OUTPUT_RELAY_9	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 26	2A	DA	DDB_OUTPUT_RELAY_10	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 27	2A	DB	DDB_OUTPUT_RELAY_11	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 28	2A	DC	DDB_OUTPUT_RELAY_12	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 29	2A	DD	DDB_OUTPUT_RELAY_13	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 30	2A	DE	DDB_OUTPUT_RELAY_14	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 31	2A	DF	DDB_OUTPUT_RELAY_15	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				
Digital Input 32	2A	E0	DDB_OUTPUT_RELAY_16	Any element in the G32 digital lookup table
Selects the DDB signal to be mapped to the digital information in the PMU data frame				

Table 2: PMU configuration settings

The P847B&C PMU supports IEEE C37.118-2005 frame transmission using TCP/IP or UDP/IP. Additional communications setting are necessary to support this.

These protocols need a port setting in addition to the device ID code. The settings are associated with the communications network to which the PMU is connected, and is normally assigned at a system level.

These two settings are described in the section on communications settings.

COURIER TEXT	Col	Row	Default Setting	Available Setting
Description				
PMU COMMS	0E	D0		
Protocol Type	0E	D1	PMU Over TCP	TCP, UDP, Multicast
Sets the transport layer protocol to be used				
TCP Port Number	0E	D2	4712	4000 to 65000 step 1

COURIER TEXT	Col	Row	Default Setting	Available Setting
Description				
Sets the TCP port number				
UDP Port Number	0E	D3	4713	4000 to 65000 step 1
Sets the UDP port number				

Table 3: PMU-specific communication settings

2.3 Label settings

2.3.1 Input labels

GROUP <n> INPUT LABELS is used to label each available opto input. The text is restricted to 16 characters and is available if Input Labels are set to **visible** in the CONFIGURATION menu.

COURIER TEXT	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 INPUT LABELS	4A	0		
This column defines the settings for the Input Labels (24 in total)				
Opto Input 1	4A	1	Input L1	Editable 16 character string
Label for Opto Input 1				
Opto Input 2	4A	2	Input L2	Editable 16 character string
Label for Opto Input 2				
Opto Input 3	4A	3	Input L3	Editable 16 character string
Label for Opto Input 3				
Opto Input 4	4A	4	Input L4	Editable 16 character string
Label for Opto Input 4				
Opto Input 5	4A	5	Input L5	Editable 16 character string
Label for Opto Input 5				
Opto Input 6	4A	6	Input L6	Editable 16 character string
Label for Opto Input 6				
Opto Input 7	4A	7	Input L7	Editable 16 character string
Label for Opto Input 7				
Opto Input 8	4A	8	Input L8	Editable 16 character string
Label for Opto Input 8				
Opto Input 9	4A	9	Input L9	Editable 16 character string
Label for Opto Input 9				
Opto Input 10	4A	0A	Input L10	Editable 16 character string
Label for Opto Input 10				
Opto Input 11	4A	0B	Input L11	Editable 16 character string
Label for Opto Input 11				
Opto Input 12	4A	0C	Input L12	Editable 16 character string
Label for Opto Input 12				
Opto Input 13	4A	0D	Input L13	Editable 16 character string
Label for Opto Input 13				
Opto Input 14	4A	0E	Input L14	Editable 16 character string

COURIER TEXT	Col	Row	Default Setting	Available Setting
Description				
Label for Opto Input 14				
Opto Input 15	4A	0F	Input L15	Editable 16 character string
Label for Opto Input 15				
Opto Input 16	4A	10	Input L16	Editable 16 character string
Label for Opto Input 16				
Opto Input 17	4A	11	Input L17	Editable 16 character string
Label for Opto Input 17				
Opto Input 18	4A	12	Input L18	Editable 16 character string
Label for Opto Input 18				
Opto Input 19	4A	13	Input L19	Editable 16 character string
Label for Opto Input 19				
Opto Input 20	4A	14	Input L20	Editable 16 character string
Label for Opto Input 20				
Opto Input 21	4A	15	Input L21	Editable 16 character string
Label for Opto Input 21				
Opto Input 22	4A	16	Input L22	Editable 16 character string
Label for Opto Input 22				
Opto Input 23	4A	17	Input L23	Editable 16 character string
Label for Opto Input 23				
Opto Input 24	4A	18	Input L24	Editable 16 character string
Label for Opto Input 24				

Table 4: Input Label Settings

2.3.2 Output labels

GROUP 1 OUTPUT LABELS is used to label each available relay input. The text is restricted to 16 characters and is available if Input Labels are set to **visible** in the CONFIGURATION menu.

Menu Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 OUTPUT LABELS	4B	00		
This column defines the settings for the Output Labels				
Relay 1	4B	01		Editable 16 character string
Label for output relay 1				
Relay 2	4B	02		Editable 16 character string
Label for output relay 2				
Relay 3	4B	03		Editable 16 character string
Label for output relay 3				
Relay 4	4B	04		Editable 16 character string
Label for output relay 4				
Relay 5	4B	05		Editable 16 character string
Label for output relay 5				
Relay 6	4B	06		Editable 16 character string
Label for output relay 6				

Menu Text	Col	Row	Default Setting	Available Setting
Description				
Relay 7	4B	07		Editable 16 character string
Label for output relay 7				
Relay 8	4B	08		Editable 16 character string
Label for output relay 8				
Relay 9	4B	09		Editable 16 character string
Label for output relay 9				
Relay 10	4B	0A		Editable 16 character string
Label for output relay 10				
Relay 11	4B	0B		Editable 16 character string
Label for output relay 11				
Relay 12	4B	0C		Editable 16 character string
Label for output relay 12				
Relay 13	4B	0D		Editable 16 character string
Label for output relay 13				
Relay 14	4B	0E		Editable 16 character string
Label for output relay 14				
Relay 15	4B	0F		Editable 16 character string
Label for output relay 15				
Relay 16	4B	10		Editable 16 character string
Label for output relay 16				
Relay 17	4B	11		Editable 16 character string
Label for output relay 17				
Relay 18	4B	12		Editable 16 character string
Label for output relay 18				
Relay 19	4B	13		Editable 16 character string
Label for output relay 19				
Relay 20	4B	14		Editable 16 character string
Label for output relay 20				
Relay 21	4B	15		Editable 16 character string
Label for output relay 21				
Relay 22	4B	16		Editable 16 character string
Label for output relay 22				
Relay 23	4B	17		Editable 16 character string
Label for output relay 23				
Relay 24	4B	18		Editable 16 character string
Label for output relay 24				

Table 5: Output Label Settings

2.4 Control and support settings

These settings exist outside the **Group** settings. The control and support settings are used to configure other features, and like the Configuration settings, do not need to adapt according to changing system conditions. These settings are used to configure system data, date and time, CT/VT ratios, SCADA type communications interfaces, input conditioners, etc. They also encompass measurements and recording functions.

The control and support settings are part of the main menu and are used to configure the PMU global configuration. It includes submenu settings as below:

- System data
- Circuit breaker control
- Date and time
- CT/VT ratios
- Communications settings
- Commissioning tests
- Opto configuration
- Control inputs
- Control input configuration
- Function keys
- IED configurator
- Control input labels

2.4.1 System data

This menu provides information for the device and general status of the unit.

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
SYSTEM DATA	0	0		
This column contains general system settings				
Language	0	1	English	English, Français, Deutsch, Español
Sets the required language to be used by the device				
Password	0	2	AAAA	****
Sets the device default password				
Sys Fn Links	0	3		0 = latched, 1 = self-reset
System Function Links: Setting to allow the fixed function trip LED to be self resetting.				
Description	0	4	MiCOM P847	MiCOM P847
Editable 16 character description of the unit				
Plant Reference	0	5	MiCOM	MiCOM
Editable 16 character plant description				
Model Number	0	6	Model Number	<Model number>
Displays the model number				
Serial Number	0	8	Serial Number	<Serial number>
Displays the serial number				
Frequency	0	9	50	50Hz, 60Hz
Sets the mains frequency				
Comms Level	0	0A	1	<conformance level displayed>
Displays the communications conformance level				
Relay Address	0	0B	255	<Unit address>

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Sets the courier address of the unit				
Plant Status	0	0C		16-bit binary setting
Displays the circuit breaker plant status for up to 8 circuit breakers.				
Control Status	0	0D		Not used
Not used				
Active Group	0	0E		1, 2, 3, 4
Displays the active settings group				
Software Ref. 1	0	11		<Software Ref. 1>
Displays the relay software version including the protocol and relay model				
Software Ref. 2	0	12		<Software Ref. 1>
Displays the software version of the Ethernet card				
Opto I/P Status	0	20		16-bit binary setting: 0 = energized, 1= de-energized
Displays the status of the opto-isolated inputs as a binary string.				
Relay O/P Status	0	21		16-bit binary setting: 0 = operated state 1= non-operated state
Displays the status of the output contacts as a binary string.				
Alarm Status	0	22		32-bit binary setting: 0 = Off, 1 = On
Displays the status of the first 32 alarms as a binary string. Includes fixed and user settable alarms. Data type G96				
Alarm Status 1	0	50		32-bit binary setting: 0 = Off, 1 = On
Displays the status of the first 32 alarms as a binary string. Includes fixed and user settable alarms. Data type G96				
Alarm Status 2	0	51		32-bit binary setting: 0 = Off, 1 = On
Displays the status of the first 32 alarms as a binary string. Includes fixed and user settable alarms. Data type G128				
Alarm Status 3	0	52		32-bit binary setting: 0 = Off, 1 = On
Displays the status of the first 32 alarms as a binary string. Includes fixed and user settable alarms. Data type G128				
Password Control	0	D1	2	0 = level 1&2, 1 = level 2, 2 = No passwords required
Sets the password control				
Password Level 1	0	D2	AAAA	4 characters
Password level 1 setting (4 characters)				
Password Level 2	0	D3	AAAA	4 characters
Password level 2 setting (4 characters)				

Table 6: System Data Settings

2.4.2 Date and time

This column displays the date and time as well as the battery condition.

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
DATE AND TIME	8	0	0	0
This column contains Date and Time stamp settings				
Date/Time	8	1	0	0
0				

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Date 12/01/1998	8	N/A	0	<Date>
Displays the date				
Time 12:00	8	N/A	0	<Time>
Displays the time				
IRIG-B Status	8	5	0	Card not fitted, Card failed, signal healthy, No signal
Displays the status of IRIG-B				
Battery Status	8	6	0	Dead, Healthy
Displays whether the battery is healthy or not				
Battery Alarm	8	7	Enabled	Enabled, Disabled
Enables or disables battery alarm. The battery alarm needs to be disabled when a battery is removed or not used				
LocalTime Enable	8	20	Fixed	Disabled, Fixed, Flexible
Setting to turn on/off local time adjustments. Disabled - No local time zone will be maintained. Time synchronization from any interface will be used to directly set the master clock and all displayed (or read) times on all interfaces will be based on the master clock with no adjustment. Fixed - A local time zone adjustment can be defined using the LocalTime offset setting and all interfaces will use local time except SNTP time synchronization and IEC 61850 timestamps. Flexible - A local time zone adjustment can be defined using the LocalTime offset setting and each interface can be assigned to the UTC zone or local time zone with the exception of the local interfaces which will always be in the local time zone and IEC 61850/SNTP which will always be in the UTC zone.				
LocalTime Offset	8	21	0	-720 mins to +720 mins step 15 mins
Setting to specify an offset of -12 to +12 hrs in 15 minute intervals for local time zone. This adjustment is applied to the time based on the master clock which is UTC/GMT				
DST Enable	8	22	Enabled	Enabled, Disabled
Setting to turn on/off daylight saving time adjustment to local time.				
DST Offset	8	23	60	30 mins, 60 mins
Setting to specify daylight saving offset which will be used for the time adjustment to local time.				
DST Start	8	24	Last	First, Second, Third Fourth, Last
Setting to specify the week of the month in which daylight saving time adjustment starts				
DST Start Day	8	25	Sunday	Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday
Setting to specify the day of the week in which daylight saving time adjustment starts				
DST Start Month	8	26	March	Any of the 12 months
Setting to specify the month in which daylight saving time adjustment starts				
DST Start Mins	8	27	60	0 mins to 1425 mins step 15 mins
Setting to specify the time of day in which daylight saving time adjustment starts. This is set relative to 00:00 hrs on the selected day when time adjustment is to start				
DST End	8	28	Last	First, Second, Third Fourth, Last
Setting to specify the week of the month in which daylight saving time adjustment ends				
DST End Day	8	29	Sunday	Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday
Setting to specify the day of the week in which daylight saving time adjustment ends				
DST End Month	8	2A	October	Any of the 12 months
Setting to specify the month in which daylight saving time adjustment ends				
DST End Mins	8	2B	60	0 mins to 1425 mins step 15 mins

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Setting to specify the time of day in which daylight saving time adjustment ends. This is set relative to 00:00 hrs on the selected day when time adjustment is to end				
RP1 Time Zone	8	30	Local	UTC, Local
Setting for the rear port 1 interface to specify if time synchronization received will be local or universal time co-ordinated				
Tunnel Time Zone	8	33	Local	UTC, Local
Setting to specify if time synchronization received will be local or universal time co-ordinate when 'tunneling' courier protocol over ethernet				

Table 7: Date and Time Settings

2.4.3 CT/VT ratios

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
CT AND VT RATIOS	0A	0	0	0
This column contains settings for Current and Voltage Transformer ratios				
Main VT A Pri'y	0A	1	110	100V to 1MV step 1V
Sets the voltage transformer input primary voltage				
Main VT A Sec'y	0A	2	110	80V to 140V step 1V
Sets the voltage transformer input secondary voltage				
Main VT B Pri'y	0A	3	110	100V to 1MV step 1V
Sets the voltage transformer input primary voltage				
Main VT B Sec'y	0A	4	110	80V to 140V step 1V
Sets the voltage transformer input secondary voltage				
Main VT C Pri'y	0A	5	110	100V to 1MV step 1V
Sets the voltage transformer input primary voltage				
Main VT C Sec'y	0A	6	110	80V to 140V step 1V
Sets the voltage transformer input secondary voltage				
Phase CT1A Pri'y	0A	7	5	1A to 30kA step 1A
Sets the phase current transformer input primary current rating				
Phase CT1A Sec'y	0A	8	5	1A, 5A
Sets the phase current transformer input secondary current rating				
Phase CT1B Pri'y	0A	9	5	1A to 30kA step 1A
Sets the phase current transformer input primary current rating				
Phase CT1B Sec'y	0A	0A	5	1A, 5A
Sets the phase current transformer input secondary current rating				
Phase CT1C Pri'y	0A	0B	5	1A to 30kA step 1A
Sets the phase current transformer input primary current rating				
Phase CT1C Sec'y	0A	0C	5	1A, 5A
Sets the phase current transformer input secondary current rating				
Phase CT2A Pri'y	0A	0D	5	1A to 30kA step 1A
Sets the phase current transformer input primary current rating				
Phase CT2A Sec'y	0A	0E	5	1A, 5A
Sets the phase current transformer input secondary current rating				
Phase CT2B Pri'y	0A	0F	5	1A to 30kA step 1A
Sets the phase current transformer input primary current rating				

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Phase CT2B Sec'y	0A	10	5	1A, 5A
Sets the phase current transformer input secondary current rating				
Phase CT2C Pri'y	0A	11	5	1A to 30kA step 1A
Sets the phase current transformer input primary current rating				
Phase CT2C Sec'y	0A	12	5	1A, 5A
Sets the phase current transformer input secondary current rating				
Phase CT3A Pri'y	0A	13	5	1A to 30kA step 1A
Sets the phase current transformer input primary current rating				
Phase CT3A Sec'y	0A	14	5	1A, 5A
Sets the phase current transformer input secondary current rating				
Phase CT3B Pri'y	0A	15	5	1A to 30kA step 1A
Sets the phase current transformer input primary current rating				
Phase CT3B Sec'y	0A	16	5	1A, 5A
Sets the phase current transformer input secondary current rating				
Phase CT3C Pri'y	0A	17	5	1A to 30kA step 1A
Sets the phase current transformer input primary current rating				
Phase CT3C Sec'y	0A	18	5	1A, 5A
Sets the phase current transformer input secondary current rating				
Phase CT4A Pri'y	0A	19	5	1A to 30kA step 1A
Sets the phase current transformer input primary current rating				
Phase CT4A Sec'y	0A	1A	5	1A, 5A
Sets the phase current transformer input secondary current rating				
Phase CT4B Pri'y	0A	1B	5	1A to 30kA step 1A
Sets the phase current transformer input primary current rating				
Phase CT4B Sec'y	0A	1C	5	1A, 5A
Sets the phase current transformer input secondary current rating				
Phase CT4C Pri'y	0A	1D	5	1A to 30kA step 1A
Sets the phase current transformer input primary current rating				
Phase CT4C Sec'y	0A	1E	5	1A, 5A
Sets the phase current transformer input secondary current rating				

Table 8: CT and VT Ratio Settings

2.4.4 Communications settings

The communications settings apply to the rear communications ports only and will depend upon the particular protocol being used. This table covers the complete range of possible settings. In practice, only those applicable will need to be set. Further details are given in the SCADA Communications chapter.

COURIER TEXT	Col	Row	Default Setting	Available Setting
Description				
COMMUNICATIONS	0E	0		
This column contains general communications settings				
RP1 Protocol	0E	1	Courier	<Protocol>
Indicates the communications protocol used on the rear communications port RP1				

COURIER TEXT	Col	Row	Default Setting	Available Setting
Description				
RP1 Address	0E	2	255	0 to 255 (Courier)
Sets the relay address (protocol dependent)				
RP1 InactivTimer	0E	3	15	1 min to 30 min step 1 min (Courier)
Defines the period of inactivity before relay reverts to its default state				
RP1 PhysicalLink	0E	7	RS485	Copper, fiber Optic, Kbus
Defines whether an electrical EIA(RS)485, fiber optic or KBus connection is being used for communication between the master station and relay. If Fiber Optic is selected, the optional fiber optic communications board is required				
RP1 Card Status	0E	0B		K-Bus OK, EIA485 OK, Fiber Optic OK (Courier)
Displays the status of the card in RP1				
RP1 Port Config	0E	0C	K Bus	Kbus, EIA485 (Courier)
Defines communications configuration type for RP1				
RP1 Comms Mode	0E	0D	IEC60870 FT1.2	IEC60870 FT1.2 Frame, 10-bit No parity
Rear Port 1 Courier Protocol EIA485 mode				
RP1 Baud Rate	0E	0E	19200 bits/s	9600 bps, 19200 bps, 38400 bps
Defines the Baud rate for RP1				
NIC Protocol	0E	1F	IEC61850	
Indicates the protocol used on the Network Interface Card				
NIC Mac Address	0E	22		<NIC MAC address>
Shows the MAC address of the rear Ethernet port				
NIC Tunl Timeout	0E	64	5	1 min to 30 min step 1 min (Ethernet)
Time to wait before an inactive tunnel to MiCOM S1 Studio is reset				
NIC Link Report	0E	6A		Alarm, Event, None (Ethernet)
Configures how a failed/unfitted network link (copper or fiber) is reported				
NIC Link Timeout	0E	6B	60000	0.1s to 60s step 0.1s
Duration to wait, after failed network link is detected, before communication by the alternative media interface is attempted				
PMU COMMS	0E	D0		
Protocol Type	0E	D1	PMU Over TCP	TCP, UDP, Multicast
Sets the transport layer protocol to be used				
TCP Port Number	0E	D2	4712	4000 to 65000 step 1
Sets the TCP port number				
UDP Port Number	0E	D3	4713	4000 to 65000 step 1
Sets the UDP port number				

Table 9: Communication Settings –PMU Comms – delete or keep?

2.4.5 Commissioning tests

There are configurable items, which allow the status of the opto-isolated inputs, output relay contacts, internal digital data bus (DDB) signals and user-programmable LEDs to be monitored. Additionally there are items to test the operation of the output contacts, user-programmable LEDs and, where available, the auto-reclose cycles.

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
COMMISSION TESTS	0F	0	0	0

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
This column contains commissioning test settings				
Opto I/P Status	0F	1	0	24-bit binary string
This displays the status of the opto-isolated inputs as a binary string: 1 = energized, 0 = de-energized				
Relay O/P Status	0F	2	0	24-bit binary string
This displays the status of the output contacts as a binary string: 1 = operational 0 = unoperational				
Test Port Status	0F	3	0	8-bit binary string
Displays the status of the eight digital data bus (DDB) signals				
LED Status	0F	4	0	8-bit binary string
8-bit binary string that indicates which of the LEDs are ON				
Monitor Bit 1	0F	5	1060	0, 1 (LED off or on)
LED 1 monitor bit				
Monitor Bit 2	0F	6	1062	0, 1 (LED off or on)
LED 2 monitor bit				
Monitor Bit 3	0F	7	1064	0, 1 (LED off or on)
LED 3 monitor bit				
Monitor Bit 4	0F	8	1066	0, 1 (LED off or on)
LED 4 monitor bit				
Monitor Bit 5	0F	9	1068	0, 1 (LED off or on)
LED 5 monitor bit				
Monitor Bit 6	0F	0A	1070	0, 1 (LED off or on)
LED 6 monitor bit				
Monitor Bit 7	0F	0B	1072	0, 1 (LED off or on)
LED 7 monitor bit				
Monitor Bit 8	0F	0C	1074	0, 1 (LED off or on)
LED 8 monitor bit				
Test Mode	0F	0D	Disabled	Disabled, Test Mode, Contacts Blocked
Allows the setting of a Test mode				
Test Pattern	0F	0E	0	32 bit binary string
Used to select the output contacts tested				
Contact Test	0F	0F	No Operation	No Operation, Apply Test, Remove Test
Used to apply or remove contacts test command				
Test LEDs	0F	10	No Operation	No Operation, Apply Test
When the Apply Test command is issued, the LEDs are ON for approximately 2 seconds. When they go OFF, the command text on the LCD reverts to No Operation				
Red LED Status	0F	1A	0	18-bit binary string
Binary string that indicates which of the user-programmable LEDs are ON				
Green LED Status	0F	1B	0	18-bit binary string
Binary string that indicates which of the user-programmable LEDs are ON				
DDB 31 - 0	0F	20	0	32-bit binary string
Displays the status of DDB signals				
DDB 63 - 32	0F	21	0	32-bit binary string
Displays the status of DDB signals				
DDB 95 - 64	0F	22	0	32-bit binary string
Displays the status of DDB signals				

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
DDB 127 - 96	0F	23	0	32-bit binary string
Displays the status of DDB signals				
DDB 159 - 128	0F	24	0	32-bit binary string
Displays the status of DDB signals				
DDB 191 - 160	0F	25	0	32-bit binary string
Displays the status of DDB signals				
DDB 223 - 192	0F	26	0	32-bit binary string
Displays the status of DDB signals				
DDB 255 - 224	0F	27	0	32-bit binary string
Displays the status of DDB signals				
DDB 287 - 256	0F	28	0	32-bit binary string
Displays the status of DDB signals				
DDB 319 - 288	0F	29	0	32-bit binary string
Displays the status of DDB signals				
DDB 351 - 320	0F	2A	0	32-bit binary string
Displays the status of DDB signals				
DDB 383 - 352	0F	2B	0	32-bit binary string
Displays the status of DDB signals				
DDB 415 - 384	0F	2C	0	32-bit binary string
Displays the status of DDB signals				
DDB 447 - 416	0F	2D	0	32-bit binary string
Displays the status of DDB signals				
DDB 479 - 448	0F	2E	0	32-bit binary string
Displays the status of DDB signals				
DDB 511 - 480	0F	2F	0	32-bit binary string
Displays the status of DDB signals				
DDB 543 - 512	0F	30	0	32-bit binary string
Displays the status of DDB signals				
DDB 575 - 544	0F	31	0	32-bit binary string
Displays the status of DDB signals				
DDB 607 - 576	0F	32	0	32-bit binary string
Displays the status of DDB signals				
DDB 639 - 608	0F	33	0	32-bit binary string
Displays the status of DDB signals				
DDB 671 - 640	0F	34	0	32-bit binary string
Displays the status of DDB signals				
DDB 703 - 672	0F	35	0	32-bit binary string
Displays the status of DDB signals				
DDB 735 - 704	0F	36	0	32-bit binary string
Displays the status of DDB signals				
DDB 767 - 736	0F	37	0	32-bit binary string
Displays the status of DDB signals				
DDB 799 - 768	0F	38	0	32-bit binary string

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Displays the status of DDB signals				
DDB 831 - 800	0F	39	0	32-bit binary string
Displays the status of DDB signals				
DDB 863 - 832	0F	3A	0	32-bit binary string
Displays the status of DDB signals				
DDB 895 - 864	0F	3B	0	32-bit binary string
Displays the status of DDB signals				
DDB 927 - 896	0F	3C	0	32-bit binary string
Displays the status of DDB signals				
DDB 959 - 928	0F	3D	0	32-bit binary string
Displays the status of DDB signals				
DDB 991 - 960	0F	3E	0	32-bit binary string
Displays the status of DDB signals				
DDB 1023 - 992	0F	3F	0	32-bit binary string
Displays the status of DDB signals				

Table 10: Commissioning Tests Settings

2.4.6 Opto configuration

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
OPTO CONFIG	11	0		
This column contains opto-input configuration settings				
Global Nominal V	11	1	24-27V	24-27, 30-34, 48-54, 110-125, 220-250, custom
Sets the nominal battery voltage for all opto inputs by selecting one of the five standard ratings in the Global Nominal V settings. If Custom is selected, each opto input can be set individually to a nominal voltage value				
Opto Input 1	11	2	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 2	11	3	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 3	11	4	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 4	11	5	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 5	11	6	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 6	11	7	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 7	11	8	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 8	11	9	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 9	11	0A	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Opto Input 10	11	0B	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 11	11	0C	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 12	11	0D	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 13	11	0E	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 14	11	0F	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 15	11	10	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 16	11	11	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 17	11	12	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 18	11	13	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 19	11	14	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 20	11	15	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 21	11	16	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 22	11	17	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 23	11	18	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Opto Input 24	11	19	24-27V	24-27, 30-34, 48-54, 110-125, 220-250
Each opto input can be set individually to a nominal voltage value if custom is selected for the global setting				
Filter Control	11	60	0xFF	8 bit binary string (0 disable filtering, 1 enable filtering)
Selects each input with a pre-set filter of ½ cycle that renders the input immune to induced noise on the wiring				
Characteristic	11	80	Standard 60%-80%	Standard 60%-80%, 50% - 70%
Selects the pick-up and drop-off characteristics of the optos. The standard setting means the optos nominally provide a Logic 1 or ON value for voltages > 80% of the set lower nominal voltage, and a Logic 0 or OFF value for the voltages < 60% of the set higher nominal voltage				

Table 11: Opto Input Settings

2.4.7 Control inputs

The control inputs function as software switches that can be set or reset either locally or remotely. These inputs can be used to trigger any function that they are connected to as part of the programmable scheme logic (PSL). The setting is only visible if the **Control Inputs** setting in the **Configuration** menu is set to set visible.

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
CONTROL INPUT	12	0		
This column contains settings for the type of control input (32 in all)				
Ctrl I/P Status	12	1		32 bit binary string. (Set = 1, Reset = 0)
Setting to allow the control inputs to be individually assigned to the Hotkey menu by setting 1 in the appropriate bit in the Hotkey Enabled cell. The hotkey menu allows the control inputs to be set, reset or pulsed without the need to enter the CONTROL INPUTS column.				
Control Input 1	12	2	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 2	12	3	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 3	12	4	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 4	12	5	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 5	12	6	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 6	12	7	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 7	12	8	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 8	12	9	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 9	12	0A	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 10	12	0B	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 11	12	0C	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 12	12	0D	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 13	12	0E	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 14	12	0F	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 15	12	10	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 16	12	11	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 17	12	12	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 18	12	13	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 19	12	14	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 20	12	15	No Operation	No Operation, Set, Reset

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Configures the control inputs as either latched or pulsed				
Control Input 21	12	16	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 22	12	17	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 23	12	18	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 24	12	19	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 25	12	1A	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 26	12	1B	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 27	12	1C	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 28	12	1D	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 29	12	1E	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 30	12	1F	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 31	12	20	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				
Control Input 32	12	21	No Operation	No Operation, Set, Reset
Configures the control inputs as either latched or pulsed				

Table 12: Control Input Settings

2.4.8 Control input configuration

Instead of operating the control inputs as described in the above section, they could also be set to perform a pre-defined control function. This is achieved by mapping them to the Hotkey menu. The operating mode for each of the 32 Control Inputs can be set individually.

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
CTRL I/P CONFIG	13	0		
This column contains settings for the type of control input (32 in all)				
Hotkey Enabled	13	1	0xFFFFFFFF	32 bit binary string. (Enabled = 1, Disabled = 0)
Setting to allow the control inputs to be individually assigned to the Hotkey menu				
Control Input 1	13	10	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 1	13	11	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 2	13	14	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Ctrl Command 2	13	15	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 3	13	18	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 3	13	19	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 4	13	1C	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 4	13	1D	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 5	13	20	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 5	13	21	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 6	13	24	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 6	13	25	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 7	13	28	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 7	13	29	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 8	13	2C	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 8	13	2D	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 9	13	30	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 9	13	31	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 10	13	34	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 10	13	35	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 11	13	38	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 11	13	39	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 12	13	3C	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 12	13	3D	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 13	13	40	Latched	Latched, Pulsed

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Configures the control inputs as either latched or pulsed				
Ctrl Command 13	13	41	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 14	13	44	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 14	13	45	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 15	13	48	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 15	13	49	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 16	13	4C	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 16	13	4D	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 17	13	50	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 17	13	51	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 18	13	54	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 18	13	55	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 19	13	58	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 19	13	59	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 20	13	5C	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 20	13	5D	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 21	13	60	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 21	13	61	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 22	13	64	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 22	13	65	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 23	13	68	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 23	13	69	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Control Input 24	13	6C	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 24	13	6D	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 25	13	70	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 25	13	71	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 26	13	74	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 26	13	75	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 27	13	78	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 27	13	79	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 28	13	7C	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 28	13	7D	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 29	13	80	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 29	13	81	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 30	13	84	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 30	13	85	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 31	13	88	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 31	13	89	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				
Control Input 32	13	8C	Latched	Latched, Pulsed
Configures the control inputs as either latched or pulsed				
Ctrl Command 32	13	8D	SET/RESET	Set/Reset, In/Out, Enabled/Disabled, On/Off
Defines the control command text (SET / RESET, In/Out, On/Off, Enabled/Disabled)				

Table 13: Control Input Configuration Settings

2.4.9 Function keys

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
FUNCTION KEYS	17	0		

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
This column controls the function key definitions				
Fn Key Status	17	1		8-bit binary string
Displays the status of each function key				
Fn Key 1	17	2	Unlocked	Disable, Lock, Unlock
Setting to activate the function key				
Fn Key 1 Mode	17	3	Toggled	Toggle, Normal
Sets the function key to toggle or normal mode				
Fn Key 1 Label	17	4	Function Key 1	16 character text string
Allows the text of the function key to be changed				
Fn Key 2	17	5	Unlocked	Disable, Lock, Unlock
Setting to activate the function key				
Fn Key 2 Mode	17	6	Toggled	Toggle, Normal
Sets the function key to toggle or normal mode				
Fn Key 2 Label	17	7	Function Key 1	16 character text string
Allows the text of the function key to be changed				
Fn Key 3	17	8	Unlocked	Disable, Lock, Unlock
Setting to activate the function key				
Fn Key 3 Mode	17	9	Toggled	Toggle, Normal
Sets the function key to toggle or normal mode				
Fn Key 3 Label	17	0A	Function Key 1	16 character text string
Allows the text of the function key to be changed				
Fn Key 4	17	0B	Unlocked	Disable, Lock, Unlock
Setting to activate the function key				
Fn Key 4 Mode	17	0C	Toggled	Toggle, Normal
Sets the function key to toggle or normal mode				
Fn Key 4 Label	17	0D	Function Key 1	16 character text string
Allows the text of the function key to be changed				
Fn Key 5	17	0E	Unlocked	Disable, Lock, Unlock
Setting to activate the function key				
Fn Key 5 Mode	17	0F	Toggled	Toggle, Normal
Sets the function key to toggle or normal mode				
Fn Key 5 Label	17	10	Function Key 1	16 character text string
Allows the text of the function key to be changed				
Fn Key 6	17	11	Unlocked	Disable, Lock, Unlock
Setting to activate the function key				
Fn Key 6 Mode	17	12	Toggled	Toggle, Normal
Sets the function key to toggle or normal mode				
Fn Key 6 Label	17	13	Function Key 1	16 character text string
Allows the text of the function key to be changed				
Fn Key 7	17	14	Unlocked	Disable, Lock, Unlock
Setting to activate the function key				
Fn Key 7 Mode	17	15	Toggled	Toggle, Normal
Sets the function key to toggle or normal mode				

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Fn Key 7 Label	17	16	Function Key 1	16 character text string
Allows the text of the function key to be changed				
Fn Key 8	17	17	Unlocked	Disable, Lock, Unlock
Setting to activate the function key				
Fn Key 8 Mode	17	18	Toggled	Toggle, Normal
Sets the function key to toggle or normal mode				
Fn Key 8 Label	17	19	Function Key 1	16 character text string
Allows the text of the function key to be changed				
Fn Key 9	17	1A	Unlocked	Disable, Lock, Unlock
Setting to activate the function key				
Fn Key 9 Mode	17	1B	Toggled	Toggle, Normal
Sets the function key to toggle or normal mode				
Fn Key 9 Label	17	1C	Function Key 1	16 character text string
Allows the text of the function key to be changed				
Fn Key 10	17	1D	Unlocked	Disable, Lock, Unlock
Setting to activate the function key				
Fn Key 10 Mode	17	1E	Toggled	Toggle, Normal
Sets the function key to toggle or normal mode				
Fn Key 10 Label	17	1F	Function Key 1	16 character text string
Allows the text of the function key to be changed				

Table 14: Function Key Settings

2.4.10 IED configurator

The contents of the IED CONFIGURATOR menu are mostly data items, displayed for information but not editable. In order to edit the configuration, it is necessary to use the IED Configurator tool within S1 Studio.

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
IED CONFIGURATOR	19	0		
This column contains IED Configurator settings				
Switch Conf.Bank	19	5	No Action	No action, Switch Banks
Setting which allows the user to switch between the current configuration, held in the Active Memory Bank, to the configuration sent to and held in the Inactive Memory Bank				
Active Conf.Name	19	10		<Active configuration name>
The name of the configuration in the Active Memory Bank, usually taken from the SCL file				
Active Conf.Rev	19	11		<Active configuration revision>
Configuration Revision number of the configuration in the Active Memory Bank, usually taken from the SCL file				
Inact.Conf.Name	19	20		<Inactive configuration name
The name of the configuration in the Inactive Memory Bank, usually taken from the SCL file				
Inact.Conf.Rev	19	21		<Inactive configuration revision>
Configuration Revision number of the configuration in the Inactive Memory Bank, usually taken from the SCL file				
IP PARAMETERS	19	30		

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
IP address	19	31	0.0.0.0	<IP address of relay>
Displays the unique network IP address that identifies the unit				
Subnet mask	19	32	0.0.0.0	<Subnet mask of relay>
Displays the sub-network the relay is connected to				
Gateway	19	33	0.0.0.0	<Gateway address>
Displays the IP address of the gateway (proxy) the relay is connected to, if any.				
IEC61850 SCL	19	50		
0				
IED Name	19	51		<8 character IED name>
8 character IED name, which is the unique name on the IEC 61850 network for the IED, usually taken from the SCL file				
IEC61850 GOOSE	19	60		
GoID	19	61		64 character GOOSE Identifier
64 character GOOSE Identifier, used for naming the published GOOSE message				
GoEna	19	70	Disabled	Enabled, Disabled
Setting to enable GOOSE publisher settings				
Test Mode	19	71	Disabled	Disabled, Pass Through, Forced
The Test Mode allows the test pattern to be sent in the GOOSE message, for example for testing or commissioning				
VOP Test Pattern	19	72	0x00000000	32 bit test pattern
The 32-bit test pattern applied in Forced test mode				
Ignore Test Flag	19	73	No	Yes, No
When set to Yes, the test flag in the subscribed GOOSE message is ignored, and the data treated as normal				

Table 15: IED Configurator Settings

2.4.11 Control input labels

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
CTRL I/P LABELS	29	0		
This column contains settings for the Input Labels				
Control Input 1	29	1	Control Input 1	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 2	29	2	Control Input 2	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 3	29	3	Control Input 3	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 4	29	4	Control Input 4	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 5	29	5	Control Input 5	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Control Input 6	29	6	Control Input 6	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 7	29	7	Control Input 7	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 8	29	8	Control Input 8	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 9	29	9	Control Input 9	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 10	29	0A	Control Input 10	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 11	29	0B	Control Input 11	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 12	29	0C	Control Input 12	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 13	29	0D	Control Input 13	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 14	29	0E	Control Input 14	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 15	29	0F	Control Input 15	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 16	29	10	Control Input 16	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 17	29	11	Control Input 17	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 18	29	12	Control Input 18	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 19	29	13	Control Input 19	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 20	29	14	Control Input 20	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 21	29	15	Control Input 21	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Control Input 22	29	16	Control Input 22	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 23	29	17	Control Input 23	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 24	29	18	Control Input 24	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 25	29	19	Control Input 25	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 26	29	1A	Control Input 26	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 27	29	1B	Control Input 27	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 28	29	1C	Control Input 28	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 29	29	1D	Control Input 29	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 30	29	1E	Control Input 30	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 31	29	1F	Control Input 31	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 32	29	20	Control Input 32	16 character text string
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				

Table 16: Control Input Label Settings

2.5 Disturbance recorder settings (oscillography)

The integral disturbance recorder has an area of memory specifically set aside for record storage. The number of records that may be stored by the P847B&C is dependent upon the selected recording duration. The P847B&C can typically store a minimum of 20 records, each of 1.5 seconds duration. Disturbance records continue to be recorded until the available memory is exhausted, at which time the oldest record(s) are overwritten to make space for the newest one.

The recorder stores actual samples that are taken at a rate of 48 samples per cycle.

Each disturbance record consists of twelve analog data channels and thirty-two digital data channels. The relevant CT and VT ratios for the analog channels are also extracted to enable scaling to primary quantities.

> **Note:** *If a CT ratio is set less than unity, the P847B&C will choose a scaling factor of zero for the appropriate channel.*

The DISTURBANCE RECORDER menu column is shown in the following table:

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
DISTURB RECORDER	0C	0		
This column contains settings for the Disturbance Recorder				
Duration	0C	1	1.5	0.1s to 10.5s step 0.01s
Overall recording time setting				
Trigger Position	0C	2	33.3	0% to 100% step 0.1%
Trigger point setting as a percentage of the duration. For example, the default settings show the overall recording time is set to 1.5 s with the trigger point being at 33.3% of this, giving 0.5 s pre-fault and 1 s post fault recording times				
Trigger Mode	0C	3	Single	Single, Extended
If set to single mode, and if a further trigger occurs while a recording is taking place, the recorder ignores the trigger. However, if this is set to Extended, the post trigger timer is reset to zero, extending the recording time				
Analog Channel 1	0C	4	VA	IA1, IB1, IC1, IA2, IB2, IC2, IA3, IB3, IC3, IA4, IB4, IC4, VA, VB, VC, Unused, Frequency
Selects any available analog input to be assigned to this channel				
Analog Channel 2	0C	5	VB	IA1, IB1, IC1, IA2, IB2, IC2, IA3, IB3, IC3, IA4, IB4, IC4, VA, VB, VC, Unused, Frequency
Selects any available analog input to be assigned to this channel				
Analog Channel 3	0C	6	VC	IA1, IB1, IC1, IA2, IB2, IC2, IA3, IB3, IC3, IA4, IB4, IC4, VA, VB, VC, Unused, Frequency
Selects any available analog input to be assigned to this channel				
Analog Channel 4	0C	7	IA1	IA1, IB1, IC1, IA2, IB2, IC2, IA3, IB3, IC3, IA4, IB4, IC4, VA, VB, VC, Unused, Frequency
Selects any available analog input to be assigned to this channel				
Analog Channel 5	0C	8	IB1	IA1, IB1, IC1, IA2, IB2, IC2, IA3, IB3, IC3, IA4, IB4, IC4, VA, VB, VC, Unused, Frequency
Selects any available analog input to be assigned to this channel				
Analog Channel 6	0C	9	IC1	IA1, IB1, IC1, IA2, IB2, IC2, IA3, IB3, IC3, IA4, IB4, IC4, VA, VB, VC, Unused, Frequency
Selects any available analog input to be assigned to this channel				
Analog Channel 7	0C	0A	Unused	IA1, IB1, IC1, IA2, IB2, IC2, IA3, IB3, IC3, IA4, IB4, IC4, VA, VB, VC, Unused, Frequency
Selects any available analog input to be assigned to this channel				
Analog Channel 8	0C	0B	Unused	IA1, IB1, IC1, IA2, IB2, IC2, IA3, IB3, IC3, IA4, IB4, IC4, VA, VB, VC, Unused, Frequency
Selects any available analog input to be assigned to this channel				
Digital Input 1	0C	0C	Relay 1	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 1 Trigger	0C	0D	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 2	0C	0E	Relay 2	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 2 Trigger	0C	0F	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 3	0C	10	Relay 3	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 3 Trigger	0C	11	Trigger L/H	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 4	0C	12	Relay 4	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 4 Trigger	0C	13	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 5	0C	14	Relay 5	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 5 Trigger	0C	15	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 6	0C	16	Relay 6	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 6 Trigger	0C	17	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 7	0C	18	Relay 7	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 7 Trigger	0C	19	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 8	0C	1A	Relay 8	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 8 Trigger	0C	1B	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 9	0C	1C	Opto 1	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 9 Trigger	0C	1D	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 10	0C	1E	Opto 2	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 10 Trigger	0C	1F	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 11	0C	20	Opto 3	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 11 Trigger	0C	21	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 12	0C	22	Opto 4	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 12 Trigger	0C	23	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 13	0C	24	Opto 5	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 13 Trigger	0C	25	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 14	0C	26	Opto 6	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 14 Trigger	0C	27	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 15	0C	28	Opto 7	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 15 Trigger	0C	29	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 16	0C	2A	Opto 8	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 16 Trigger	0C	2B	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 17	0C	2C	Not Used	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 17 Trigger	0C	2D	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 18	0C	2E	Not Used	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 18 Trigger	0C	2F	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 19	0C	30	Not Used	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 19 Trigger	0C	31	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 20	0C	32	Not Used	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 20 Trigger	0C	33	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 21	0C	34	Not Used	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 21 Trigger	0C	35	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 22	0C	36	Not Used	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 22 Trigger	0C	37	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 23	0C	38	Not Used	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 23 Trigger	0C	39	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 24	0C	3A	Not Used	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 24 Trigger	0C	3B	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 25	0C	3C	Not Used	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 25 Trigger	0C	3D	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 26	0C	3E	Not Used	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 26 Trigger	0C	3F	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 27	0C	40	Not Used	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 27 Trigger	0C	41	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 28	0C	42	Not Used	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 28 Trigger	0C	43	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 29	0C	44	Not Used	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 29 Trigger	0C	45	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 30	0C	46	Not Used	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 30 Trigger	0C	47	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 31	0C	48	Not Used	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 31 Trigger	0C	49	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Digital Input 32	0C	4A	Not Used	Any of 8 O/P Contacts or Any of 8 Opto Inputs or Internal Digital Signals
The digital channels can be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals such as protection starts and LEDs				
Input 32 Trigger	0C	4B	No Trigger	No trigger, Trigger L/H, trigger H/L
Any of the digital channels can be selected to trigger the disturbance recorder on either a low-to-high (L/H) or a high-to-low (H/L) transition				
Analog Channel 9	0C	50	Unused	IA1, IB1, IC1, IA2, IB2, IC2, IA3, IB3, IC3, IA4, IB4, IC4, VA, VB, VC, Unused, Frequency
Selects any available analog input to be assigned to this channel				
Analog Channel 10	0C	51	Unused	IA1, IB1, IC1, IA2, IB2, IC2, IA3, IB3, IC3, IA4, IB4, IC4, VA, VB, VC, Unused, Frequency
Selects any available analog input to be assigned to this channel				
Analog Channel 11	0C	52	Unused	IA1, IB1, IC1, IA2, IB2, IC2, IA3, IB3, IC3, IA4, IB4, IC4, VA, VB, VC, Unused, Frequency

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Selects any available analog input to be assigned to this channel				
Analog Channel 12	0C	53	Unused	IA1, IB1, IC1, IA2, IB2, IC2, IA3, IB3, IC3, IA4, IB4, IC4, VA, VB, VC, Unused, Frequency
Selects any available analog input to be assigned to this channel				

Table 17: Disturbance Recorder Settings

The pre and post trigger recording times are set by a combination of the Duration and Trigger Position cells. Duration sets the overall recording time and the Trigger Position sets the trigger point as a percentage of the duration. For example, the default settings show that the overall recording time is set to 1.5 s with the trigger point being at 33.3% of this, giving 0.5 s pre-fault and 1s post fault recording times.

If a further trigger occurs whilst a recording is taking place, the recorder will ignore the trigger if the Trigger Mode has been set to Single. However, if this has been set to Extended, the post trigger timer will be reset to zero, thereby extending the recording time.

As can be seen from the menu, each of the analog channels is selectable from the available analog inputs to the P847B&C. The digital channels may be mapped to any of the opto isolated inputs or output contacts, in addition to a number of internal P847B&Cdigital signals, such as protection starts and LEDs. The complete list of these signals may be found by viewing the available settings in the P847 menu or using the setting file in S1 Studio. Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition, using the Input Trigger cell. The default trigger settings are that any dedicated trip output contacts (for example, relay 3) will trigger the recorder.

It is not possible to view the disturbance records locally using the LCD; they must be extracted using suitable software such as S1 Studio. This process is fully explained in the Communications chapter.

Note:	*Disturbance records within the P847 are not stored in a phasor format and individual recorded measurements are not time tagged.*

3 MEASUREMENTS DESCRIPTIONS

The principal function of the P847B&C PMU is to monitor power system quantities and to present these quantities in the synchronized phasor format described in IEEE C37.118. This synchrophasor information is made available via Ethernet communications to phasor data concentrators for system-wide attention. In addition, the synchrophasor quantities can be viewed locally on the unit's LCD display, or by using the S1 Studio suite of applications.

As well as measurements, the P847B&C is equipped with integral measurements, event, fault and disturbance recording facilities suitable for analysis of complex system disturbances.

The P847 is flexible enough to allow for the programming of these functions for specific user application requirements.

The P847 is able to measure and display the following quantities:

- Synchrophasors
- Phase Voltages
- Phase Currents
- Sequence Voltages and Currents
- Power and Energy Quantities
- Rms. Voltages and Currents
- Peak, Fixed and Rolling Demand Values

3.1 Synchrophasors

The synchrophasor measurements can be viewed in the Measurements menu of the P847B&C. The displayed synchrophasor measurements include phase and sequence voltage, phase and sequence current, frequency, and rate of change of frequency.

3.1.1 Measurement Settings

The following settings under the heading measurement set-up can be used to configure the P847B&C measurement function.

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
MEASURE'T SETUP	0D	0		
This column contains settings for the measurement setup				
Default Display	0D	1	Description	3Ph + N Current, 3Ph Neutral Voltage, Power, Date and Time, Description, Plant Reference, Frequency, Access Level
Used to select the default display from a range of options				
Measurement Mode	0D	5	0	0, 1, 2, 3
This setting is used to control the signing of the real and reactive power quantities				

Table 18: Measurement Settings

4 EVENT RECORDS

The product records and time tags up to 512 events and stores them in non-volatile (battery backed up) memory. This allows you to establish the sequence of events that occurred following a particular power system condition, switching sequence etc. When the available space is exhausted, the oldest event is automatically overwritten by the new one.

The real time clock within the unit provides the time tag to each event, to a resolution of 1ms. Disturbance records within the P847 are not stored in a phasor format and individual recorded measurements are not time tagged.

The event records are available for viewing either the front plate LCD or remotely the communications ports (courier versions only).

Local viewing on the LCD is achieved in the menu column entitled VIEW RECORDS. This column allows viewing of event, fault and maintenance records and is shown in the following table:

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
VIEW RECORDS	1	0		
This column contains record configuration				
Select Event [0...n]	1	1	0	0 to 499, step 1
Selects the required event record				
Menu Cell Ref	1	2	(From Record)	
Indicates the type of event				
Time & Date	1	3	(From Record)	
Indicates time and date stamp for the event				
Event Text	1	4		
Description of the event				
Event Value	1	5		
32-bit binary string indicating ON (1) or OFF (0) status of relay contact or opto input or alarm or protection event depending on event type				
Select Maint [0...n]	1	F0		0 to 9, step 1
Selects the required maintenance record				
Maint Text	1	F1		
Description of the maintenance record				
Maint Type	1	F2		
Displays the type of the maintenance record				
Maint Data	1	F3		
Displays the maintenance data				
Reset Indication	1	FF	No	No, Yes
Resets latched LEDs and latched relay contacts provided the relevant protection element has reset				

Table 19: View records

4.1 Types of event

An event may be a change of state of a control input or output relay, an alarm condition, setting change etc. The following sections show the various items that constitute an event:

4.1.1 Change of state of opto-isolated digital inputs

If one or more of the opto-isolated digital inputs (opto-inputs) has changed state, the new status is logged as an event. When this event is selected to be viewed on the LCD, three applicable cells will become visible as shown below:

- Time & date of event
- LOGIC INPUTS 1
- Event Value 01010101

The Event Value is an 8 bit string showing the status of the opto inputs, where the least significant bit (extreme right) corresponds to opto input 1. The same information is present if the event is extracted and viewed using a PC.

4.1.2 Change of state of one or more output relay contacts

If one or more of the output relay contacts have changed state since the last time that the protection algorithm ran, then the new status is logged as an event. When this event is selected to be viewed on the LCD, three applicable cells will become visible as shown below:

- Time & date of event
- OUTPUT CONTACTS 1
- Event Value 01010101

The Event Value is an 8 bit string showing the status of the output contacts, where the least significant bit (extreme right) corresponds to output contact 1 etc. The same information is present if the event is extracted and viewed using a PC.

4.1.3 Protection element starts and trips

Any operation of protection elements, (either a start or a trip condition) will be logged as an event record, consisting of a text string indicating the operated element and an event value. Again, this value is intended for use by the event extraction software, such as S1 Studio, rather than for the user, and is therefore invisible when the event is viewed on the LCD.

4.1.4 General events

A number of events come under the heading of General Events - an example is shown below:

Nature of event	Displayed text in event record	Displayed value
Level 1 password modified, either from user interface, front or rear port.	PW1 modified UI, F, R or R2	0 UI=6, F=11, R=16, R2=38

Table 20: General Events

4.1.5 Maintenance reports

Internal failures detected by the self-monitoring circuitry, such as watchdog failure, field voltage failure etc. are logged into a maintenance report. The maintenance report holds up to 5 such events and is accessed from the **Select Report** cell at the bottom of the VIEW RECORDS column.

Each entry consists of a self explanatory text string and a Type and Data cell, which are explained in the menu extract at the beginning of this section.

Each time a Maintenance Report is generated, an event is also created. The event simply states that a report was generated, with a corresponding time stamp.

4.1.6 Setting changes

Changes to any setting within the P847B&C are logged as an event. Two examples are shown in the following table:

Type of setting change	Displayed text in event record	Displayed value
Control/Support Setting	C & S Changed	22
Group # Change	Group # Changed	# (1, 2, 4 or 4)

Table 21: Setting changes

> ***Note:*** *Control/Support settings are communications, measurement, CT/VT and ratio settings, which are not duplicated within the four setting groups. When any of these settings are changed, the event record is created simultaneously. However, changes to protection or disturbance recorder settings will only generate an event once the settings have been confirmed at the setting trap.*

4.2 Resetting of event

To delete the event or maintenance reports, go to the RECORD CONTROL column.

4.3 Viewing event records using S1 Studio support software

When the event records are extracted and viewed on a PC they look slightly different than when viewed on the LCD. The following shows an example of how various events appear when displayed using S1 Studio:

Monday 03 January 2009 15:35:55 GMT A/R Lockout ON

MiCOM: MiCOM P847

Model Number: P84711BA1M0600K

Address: 001 Column: 00 Row: 22

Event Type: Alarm event

The first line gives the description and time stamp for the event, while additional information can be collapsed using the +/– symbol.

4.4 Event filtering

It is possible to disable the reporting of events from all interfaces that supports setting changes. The settings that control the various types of events are in the record control column. The effect of setting each to disabled is as follows:

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
RECORD CONTROL	0B	0		
This column contains settings for Record Controls				
Clear Events	0B	1	No	No, Yes
Selecting Yes clears the existing event log and generates an event which shows the events have been erased				
Clear Maint	0B	3	No	No, Yes
Selecting Yes erases the existing maintenance records				
Alarm Event	0B	4	Enabled	Enabled, disabled
Disabling this setting means that no event is generated for alarms				
Relay O/P Event	0B	5	Enabled	Enabled, disabled

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Disabling this setting means that no event is generated for any change in logic output state				
Opto Input Event	0B	6	Enabled	Enabled, disabled
Disabling this setting means that no event is generated for any change in logic input state				
General Event	0B	7	Enabled	Enabled, disabled
Disabling this setting means that no General Events are generated				
Maint Rec Event	0B	9	Enabled	Enabled, disabled
Disabling this setting means that no event is generated for any maintenance records				
Clear Disturbance	0B	30	No	No, Yes
Not in Steve's Doc				
DDB 31 - 0	0B	40	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 63 - 32	0B	41	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 95 - 64	0B	42	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 127 - 96	0B	43	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 159 - 128	0B	44	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 191 - 160	0B	45	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 223 - 192	0B	46	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 255 - 224	0B	47	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 287 - 256	0B	48	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 319 - 288	0B	49	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 351 - 320	0B	4A	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 383 - 352	0B	4B	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 415 - 384	0B	4C	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Digital Data Bus				
DDB 447 - 416	0B	4D	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 479 - 448	0B	4E	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 511 - 480	0B	4F	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 543 - 512	0B	50	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 575 - 544	0B	51	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 607 - 576	0B	52	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 639 - 608	0B	53	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 671 - 640	0B	54	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 703 - 672	0B	55	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 735 - 704	0B	56	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 767 - 736	0B	57	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 799 - 768	0B	58	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 831 - 800	0B	59	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 863 - 832	0B	5A	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 895 - 864	0B	5B	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 927 - 896	0B	5C	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Digital Data Bus				
DDB 959 - 928	0B	5D	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 991 - 960	0B	5E	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				
DDB 1023 - 992	0B	5F	0xFFFFFFFF	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Digital Data Bus				

Table 22: Record Control Settings

> ***Note:*** *Some occurrences will result in more than one type of event, for example a battery failure will produce an alarm event and a maintenance record event.*

If the Protection Event setting is enabled a further set of settings is revealed which allow the event generation by individual DDB signals to be enabled or disabled.

OPERATION

CHAPTER 10

1 CHAPTER OVERVIEW

The Operation chapter describes in detail the operation of the P847B&C Phasor Measurement Unit (PMU). The P847 models B&C are targeted towards the measurement and communication of synchrophasors, typically to transmit synchrophasor data to a phasor data concentrator (PDC).

The two models differ only in terms of the number of digital inputs and outputs that are supported:

- Model B has 16 opto-isolated digital inputs (opto-inputs) and 8 digital outputs
- Model C has 24 opto-inputs and 24 outputs.

This chapter consists of the following sections:

2 PHASOR MEASUREMENTS

The electrical power system voltage and current signals are fed into the P847 via the on-board current and voltage transformers situated on the transformer board. The PMU samples these signals at precisely 48 samples per power system cycle. The sampling process is controlled by a frequency tracking algorithm that can respond quickly and accurately to changes in power system frequency. The analog quantities are converted into digital quantities and presented to the unit’s processing machinery via a serial data bus.

An accurate time signal is required to provide referencing for the measured quantities. This is provided by the Global Positioning System (GPS), which supplies a UTC (Universal Time Coordinated) signal. The P594 GPS receiver receives this timing signal transmitted from the GPS satellite system, and from this produces two timing signals:

- An IRIG-B demodulated signal for second-of-century timing (seconds since Jan 1 1970)
- An accurate 1 pulse per second signal for fraction of second synchronization

The acquired data are then transformed into phasor values using a phasor filter with an adjustable filter length and presented in the form of either polar quantities (magnitude/angle) or rectangular quantities (real and imaginary values) according to user preference.

From the input signals, it is also possible to determine the system frequency and the rate-of-change of frequency. These quantities are packaged into a message with the selected voltage and current phasor signals and user-mapped digital signals for transmission to the data recipient (usually a Phasor Data Concentrator) via an Ethernet communications link

Figure 1 below shows a block diagram of the P847 PMU architecture

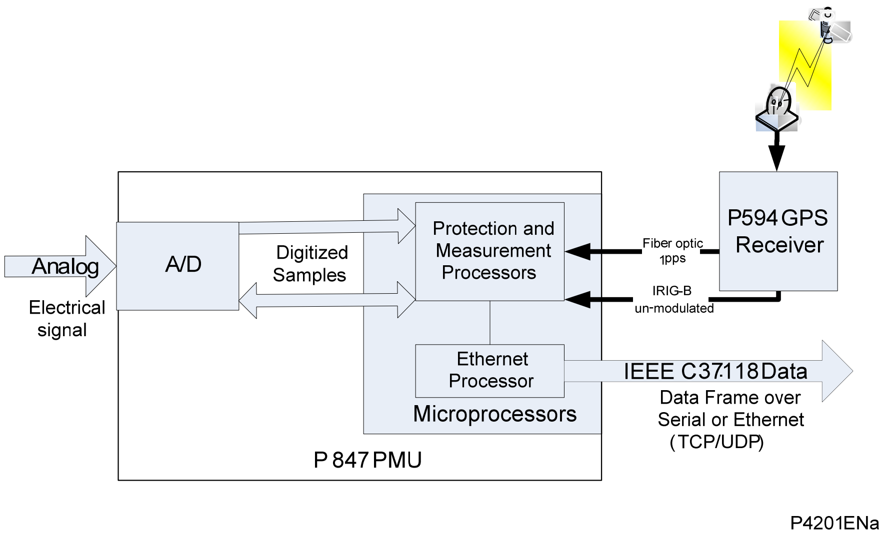


Figure 1: Phasor measurement

2.1 Available phasor measurements

The phasor measurements available from the P847B&C vary according to the model and the configuration. In addition to the digital input/ouput allocations described previously, models B & C of the P847 feature 12 current (CT) inputs and 3 voltage (VT) inputs.

Each of the 12 current input signals and the 3 voltage input signals can be freely allocated for individual phasor measurements, each with their own CT/VT ratio setting and the following phasor measurements are available:

- Voltages: VA, VB, VC, V1, V2, V0
- Currents: IA, IB, IC, I1, I2, I0, IA2, IB2, IC2, I1_2, I2_2, I0_2, IA3, IB3, IC3, I1_3, I2_3, I0_3, IA4, IB4, IC4, I1_4, I2_4, I0_4

For all models and configurations, the system frequency and rate of change of frequency are also presented, as this is a requirement of IEEE C37.118.

2.2 Phasor representation

The synchrophasor representation X of a signal *x(t)* is given below:

Rectangular representation: X= Xr+jXi

Polar representation: $X= (Xm/\sqrt{2})e^{j\theta}$

Where Xm is the peak magnitude of the filtered synchronized vector and θ is the phase angle relative to a cosine function at nominal frequency. IEEE C37.118 specifies that the angle θ is 0° when the maximum of the signal to be measured coincides with the GPS pulse and -90° if the positive zero crossing coincides with the GPS pulse.

Figure 2 shows this conversion, where Xr(n) and Xi(n)are the real and imaginary filtered rms components at a particular instance of time, and θ is the phase angle, which may be between $-\pi$ radians (-180°) to $+\pi$ radians (+180°).

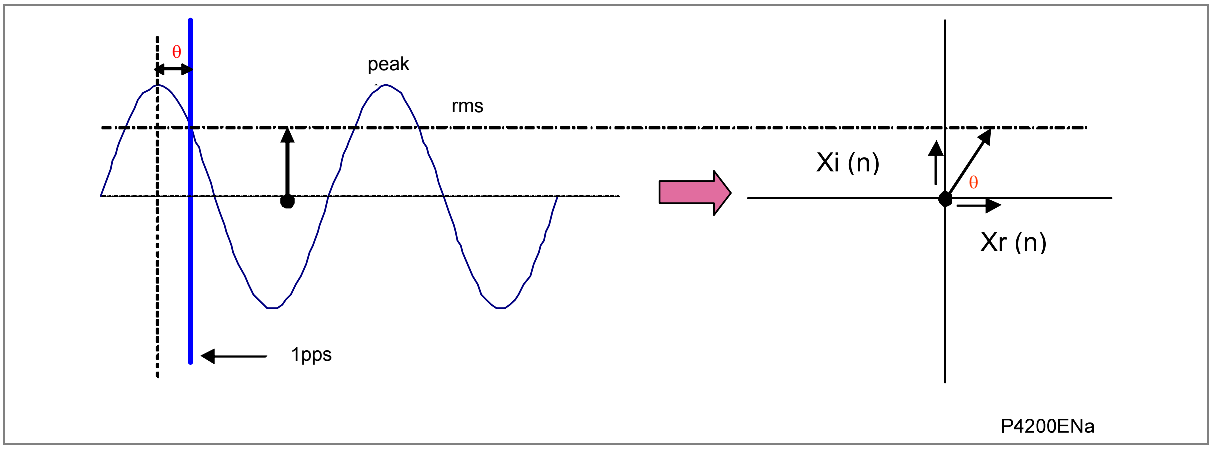


Figure 2: Phasor angle reference

2.3 Filtering

The P847B&C provides a user configurable filter. The filter length options are 1, 3, 5, 7 and 13 cycles. The shorter 1 cycle filter provides a fast dynamic response however it is less effective at filtering out-of-band interference. Conversely, the 13 cycle provides the best steady state accuracy however the trade-off is the speed of the dynamic response. The recommended settings are shown in Table 1.

Fundamental Frequency (Hz)	Reporting Rate (fps)	Filter Length
50	10*	13
	25	13
	50	5
60	10*	13
	12	13
	15	13
	20	13
	30	13
	60	5

Table 1: Recommended filter length settings

*Under the current IEEE standard C37.118-2005 it is not possible to meet the out-of-band requirements at these reporting rates

3 PHASOR SYNCHRONIZATION

The GPS 1pps signal, corresponding to Universal Coordinated Time (UTC), is used as the reference for phasor synchronization. The filter window is centered around this reference.

Figure 3 shows the synchronization of a phasor measurement for a 1 cycle filter length. The 24 samples taken before the pulse are used together with the 24 samples taken after the pulse to produce the synchrophasor.

The phase shift between the nearest sample and the GPS pulse (which can be up to half of a sampling interval), is measured using a 37.5 MHz internal CPU clock. Compensation is applied to the filtered result, by calculating the phase difference between the absolute reference from the 1pps signal and the samples either side.

The PMU also generates an internal reference signal for the center of subsequent windows every cycle to provide measurement references until the next GPS pulse arrives.

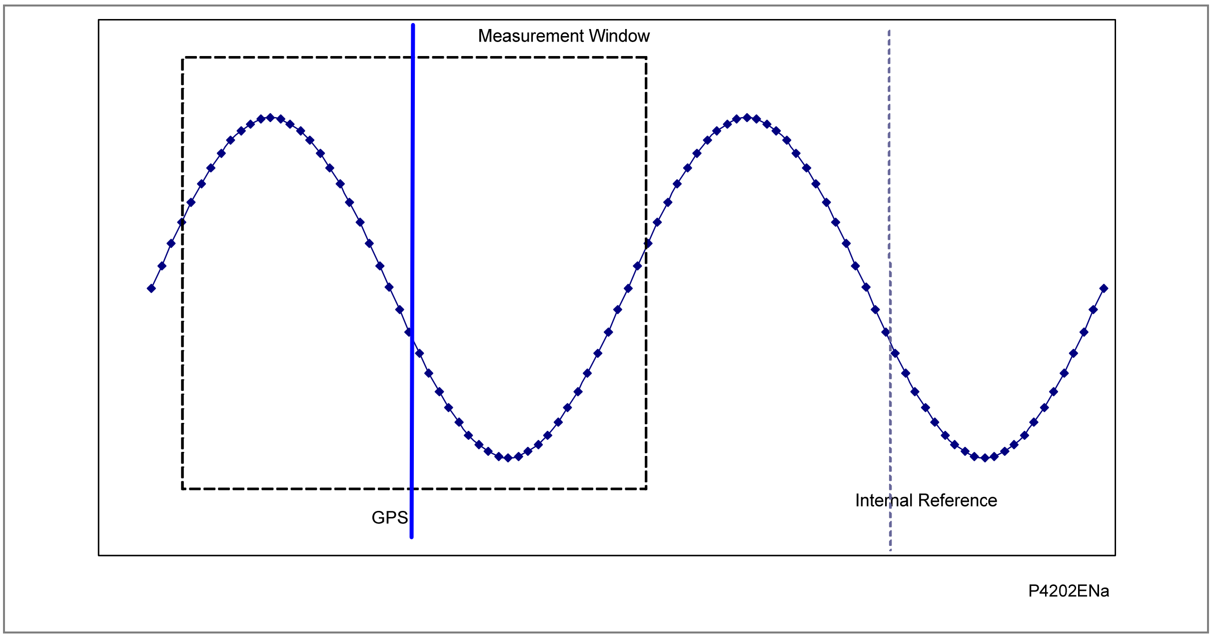


Figure 3: Phasor window

3.1 Timestamping

The P847's internal real time clock is synchronized by the P594 IRIG-B signal, and is used to time stamp the measurements. The arrival of the 1pps GPS pulse signifies an absolute multiple of a second.

The internally generated measurements are time stamped at intervals appropriate to the reporting rate.

An IRIG-B input is used to time-stamp events. It is important that the IRIG-B input is not pre-compensated for the difference between Universal Coordinated Time (UTC) and local time.

When using a P594 to provide the IRIG-B signal, for example, ensure that any time zone compensation is switched off, as the P847 will compensate for this.

3.2 Loss of GPS 1PPS

Following power up, the P847 provides synchrophasor measurements as soon as a valid GPS 1PPS signal has been received. No synchrophasor measurements are provided until this happens.

If measurements have already started, and the GPS signal is subsequently lost for any reason, the co-processor internal clock will generate the required pulses every second. This will allow the generation and transmission of synchrophasors to continue. The accuracy of an internally generated pulse cannot, however, match that of the GPS signal, therefore the degraded operation needs to be identified and flagged. To indicate degraded operation, the Clock failure bits are set and a local alarm indication is raised.

4 PHASOR REPORTING

As well as the synchrophasors themselves, the IEEE C37.118 standard also defines how these synchrophasors are to be communicated.

The synchrophasor signals are encapsulated into data frames for transmission across an Ethernet network. An example of a typical data packet is shown below.

Field function	Field size (bytes)
Message synchronization	2
Frame size definition	2
PMU ID code*	2
Real time timing information	8
Status information	2
Phasor data values	Variable, but typically 120
System frequency measurement	2
Rate of change of system frequency	2
Digital data values	2
Frame checksum	2
Total	Variable, but typically 144

Table 2: Synchrophasor data frame

* *The PMU ID code is a unique address that associates the synchrophasor values to the PMU responsible for producing them*

5 PMU CONFIGURATION SETTINGS

IEEE C37.118 defines the requirements for synchrophasors supported by PMUs such as the P847. These include PMU Configuration settings, which consist of the following:

- Device ID Code
- Data rate selection
- Phasor format
- Phasor measurement/transmission selection
- Digital input mapping
- Filter length.

5.1 Device ID code

Each PMU is assigned a unique address that is represented by an ID code. For the correct system operation, the ID code for each PMU configured in the scheme must be set differently. This allows a PDC to correctly identify the PMU.

5.2 Data Rate

The rate at which the frames are sent is described by the standard and defined by two settings:

- For 50 Hz operation the frame repetition rate can be set to 10, 25 or 50 frames per second.
- For 60 Hz operation the frame repetition rate can be set to 10, 12, 15, 20, 30, or 60 frames per second.

The calculations for bandwidth requirements are provided in the SCADA section. They are summarized here for convenience:

- 82.4 kbps for a maximum frame rate of 50 frames per second (TCP)
- 98.88 kbps for a maximum frame rate of 60 frames per second (TCP)
- 68.8 kbps for a maximum frame rate of 50 frames per second (UDP)
- 82.56 kbps for a maximum frame rate of 60 frames per second (UDP)

So for the worst case condition (60 x C37.118 frames per second over TCP/IP), the maximum theoretical number of attached PMUs is as follows:

- 10000/98.88 = 101 for a 10 Mbps network
- 100000/98.88 = 1011 for a 100 Mbps network

The chosen transfer rate therefore depends on the total capacity of the network (10 Mbps or 100 Mbps), existing network load and the maximum permitted utilization.

The system should be designed with the WAMPACS application requirements in mind. If a fast response is needed, then the reporting rate should be set high. If slower response rates can be tolerated, or if the communication network bandwidth is restricted, then a slower transfer rate should be selected.

5.3 Phasor format

The setting choice is: Polar (magnitude/angle) or Rectangular (real and imaginary value) and will depend on user preference and the application requirements.

5.4 Data Types

There are two settings for setting the optional data types used within the C37.118 data frame. One setting allows the data format of the frequency and the rate of change of frequency to be changed between integer and floating point. The other setting allows the data format of all the phasors to be changed between integer and floating point.

Settings	Options	Default	Description
Freq/Rocof Fmt	Floating Point / Integer	Floating Point	Data format of frequency and rate of change of frequency
Phasor Data Fmt	Floating Point / Integer	Floating Point	Data format of all the phasors

5.5 Magnitude and phase angle correction

There are three settings for each phasor, to enable the user to manually adjust the magnitude and phase angle. These settings can be used to compensate for errors introduced by the connection to the primary equipment. They are immediately after the Enable/Disable setting for each phasor in the menu and are only visible if the respective phasor is enabled.

Settings	Range	Step size	Default	Description
Vctr Grp Cor	-180° to +180°	30°	0°	Vector group angle correction
Ang Correct	-10° to +10°	0.01°	0°	Phase angle correction for general angle errors
Mag Correct	0.9 to 1.1 pu	0.001 pu	1	Magnitude correction

Both the magnitude and phase angle compensation can be globally enabled and disabled using the 'Mag. Corr Status' and the 'AngleCorr Status' settings.

5.6 Digital input mapping

There are 32 digital signals available for transmission in accordance with the IEEE C37.118 communication standard. Eight of these can be selected by the user. There are a number of possible applications for these digital signals. For example, they could be mapped to available DDB signals.

6 ETHERNET CONFIGURATION

The P847 supports the transmission of synchrophasor information over Ethernet communications only which must be configured appropriately.

The phasor data frames presented in the preceding sections can be mapped to either transmission control protocol (TCP) or user datagram protocol (UDP) according to preference. TCP is a connection-oriented protocol. It manages message acknowledgement, re-transmission and time out. As such it can be considered to be reliable and ordered, but carrying overheads. UDP is a simpler protocol that broadcasts messages from the transmitter without checking the state of the receiver. As such it can be considered unreliable and not ordered, but lean. The choice will come down to the specific requirements of the application.

> **Note:** *UDP is a stateless protocol so the order of packets is not guaranteed. In addition to this, once a connection is established and transmission of phasor data initiated, the transmission will not stop until the IED receives the* ***stop transmission*** *command from the client phasor data concentrator (or the interface is reconfigured).*

The TCP or UDP mapped messages are written to and read from using standard IP input output functions. These functions apply a numerical identifier for the data structures of the terminals of the communications. The terminal is referred to as a port and the numerical identifier is called the port number. The port number needs to be set to align with the recipient data concentrator.

The selection of TCP or UDP, and the setting of the port number are found under the Communications settings column of the P847. As default the port numbers are 4712 for TCP, and 4713 for UDP as per the recommendations of C37.118.

Other settings that are are the IP address, subnet mask, and gateway address. Unless the P847 is equipped with DNP3 over Ethernet communications, these are set using the IED configurator (IEC 61850 IED Configurator) tool which is resident in the S1 Studio software package. In the case of a P847 equipped with DNP3 over Ethernet communications, the settings for these are found in the Communications settings column of the menu.

> Note: *The P847 must have started to receive a valid one pulse per second synchronizing signal before it will start transmitting C37.118 frames.*

Optional redundant fiber-optic Ethernet communications is available for the P847 PMU Models B and C. The details of the redundant fiber-optic Ethernet communications are described in the Redundant Ethernet chapter of this manual. Of particular note is the fact that a second IP address needs to be set up for the redundant version. As DIP switches need to be set for this purpose, this involves partial dismantling of the product, which should be carried out before installation and commissioning.

APPLICATION EXAMPLES

CHAPTER 11

1 CHAPTER OVERVIEW

The Application chapter describes how the P847B&C Phasor Measurement Unit (PMU) can be applied, providing application examples where appropriate.

This chapter consists of the following sections:

2 INTRODUCTION

The P847 Phasor Measurement Unit (PMU) provides very accurate real time measurement of the electrical power system state, facilitating accurate system monitoring and control. When deployed across the network, the devices can be used for wide-area monitoring, protection and control of the power system.

Traditionally, power system monitoring has been based on SCADA data where the acquisition of the data has not been accurately time synchronized. Accurate time sychronisation is needed to compare phase angle measurements between points in the power network. Without this, it is not possible to accurately estimate the state of the power network. In particular, it may not be possible to adequately model the power system behavior during dynamic conditions such as power oscillations, or topology changes reflected through load flow changes. If the data acquisition rate is slow compared to the network dynamics, corrective actions may be applied too late, leading to possible system instabilities and even collapse of the power system. Phasor measurement technology has been developed to help overcome these limitations.

A phasor is a representation of a power system quantity, specifying both amplitude and phase. When provided with an accurate time synchronization signal, a PMU is capable of producing time synchronized phasors, known as synchrophasors. IEEE C37.118-2005 (IEEE Standard for Synchrophasors for Power Systems) defines these concepts along with the requirements for synchrophasor measurement accuracy and communication.

Synchrophasor technology can bring benefits, particularly to the monitoring and control of systems with components such as series capacitors or shunt reactors which prove problematic with traditional SCADA based state estimation techniques.

Synchrophasor technology uses high-bandwidth, cost effective communications networks. It also uses the accurate, wide area time synchronization available from the global positioning satellite system (GPS).

PMUs are intended to be component parts of Wide Area Monitoring, Protection And Control (WAMPAC) systems, a concept developed in response to system blackouts.

As the number of deployed PMUs grows, so too will the accuracy of power system modeling, resulting in increased power transfer efficiency, optimization of grid management and minimization of dangerous and costly blackouts.

3 APPLICATION OF PHASOR MEASUREMENTS

The data from the P847 PMU can be used with a variety of advanced hardware and software.

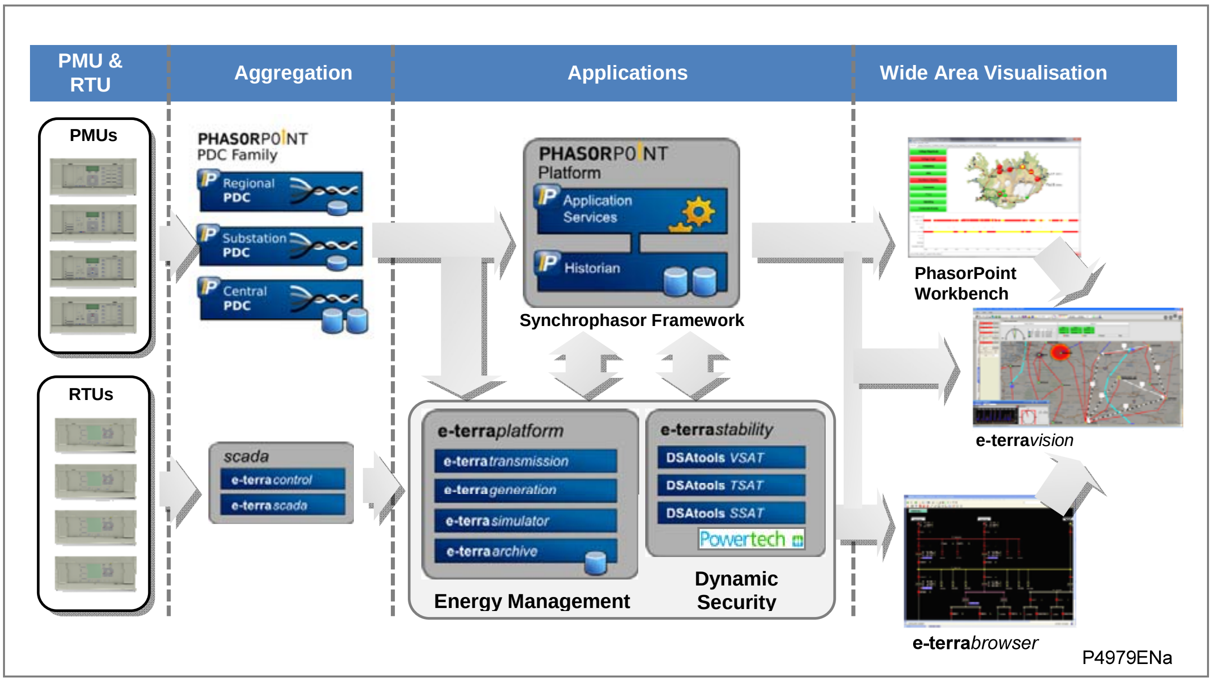


Figure 1: End-to-end Alstom Grid Wide Area Monitoring systems (WAMS)

The P847 provides the basis of schemes for:

- Monitoring angular instability
- Monitoring frequency or rate of change of frequency
- Monitoring voltage instability
- State estimation (based on time-synchronized, measured data)
- Wide area visualization
- Oscillatory stability analysis
- System recording or analysis
- System restoration
- Small Signal Stability Detection

3.1 PhasorPoint Applications

PhasorPoint is a complete software solution for Wide Area Monitoring Systems (WAMS). It enables data from Phasor Measurement Units (PMU) to be stored and displayed. Power system operators can then use synchrophasor applications based on the data. PhasorPoint systems provide Smart Grid solutions in the key areas of:

- Improving power system security
- Transfer constraint relief
- Assessment of power system dynamics

- Dynamic model validation
- Tuning of power system stabilisers
- Assessment of network and generator connections
- Managing islanded situations and resynchronisation

3.1.1 Transfer Constraint Relief

PhasorPoint can use PMU data to increase power flows over regional interconnectors. The Oscillatory Stability Management (OSM) application provides real-time measures of system dynamic behaviour. It uses damping measurement based limit rather than a lower model based limit.

Transient events or gradual changes can result in instability. This can lead to growing or large sustained oscillations. Such events can be limited by damping. Poor damping is an early warning sign of an increased risk of instability. Stability (and therefore reliability) can be improved by reducing transfer in this situation.

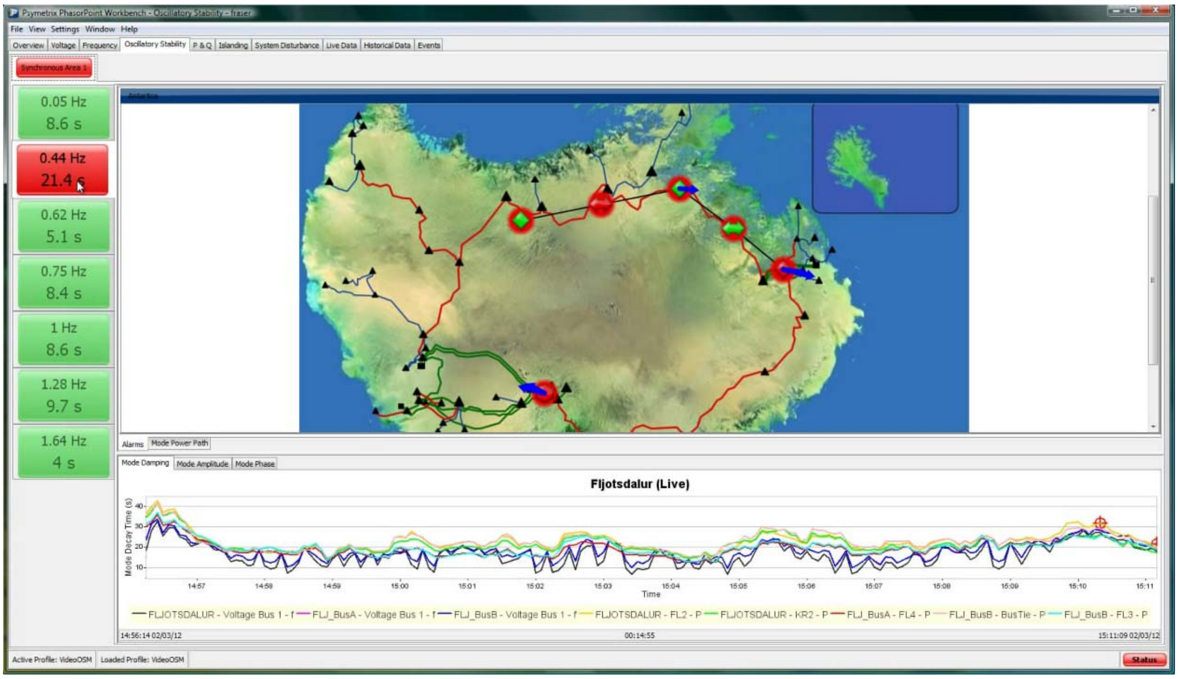


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Figure 2: PhasorPoint Oscillatory Stability Management (OSM) application

3.1.2 Islanding, Resynchronisation and Blackstart (IRB)

The PhasorPoint Islanding, Resynchronisation and Blackstart (IRB) application is used to detect and resynchronise a power system that has split into islands. PhasorPoint islanding detection is made with no reference to topology and is fast, typically within (1 sec). This is because loss of synchronism occurs before network separation and out-of-step occurs.

Early notification and characterisation of the problem allows the operators to immediately see where the islands are created, and to visually assess the extent of the imbalances in the islands. They can resolve the situation by reducing the frequency difference between separated regions before attempting reconnection, normally with a synchrocheck relay. Following resynchronisation, the operators have immediate feedback on the success of the operation. If successful, the angles stay aligned; if not, they will drift apart and the system will split again.

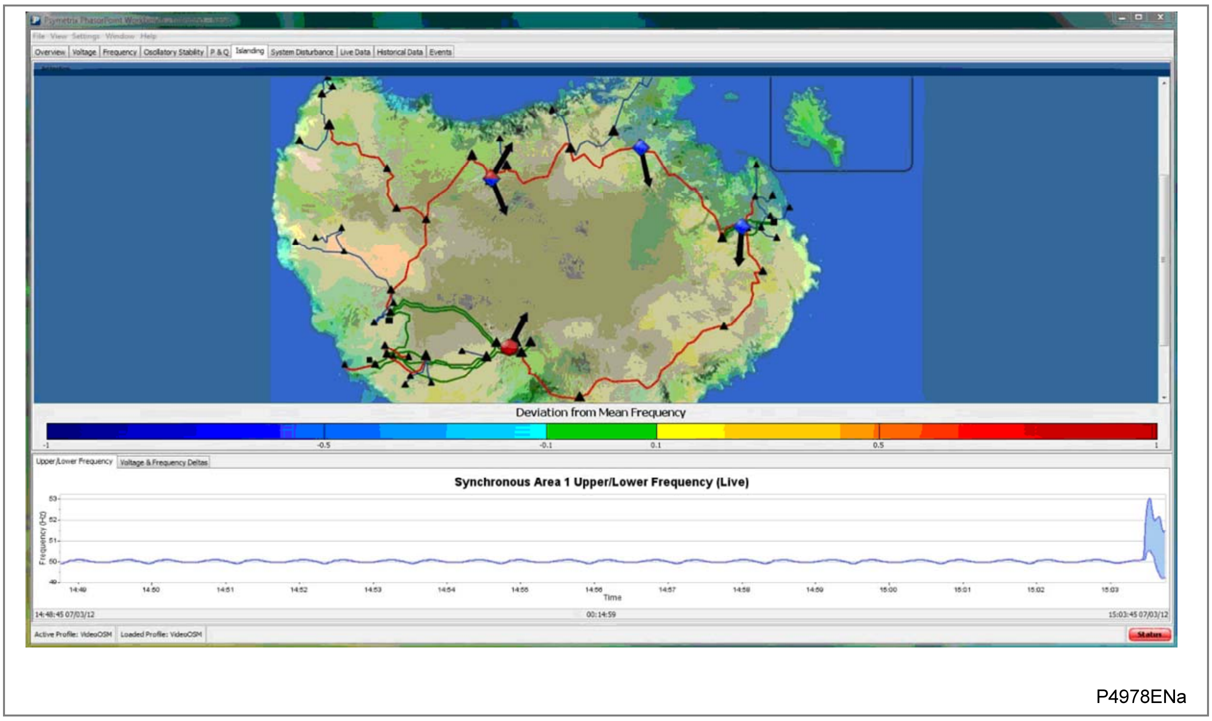

Figure 3: PhasorPoint Island, Resynchronisation and Blackstart (IRB) application

3.1.3 Connection of Renewables

Generation of renewable energy is not constant. This can influence network stability. PhasorPoint can identify long-term trends in the frequency and oscillatory stability of the power system as renewable energy increases. PhasorPoint is also valuable for analysing events, as voltage angles are useful for identifying changes in regional load balance, even if individual changes are not observable. PhasorPoint helps identify and deal with risks at an early stage before system reliability is compromised.

3.1.4 Improving Dynamic Performance

PhasorPoint uses PMU data to identify and track down issues with the dynamic performance of the power system and connected plants. PhasorPoint allows you to prioritise actions to improve dynamic performance. It also provides an assessment of how effective the actions are.

The P847 PMU provides a sophisticated, state-of-the-art frequency tracking algorithm. It responds very quickly and accurately during dynamic conditions, making it ideal for applications such as this.

3.2 e-terra Applications

The PMU data is transmitted to an upstream Phasor Data Concentrator (PDC) over TCP/IP or UDP/IP according to IEEE C37.118. The data from the PDC is displayed in a graphical format and can be used for monitoring and control purposes. The PMU data can be displayed on any PDC with a graphical display or on e-terravision which is a graphical display of the Energy Measurement System (EMS) software.

The following diagram shows PMU deployment and the angle difference between various substations presented on the e-terravision dashboard. In this example, the angle difference between two nodes has exceeded a user-settable value and shown in red, raising the alarm to a system operator that quick predefined corrective actions are needed.

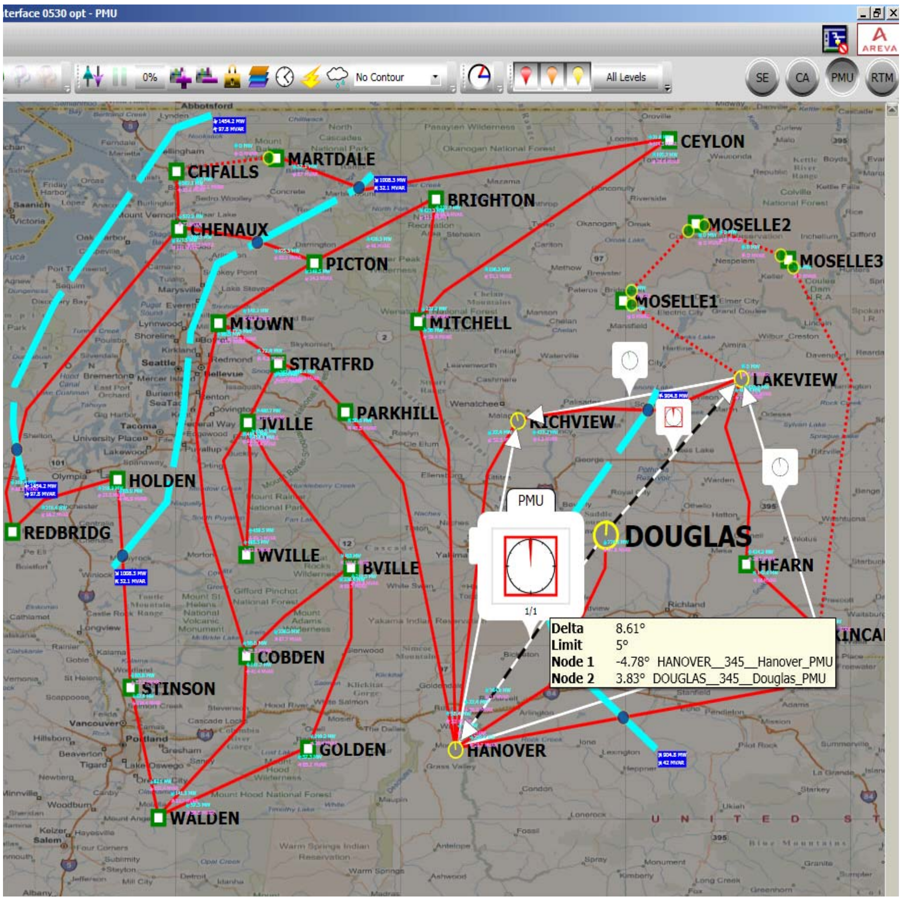

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Figure 4: Phase angle difference between various substations

PSL EDITOR

CHAPTER 12

1 CHAPTER OVERVIEW

The purpose of the Programmable Scheme Logic (PSL) is to allow you to configure an individual scheme to suit your own particular application. This is achieved through the use of programmable logic gates and delay timers. This chapter describes the PSL Editor, which allows you to do this. It consists of the following sections:

2 INTRODUCTION TO THE PSL EDITOR

The programmable scheme logic (PSL) editor is provided to map the digital inputs of the MiCOM ALSTOM Px40 products, to combine these inputs with internally generated digital signals using logic gates and timers, and to map the resultant signals to the digital outputs of the MiCOM ALSTOM Px40 products.

The PSL is built around a concept called the digital data bus (DDB). The DDB is a listing of all the digital signals (inputs, outputs, and internal signals) that are available for use in the PSL.

Inputs to the PSL include:

- Opto-isolated digital inputs (opto-inputs)
- IEC 61850 GOOSE inputs
- Control inputs
- Function keys

Outputs from the PSL include:

- Relay outputs
- Light emitting diodes
- IEC 61850 GOOSE outputs
- Trigger signals

Internal signals include “inputs” to the PSL (i.e. signals generated within the product that can be used to affect the operation of the scheme logic) and “outputs” from the PSL (i.e. signals that can be driven from the PSL to activate specific functions in the product). Examples of internal inputs and outputs include:

- GPS Alarm : an input that is asserted if the GPS signal is lost
- F out of Range : an input that is asserted if the system frequency goes out of range
- Reset Relays/LED : an output that can be asserted to reset the output relays and LEDs

The PSL consists of software logic gates and timers which combine and condition the DDB signals. The logic gates can be programmed to perform a range of different logic functions and can accept any number of inputs. The timers are used either to create a programmable delay or to condition the logic outputs.

The PSL logic is event driven. Only the part of the PSL logic that is affected by the particular input change that has occurred is processed. This reduces the amount of processing time that is used by the PSL.

This system gives you flexibility to create your own scheme logic design. This also means that the PSL can be configured into a very complex system, so you need a suitable PC support package to allow you to design your PSL scheme. This PC support package is provided in the form of the S1 Studio suite of tools, which includes the PSL Editor.

With the Px40 PSL Module you can:

- Start a new PSL diagram
- Extract a PSL file from a Px40 IED
- Download PSL file to a Px40 IED
- Open a diagram from a PSL file
- Add logic components to a PSL file

- Move components in a PSL file
- Edit link of a PSL file
- Add link to a PSL file
- Highlight path in a PSL file
- Use a conditioner output to control logic
- Print PSL files

To start the PSL editor, from the Studio S1 main menu, select:

Tools > PSL editor (Px40).

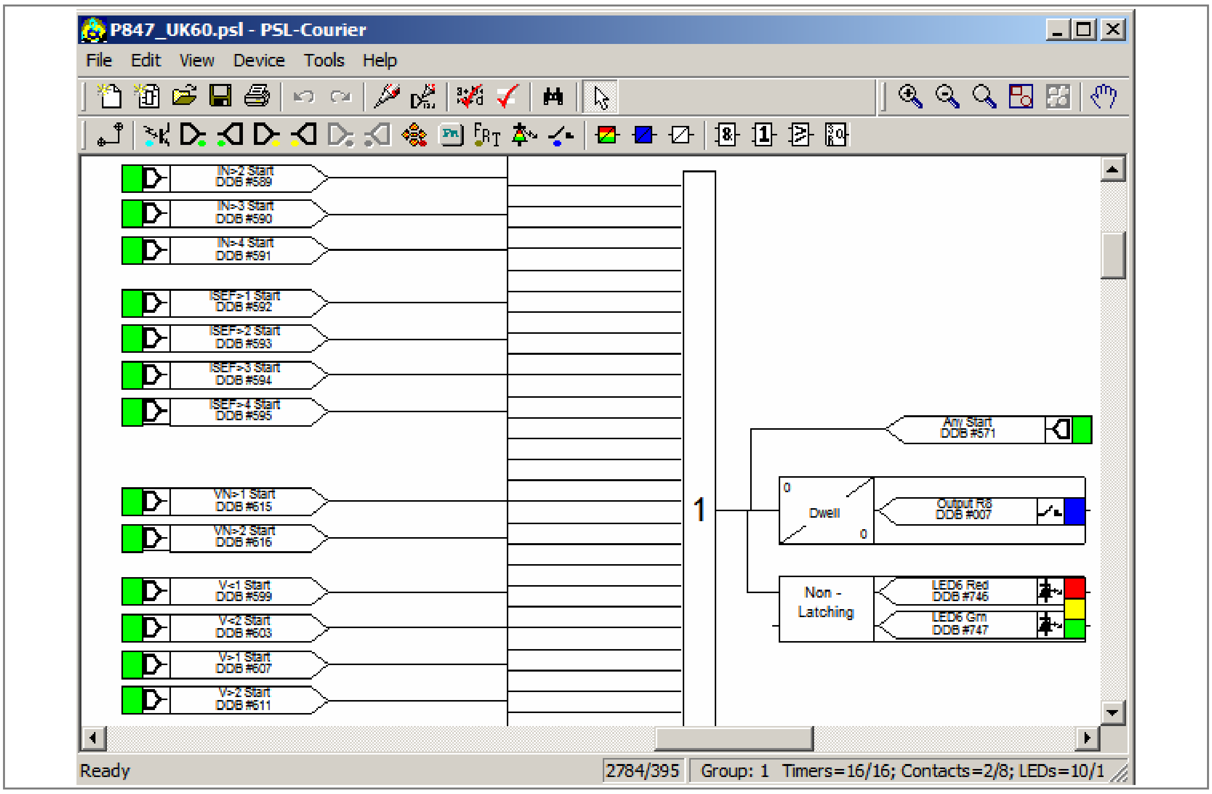


Figure 1: PSL Editor window

2.1 Warnings

Checks are done before a scheme is downloaded to the relay. Various warning messages may be displayed as a result of these checks.

In most cases, the model number of the unit will match that of the model number stored in the PSL software on the PC. The Editor first reads in the model number of the connected unit, then compares it with its stored model number using a "wildcard" comparison. If a model mismatch occurs, a warning is generated before sending starts. Both the stored model number and the number read from the relay are displayed with the warning.

It is up to the user to decide whether the settings to be downloaded are compatible, and to be aware that incompatible settings could lead to undesirable behavior of the unit.

If there are any obvious potential problems, a list is generated. The types of potential problems that the program attempts to detect are:

- One or more gates, LED signals, contact signals, or timers have their outputs linked directly back to their inputs. An erroneous link of this sort could lock up the relay, or cause other problems to arise.
- A programmable gate has its ITT (Inputs To Trigger) value set to greater than the number of actual inputs. This will mean the gate can never activate. There is no check for the case where the ITT value is lower than the number of inputs. A 0-value does not generate a warning.
- Too many gates. There is a theoretical upper limit of 256 gates in a scheme, but the practical limit is determined by the complexity of the logic. In practice the scheme would have to be very complex, and this error is unlikely to occur.
- Too many links. There is no fixed upper limit to the number of links in a scheme. However, as with the maximum number of gates, the practical limit is determined by the complexity of the logic. In practice the scheme would have to be very complex, and this error is unlikely to occur.

3 PSL EDITOR TOOLBAR

There are a number of toolbars available to help with navigating and editing the PSL.

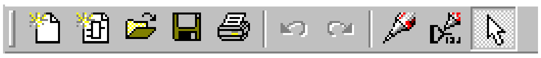
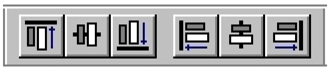
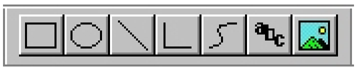
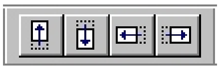
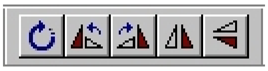
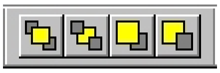
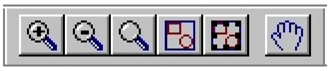
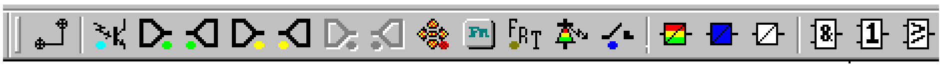
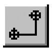
Toolbar	Description
	Standard tools: For file management and printing
	Alignment tools: To snap logic elements into horizontally or vertically aligned groupings
	Drawing tools : To add text comments and other annotations, for easier reading of PSL schemes
	Nudge tools: To move logic elements
	Rotation tools: Tools to spin, mirror and flip
	Structure tools: To change the stacking order of logic components
	Zoom and pan tools: For scaling the displayed screen size, viewing the entire PSL, or zooming to a selection

Table 1: Toolbars

3.1 Logic Symbols



The logic symbol toolbar provides icons to place each type of logic element into the scheme diagram. Not all elements are available in all devices. Icons will only be displayed for those elements available in the selected device.

Symbol	Function	Explanation
	Link	Create a link between two logic symbols
	Opto Signal	Create an opto signal
	Input Signal	Create an input signal
	Output Signal	Create an output signal
	GOOSE In	Create an input signal to logic to receive a GOOSE message transmitted from another IED. Used in either UCA2.0 or IEC 61850 GOOSE applications only
	GOOSE Out	Create an output signal from logic to transmit a GOOSE message to another IED. Used in either UCA2.0 or IEC 61850 GOOSE applications only
	Control In	Create an input signal to logic that can be operated from an external command
	Function Key	Create a function key input signal
	Trigger Signal	Create a fault record trigger
	LED Signal	Create an LED input signal that repeats the status of tri-color LED

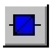
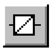
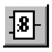
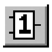
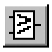
Symbol	Function	Explanation
	Contact Signal	Create a contact signal
	LED Conditioner	Create an LED conditioner
	Contact Conditioner	Create a contact conditioner
	Timer	Create a timer
	AND Gate	Create an AND Gate
	OR Gate	Create an OR Gate
	Programmable Gate	Create a programmable gate

Table 2: Logic symbol toolbar

4 PSL LOGIC SIGNALS PROPERTIES

1. Use the logic toolbar to select logic signals. This is enabled by default but to hide or show it, select View > Logic Toolbar.
2. Zoom in or out of a logic diagram using the toolbar icon or select View > Zoom Percent.
3. Right-click any logic signal and a context-sensitive menu appears.

Certain logic elements show the **Properties…** option. If you select this, a **Component Properties** window appears. The contents of this window and the signals listed will vary according to the logic symbol selected. The following sections describe each of the available logic symbols. The actual DDB numbers are provided in the DDB table in the PSL Schemes chapter.

4.1 Link Properties: 

Links form the logical link between the output of a signal, gate or condition and the input to any element. Any, which is connected to the input of a gate, can be inverted. To do this:

1. Right-click the input
2. Select Properties…. The Link Properties window appears.
3. Check the box to invert the link. Or uncheck for a non-inverted link

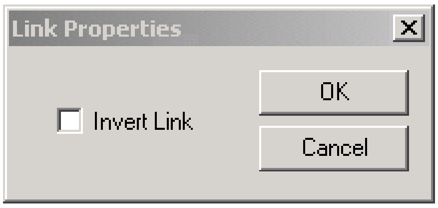


Figure 2: Rules for Linking Symbols

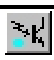
An inverted link is shown with a small circle on the input to a gate. A link must be connected to the input of a gate to be inverted.

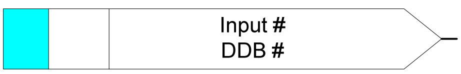
Links can only be started from the output of a signal, gate, or conditioner, and must end at an input to any element.

Signals can only be an input or an output. To follow the convention for gates and conditioners, input signals are connected from the left and output signals to the right. The Editor automatically enforces this convention.

A link is refused for the following reasons:

- There has been an attempt to connect to a signal that is already driven. The reason for the refusal may not be obvious because the signal symbol may appear elsewhere in the diagram. In this case you can right-click the link and select **Highlight** to find the other signal. Click anywhere on the diagram to disable the highlight.
- An attempt has been made to repeat a link between two symbols. The reason for the refusal may not be obvious because the existing link may be represented elsewhere in the diagram.

4.2 Opto Signal Properties: 



Each opto-input can be selected and used for programming in PSL. Activation of the opto-input will drive an associated DDB signal.

4.3 Input Signal Properties: 

IED logic functions provide logic output signals that can be used for programming in PSL. Depending on the IED functionality, operation of an active IED function will drive an associated DDB signal in PSL.

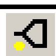
4.4 Output Signal Properties: 

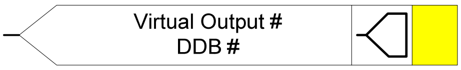
Relay logic functions provide logic input signals that can be used for programming in PSL. Depending on the relay functionality, activation of the output signal will drive an associated DDB signal in PSL and cause an associated response to the relay function.

4.5 GOOSE Input Signal Properties: 

The Programmable Scheme Logic interfaces with the GOOSE Scheme Logic by means of 32 Virtual inputs. The Virtual Inputs can be used in much the same way as the opto-input signals.

The logic that drives each of the Virtual Inputs is contained within the relay's GOOSE Scheme Logic file. It is possible to map any number of bit-pairs, from any subscribed device, using logic gates onto a Virtual Input (see S1 documentation for further details).

4.6 GOOSE Output Signal Properties: 



The Programmable Scheme Logic interfaces with the GOOSE Scheme Logic by means of 32 Virtual outputs.

It is possible to map virtual outputs to bit-pairs for transmitting to any subscribed devices (see S1 documentation for further details).

4.7 Control in Signal Properties: 

There are 32 control inputs which can be activated via the relay menu, the hotkeys or via courier communications. Depending on the programmed setting that is, latched or pulsed, an associated DDB signal will be activated in PSL when a control input is operated.

4.8 Function Key Properties:

Each function key can be selected and used for programming in PSL. Activation of the function key will drive an associated DDB signal. The DDB signal will remain active according to the programmed setting (toggled or normal). Toggled mode means the DDB signal will remain in the new state until the function key is pressed again. In Normal mode, the DDB will only be active for the duration of the key press.

4.9 LED Signal Properties:

All programmable LEDs will drive associated DDB signals when the LED is activated.

4.10 Contact Signal Properties:

All relay output contacts will drive associated DDB signal when the output contact is activated.

4.11 LED Conditioner Properties:

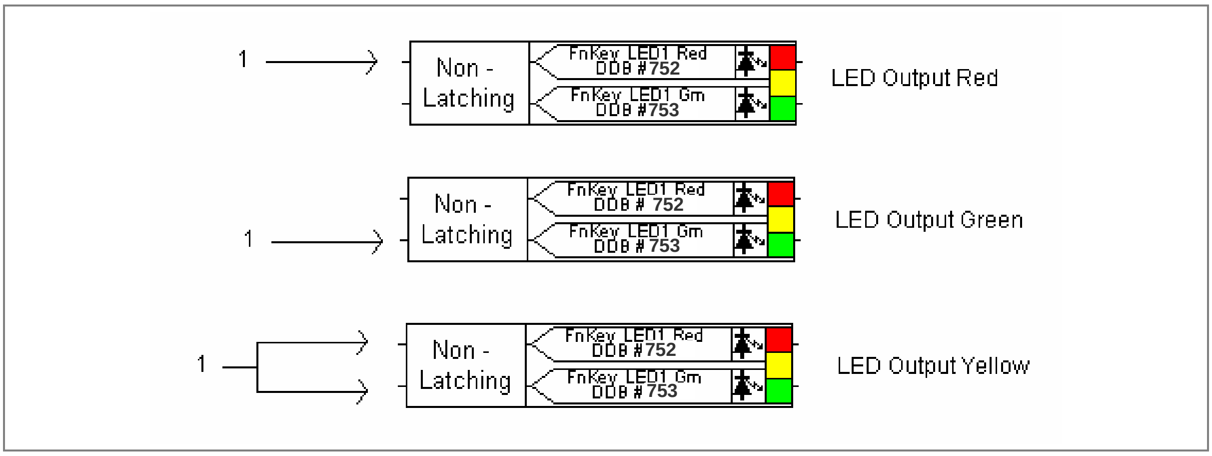
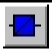


Figure 3: LED conditioner properties

1. Select the LED name from the list (only shown when inserting a new symbol).
2. Configure the LED output to be Red, Yellow or Green.
3. Configure a Green LED by driving the Green DDB input.
4. Configure a RED LED by driving the RED DDB input.
5. Configure a Yellow LED by driving the RED and GREEN DDB inputs simultaneously
6. Configure the LED output to be latching or non-latching

4.12 Contact Conditioner Properties: 

Each contact can be conditioned with an associated timer that can be selected for pick up, drop off, dwell, pulse, pick-up/drop-off, straight-through, or latching operation.

Straight-through means it is not conditioned at all whereas **Latching** is used to create a sealed-in or lockout type function.

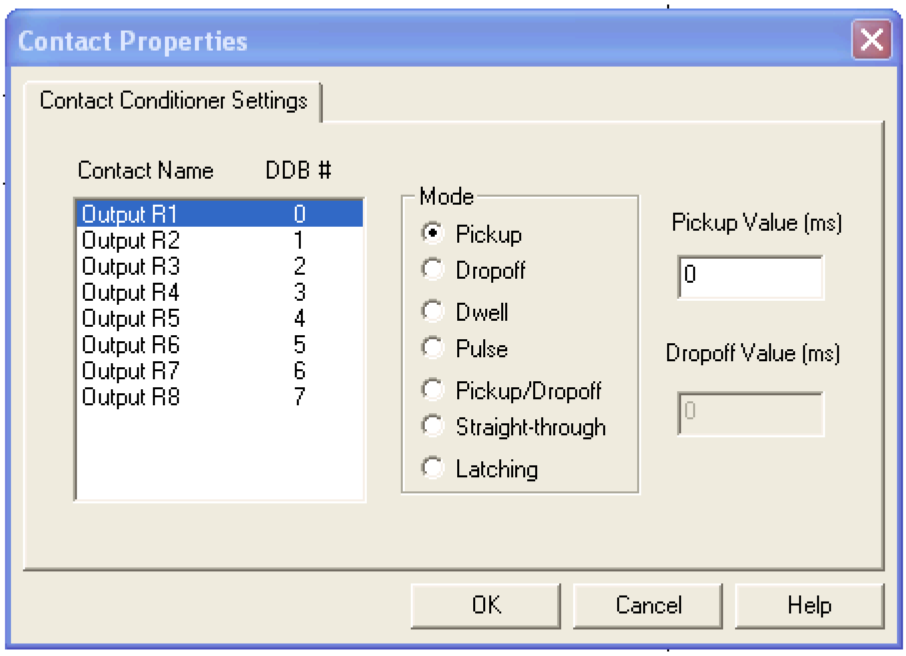
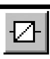


Figure 4: Contact properties

1. Select the contact name from the Contact Name list (only shown when inserting a new symbol).
2. Choose the conditioner type required in the Mode tick list.
3. Set the Pick-up Time (in milliseconds), if required.
4. Set the Drop-off Time (in milliseconds), if required.

4.13 Timer Properties: 

Each timer can be selected for pick up, drop off, dwell, pulse or pick-up/drop-off operation.

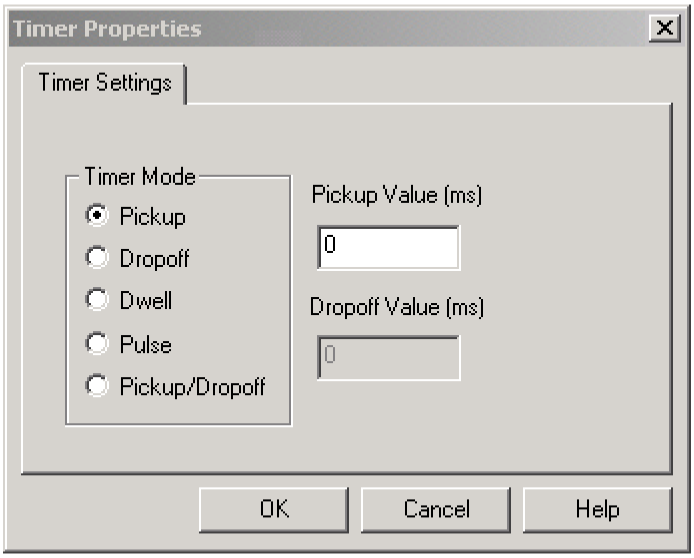
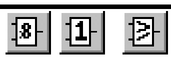


Figure 5: Timer properties

1. Choose the operation mode from the Timer Mode tick list.
2. Set the Pick-up Time (in milliseconds), if required.
3. Set the Drop-off Time (in milliseconds), if required.

4.14 Gate Properties: 

A Gate may be an AND, OR, or programmable gate.

- An **AND** gate requires that all inputs are TRUE for the output to be TRUE.
- An **OR** gate requires that one or more input is TRUE for the output to be TRUE.
- A **Programmable** gate requires that the number of inputs that are TRUE is equal to or greater than its ‘Inputs to Trigger’ setting for the output to be TRUE.

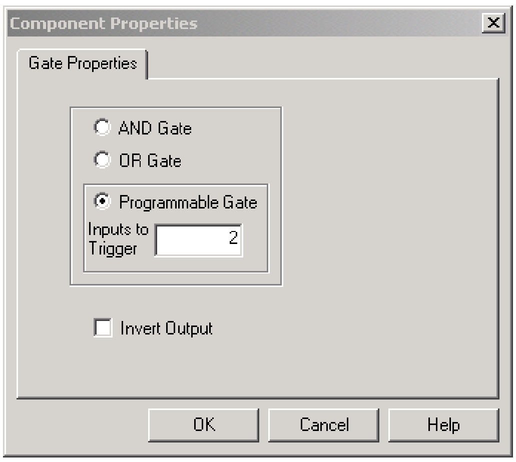


Figure 6: Gate properties

1. Select the Gate type AND, OR, or Programmable.
2. Set the number of inputs to trigger when Programmable Gate is selected.

3. Select if the output of the gate should be inverted using the Invert Output check box. An inverted output is indicated with a "bubble" on the gate output.

4.15 SR Programmable Gate Properties

A **Programmable** SR gate can be selected to operate with the following three latch properties:

S input	R input	O - Standard	O – Set input dominant	O – Reset input dominant
0	0	0	0	0
0	1	0	0	0
1	0	1	1	1
1	1	0	1	1

Table 3: SR programmable gate properties

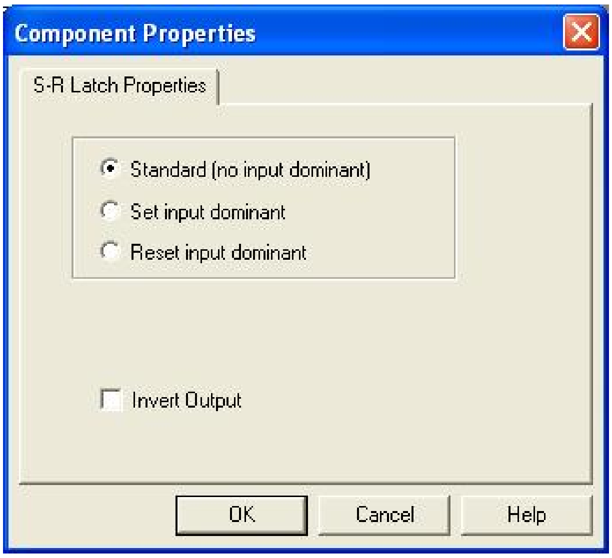


Figure 7: SR latch properties

Select if the output of the gate should be inverted using the Invert Output check box. An inverted output is indicated with a "bubble" on the gate output.

PSL SCHEMES

CHAPTER 13

1 OVERVIEW

This chapter describes the PSL scheme and mappings specific to the P847B&C. It contains the following sections:

2 DESCRIPTION OF LOGIC NODES

MiCOM ALSTOM Px40 products are supplied with a pre-loaded default PSL scheme and, if that suits your requirements, you do not need to take any action. If you want to change the input-output mapping, or to implement custom scheme logic, you will need to know the details of the logic nodes (also referred to as digital databus –DDB-) signal numbers. This section provides a complete listing of all the DDB signals available within the P847 model C. For model B, the listing is similar, varying only to reflect the smaller numbers of opto-isolated digital inputs and relay outputs that are supported.

DDB	English Text	Source	Description
0	Relay 1	Output conditioner	Output Relay 1
1	Relay 2	Output conditioner	Output Relay 2
2	Relay 3	Output conditioner	Output Relay 3
3	Relay 4	Output conditioner	Output Relay 4
4	Relay 5	Output conditioner	Output Relay 5
5	Relay 6	Output conditioner	Output Relay 6
6	Relay 7	Output conditioner	Output Relay 7
7	Relay 8	Output conditioner	Output Relay 8
8	Relay 9	Output conditioner	Output Relay 9
9	Relay 10	Output conditioner	Output Relay 10
10	Relay 11	Output conditioner	Output Relay 11
11	Relay 12	Output conditioner	Output Relay 12
12	Relay 13	Output conditioner	Output Relay 13
13	Relay 14	Output conditioner	Output Relay 14
14	Relay 15	Output conditioner	Output Relay 15
15	Relay 16	Output conditioner	Output Relay 16
16	Relay 17	Output conditioner	Output Relay 17
17	Relay 18	Output conditioner	Output Relay 18
18	Relay 19	Output conditioner	Output Relay 19
19	Relay 20	Output conditioner	Output Relay 20
20	Relay 21	Output conditioner	Output Relay 21
21	Relay 22	Output conditioner	Output Relay 22
22	Relay 23	Output conditioner	Output Relay 23
23	Relay 24	Output conditioner	Output Relay 24
32	Opto 1	Opto Input	Opto Input 1
33	Opto 2	Opto Input	Opto Input 2
34	Opto 3	Opto Input	Opto Input 3
35	Opto 4	Opto Input	Opto Input 4
36	Opto 5	Opto Input	Opto Input 5
37	Opto 6	Opto Input	Opto Input 6
38	Opto 7	Opto Input	Opto Input 7
39	Opto 8	Opto Input	Opto Input 8
40	Opto 9	Opto Input	Opto Input 9
41	Opto 10	Opto Input	Opto Input 10
42	Opto 11	Opto Input	Opto Input 11
43	Opto 12	Opto Input	Opto Input 12
44	Opto 13	Opto Input	Opto Input 13

DDB	English Text	Source	Description
45	Opto 14	Opto Input	Opto Input 14
46	Opto 15	Opto Input	Opto Input 15
47	Opto 16	Opto Input	Opto Input 16
48	Opto 17	Opto Input	Opto Input 17
49	Opto 18	Opto Input	Opto Input 18
50	Opto 19	Opto Input	Opto Input 19
51	Opto 20	Opto Input	Opto Input 20
52	Opto 21	Opto Input	Opto Input 21
53	Opto 22	Opto Input	Opto Input 22
54	Opto 23	Opto Input	Opto Input 23
55	Opto 24	Opto Input	Opto Input 24
128	Relay Cond 1	PSL	Input to Relay Output Condition
129	Relay Cond 2	PSL	Input to Relay Output Condition
130	Relay Cond 3	PSL	Input to Relay Output Condition
131	Relay Cond 4	PSL	Input to Relay Output Condition
132	Relay Cond 5	PSL	Input to Relay Output Condition
133	Relay Cond 6	PSL	Input to Relay Output Condition
134	Relay Cond 7	PSL	Input to Relay Output Condition
135	Relay Cond 8	PSL	Input to Relay Output Condition
136	Relay Cond 9	PSL	Input to Relay Output Condition
137	Relay Cond 10	PSL	Input to Relay Output Condition
138	Relay Cond 11	PSL	Input to Relay Output Condition
139	Relay Cond 12	PSL	Input to Relay Output Condition
140	Relay Cond 13	PSL	Input to Relay Output Condition
141	Relay Cond 14	PSL	Input to Relay Output Condition
142	Relay Cond 15	PSL	Input to Relay Output Condition
143	Relay Cond 16	PSL	Input to Relay Output Condition
144	Relay Cond 17	PSL	Input to Relay Output Condition
145	Relay Cond 18	PSL	Input to Relay Output Condition
146	Relay Cond 19	PSL	Input to Relay Output Condition
147	Relay Cond 20	PSL	Input to Relay Output Condition
148	Relay Cond 21	PSL	Input to Relay Output Condition
149	Relay Cond 22	PSL	Input to Relay Output Condition
150	Relay Cond 23	PSL	Input to Relay Output Condition
151	Relay Cond 24	PSL	Input to Relay Output Condition
160	Timer in 1	PSL	Input to Auxiliary Timer 1
161	Timer in 2	PSL	Input to Auxiliary Timer 2
162	Timer in 3	PSL	Input to Auxiliary Timer 3
163	Timer in 4	PSL	Input to Auxiliary Timer 4
164	Timer in 5	PSL	Input to Auxiliary Timer 5
165	Timer in 6	PSL	Input to Auxiliary Timer 6
166	Timer in 7	PSL	Input to Auxiliary Timer 7
167	Timer in 8	PSL	Input to Auxiliary Timer 8
168	Timer in 9	PSL	Input to Auxiliary Timer 9

DDB	English Text	Source	Description
169	Timer in 10	PSL	Input to Auxiliary Timer 10
170	Timer in 11	PSL	Input to Auxiliary Timer 11
171	Timer in 12	PSL	Input to Auxiliary Timer 12
172	Timer in 13	PSL	Input to Auxiliary Timer 13
173	Timer in 14	PSL	Input to Auxiliary Timer 14
174	Timer in 15	PSL	Input to Auxiliary Timer 15
175	Timer in 16	PSL	Input to Auxiliary Timer 16
176	Timer out 1	Auxiliary Timer	Output from Auxiliary Timer 1
177	Timer out 2	Auxiliary Timer	Output from Auxiliary Timer 2
178	Timer out 3	Auxiliary Timer	Output from Auxiliary Timer 3
179	Timer out 4	Auxiliary Timer	Output from Auxiliary Timer 4
180	Timer out 5	Auxiliary Timer	Output from Auxiliary Timer 5
181	Timer out 6	Auxiliary Timer	Output from Auxiliary Timer 6
182	Timer out 7	Auxiliary Timer	Output from Auxiliary Timer 7
183	Timer out 8	Auxiliary Timer	Output from Auxiliary Timer 8
184	Timer out 9	Auxiliary Timer	Output from Auxiliary Timer 9
185	Timer out 10	Auxiliary Timer	Output from Auxiliary Timer 10
186	Timer out 11	Auxiliary Timer	Output from Auxiliary Timer 11
187	Timer out 12	Auxiliary Timer	Output from Auxiliary Timer 12
188	Timer out 13	Auxiliary Timer	Output from Auxiliary Timer 13
189	Timer out 14	Auxiliary Timer	Output from Auxiliary Timer 14
190	Timer out 15	Auxiliary Timer	Output from Auxiliary Timer 15
191	Timer out 16	Auxiliary Timer	Output from Auxiliary Timer 16
192	Control Input 1	Virtual Input Command	Control Input 1
193	Control Input 2	Virtual Input Command	Control Input 2
194	Control Input 3	Virtual Input Command	Control Input 3
195	Control Input 4	Virtual Input Command	Control Input 4
196	Control Input 5	Virtual Input Command	Control Input 5
197	Control Input 6	Virtual Input Command	Control Input 6
198	Control Input 7	Virtual Input Command	Control Input 7
199	Control Input 8	Virtual Input Command	Control Input 8
200	Control Input 9	Virtual Input Command	Control Input 9
201	Control Input 10	Virtual Input Command	Control Input 10
202	Control Input 11	Virtual Input Command	Control Input 11
203	Control Input 12	Virtual Input Command	Control Input 12
204	Control Input 13	Virtual Input Command	Control Input 13
205	Control Input 14	Virtual Input Command	Control Input 14
206	Control Input 15	Virtual Input Command	Control Input 15
207	Control Input 16	Virtual Input Command	Control Input 16
208	Control Input 17	Virtual Input Command	Control Input 17
209	Control Input 18	Virtual Input Command	Control Input 18
210	Control Input 19	Virtual Input Command	Control Input 19
211	Control Input 20	Virtual Input Command	Control Input 20
212	Control Input 21	Virtual Input Command	Control Input 21

DDB	English Text	Source	Description
213	Control Input 22	Virtual Input Command	Control Input 22
214	Control Input 23	Virtual Input Command	Control Input 23
215	Control Input 24	Virtual Input Command	Control Input 24
216	Control Input 25	Virtual Input Command	Control Input 25
217	Control Input 26	Virtual Input Command	Control Input 26
218	Control Input 27	Virtual Input Command	Control Input 27
219	Control Input 28	Virtual Input Command	Control Input 28
220	Control Input 29	Virtual Input Command	Control Input 29
221	Control Input 30	Virtual Input Command	Control Input 30
222	Control Input 31	Virtual Input Command	Control Input 31
223	Control Input 32	Virtual Input Command	Control Input 32
224	Virtual Input 1	GOOSE Input Command	GOOSE Input 1
225	Virtual Input 2	GOOSE Input Command	GOOSE Input 2
226	Virtual Input 3	GOOSE Input Command	GOOSE Input 3
227	Virtual Input 4	GOOSE Input Command	GOOSE Input 4
228	Virtual Input 5	GOOSE Input Command	GOOSE Input 5
229	Virtual Input 6	GOOSE Input Command	GOOSE Input 6
230	Virtual Input 7	GOOSE Input Command	GOOSE Input 7
231	Virtual Input 8	GOOSE Input Command	GOOSE Input 8
232	Virtual Input 9	GOOSE Input Command	GOOSE Input 9
233	Virtual Input 10	GOOSE Input Command	GOOSE Input 10
234	Virtual Input 11	GOOSE Input Command	GOOSE Input 11
235	Virtual Input 12	GOOSE Input Command	GOOSE Input 12
236	Virtual Input 13	GOOSE Input Command	GOOSE Input 13
237	Virtual Input 14	GOOSE Input Command	GOOSE Input 14
238	Virtual Input 15	GOOSE Input Command	GOOSE Input 15
239	Virtual Input 16	GOOSE Input Command	GOOSE Input 16
240	Virtual Input 17	GOOSE Input Command	GOOSE Input 17
241	Virtual Input 18	GOOSE Input Command	GOOSE Input 18
242	Virtual Input 19	GOOSE Input Command	GOOSE Input 19
243	Virtual Input 20	GOOSE Input Command	GOOSE Input 20
244	Virtual Input 21	GOOSE Input Command	GOOSE Input 21
245	Virtual Input 22	GOOSE Input Command	GOOSE Input 22
246	Virtual Input 23	GOOSE Input Command	GOOSE Input 23
247	Virtual Input 24	GOOSE Input Command	GOOSE Input 24
248	Virtual Input 25	GOOSE Input Command	GOOSE Input 25
249	Virtual Input 26	GOOSE Input Command	GOOSE Input 26
250	Virtual Input 27	GOOSE Input Command	GOOSE Input 27
251	Virtual Input 28	GOOSE Input Command	GOOSE Input 28
252	Virtual Input 29	GOOSE Input Command	GOOSE Input 29
253	Virtual Input 30	GOOSE Input Command	GOOSE Input 30
254	Virtual Input 31	GOOSE Input Command	GOOSE Input 31
255	Virtual Input 32	GOOSE Input Command	GOOSE Input 32
256	Virtual Output 1	PSL	GOOSE Output 1

DDB	English Text	Source	Description
257	Virtual Output 2	PSL	GOOSE Output 2
258	Virtual Output 3	PSL	GOOSE Output 3
259	Virtual Output 4	PSL	GOOSE Output 4
260	Virtual Output 5	PSL	GOOSE Output 5
261	Virtual Output 6	PSL	GOOSE Output 6
262	Virtual Output 7	PSL	GOOSE Output 7
263	Virtual Output 8	PSL	GOOSE Output 8
264	Virtual Output 9	PSL	GOOSE Output 9
265	Virtual Output10	PSL	GOOSE Output 10
266	Virtual Output11	PSL	GOOSE Output 11
267	Virtual Output12	PSL	GOOSE Output 12
268	Virtual Output13	PSL	GOOSE Output 13
269	Virtual Output14	PSL	GOOSE Output 14
270	Virtual Output15	PSL	GOOSE Output 15
271	Virtual Output16	PSL	GOOSE Output 16
272	Virtual Output17	PSL	GOOSE Output 17
273	Virtual Output18	PSL	GOOSE Output 18
274	Virtual Output19	PSL	GOOSE Output 19
275	Virtual Output20	PSL	GOOSE Output 20
276	Virtual Output21	PSL	GOOSE Output 21
277	Virtual Output22	PSL	GOOSE Output 22
278	Virtual Output23	PSL	GOOSE Output 23
279	Virtual Output24	PSL	GOOSE Output 24
280	Virtual Output25	PSL	GOOSE Output 25
281	Virtual Output26	PSL	GOOSE Output 26
282	Virtual Output27	PSL	GOOSE Output 27
283	Virtual Output28	PSL	GOOSE Output 28
284	Virtual Output29	PSL	GOOSE Output 29
285	Virtual Output30	PSL	GOOSE Output 30
286	Virtual Output31	PSL	GOOSE Output 31
287	Virtual Output32	PSL	GOOSE Output 32
288	SG-opto Invalid	Group Selection	Setting Group via opto invalid
289	Prot'n Disabled	Commissioning Test	Test Mode Enabled
290	DDB Alarm 2	Commissioning Test	DDB Alarm 2
293	VT Fail Alarm	VT Supervision	VTS Indication
294	CT Fail Alarm	CT Supervision	CTS Alarm
295	DDB Alarm 7	CT Supervision	DDB Alarm 7
296	DDB Alarm 8	CT Supervision	DDB Alarm 8
297	DDB Alarm 9	Powerswing Blocking	DDB Alarm 9
298	CB Fail Alarm	CB Fail	BF Block AR
299	CB Monitor Alarm	CB Monitoring	CB Monitor Alarm
300	CB Lockout Alarm	CB Monitoring	CB Lockout Alarm
301	CB Status Alarm	CB Status	CB Status Alarm
302	CB Trip Fail	CB Control	CB Failed to Trip

DDB	English Text	Source	Description
303	CB Close Fail	CB Control	CB Failed to Close
304	Man CB Unhealthy	CB Control	Control CB Unhealthy
305	DDB Alarm 17	CB Control	DDB Alarm 17
306	DDB Alarm 18	Autoreclose	DDB Alarm 18
307	DDB Alarm 19	Autoreclose	DDB Alarm 19
308	DDB Alarm 20	Autoreclose	DDB Alarm 20
309	DDB Alarm 21	Check sync	DDB Alarm 21
310	GPS Alarm	Co-processor interface	GPS Alarm
317	DDB Alarm 29	PSL	DDB Alarm 29
318	DDB Alarm 30	PSL	DDB Alarm 30
319	F out of Range	Frequency Tracking	Frequency out of range
320	DDB Alarm 32	CB2 Fail	DDB Alarm 32
321	DDB Alarm 33	CB Monitoring	DDB Alarm 33
322	DDB Alarm 34	CB Monitoring	DDB Alarm 34
323	DDB Alarm 35	CB2 Status	DDB Alarm 35
324	DDB Alarm 36	CB2 Control	DDB Alarm 36
325	DDB Alarm 37	CB2 Control	DDB Alarm 37
326	DDB Alarm 38	CB2 Control	DDB Alarm 38
327	DDB Alarm 39	CB2 Control	DDB Alarm 39
334	Main Prot. Fail	Co-processor interface	Copro Main Prot. Fail
335	DDB Alarm 47	Co-processor interface	DDB Alarm 47
336	SR User Alarm 1	PSL	SR User Alarm 1
337	SR User Alarm 2	PSL	SR User Alarm 2
338	SR User Alarm 3	PSL	SR User Alarm 3
339	SR User Alarm 4	PSL	SR User Alarm 4
340	SR User Alarm 5	PSL	SR User Alarm 5
341	SR User Alarm 6	PSL	SR User Alarm 6
342	SR User Alarm 7	PSL	SR User Alarm 7
343	SR User Alarm 8	PSL	SR User Alarm 8
344	MR User Alarm 9	PSL	MR User Alarm 9
345	MR User Alarm 10	PSL	MR User Alarm 10
346	MR User Alarm 11	PSL	MR User Alarm 11
347	MR User Alarm 12	PSL	MR User Alarm 12
348	MR User Alarm 13	PSL	MR User Alarm 13
349	MR User Alarm 14	PSL	MR User Alarm 14
350	MR User Alarm 15	PSL	MR User Alarm 15
351	MR User Alarm 16	PSL	MR User Alarm 16
352	Battery Fail	Self monitoring	Battery Fail
353	Field Volts Fail	Self monitoring	Field Volts Fail
355	GOOSE IED Absent	Ethernet Interface	Platform Alarm 4
356	NIC Not Fitted	Ethernet Interface	Platform Alarm 5
357	NIC No Response	Ethernet Interface	Platform Alarm 6
358	NIC Fatal Error	Ethernet Interface	Platform Alarm 7
359	NIC Soft. Reload	Ethernet Interface	Platform Alarm 8

DDB	English Text	Source	Description
360	Bad TCP/IP Cfg.	Ethernet Interface	Platform Alarm 9
361	Bad OSI Config.	Ethernet Interface	Platform Alarm 10
362	NIC Link Fail	Ethernet Interface	Platform Alarm 11
363	NIC SW Mis-Match	Ethernet Interface	Platform Alarm 12
364	IP Addr Conflict	Ethernet Interface	Platform Alarm 13
369	Backup Setting	Self monitoring	Platform Alarm 18
370	Reserved		Platform Alarm 19
371	Reserved		Platform Alarm 20
372	Reserved		Platform Alarm 21
373	Reserved		Platform Alarm 22
374	Reserved		Platform Alarm 23
375	Reserved		Platform Alarm 24
376	Reserved		Platform Alarm 25
377	Reserved		Platform Alarm 26
378	Reserved		Platform Alarm 27
379	Reserved		Platform Alarm 28
380	Reserved		Platform Alarm 29
381	Reserved		Platform Alarm 30
382	Reserved		Platform Alarm 31
383	Reserved		Platform Alarm 32
384	Time Synch	PSL	Time Synch by Opto
385	I>1 Timer Block	PSL	Block Phase Overcurrent Stage 1 time delay
386	I>2 Timer Block	PSL	Block Phase Overcurrent Stage 2 time delay
387	I>3 Timer Block	PSL	Block Phase Overcurrent Stage 3 time delay
388	I>4 Timer Block	PSL	Block Phase Overcurrent Stage 4 time delay
389	IN>1 Timer Block	PSL	Block Standby Earth Fault Stage 1 time delay
390	IN>2 Timer Block	PSL	Block Standby Earth Fault Stage 2 time delay
391	IN>3 Timer Block	PSL	Block Standby Earth Fault Stage 3 time delay
392	IN>4 Timer Block	PSL	Block Standby Earth Fault Stage 4 time delay
393	ISEF>1 Timer Blk	PSL	Block SEF Stage 1 time delay
394	ISEF>2 Timer Blk	PSL	Block SEF Stage 2 time delay
395	ISEF>3 Timer Blk	PSL	Block SEF Stage 3 time delay
396	ISEF>4 Timer Blk	PSL	Block SEF Stage 4 time delay
397	I2>Timer Block	PSL	Block negative phase seq OC
398	V<1 Timer Block	PSL	V<1 Block Timer
399	V<2 Timer Block	PSL	V<2 Block Timer
400	V>1 Timer Block	PSL	V>1 Block Timer
401	V>2 Timer Block	PSL	V>2 Block Timer
402	VN>1 Timer Blk	PSL	Residual OV 1 Timer Block
403	VN>2 Timer Blk	PSL	Residual OV 2 Timer Block
404	CB Aux 3ph(52-A)	PSL	52-A CB Contact Input
405	CB Aux A(52-A)	PSL	52-A CB Contact Input A Phase
406	CB Aux B(52-A)	PSL	52-A CB Contact Input B Phase
407	CB Aux C(52-A)	PSL	52-A CB Contact Input C Phase

DDB	English Text	Source	Description
408	CB Aux 3ph(52-B)	PSL	52-B CB Contact Input
409	CB Aux A(52-B)	PSL	52-B CB Contact Input A Phase
410	CB Aux B(52-B)	PSL	52-B CB Contact Input B Phase
411	CB Aux C(52-B)	PSL	52-B CB Contact Input C Phase
420	CB in Service	PSL	CB Healthy
422	MCB/VTS	PSL	MCB/VTS opto
423	Trip CB	PSL	Logic Input Trip
424	Close CB	PSL	Logic Input Close
427	Reset Close Dly	PSL	Reset Manual CB Close Timer Delay
428	Reset Relays/LED	PSL	Reset Latched Relays & LED's
429	Reset Thermal	PSL	Reset Thermal State
430	Reset Lockout	PSL	Reset Lockout Opto Input
431	Reset CB Data	PSL	Reset CB Maintance values
436	Test Mode	PSL	Commissioning Tests
440	Inhibit I>1	PSL	Inhibit stage 1 overcurrent
441	Inhibit I>2	PSL	Inhibit stage 2 overcurrent
442	Inhibit I>3	PSL	Inhibit stage 3 overcurrent
443	Inhibit I>4	PSL	Inhibit stage 4 overcurrent
444	Inhibit IN>1	PSL	Inhibit stage 1 earth fault
445	Inhibit IN>2	PSL	Inhibit stage 2 earth fault
446	Inhibit IN>3	PSL	Inhibit stage 3 earth fault
447	Inhibit IN>4	PSL	Inhibit stage 4 earth fault
448	Inhibit V<1	PSL	Inhibit stage 1 undervoltage
449	Inhibit V<2	PSL	Inhibit stage 2 undervoltage
450	Inhibit V>1	PSL	Inhibit stage 1 overvoltage
451	Inhibit V>2	PSL	Inhibit stage 2 overvoltage
452	Inhibit VN>1	PSL	Inhibit stage 1 residual overvoltage
453	Inhibit VN>2	PSL	Inhibit stage 2 residual overvoltage
454	Inhibit I2>	PSL	Inhibit Neg Seq Overcurrent
455	Inhibit Thermal	PSL	Inhibit thermal protection
456	InhibitCB Status	PSL	Inhibit CB status
457	Inhibit CB Fail	PSL	Inhibit CB Fail
458	Inhibit OpenLine	PSL	Inhibit Broken conductor
459	Inhibit VTS	PSL	Inhibit VTS
460	Inhibit CTS	PSL	Inhibit CTS
462	Disable CTS	PSL	Disable CTS
463	RP1 Read Only	RP1 Read Only	RP1 Read Only DDB
464	RP2 Read Only	RP2 Read Only	RP2 Read Only DDB
465	NIC Read Only	NIC Read Only	NIC Read Only DDB
466	Any Trip	Trip Conversion Logic	Any Trip
467	Trip Output A	Trip Conversion Logic	Trip A
468	Trip Output B	Trip Conversion Logic	Trip B
469	Trip Output C	Trip Conversion Logic	Trip C
470	Trip 3ph	Trip Conversion Logic	3 Phase Trip

DDB	English Text	Source	Description
471	2/3 Ph Fault	Trip Conversion Logic	2/3 Phase fault
472	3 Ph Fault	Trip Conversion Logic	3 Phase Fault
473	Trip Inputs 3Ph	PSL	Trip 3 Phase - Input to Trip Latching Logic
474	Trip Inputs A	PSL	A Phase Trip- Input to Trip Latching Logic
475	Trip Inputs B	PSL	B Phase Trip- Input to Trip Latching Logic
476	Trip Inputs C	PSL	C Phase Trip- Input to Trip Latching Logic
477	Force 3Pole Trip	PSL	Force 3 Pole tripping
478	External Trip3ph	PSL	External Trip 3ph
479	External Trip A	PSL	External Trip A
480	External Trip B	PSL	External Trip B
481	External Trip C	PSL	External Trip C
486	SG Select x1		Binary coded setting group selector 1
487	SG Select 1x		Binary coded setting group selector 2
492	I2> Inhibit	PSL	Inhibit I2> protection
493	I2>1 Tmr Blk	PSL	Block I2> Stage 1 Timer
494	I2>2 Tmr Blk	PSL	Block I2> Stage 2 Timer
495	I2>3 Tmr Blk	PSL	Block I2> Stage 3 Timer
496	I2>4 Tmr Blk	PSL	Block I2> Stage 4 Timer
497	I2>1 Start	Neg Sequence overcurrent	I2> Stage 1 Start
498	I2>2 Start	Neg Sequence overcurrent	I2> Stage 2 Start
499	I2>3 Start	Neg Sequence overcurrent	I2> Stage 3 Start
500	I2>4 Start	Neg Sequence overcurrent	I2> Stage 4 Start
501	I2>1 Trip	Neg Sequence overcurrent	I2> Stage 1 Trip
502	I2>2 Trip	Neg Sequence overcurrent	I2> Stage 2 Trip
503	I2>3 Trip	Neg Sequence overcurrent	I2> Stage 3 Trip
504	I2>4 Trip	Neg Sequence overcurrent	I2> Stage 4 Trip
511	df/dt> Inhibit	PSL	Inhibit df/dt protection
512	df/dt>1 Tmr Blk	PSL	Block ROCOF Stage 1 Timer
513	df/dt>2 Tmr Blk	PSL	Block ROCOF Stage 2 Timer
514	df/dt>3 Tmr Blk	PSL	Block ROCOF Stage 3 Timer
515	df/dt>4 Tmr Blk	PSL	Block ROCOF Stage 4 Timer
516	df/dt>1 Start	df/dt protection	ROCOF Stage 1 Start
517	df/dt>2 Start	df/dt protection	ROCOF Stage 2 Start
518	df/dt>3 Start	df/dt protection	ROCOF Stage 3 Start
519	df/dt>4 Start	df/dt protection	ROCOF Stage 4 Start
520	df/dt>1 Trip	df/dt protection	ROCOF Stage 1 Trip
521	df/dt>2 Trip	df/dt protection	ROCOF Stage 2 Trip
522	df/dt>3 Trip	df/dt protection	ROCOF Stage 3 Trip
523	df/dt>4 Trip	df/dt protection	ROCOF Stage 4 Trip
524	I>1 Trip	Overcurrent	1st Stage O/C Trip 3ph
525	I>1 Trip A	Overcurrent	1st Stage O/C Trip A
526	I>1 Trip B	Overcurrent	1st Stage O/C Trip B
527	I>1 Trip C	Overcurrent	1st Stage O/C Trip C
528	I>2 Trip	Overcurrent	2nd Stage O/C Trip 3ph

DDB	English Text	Source	Description
529	I>2 Trip A	Overcurrent	2nd Stage O/C Trip A
530	I>2 Trip B	Overcurrent	2nd Stage O/C Trip B
531	I>2 Trip C	Overcurrent	2nd Stage O/C Trip C
532	I>3 Trip	Overcurrent	3rd Stage O/C Trip 3ph
533	I>3 Trip A	Overcurrent	3rd Stage O/C Trip A
534	I>3 Trip B	Overcurrent	3rd Stage O/C Trip B
535	I>3 Trip C	Overcurrent	3rd Stage O/C Trip C
536	I>4 Trip	Overcurrent	4th Stage O/C Trip 3ph
537	I>4 Trip A	Overcurrent	4th Stage O/C Trip A
538	I>4 Trip B	Overcurrent	4th Stage O/C Trip B
539	I>4 Trip C	Overcurrent	4th Stage O/C Trip C
540	IN>1 Trip	Earth Fault	1st Stage SBEF Trip
541	IN>2 Trip	Earth Fault	2nd Stage SBEF Trip
542	IN>3 Trip	Earth Fault	3rd Stage SBEF Trip
543	IN>4 Trip	Earth Fault	4th Stage SBEF Trip
544	ISEF>1 Trip	SEF	1st Stage SEF Trip
545	ISEF>2 Trip	SEF	2nd Stage SEF Trip
546	ISEF>3 Trip	SEF	3rd Stage SEF Trip
547	ISEF>4 Trip	SEF	4th Stage SEF Trip
548	Broken Wire Trip	Broken Conductor	Broken Conductor Trip
549	Thermal Trip	Thermal overload	Thermal Overload Trip
550	V<1 Trip	Undervoltage	UV 1 3 Phase Trip
551	V<1 Trip A/AB	Undervoltage	UV 1 A Phase Trip
552	V<1 Trip B/BC	Undervoltage	UV 1 B Phase Trip
553	V<1 Trip C/CA	Undervoltage	UV 1 C Phase Trip
554	V<2 Trip	Undervoltage	UV 2 3 Phase Trip
555	V<2 Trip A/AB	Undervoltage	UV 2 A Phase Trip
556	V<2 Trip B/BC	Undervoltage	UV 2 B Phase Trip
557	V<2 Trip C/CA	Undervoltage	UV 2 C Phase Trip
558	V>1 Trip	Overvoltage	OV 1 3 Phase Trip
559	V>1 Trip A/AB	Overvoltage	OV 1 A Phase Trip
560	V>1 Trip B/BC	Overvoltage	OV 1 B Phase Trip
561	V>1 Trip C/CA	Overvoltage	OV 1 C Phase Trip
562	V>2 Trip	Overvoltage	OV 2 3 Phase Trip
563	V>2 Trip A/AB	Overvoltage	OV 2 A Phase Trip
564	V>2 Trip B/BC	Overvoltage	OV 2 B Phase Trip
565	V>2 Trip C/CA	Overvoltage	OV 2 C Phase Trip
567	VN>1 Trip	Residual overvoltage	Residual OV 1 Trip
568	VN>2 Trip	Residual overvoltage	Residual OV 2 Trip
569	Fault REC TRIG	PSL	Trigger for Fault Recorder
570	I2> Trip	Neg Sequence overcurrent	Neg Seq OC Trip
571	Any Start	PSL	Any Start
572	I>1 Start	Overcurrent	1st Stage O/C Start 3ph
573	I>1 Start A	Overcurrent	1st Stage O/C Start A

DDB	English Text	Source	Description
574	I>1 Start B	Overcurrent	1st Stage O/C Start B
575	I>1 Start C	Overcurrent	1st Stage O/C Start C
576	I>2 Start	Overcurrent	2nd Stage O/C Start 3ph
577	I>2 Start A	Overcurrent	2nd Stage O/C Start A
578	I>2 Start B	Overcurrent	2nd Stage O/C Start B
579	I>2 Start C	Overcurrent	2nd Stage O/C Start C
580	I>3 Start	Overcurrent	3rd Stage O/C Start 3ph
581	I>3 Start A	Overcurrent	3rd Stage O/C Start A
582	I>3 Start B	Overcurrent	3rd Stage O/C Start B
583	I>3 Start C	Overcurrent	3rd Stage O/C Start C
584	I>4 Start	Overcurrent	4th Stage O/C Start 3ph
585	I>4 Start A	Overcurrent	4th Stage O/C Start A
586	I>4 Start B	Overcurrent	4th Stage O/C Start B
587	I>4 Start C	Overcurrent	4th Stage O/C Start C
588	IN>1 Start	Earth Fault	1st Stage SBEF Start
589	IN>2 Start	Earth Fault	2nd Stage SBEF Start
590	IN>3 Start	Earth Fault	3rd Stage SBEF Start
591	IN>4 Start	Earth Fault	4th Stage SBEF Start
592	ISEF>1 Start	SW	1st Stage SEF Start
593	ISEF>2 Start	SW	2nd Stage SEF Start
594	ISEF>3 Start	SW	3rd Stage SEF Start
595	ISEF>4 Start	SW	4th Stage SEF Start
596	Thermal Alarm	Thermal overload	Thermal Overload Alarm
599	V<1 Start	Undervoltage	UV 1 3 Phase Start
600	V<1 Start A/AB	Undervoltage	UV 1 A Phase Start
601	V<1 Start B/BC	Undervoltage	UV 1 B Phase Start
602	V<1 Start C/CA	Undervoltage	UV 1 C Phase Start
603	V<2 Start	Undervoltage	UV 2 3 Phase Start
604	V<2 Start A/AB	Undervoltage	UV 2 A Phase Start
605	V<2 Start B/BC	Undervoltage	UV 2 B Phase Start
606	V<2 Start C/CA	Undervoltage	UV 2 C Phase Start
607	V>1 Start	Overvoltage	OV 1 3 Phase Start
608	V>1 Start A/AB	Overvoltage	OV 1 A Phase Start
609	V>1 Start B/BC	Overvoltage	OV 1 B Phase Start
610	V>1 Start C/CA	Overvoltage	OV 1 C Phase Start
611	V>2 Start	Overvoltage	OV 2 3 Phase Start
612	V>2 Start A/AB	Overvoltage	OV 2 A Phase Start
613	V>2 Start B/BC	Overvoltage	OV 2 B Phase Start
614	V>2 Start C/CA	Overvoltage	OV 2 C Phase Start
615	VN>1 Start	Residual overvoltage	Residual OV 1 Start
616	VN>2 Start	Residual overvoltage	Residual OV 2 Start
618	VA< start	Poledead	Phase A Under Voltage
619	VB< start	Poledead	Phase B Under Voltage
620	VC< start	Poledead	Phase C Under Voltage

DDB	English Text	Source	Description
621	VTS Fast Block	VT Supervision	VTS Fast Block
622	VTS Slow Block	VT Supervision	VTS Slow Block
623	Bfail1 Trip 3ph	CB Fail	Bfail1 Trip 3ph
624	Bfail2 Trip 3ph	CB Fail	Bfail2 Trip 3ph
627	Control Trip	CB Control	Control Trip
628	Control Close	CB Control	Control Close
631	Close in Prog	CB Control	Control Close in Progress
649	Lockout Alarm	CB Control	Composite Lockout Alarm
653	IA< Start	Undercurrent	IA< operate
654	IB< Start	Undercurrent	IB< operate
655	IC< Start	Undercurrent	IC< operate
659	ISEF< Start	Undercurrent	ISEF< operate
672	All Poles Dead	Poledead logic	All Poles Dead
673	Any Pole Dead	Poledead logic	Any Pole Dead
674	Pole Dead A	Poledead logic	Phase A Pole Dead
675	Pole Dead B	Poledead logic	Phase B Pole Dead
676	Pole Dead C	Poledead logic	Phase C Pole Dead
677	VTS Acc Ind	Fixed Logic	Accelerate Ind
678	VTS Volt Dep	Fixed Logic	Any Voltage Dependent
682	CB Open 3 ph	CB Status	3 ph CB Open
683	CB Open A ph	CB Status	Ph A CB Open
684	CB Open B ph	CB Status	Ph B CB Open
685	CB Open C ph	CB Status	Ph C CB Open
686	CB Closed 3 ph	CB Status	3 ph CB Closed
687	CB Closed A ph	CB Status	Ph A CB Closed
688	CB Closed B ph	CB Status	Ph B CB Closed
689	CB Closed C ph	CB Status	Ph C CB Closed
707	CTS Block		Used to block E/F BC etc
708	CTS Block Diff	CT Supervision	Used to block C Diff
709	CTS Restrain	CT Supervision	Used to restrain C Diff
711	Faulted Phase A	PSL	Faulted Phase A
712	Faulted Phase B	PSL	Faulted Phase B
713	Faulted Phase C	PSL	Faulted Phase C
714	Faulted Phase N	PSL	Faulted Phase N
715	Started Phase A	PSL	Started Phase A
716	Started Phase B	PSL	Started Phase B
717	Started Phase C	PSL	Started Phase C
718	Started Phase N	PSL	Started Phase N
726	Function Key 1	Function Key 1	Function Key 1
727	Function Key 2	Function Key 2	Function Key 2
728	Function Key 3	Function Key 3	Function Key 3
729	Function Key 4	Function Key 4	Function Key 4
730	Function Key 5	Function Key 5	Function Key 5
731	Function Key 6	Function Key 6	Function Key 6

DDB	English Text	Source	Description
732	Function Key 7	Function Key 7	Function Key 7
733	Function Key 8	Function Key 8	Function Key 8
734	Function Key 9	Function Key 9	Function Key 9
735	Function Key 10	Function Key 10	Function Key 10
736	LED1 Red	Tri LED Red 1	Tri LED Red 1
737	LED1 Grn	Tri LED Green 1	Tri LED Green 1
738	LED2 Red	Tri LED Red 2	Tri LED Red 2
739	LED2 Grn	Tri LED Green 2	Tri LED Green 2
740	LED3 Red	Tri LED Red 3	Tri LED Red 3
741	LED3 Grn	Tri LED Green 3	Tri LED Green 3
742	LED4 Red	Tri LED Red 4	Tri LED Red 4
743	LED4 Grn	Tri LED Green 4	Tri LED Green 4
744	LED5 Red	Tri LED Red 5	Tri LED Red 5
745	LED5 Grn	Tri LED Green 5	Tri LED Green 5
746	LED6 Red	Tri LED Red 6	Tri LED Red 6
747	LED6 Grn	Tri LED Green 6	Tri LED Green 6
748	LED7 Red	Tri LED Red 7	Tri LED Red 7
749	LED7 Grn	Tri LED Green 7	Tri LED Green 7
750	LED8 Red	Tri LED Red 8	Tri LED Red 8
751	LED8 Grn	Tri LED Green 8	Tri LED Green 8
752	FnKey LED1 Red	Tri LED Red 9	Tri LED Red 9
753	FnKey LED1 Grn	Tri LED Green 9	Tri LED Green 9
754	FnKey LED2 Red	Tri LED Red 10	Tri LED Red 10
755	FnKey LED2 Grn	Tri LED Green 10	Tri LED Green 10
756	FnKey LED3 Red	Tri LED Red 11	Tri LED Red 11
757	FnKey LED3 Grn	Tri LED Green 11	Tri LED Green 11
758	FnKey LED4 Red	Tri LED Red 12	Tri LED Red 12
759	FnKey LED4 Grn	Tri LED Green 12	Tri LED Green 12
760	FnKey LED5 Red	Tri LED Red 13	Tri LED Red 13
761	FnKey LED5 Grn	Tri LED Green 13	Tri LED Green 13
762	FnKey LED6 Red	Tri LED Red 14	Tri LED Red 14
763	FnKey LED6 Grn	Tri LED Green 14	Tri LED Green 14
764	FnKey LED7 Red	Tri LED Red 15	Tri LED Red 15
765	FnKey LED7 Grn	Tri LED Green 15	Tri LED Green 15
766	FnKey LED8 Red	Tri LED Red 16	Tri LED Red 16
767	FnKey LED8 Grn	Tri LED Green 16	Tri LED Green 16
768	FnKey LED9 Red	Tri LED Red 17	Tri LED Red 17
769	FnKey LED9 Grn	Tri LED Green 17	Tri LED Green 17
770	FnKey LED10 Red	Tri LED Red 18	Tri LED Red 18
771	FnKey LED10 Grn	Tri LED Green 18	Tri LED Green 18
800	LED1 Con R	LED_CON_R1	LED_CON_R1
801	LED1 Con G	LED_CON_G1	LED_CON_G1
802	LED2 Con R	LED_CON_R2	LED_CON_R2
803	LED2 Con G	LED_CON_G2	LED_CON_G2

DDB	English Text	Source	Description
804	LED3 Con R	LED_CON_R3	LED_CON_R3
805	LED3 Con G	LED_CON_G3	LED_CON_G3
806	LED4 Con R	LED_CON_R4	LED_CON_R4
807	LED4 Con G	LED_CON_G4	LED_CON_G4
808	LED5 Con R	LED_CON_R5	LED_CON_R5
809	LED5 Con G	LED_CON_G5	LED_CON_G5
810	LED6 Con R	LED_CON_R6	LED_CON_R6
811	LED6 Con G	LED_CON_G6	LED_CON_G6
812	LED7 Con R	LED_CON_R7	LED_CON_R7
813	LED7 Con G	LED_CON_G7	LED_CON_G7
814	LED8 Con R	LED_CON_R8	LED_CON_R8
815	LED8 Con G	LED_CON_G8	LED_CON_G8
816	FnKey LED1 ConR	LED_CON_R9	LED_CON_R9
817	FnKey LED1 ConG	LED_CON_G9	LED_CON_G9
818	FnKey LED2 ConR	LED_CON_R10	LED_CON_R10
819	FnKey LED2 ConG	LED_CON_G10	LED_CON_G10
820	FnKey LED3 ConR	LED_CON_R11	LED_CON_R11
821	FnKey LED3 ConG	LED_CON_G11	LED_CON_G11
822	FnKey LED4 ConR	LED_CON_R12	LED_CON_R12
823	FnKey LED4 ConG	LED_CON_G12	LED_CON_G12
824	FnKey LED5 ConR	LED_CON_R13	LED_CON_R13
825	FnKey LED5 ConG	LED_CON_G13	LED_CON_G13
826	FnKey LED6 ConR	LED_CON_R14	LED_CON_R14
827	FnKey LED6 ConG	LED_CON_G14	LED_CON_G14
828	FnKey LED7 ConR	LED_CON_R15	LED_CON_R15
829	FnKey LED7 ConG	LED_CON_G15	LED_CON_G15
830	FnKey LED8 ConR	LED_CON_R16	LED_CON_R16
831	FnKey LED8 ConG	LED_CON_G16	LED_CON_G16
832	FnKey LED9 ConR	LED_CON_R17	LED_CON_R17
833	FnKey LED9 ConG	LED_CON_G17	LED_CON_G17
834	FnKey LED10 ConR	LED_CON_R18	LED_CON_R18
835	FnKey LED10 ConG	LED_CON_G18	LED_CON_G18
840	I^ Maint Alarm	CB Monitoring	Broken Current Alarm
841	I^ Lockout Alarm	CB Monitoring	Broken Current lookout
842	CB OPs Maint	CB Monitoring	Maintenance Alarm
843	CB OPs Lock	CB Monitoring	Maintenance Lockout
844	CB Time Maint	CB Monitoring	Excessive Op Time Alarm
845	CB Time Lockout	CB Monitoring	Excessive Op Time Lookout
846	Fault Freq Lock	CB Monitoring	EFF Lockout
854	Backup Enabled		Backup Enabled
855	SEF Trip	FL	SEF Trip
856	B Fail SEF Trip	FL	Current Prot SEF Trip
857	F<1 Timer Block	PSL	Block Underfrequency Stage 1 Timer
858	F<2 Timer Block	PSL	Block Underfrequency Stage 2 Timer

DDB	English Text	Source	Description
859	F<3 Timer Block	PSL	Block Underfrequency Stage 3 Timer
860	F<4 Timer Block	PSL	Block Underfrequency Stage 4 Timer
861	F>1 Timer Block	PSL	Block Overfrequency Stage 1 Timer
862	F>2 Timer Block	PSL	Block Overfrequency Stage 2 Timer
863	F<1 Start	Frequency Protection	Under frequency Stage 1 START
864	F<2 Start	Frequency Protection	Under frequency Stage 2 START
865	F<3 Start	Frequency Protection	Under frequency Stage 3 START
866	F<4 Start	Frequency Protection	Under frequency Stage 4 START
867	F>1 Start	Frequency Protection	Over frequency Stage 1 START
868	F>2 Start	Frequency Protection	Over frequency Stage 2 START
869	F<1 Trip	Frequency Protection	Under frequency Stage 1 trip
870	F<2 Trip	Frequency Protection	Under frequency Stage 2 trip
871	F<3 Trip	Frequency Protection	Under frequency Stage 3 trip
872	F<4 Trip	Frequency Protection	Under frequency Stage 4 trip
873	F>1 Trip	Frequency Protection	Over frequency Stage 1 Trip
874	F>2 Trip	Frequency Protection	Over frequency Stage 2 Trip
875	Inhibit F<1	PSL	Inhibit Stage 1 Underfrequency
876	Inhibit F<2	PSL	Inhibit Stage 2 Underfrequency
877	Inhibit F<3	PSL	Inhibit Stage 3 Underfrequency
878	Inhibit F<4	PSL	Inhibit Stage 4 Underfrequency
879	Inhibit F>1	PSL	Inhibit Stage 1 Overfrequency
880	Inhibit F>2	PSL	Inhibit Stage 2 Overfrequency
884	HMI Access Lvl 1		HMI Access Lvl 1
885	HMI Access Lvl 2		HMI Access Lvl 2
886	FPort AccessLvl1		FPort AccessLvl1
887	FPort AccessLvl2		FPort AccessLvl2
888	RPrt1 AccessLvl1		RPrt1 AccessLvl1
889	RPrt1 AccessLvl2		RPrt1 AccessLvl2
890	RPrt2 AccessLvl1		RPrt2 AccessLvl1
891	RPrt2 AccessLvl2		RPrt2 AccessLvl2
892	Monitor Bit 1	Commissioning Test	Monitor Port 1
893	Monitor Bit 2	Commissioning Test	Monitor Port 2
894	Monitor Bit 3	Commissioning Test	Monitor Port 3
895	Monitor Bit 4	Commissioning Test	Monitor Port 4
896	Monitor Bit 5	Commissioning Test	Monitor Port 5
897	Monitor Bit 6	Commissioning Test	Monitor Port 6
898	Monitor Bit 7	Commissioning Test	Monitor Port 7
899	Monitor Bit 8	Commissioning Test	Monitor Port 8
900	New Fault Record	Fault recorder	New Fault Record
902	PSL Int 1	PSL	PSL Internal Node
903	PSL Int 2	PSL	PSL Internal Node
904	PSL Int 3	PSL	PSL Internal Node
905	PSL Int 4	PSL	PSL Internal Node
906	PSL Int 5	PSL	PSL Internal Node

DDB	English Text	Source	Description
907	PSL Int 6	PSL	PSL Internal Node
908	PSL Int 7	PSL	PSL Internal Node
909	PSL Int 8	PSL	PSL Internal Node
910	PSL Int 9	PSL	PSL Internal Node
911	PSL Int 10	PSL	PSL Internal Node
912	PSL Int 11	PSL	PSL Internal Node
913	PSL Int 12	PSL	PSL Internal Node
914	PSL Int 13	PSL	PSL Internal Node
915	PSL Int 14	PSL	PSL Internal Node
916	PSL Int 15	PSL	PSL Internal Node
917	PSL Int 16	PSL	PSL Internal Node
918	PSL Int 17	PSL	PSL Internal Node
919	PSL Int 18	PSL	PSL Internal Node
920	PSL Int 19	PSL	PSL Internal Node
921	PSL Int 20	PSL	PSL Internal Node
922	PSL Int 21	PSL	PSL Internal Node
923	PSL Int 22	PSL	PSL Internal Node
924	PSL Int 23	PSL	PSL Internal Node
925	PSL Int 24	PSL	PSL Internal Node
926	PSL Int 25	PSL	PSL Internal Node
927	PSL Int 26	PSL	PSL Internal Node
928	PSL Int 27	PSL	PSL Internal Node
929	PSL Int 28	PSL	PSL Internal Node
930	PSL Int 29	PSL	PSL Internal Node
931	PSL Int 30	PSL	PSL Internal Node
932	PSL Int 31	PSL	PSL Internal Node
933	PSL Int 32	PSL	PSL Internal Node
934	PSL Int 33	PSL	PSL Internal Node
935	PSL Int 34	PSL	PSL Internal Node
936	PSL Int 35	PSL	PSL Internal Node
937	PSL Int 36	PSL	PSL Internal Node
938	PSL Int 37	PSL	PSL Internal Node
939	PSL Int 38	PSL	PSL Internal Node
940	PSL Int 39	PSL	PSL Internal Node
941	PSL Int 40	PSL	PSL Internal Node
942	PSL Int 41	PSL	PSL Internal Node
943	PSL Int 42	PSL	PSL Internal Node
944	PSL Int 43	PSL	PSL Internal Node
945	PSL Int 44	PSL	PSL Internal Node
946	PSL Int 45	PSL	PSL Internal Node
947	PSL Int 46	PSL	PSL Internal Node
948	PSL Int 47	PSL	PSL Internal Node
949	PSL Int 48	PSL	PSL Internal Node
950	PSL Int 49	PSL	PSL Internal Node

DDB	English Text	Source	Description
951	PSL Int 50	PSL	PSL Internal Node
952	PSL Int 51	PSL	PSL Internal Node
953	PSL Int 52	PSL	PSL Internal Node
954	PSL Int 53	PSL	PSL Internal Node
955	PSL Int 54	PSL	PSL Internal Node
956	PSL Int 55	PSL	PSL Internal Node
957	PSL Int 56	PSL	PSL Internal Node
958	PSL Int 57	PSL	PSL Internal Node
959	PSL Int 58	PSL	PSL Internal Node
960	PSL Int 59	PSL	PSL Internal Node
961	PSL Int 60	PSL	PSL Internal Node
962	PSL Int 61	PSL	PSL Internal Node
963	PSL Int 62	PSL	PSL Internal Node
964	PSL Int 63	PSL	PSL Internal Node
965	PSL Int 64	PSL	PSL Internal Node
966	PSL Int 65	PSL	PSL Internal Node
967	PSL Int 66	PSL	PSL Internal Node
968	PSL Int 67	PSL	PSL Internal Node
969	PSL Int 68	PSL	PSL Internal Node
970	PSL Int 69	PSL	PSL Internal Node
971	PSL Int 70	PSL	PSL Internal Node
972	PSL Int 71	PSL	PSL Internal Node
973	PSL Int 72	PSL	PSL Internal Node
974	PSL Int 73	PSL	PSL Internal Node
975	PSL Int 74	PSL	PSL Internal Node
976	PSL Int 75	PSL	PSL Internal Node
977	PSL Int 76	PSL	PSL Internal Node
978	PSL Int 77	PSL	PSL Internal Node
979	PSL Int 78	PSL	PSL Internal Node
980	PSL Int 79	PSL	PSL Internal Node
981	PSL Int 80	PSL	PSL Internal Node
982	PSL Int 81	PSL	PSL Internal Node
983	PSL Int 82	PSL	PSL Internal Node
984	PSL Int 83	PSL	PSL Internal Node
985	PSL Int 84	PSL	PSL Internal Node
986	PSL Int 85	PSL	PSL Internal Node
987	PSL Int 86	PSL	PSL Internal Node
988	PSL Int 87	PSL	PSL Internal Node
989	PSL Int 88	PSL	PSL Internal Node
990	PSL Int 89	PSL	PSL Internal Node
991	PSL Int 90	PSL	PSL Internal Node
992	PSL Int 91	PSL	PSL Internal Node
993	PSL Int 92	PSL	PSL Internal Node
994	PSL Int 93	PSL	PSL Internal Node

DDB	English Text	Source	Description
995	PSL Int 94	PSL	PSL Internal Node
996	PSL Int 95	PSL	PSL Internal Node
997	PSL Int 96	PSL	PSL Internal Node
998	PSL Int 97	PSL	PSL Internal Node
999	PSL Int 98	PSL	PSL Internal Node
1000	PSL Int 99	PSL	PSL Internal Node
1001	PSL Int 100	PSL	PSL Internal Node
1002	VTS Ia>	VT Supervision	Ia over threshold
1003	VTS Ib>	VT Supervision	Ib over threshold
1004	VTS Ic>	VT Supervision	Ic over threshold
1005	VTS Va>	VT Supervision	Va over threshold
1006	VTS Vb>	VT Supervision	Vb over threshold
1007	VTS Vc>	VT Supervision	Vc over threshold
1008	VTS I2>	VT Supervision	I2 over threshold
1009	VTS V2>	VT Supervision	V2 over threshold
1010	VTS Ia delta>	VT Supervision	Superimposed Ia over threshold
1011	VTS Ib delta>	VT Supervision	Superimposed Ib over threshold
1012	VTS Ic delta>	VT Supervision	Superimposed Ic over threshold
1013	Freq High	Frequency Tracking	Freq High
1014	Freq Low	Frequency Tracking	Freq Low
1015	Freq Not found	Frequency Tracking	Freq Not found
1016	Stop Freq Track	Frequency Tracking	Stop Freq Track
1018	I> Trip by VTS		O/C Trip By VTS

Table 1: Full listing of logic nodes (DDBs) for P847BC

Note : The DDB numbers are displayed as part of the associated symbol in the PSL editor.

3 MAPPINGS

3.1 Logic Input Mappings

The default mappings for the opto-isolated inputs are shown in Table 2:

Opto-Input number	Menu text	Function
1	Input L1	Not mapped
2	Input L2	Not mapped
3	Input L3	Not mapped
4	Input L4	Not mapped
5	Input L5	Not mapped
6	Input L6	Not mapped
7	Input L7	Not mapped
8	Input L8	Not mapped
9	Input L9	Not mapped
10	Input L10	Not mapped
11	Input L11	Not mapped
12	Input L12	Not mapped
13	Input L13	Not mapped
14	Input L14	Not mapped
15	Input L15	Not mapped
16	Input L16	Not mapped
17	Input L17	Not mapped
18	Input L18	Not mapped
19	Input L19	Not mapped
20	Input L20	Not mapped
21	Input L21	Not mapped
22	Input L22	Not mapped
23	Input L23	Not mapped
24	Input L24	Not mapped

Table 2: Opto-input mappings

3.2 Standard Output Contact Mappings

The default mappings for each of the relay output contacts are shown in Table 3

Relay contact number	Menu text	Function
1	Output R1	Not mapped
2	Output R2	Not mapped
3	Output R3	Not mapped
4	Output R4	Not mapped
5	Output R5	Not mapped
6	Output R6	Not mapped
7	Output R7	Not mapped

Relay contact number	Menu text	Function
8	Output R8	Not mapped
9	Output R9	Not mapped
10	Output R10	Not mapped
11	Output R11	Not mapped
12	Output R12	Not mapped
13	Output R13	Not mapped
14	Output R14	Not mapped
15	Output R15	Not mapped
16	Output R16	Not mapped
17	Output R17	Not mapped
18	Output R18	Not mapped
19	Output R19	Not mapped
20	Output R20	Not mapped
21	Output R21	Not mapped
22	Output R22	Not mapped
23	Output R23	Not mapped
24	Output R24	Not mapped

Table 3: Output relay contact mappings

Note: *A fault record can be generated by connecting one or several contacts to the **Fault Record Trigger** in PSL. It is recommended that the triggering contact is **self reset** and not **latching**. If a latching contact is used, the fault record is not generated until the contact has fully reset.*

3.3 Programmable LED Output Mappings

The default mappings for each of the programmable LEDs are shown in Table 4:

LED number	LED input connection/text	Latched	P847 LED function indication
1	LED 1 Red	No	Not Mapped
2	LED 2 Red	No	Not Mapped
3	LED 3 Red	No	Not Mapped
4	LED 4 Red	No	Not Mapped
5	LED 5 Red	No	Not Mapped
6	LED 6 Red	No	Not Mapped
7	LED 7 Grn.	No	Not Mapped
8	LED 8 Red	No	Not Mapped
9	FnKey LED1 Red	No	Not Mapped
10	FnKey LED2 Red	No	Not Mapped
11	FnKey LED3 Red	No	Not Mapped
12	FnKey LED4 Red	No	Not Mapped
13	FnKey LED5 Red	No	Not Mapped
14	FnKey LED6 Red	No	Not Mapped
15	FnKey LED7 Red	No	Not Mapped

LED number	LED input connection/text	Latched	P847 LED function indication
16	FnKey LED8 Red	No	Not Mapped
17	FnKey LED9 Red	No	Not Mapped
18	FnKey LED10 Red	No	Not Mapped

Table 4: LED output mappings

3.4 PSL DATA Column

The unit contains a PSL DATA column that can be used to track PSL modifications. A total of 12 cells are contained in the PSL DATA column, 3 for each setting group. The function for each cell is shown in Table 5:

Menu text	Description
Grp. PSL Ref	When downloading a PSL to the IED, you will be prompted to enter the relevant group and a reference identifier. The first 32 characters of the reference ID will be displayed in this cell. The cursor keys can be used to scroll through 32 characters, as only 16 can be displayed at any one time
18 Aug 2008 08:59:32.047	This cell displays the date and time when the PSL was down loaded to the relay
Grp. 1 PSL ID - 2062813232	This is a unique number for the PSL that has been entered. Any change in the PSL will result in a different number being displayed

Table 5: PSL Data Column

Note: *The above cells are repeated for each setting group.*

4 VIEWING AND PRINTING PSL DIAGRAMS

It is possible to view and print the PSL diagrams for the device. Typically, these diagrams allow you to see the following mappings:

- Opto Input Mappings
- Output Relay Mappings
- LED Mappings
- Start Indications
- Phase Trip Mappings
- System Check Mapping

To download the default PSL diagrams for the device and to print them:

1. Close S1 Studio.
2. Select **Programs** > **Alstom Grid** > **S1 Studio** > **Data Model Manager**.
3. Click **Add** then **Next**.
4. Click **Internet** then **Next.**
5. Select your language then click **Next**.
6. From the tree view, select the model and software version.
7. Click **Install**. When complete click **OK**.
8. Close the Data Model Manager and start S1 Studio.
9. Select **Tools** > **PSL Editor (Px40)**.
10. In the PSL Editor select **File** > **Open**. The downloaded psl files are in C:\Program Files\Alstom Grid\S1\Courier\PSL\Defaults.
11. Highlight the required PSL diagram and select **File** > **Print**.

INSTALLATION

CHAPTER 14

1 CHAPTER OVERVIEW

This chapter describes the installation of the unit and consists of the following sections:

2 HANDLING THE GOODS

MiCOM ALSTOM products are of robust construction but require careful treatment before installation on site. This section discusses the requirements for receiving and unpacking the goods, and the associated considerations regarding product care and personal safety.

Caution Before lifting or moving the equipment you should be familiar with the Safety Section.

Receipt of the Goods

On receipt, ensure the correct product has been delivered. Unpack the product immediately to ensure there has been no external damage in transit. If the product has been damaged, make a claim to the transport contractor and notify Alstom Grid promptly.

Return any units that are not intended for immediate installation to their protective polythene bags and delivery carton.

Unpacking

When unpacking and installing the unit, take care not to damage any of the parts and make sure that additional components are not accidentally left in the packing or lost. Do not discard any CDROMs or technical documentation - this should accompany the unit to its destination substation.

Note: With the lower access cover open, the red tab of the battery isolation strip protrudes from the positive battery terminal. Do not remove this strip because it prevents battery drain during transportation and storage; it will be removed as part of the commissioning process.

The site should be well lit to aid inspection, clean, dry and reasonably free from dust and excessive vibration. This particularly applies to installations, which are being carried out at the same time as construction work.

Storage

If the unit is not installed immediately, store it in a place free from dust and moisture in its original carton. Keep any de-humidifier bags included in the packing. The de-humidifier crystals lose their efficiency if the bag is exposed to ambient conditions. Restore the crystals by gently heating the bag for about an hour before replacing it in the carton.

On subsequent unpacking, make sure that any dust on the carton does not fall inside. Avoid storing in locations of high humidity. In locations of high humidity the carton and packing may become impregnated with moisture and the de-humidifier crystals will lose their efficiency.

The unit can be stored between –25º to +70ºC (-13ºF to +158ºF).

3 MOUNTING THE UNIT

MiCOM ALSTOM products are dispatched either individually or as part of a panel or rack assembly.

Individual products are normally supplied with an outline diagram showing the dimensions for panel cutouts and hole centers. For details on this, see the Physical Description chapter

Secondary front covers to prevent unauthorized changing of settings and alarm status are available as an optional item.

MiCOM ALSTOM products are designed so the fixing holes in the mounting flanges are only accessible when the access covers are open.

If you use a P991 or MMLG test block with the product, when viewed from the front, position the test block on the right-hand side of the associated product. This minimizes the wiring between the product and test block, and allows the correct test block to be easily identified during commissioning and maintenance tests.

If you need to test the product for correct operation during installation, open the lower access cover, hold the battery in place and pull the red tab to remove the battery isolation strip. See Figure 1.

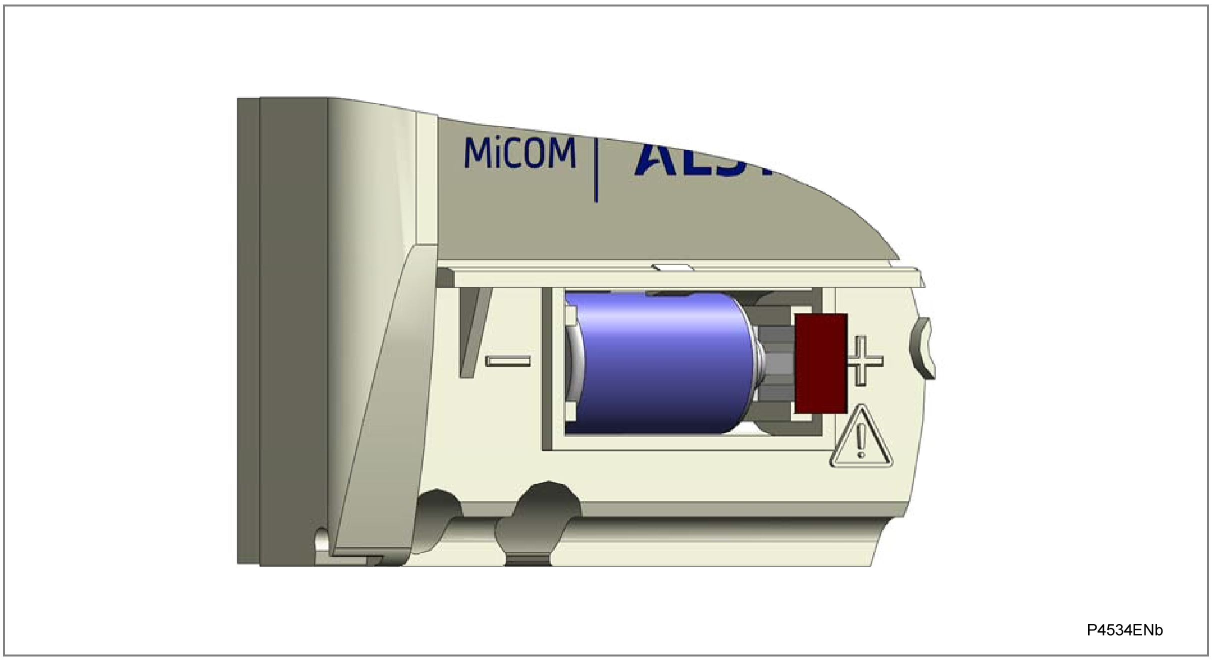


Figure 1: Location of battery isolation strip

Panel mounting

MiCOM ALSTOM products can be flush mounted into panels using M4 SEMS Taptite self-tapping screws with captive 3 mm thick washers (also known as a SEMS unit). These fastenings are available in packs of five (our part number ZA0005 104).

> **Caution** **Risk of damage to the front cover molding. Do not use conventional self-tapping screws, including those supplied for mounting MiDOS products because they have slightly larger heads.**

Alternatively tapped holes can be used if the panel has a minimum thickness of 2.5 mm.

For applications where the product needs to be semi-projection or projection mounted, a range of collars are available.

If several products are mounted in a single cut-out in the panel, mechanically group them horizontally or vertically into rigid assemblies before mounting in the panel.

> ***Note:*** *Fastening MiCOM ALSTOM products with pop rivets is not advised because it does not allow easy removal if repair is necessary.*

If the product is mounted on a panel complying with BS EN60529 IP52, fit a metallic sealing strip between adjoining products (Part no GN2044 001) and fit a sealing ring from around the complete assembly.

Width	Single tier	Double tier
10TE	GJ9018 002	GJ9018 018
15TE	GJ9018 003	GJ9018 019
20TE	GJ9018 004	GJ9018 020
25TE	GJ9018 005	GJ9018 021
30TE	GJ9018 006	GJ9018 022
35TE	GJ9018 007	GJ9018 023
40TE	GJ9018 008	GJ9018 024
45TE	GJ9018 009	GJ9018 025
50TE	GJ9018 010	GJ9018 026
55TE	GJ9018 011	GJ9018 027
60TE	GJ9018 012	GJ9018 028
65TE	GJ9018 013	GJ9018 029
70TE	GJ9018 014	GJ9018 030
75TE	GJ9018 015	GJ9018 031
80TE	GJ9018 016	GJ9018 032

Table 1: IP52 sealing rings

For further details on mounting MiDOS products, see publication R7012, MiDOS Parts Catalogue and Assembly Instructions.

Rack mounting

MiCOM ALSTOM products can be rack mounted using single-tier rack frames (our part number FX0021 101), as shown in Figure 2. These frames are designed with dimensions in accordance with IEC 60297 and are supplied pre-assembled ready to use. On a standard 483 mm rack this enables combinations of case widths up to a total equivalent of size 80TE to be mounted side by side.

The two horizontal rails of the rack frame have holes drilled at approximately 26 mm intervals. Attach the products by their mounting flanges using M4 Taptite self-tapping screws with captive 3 mm thick washers (also known as a SEMS unit). These fastenings are available in packs of five (our part number ZA0005 104).

> **Caution** **Risk of damage to the front cover molding. Do not use conventional self-tapping screws, including those supplied for mounting MiDOS products because they have slightly larger heads.**

Once the tier is complete, the frames are fastened into the racks using mounting angles at each end of the tier.

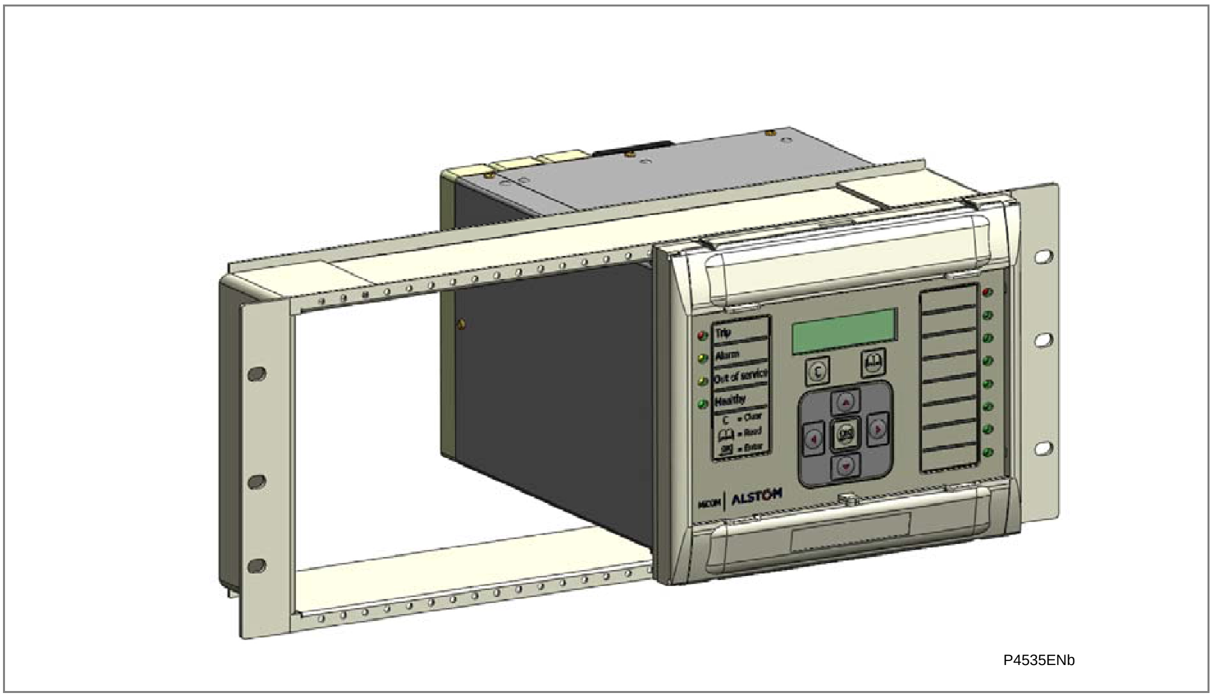


Figure 2: Rack mounting of products

Products can be mechanically grouped into single tier (4U) or multi-tier arrangements using the rack frame. This enables schemes using products from the MiCOM ALSTOM and MiDOS product ranges to be pre-wired together before mounting.

Use blanking plates if there are empty spaces. The spaces may be for future installation of products or because the total size is less than 80TE on any tier. Blanking plates can also be used to mount ancillary components. They are only available in black. Table 2 shows the sizes that can be ordered.

For further details on mounting MiDOS products, see publication R7012, MiDOS Parts Catalogue and Assembly Instructions.

Case size summation	Blanking plate part number
5TE	GJ2028 101
10TE	GJ2028 102
15TE	GJ2028 103
20TE	GJ2028 104
25TE	GJ2028 105
30TE	GJ2028 106
35TE	GJ2028 107
40TE	GJ2028 108

Table 2: Blanking plates

4 CABLES AND CONNECTORS

This section is a guide to selecting the appropriate cable and connector type for each terminal on the product.

Caution **Before carrying out any work on the equipment you should be familiar with the Safety Section and the ratings on the equipment's rating label.**

4.1 Terminal blocks

The unit may use one or more of the terminal blocks shown in Figure 3:

- MiDOS terminal blocks: For CT and VT circuits.
- Heavy duty terminal blocks: For CT and VT circuits
- Medium duty terminal blocks: For the power supply, relay outputs and rear communications port.
- RTD/CLIO terminal block for connection to analogue transducers

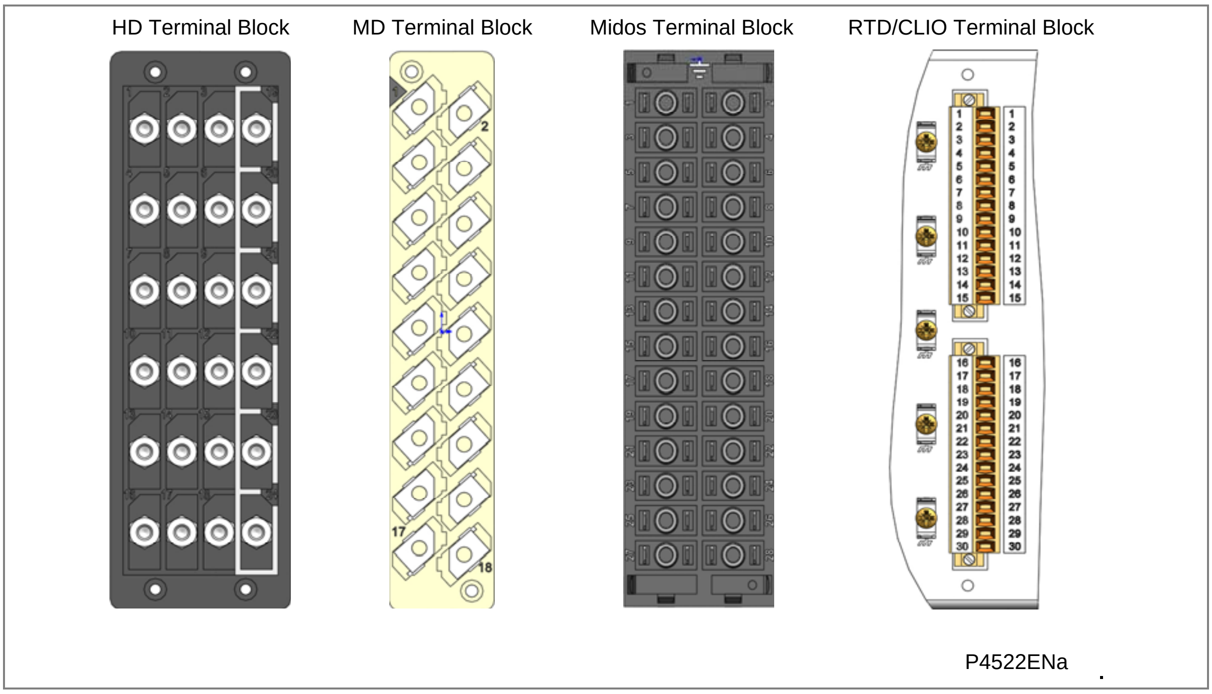


Figure 3: Terminal block types

Note: The P847 uses MD and MiDOS terminal blocks. It does not use HD or RTD/CLIO terminal blocks.

Terminal block connectors
MiCOM ALSTOM products are supplied with sufficient M4 screws for making connections to the rear mounted terminal blocks using ring terminals, with a recommended maximum of two ring terminals per terminal.

If required, M4 90° crimp ring terminals can be supplied in three different sizes depending on wire size. Each type is available in bags of 100.

Part number	Wire size	Insulation color
ZB9124 901	0.25 - 1.65 mm2 (22 – 16 AWG)	Red
ZB9124 900	1.04 - 2.63 mm2 (16 – 14 AWG)	Blue
ZB9124 904	2.53 - 6.64 mm2 (12 – 10 AWG)	Un-insulated

Table 3: M4 90° crimp ring terminals

Caution For reason of safety, fit an insulating sleeve over the ring terminal.

Wire Sizes

The following minimum wire sizes are recommended:

- Current Transformers: 2.5 mm^2
- Auxiliary Supply, Vx: 1.5 mm^2
- Other Circuits 1: 1.0 mm^2

Due to the limitations of the ring terminal, the maximum wire size that can be used for any of the medium or heavy duty terminals is 6.0 mm^2 using ring terminals that are not pre-insulated. If using only pre-insulated ring terminals, the maximum wire size that can be used is reduced to 2.63 mm^2 per ring terminal. If you need a larger wire size, use two wires in parallel, each terminated in a separate ring terminal at the product.

The wire used for all connections to the medium and heavy duty terminal blocks, except the EIA(RS)485 port, should have a minimum voltage rating of 300 Vrms.

Each opto input has a selectable preset ½ cycle filter. This makes the input immune to noise induced on the wiring. Although this is secure it can be slow, particularly for intertripping. If you switch off the ½ cycle filter, either use double pole switching on the input, or use screened twisted cable on the input circuit.

4.2 Connecting the Power Supply

Connections to the power supply terminals are made using pins 1 and 2 on the power supply/Relayoutput/RP1 terminal block. This is always the terminal block on the far right hand-side when viewing the product from the rear.

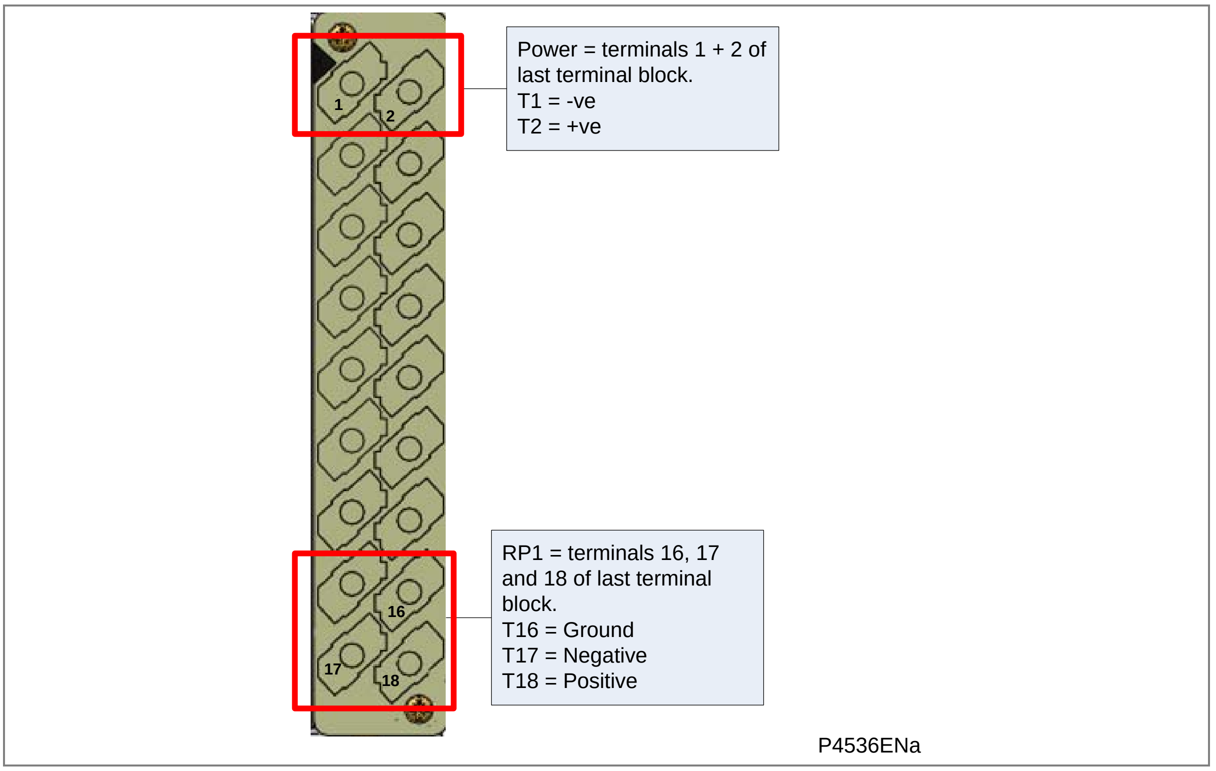


Figure 4: Power supply terminal block

Protect the auxiliary power supply wiring with a 16 A high rupture capacity (HRC) type NIT or TIA fuse. For safety reasons, current transformer circuits must never be fused. Other circuits should be appropriately fused to protect the wire used.

4.3 EIA(RS)485 rear port (RP1)

Connections to the EIA(RS)485 port are made using ring terminals. 2-core screened cable is recommended with a maximum total length of 1000 m or 200 nF total cable capacitance.

A typical cable specification would be:

- Each core: 16/0.2 mm copper conductors, PVC insulated
- Nominal conductor area: 0.5 mm^2 per core
- Screen: Overall braid, PVC sheathed

The connections are made to pins 16, 17 and 18 as shown in Figure 4:

4.4 IRIG-B connections

The IRIG-B input and BNC connector have a characteristic impedance of 50 Ω. It is recommended that connections between the IRIG-B equipment and the product are made using coaxial cable of type RG59LSF with a halogen free, fire retardant sheath.

4.5 1PPS Fiber-optic port

The 1PPS signal is connected to a fiber optic port on the coprocessor board in slot B. The fiber optic port uses an ST type connector, compatible with fiber multimode 50/125 µm or 62.5/125 µm – 850 nm.

4.6 EIA(RS)232 front port

Short term connections to the EIA(RS)232 port, located behind the bottom access cover, can be made using a screened multi-core communication cable up to 15 m long, or a total capacitance of 2500 pF. The cable should be terminated at the product end with a 9-way, metal shelled, D-type male plug. For details of the pin connections, see the Hardware and Software Design chapter, Front Serial Port section.

4.7 Ethernet Fiber-optic port

Fiber optic connection is recommended for use in permanent connections in a substation environment. The 100 Mbps fiber optic port uses type ST connectors (one for Tx and one for Rx), compatible with fiber multimode 50/125 µm or 62.5/125 µm – 1300 nm.

If the unit has a redundant Ethernet board, see the "Redundant Ethernet" chapter for details of connections.

Note: *For models equipped with redundant Ethernet connections the product must be partially dismantled to set the fourth octet of the second IP address. This ideally, should be done before installation.*

4.8 Ethernet RJ-45 metallic port

If the unit has a metallic Ethernet connection, it can be connected to either a 10Base-T or a 100Base-TX Ethernet hub; the port automatically senses which type of hub is connected. Due to noise sensitivity this connection type is recommended for short-term short distance connections, ideally where the products and hubs are in the same cubicle.

The connector for the Ethernet port is a shielded RJ-45. Table 4 shows the signals and pins on the connector.

Pin	Signal name	Signal definition
1	TXP	Transmit (positive)
2	TXN	Transmit (negative)
3	RXP	Receive (positive)
4	-	Not used
5	-	Not used
6	RXN	Receive (negative)
7	-	Not used
8	-	Not used

Table 4: RJ45 Ethernet connections

4.9 Download/monitor port

Short term connections to the download/monitor port, located behind the bottom access cover, can be made using a screened 25-core communication cable up to 4 m long. The cable should be terminated at the product end with a 25-way, metal shelled, D-type male plug.

4.10 Ground connection

Every product must be connected to the cubicle grounding bar using the M4 grounding studs in the bottom left-hand corner of the product case. The minimum recommended wire size is 2.5 mm^2 and should have a ring terminal at the product end.

Due to the limitations of the ring terminal, the maximum wire size that can be used for any of the medium or heavy duty terminals is 6.0 mm^2 per wire. If a greater cross-sectional area is required, two parallel connected wires, each terminated in a separate ring terminal at the product, or a metal grounding bar could be used.

Note: *To prevent any possibility of electrolytic action between brass or copper ground conductors and the rear panel of the product, precautions should be taken to isolate them from one another. This could be achieved in several ways, including placing a nickel-plated or insulating washer between the conductor and the product case, or using tinned ring terminals.*

COMMISSIONING INSTRUCTIONS

CHAPTER 15

1 CHAPTER OVERVIEW

The Commissioning chapter describes in detail the commissioning process for the P847B&C PMU.

This chapter consists of the following sections:

2 GENERAL GUIDELINES

As an Intelligent Electronic Device (IED), the P847B&C employs a high degree of self-checking and will raise an alarm in the unlikely event of a failure. This is why the commissioning tests can be less extensive than those for non-numeric electronic or electro-mechanical relays.

To commission numeric IEDs, you need only verify that the hardware is functioning correctly and the application-specific software settings have been applied to the IED. You do not need to test every IED function if the settings have been verified by one of these methods:

- Extraction of the applied settings using appropriate setting software
- Using the operator interface

Unless previously agreed, the customer is responsible for determining the application-specific settings to be applied to the IED and for testing any scheme logic applied by external wiring or configuration of the IED's internal programmable scheme logic.

The menu language is user-selectable, so the Commissioning Engineer can change it for commissioning purposes if required.

> *Note: Restore the language setting to the customer's preferred language on completion.*

The P847B&C is a Phasor Measurement Unit (PMU) that ordinarily will form part of a Wide-Area Monitoring, Protection And Control System (WAMPACS). Typically a number of PMUs will connect to a WAMPACS by means of Phasor Data Concentrators (PDCs).

Connections between PMUs and PDCs and between PDCs and WAMPACS are achieved using Internet Protocol (IP) communications made over Ethernet connections. The device communications need to be set up correctly so that all parts can communicate correctly with each other. These communications settings are normally specified at a high-level system design. These requirements are obtained from the system administrator.

Alternatively, it may be that the PMU is being installed in isolation (with additional WAMPACS components to be added later). In these cases, the communication configuration settings may not be available, so some example values are given to allow the PMU functionality to be tested in the absence of network information.

These PC-based software tools are needed to set up the PMU communications and to test the transmission of synchrophasor data over the IEEE C37.118 communications link:

- IED configurator. Labeled "IEC 61850 Configurator", this is part of the S1 Studio suite.
- Phasor Terminal Software. This is available from the Alstom Grid website at www.alstom.com. It is used for capturing data stream transmission from the Ethernet port.

> **Warning: Before carrying out any work on the equipment the user should be familiar with the contents of the Safety Section or Safety Guide SFTY/4LM/H11 or later issue and the ratings on the equipment's rating label.**

> **Warning: Do not disassemble the MiCOM ALSTOM P847B&C IED relay in any way during commissioning, other than to test the CT shorting links.**

3 GPS SYNCHRONIZATION

The P847B&C requires an accurate source of timing information, when being used for synchrophasor applications. It is designed to work with the one pulse per second (1pps) and the IRIG-B time synchronization signals provided by the P594 synchronizing unit.

The P594 must be commissioned, fully operational and delivering the required timing signals before commissioning the P847B&C. On power-up, the unit's **GPS Fail** flag will be set active until you connect up the 1PPS GPS source to the designated fiber optic input

If the 1pps signal is not available when the P847B&C is commissioned, it will not generate synchrophasors.

For consistency of timestamping of event records, the Universal Coordinated Time (UTC) offset should not be applied on the associated P594.

4 REDUNDANT ETHERNET

Models B and C of the P847B&C may be equipped with a redundant Ethernet communications option.

The redundant Ethernet operation is described in the Redundant Ethernet chapter.

> *Note: Setting the 4^{th} octet of the second IP address requires partial disassembly of the product. It is assumed that this will have been set prior to installation and commissioning.*

5 SETTING FAMILIARIZATION

When commissioning a device for the first time, you should allow enough time to become familiar with the method by which the settings are applied and the operation of the software.

The Configuration chapter contains a detailed description of the menu structure of the device

With the secondary front cover in place, most of the keys are accessible, allowing you to read all menu cells and to reset all LEDs and alarms. However, no configuration settings can be changed, neither can fault and event records be cleared.

Removing the secondary front cover allows access to all keys so that settings can also be changed. However, menu cells having access levels higher than the default level will require the appropriate password to be entered before changes can be made.

Alternatively, using a portable PC together with suitable setting software (such as S1 Studio), the menu can be viewed a page at a time to display a full column of data and text. This PC software also allows settings to be entered more easily, saved to a file on disk for future reference or printed to produce a setting record. Refer to the PC software user manual for details.

6 COMMISSIONING TEST MENU

The IED provides several test facilities under the COMMISSION TESTS menu heading. There are menu cells which allow the status of the opto-isolated inputs, output relay contacts, internal Digital Data Bus (DDB) signals and user-programmable LEDs to be monitored. Also there are cells to test the operation of the output contacts and user-programmable LEDs

Table 1 shows the commissioning tests, including setting ranges and factory defaults.

Menu Text	Default Setting	Settings
COMMISSION TESTS		
Opto I/P Status	–	–
Relay O/P Status	–	–
Test Port Status	–	–
LED Status	–	–
Monitor Bit 1	736: LED_CON_R1	0 to 1023 (see menus database)
Monitor Bit 2	738: LED_CON_R2	0 to 1023 (see menus database)
Monitor Bit 3	740: LED_CON_R3	0 to 1023 (see menus database)
Monitor Bit 4	742: LED_CON_R4	0 to 1023 (see menus database)
Monitor Bit 5	744: LED_CON_R5	
Monitor Bit 6	746: LED_CON_R6	
Monitor Bit 7	748: LED_CON_R7	
Monitor Bit 8	750: LED_CON_R8	
Test Mode	Disabled	Disabled Test Mode Contacts Blocked
Test Pattern	All bits set to 0	0 = Not Operated 1 = Operated
Contact Test	No Operation	No Operation Apply Test Remove Test
Test LEDs	No Operation	No Operation Apply Test

Table 1: Commissioning test menu

6.1 Opto I/P Status

This menu cell displays the status of the opto-isolated inputs as a binary string, a 1 indicating an energized opto-isolated input and a 0 a de-energized one. If the cursor is moved along the binary numbers, the corresponding label text is displayed for each logic input.

It can be used during commissioning or routine testing to monitor the status of the opto-isolated inputs while they are sequentially energized with a suitable dc voltage.

6.2 Relay O/P Status

This menu cell displays the status of the DDB signals that result in energization of the output relays as a binary string, a 1 indicating an operated state and 0 a non-operated state. If the cursor is moved along the binary numbers the corresponding label text will be displayed for each relay output.

The information displayed can be used during commissioning or routine testing to indicate the status of the output relays when the IED is in service. Also fault finding for output relay damage can be performed by comparing the status of the output contact under investigation with its associated bit.

> ***Note:*** *When the **Test Mode** cell is set to **Contacts Blocked,** this cell continues to indicate which contacts would operate if the IED was in-service. It does not show the actual status of the output relays.*

6.3 Test Port Status

This menu cell displays the status of the eight digital databus (DDB) signals that have been allocated in the **Monitor Bit** cells. If the cursor is moved along the binary numbers, the corresponding DDB signal text string is displayed for each monitor bit.

By using this cell with suitable monitor bit settings, the state of the DDB signals can be displayed as various operating conditions or sequences are applied to the IED. Therefore the programmable scheme logic can be tested.

6.4 Red LED Status and Green LED Status

The ‘Red LED Status’ and ‘Green LED Status’ cells are 18-bit binary strings that indicate which of the user-programmable LEDs on the IED are illuminated when accessing the IED from a remote location, a ‘1’ indicating a particular LED is lit and a ‘0’ not lit. When the status of a particular LED in both cells is ‘1’, this indicates the LEDs illumination is yellow.

6.5 Monitor Bits 1 to 8

The eight **Monitor Bit** cells allow the user to select the status of which DDB signals can be observed in the **Test Port Status** cell or using the monitor/download port.

Each **Monitor Bit** is set by entering the required DDB signal number (0 – 1023) from the list of available DDB signals in the Programmable Scheme Logic Schemes chapter. The pins of the monitor/download port used for monitor bits are given in Table 2. The signal ground is available on pins 18, 19, 22 and 25.

Monitor Bit	1	2	3	4	5	6	7	8
Monitor/Download Port Pin	11	12	15	13	20	21	23	24

Table 2: Monitor bits and pins

> **Warning: The monitor/download port is not electrically isolated against induced voltages on the communications channel. It should therefore only be used for local communications.**

6.6 Test Mode

This menu cell allows secondary injection testing to be performed on the IED. It also lets you test the output contacts directly by applying menu-controlled test signals.

> **Warning: When the “Test Mode” cell is set to “contacts blocked” the scheme logic does not drive the output relays, so there is no danger of tripping any associated circuit breakers.**

To select test mode select the **Test Mode** option. This takes the IED out-of-service causing an alarm condition to be recorded and the yellow **Out of Service** LED to illuminate. This also freezes any information stored in the CB CONDITION column. However the output contacts are still active in this mode.

To disable the output contacts in addition to the above select **Blocked**.

Once testing is complete the IED must be returned back into service. To do this, set the cell back to **Disabled**.

Note: Test mode can also be selected by energizing an opto mapped to the Test Mode signal.

6.6.1 Test Pattern

The **Test Pattern** cell is used to select the output relay contacts that will be tested when the **Contact Test** cell is set to **Apply Test**. The cell has a binary string with one bit for each user-configurable output contact which can be set to **1** to operate the output under test conditions and **0** to not operate it.

6.7 Contact Test

When the **Apply Test** command in this cell is issued, the contacts set for operation (set to **1**) in the **Test Pattern** cell change state. Once the test has been applied, the command text on the liquid crystal display (LCD) will change to **No Operation** and the contacts will remain in the Test State until reset by issuing the **Remove Test** command. The command text on the LCD will show **No Operation** after the **Remove Test** command has been issued.

Note: *When the **Test Mode** cell is set to **Contacts Blocked** the **Relay O/P Status** cell does not show the current status of the output relays and hence can not be used to confirm operation of the output relays. Therefore it will be necessary to monitor the state of each contact in turn.*

6.8 Test LEDs

When the **Apply Test** command in this cell is issued the 18 user-programmable LEDs show yellow for approximately 2 seconds before switching off and the command text on the LCD reverts to **No Operation**.

6.9 Using a Monitor/Download Port Test Box

A monitor/download port test box containing eight LEDs and a switchable audible indicator is available. It is housed in a small plastic box with a 25-pin male D-connector that plugs directly into the IED’s monitor/download port. There is also a 25-pin female D-connector which allows other connections to be made to the monitor/download port while the monitor/download port test box is in place.

Each LED corresponds to one of the monitor bit pins on the monitor/download port with **Monitor Bit 1** being on the left-hand side when viewed from the front of the IED. The audible indicator can either be selected to sound if a voltage appears any of the eight monitor pins or remain silent so that indication of state is by LED alone.

7 COMMISSIONING EQUIPMENT

7.1 Minimum Equipment Required

As a minimum, the following equipment is required:

- Multimeter with suitable voltage and current ranges
- Phase angle meter
- Phase rotation meter
- A portable PC, installed with appropriate software
- S1 Studio
- Phasor Terminal Software
- Ethernet connection leads

Note: *Not all versions of the P847B&C device have electrical (CAT5) Ethernet connection support. All versions do have fiber-optic connection capability and so, dependent upon the P847B&C version, the PC connectivity, and the system configuration, some form of fiber-optic to electrical conversion may be needed to test the Ethernet communications. Where electrical connection can be made, it may be necessary to use a cross-over connection if using older-type PCs.*
Test equipment may contain many of the above features in one unit.

7.2 Optional Equipment

The following equipment is optional:

- Multifunctional dynamic current and voltage injection test set
- Multi-finger test plug type MMLB01 (if test block type MMLG is installed)
- An electronic or brushless insulation tester with a dc output not exceeding 500 V (for insulation resistance testing when required)
- KITZ K-Bus to EIA(RS)232 protocol converter (if the first rear EIA(RS)485 K-Bus port or second rear port configured for K-Bus is being tested and one is not already installed)
- A printer, for printing a setting record from the portable PC

8 PRODUCT CHECKS

These product checks cover all aspects of the IED to ensure that:

- It has not been physically damaged prior to commissioning
- It is functioning correctly
- All input quantity measurements are within the stated tolerances

If the application-specific settings have been applied to the IED prior to commissioning, you should make a copy of the settings. This will allow you to restore them at a later date if necessary. This could be done by:

- Obtaining a setting file from the customer.
  This requires a portable PC with appropriate setting software for transferring the settings from the PC to the IED.
- Extracting the settings from the IED itself.
  This requires a portable PC with appropriate setting software.
- Manually creating a setting record.
  This can be done using a copy of the setting record at the end of this chapter to record the settings as the IED's menu is sequentially stepped through using the front panel user interface

If password-protection is enabled and the customer has changed password 2 that prevents unauthorized changes to some of the settings, either the revised password 2 should be provided, or the customer should restore the original password prior to commencement of testing.

> ***Note:*** *If the password has been lost, a recovery password can be obtained from Alstom Grid by quoting the serial number of the IED. The recovery password is unique to that IED and is unlikely to work on any other IED.*

8.1 With the IED De-energized

> **DANGER: The following group of tests should be carried out without the auxiliary supply being applied to the IED and, if applicable, with the trip circuit isolated.**

The current and voltage transformer connections must be isolated from the IED for these checks. If a P991 test block is provided, the required isolation can easily be achieved by inserting test plug type P992 that effectively open-circuits all wiring routed through the test block.

Before inserting the test plug, reference should be made to the scheme diagram to ensure that this will not cause damage or a safety hazard. For example, the test block may be associated with protection current transformer circuits. It is essential that the sockets in the test plug, which correspond to the current transformer secondary windings, are linked before the test plug is inserted into the test block.

> **DANGER: Never open-circuit the secondary circuit of a current transformer since the high voltage produced may be lethal and could damage insulation.**

If a test block is not provided, the voltage transformer supply to the IED should be isolated by means of the panel links or connecting blocks. The line current transformers should be short-circuited and disconnected from the IED terminals. Where means of isolating the auxiliary supply and trip circuit (for example isolation links, fuses and MCB) are provided, these should be used. If this is not possible, the wiring to these circuits must be disconnected and the exposed ends suitably terminated to prevent them from being a safety hazard.

8.1.1 Visual Inspection

> **Warning: The rating information given under the top access cover on the front of the IED should be checked. Check that the IED being tested is correct for the line or circuit. Ensure that the circuit reference and system details are entered onto the setting record sheet.**

Carefully examine the IED to see that no physical damage has occurred since installation.

Ensure that the case earthing connections, bottom left-hand corner at the rear of the IED case, are used to connect the IED to a local earth bar using an adequate conductor.

8.1.2 Current Transformer Shorting Contacts

If required, check the current transformer shorting contacts to ensure that they close when the heavy-duty terminal block is disconnected from the current input PCB.

For P847B&C Models B and C variants (80TE), the heavy duty terminal blocks are references D and F in Figure 1.

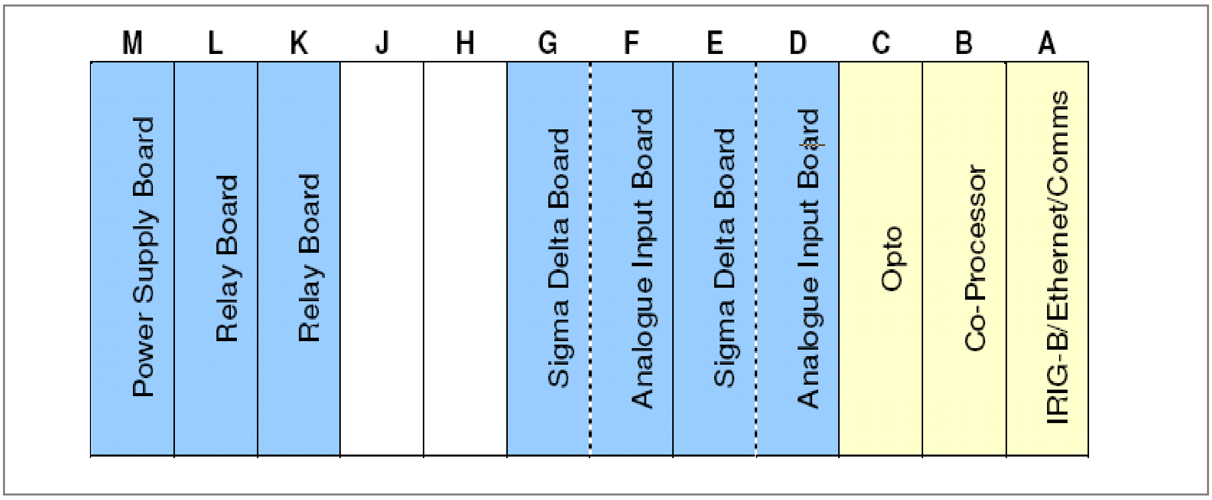


Figure 1: 80TE Models B and C rear panel

The heavy-duty terminal block is fastened to the rear panel using four crosshead screws. These are located two at the top and two at the bottom.

> ***Note:*** *The use of a magnetic bladed screwdriver is recommended to minimize the risk of the screws being left in the terminal block or lost.*

Pull the terminal block away from the rear of the case and check with a continuity tester that all the shorting switches being used are closed.

Table 3 shows the terminals between which shorting contacts are fitted.

Current input	Shorting contact between terminals P847B&C
IA1	D11 – D12
IB1	D13 – D14
IC1	D15 – D16
IA2	D17 – D18
IB2	D19 – D20

Current input	Shorting contact between terminals P847B&C
IC2	D21 – D22
IA3	D23 – D24
IB3	D25 – D26
IC3	D27 – D28
IA4	F23 – F24
IB4	F25 – F26
IC4	F27 – F28

Table 3: P847B&C Models B and C (80TE) shorting contacts

8.1.3 Insulation

Insulation resistance tests are only necessary during commissioning if explicitly requested.

Isolate all wiring from the earth and test the insulation with an electronic or brushless insulation tester at a dc voltage not exceeding 500 V. Terminals of the same circuits should be temporarily connected together.

The main groups of IED terminals are:

1. Voltage transformer circuits
2. Current transformer circuits
3. Auxiliary voltage supply
4. Field voltage output and opto-isolated control inputs
5. Relay contacts
6. EIA(RS)485 communication port
7. Ethernet communication port
8. Case earth

The insulation resistance should be greater than 100 MΩ at 500 V.

On completion of the insulation resistance tests, ensure all external wiring is correctly reconnected to the IED.

8.1.4 External Wiring

Warning: Check that the external wiring is correct to the relevant IED diagram and scheme diagram. Ensure as far as practical that phasing/phase rotation appears to be as expected. The IED diagram number appears on the rating label under the top access cover on the front of the IED.

If a P991 test block is provided, the connections should be checked against the scheme diagram. It is recommended that the supply connections are to the live side of the test block colored orange with the odd numbered terminals (1, 3, 5, 7 etc.). The auxiliary supply is normally routed using terminals 13 (supply positive) and 15 (supply negative), with terminals 14 and 16 connected to the IED's positive and negative auxiliary supply terminals respectively. However, check the wiring against the schematic diagram for the installation to ensure compliance with the customer's normal practice.

8.1.5 Watchdog Contacts

Using a continuity tester, check that the Watchdog contacts are in the following states (for a de-energized IED):

Model	Terminals	De-energized contact	Energized contact
P847 B & C (80TE)	M11 - M12	Closed	Open
P847 B & C (80TE)	M13 - M14	Open	Closed

Table 4: Shorting contacts

8.1.6 Auxiliary Supply

The IED can be operated from either a dc only or AC/DC auxiliary supply depending on the IED's nominal supply rating. The incoming voltage must be within the operating range specified in Table 5.

Without energizing the IED measure the auxiliary supply to ensure it is within the operating range.

Nominal supply rating DC [AC rms]		DC operating range	AC operating range
24 - 48 V	[-]	19 to 65 V	-
48 - 110 V	[30 - 100 V]	37 to 150 V	24 - 110 V
125 - 250 V	[100 - 240 V]	87 to 300 V	80 to 265 V

Table 5: Operational range of auxiliary supply Vx

Note: *The IED can withstand an ac ripple of up to 12% of the upper rated voltage on the dc auxiliary supply.*

Warning: Do not energize the IED using the battery charger with the battery disconnected as this can irreparably damage the IED's power supply circuitry.
Energize the IED only if the auxiliary supply is within the specified operating ranges. If a test block is provided, it may be necessary to link across the front of the test plug to connect the auxiliary supply to the IED.

8.2 With the IED Energized

The following group of tests verifies that the IED hardware and software is functioning correctly and should be carried out with the auxiliary supply applied to the IED.

Warning: The current and voltage transformer connections must remain isolated from the IED for these checks. The trip circuit should also remain isolated to prevent accidental operation of the associated circuit breaker.

8.2.1 Watchdog Contacts

Using a continuity tester, check the watchdog contacts are in the states given in Table 4.

8.2.2 LCD Front Panel Display

The Liquid Crystal Display (LCD) is designed to operate in a wide range of substation ambient temperatures. For this purpose, the IEDs have an **LCD Contrast** setting. This allows the user to adjust how light or dark the characters displayed will be. The contrast is factory pre-set, but it may be necessary to adjust the contrast to give the best in-service display. To change the contrast, cell

[09FF: LCD Contrast] at the bottom of the CONFIGURATION column can be incremented (darker) or decremented (lighter), as required.

Warning: Before applying a contrast setting, make sure that it will not make the display so light or dark such that menu text becomes unreadable. It is possible to restore the visibility of a display by downloading a S1 Studio setting file, with the LCD Contrast set within the typical range of 7 - 11.

8.2.3 Date and Time

Before setting the date and time, ensure that the factory-fitted battery isolation strip, that prevents battery drain during transportation and storage, has been removed. With the lower access cover open, the presence of the battery isolation strip can be checked by a red tab protruding from the positive side of the battery compartment. Press on the battery lightly, to prevent it from falling out of the battery compartment, then pull the red tab to remove the isolation strip.

The date and time should now be set to the correct values.

The P847B&C requires a time synchronizing signal conforming to IRIG-B, such as that provided by the P594, and this should be connected.

Ensure the relay is receiving the IRIG-B signal by checking that cell [0805: DATE and TIME, IRIG-B Status] reads **Active**.

Once the IRIG-B signal is active, adjust the time offset of the Universal Time Coordinated (UTC) (also known as satellite clock time) on the satellite clock equipment so that the local time is displayed.

Check the time, date and month are correct in cell [0801: DATE and TIME, Date/Time]. The IRIG-B signal does not contain the current year so it will need to be set manually in this cell.

If the auxiliary supply fails, with a battery fitted in the compartment behind the bottom access cover, the time and date is maintained however the inernal clock alone does not maintain sufficient accuracy for the transmission of synchrophasors. When the auxillary supply is restored the P847 will need to resynchronize with the P594 GPS clock before accurate synchrophasor measurements can be transmitted again.

To test this remove the auxiliary supply from both the P594 and the P847. Leave the relays de-energized for approximately 30 seconds and then restore the auxiliary supply. It will take up to 15 minutes for the P594 to resynchronize with the GPS and resume its output signals, during this time GPS FAIL alarm will be visible on the P847. When the P594 resynchronizes the GPS FAIL alarm on the P847 should be removed and the time on the P847 should be correct.

8.2.4 Light Emitting Diodes (LEDs)

On power-up, all LEDs should flash yellow to allow visual verification of their successful operation. Following this, the green HEALTHY LED should go ON and stay ON, indicating that the IED is healthy. The IED has non-volatile memory which stores the state (on or off) of the alarm, trip and, if configured to latch, user-programmable LED indicators when the IED was last energized from an auxiliary supply. Therefore these indicators may also go ON when the auxiliary supply is applied.

If any of these LEDs are on then they should be reset before proceeding with further testing. If the LEDs successfully reset (the LED goes off), no testing is needed for that LED because it is known to be operational.

Note: *It is likely that alarms related to the communications channels will not reset at this stage.*

8.2.5 Testing the Alarm and Out of Service LEDs

The alarm and out-of-service LEDs can be tested using the COMMISSION TESTS menu column. Set cell [0F0D: COMMISSION TESTS, Test Mode] to **Contacts Blocked**. Check that the out-of-service LED is ON continuously and the alarm LED flashes.

It is not necessary to return cell [0F0D: COMMISSION TESTS, Test Mode] to **Disabled** at this stage because the test mode will be required for later tests.

8.2.6 Testing the User-Programmable LEDs

To test these LEDs set cell [0F10: COMMISSION TESTS, Test LEDs] to **Apply Test**. Check that all 18 LED's on the right-hand side of the IED illuminate yellow.

8.2.7 Field Voltage Supply

The IED generates a field voltage of nominally 48 V that can be used to energize the opto-isolated inputs (alternatively the substation battery may be used).

Measure the field voltage across the terminals 7 and 9 on the terminal block given in Table 6. Check that the field voltage is within the range 40 V to 60 V when no load is connected and that the polarity is correct.

Repeat for terminals 8 and 10.

Model	Supply rail	Terminals
P847 B & C (80TE)	+ve	M7 & M8
P847 B & C (80TE)	–ve	M9 & M10

Table 6: Field voltage terminals

8.2.8 Input Opto-Isolators

This test checks that all the opto-isolated inputs on the IED are functioning correctly.

The opto-isolated inputs should be energized one at a time. For terminal numbers, please see the external connection diagrams in the "Wiring Diagrams" chapter. Ensuring correct polarity, connect the field supply voltage to the appropriate terminals for the input being tested.

Warning: The opto-isolated inputs may be energized from an external dc auxiliary supply (e.g. the station battery) in some installations. Check that this is not the case before connecting the field voltage otherwise damage to the IED may result.

The status of each opto-isolated input can be viewed using either cell [0020: SYSTEM DATA, Opto I/P Status] or [0F01: COMMISSION TESTS, Opto I/P Status], a **1** indicating an energized input and a **0** indicating a de-energized input. When each opto-isolated input is energized, one of the characters on the bottom line of the display changes to indicate the new state of the input.

8.2.9 Output Relays

This test checks that all the output relays are functioning correctly.

Ensure that the IED is still in test mode by viewing cell [0F0D: COMMISSION TESTS, Test Mode] to ensure that it is set to **Blocked**.

The output relays should be energized one at a time. To select output relay 1 for testing, set cell [0F0E: COMMISSION TESTS, Test Pattern] as appropriate.

Connect a continuity tester across the terminals corresponding to output relay 1 as shown in the external connection diagram in the Installation chapter (*P847/EN IN*).

To operate the output relay set cell [0F0F: COMMISSION TESTS, Contact Test] to **Apply Test**. Operation will be confirmed by the continuity tester operating for a normally open contact and ceasing to operate for a normally closed contact. Measure the resistance of the contacts in the closed state.

Reset the output relay by setting cell [0F0F: COMMISSION TESTS, Contact Test] to **Remove Test**.

> ***Note:*** *Ensure that thermal ratings of anything connected to the output relays during the contact test procedure are not exceeded by the associated output relay being operated for too long. It is therefore advised that the time between application and removal of the contact test is kept to a minimum.*

Repeat the test for the remaining relays.

Return the IED to service by setting cell [0F0D: COMMISSION TESTS, Test Mode] to **Disabled**.

8.2.10 Ethernet Communications

IEC 61850 communications over Ethernet may be tested using an appropriate piece of test software.

8.2.11 Courier Communications

If a K-Bus to EIA(RS)232 KITZ protocol converter is installed, connect a portable PC running the appropriate software to the incoming (remote from relay) side of the protocol converter. The terminal numbers for the IED's K-Bus port are given in Table 7.

Model	Connection	Terminal
	K-Bus	
P847 B & C (80TE)	Screen	M16
P847 B & C (80TE)	1	M17
P847 B & C (80TE)	2	M18

Table 7: EIA(RS)485 terminals

Ensure that the communications baud rate and parity settings in the application software are set the same as those on the protocol converter (usually a KITZ but could be a SCADA RTU). The IED's courier address in cell [0E02: COMMUNICATIONS, Remote Access] must be set to a value between 1 and 254.

Check that communications can be established with this IED using the portable PC.

8.2.12 Current Inputs

This verifies that the current measurement inputs are configured correctly.

All IEDs will leave the factory set for operation at a system frequency of 50 Hz. If operation at 60 Hz is required then this must be set in cell [0009: SYSTEM DATA, Frequency].

Apply current equal to the line current transformer secondary winding rating to each current transformer input of the corresponding rating in turn, see the external connection diagram for the terminal numbers, checking its magnitude using a multimeter/test set readout. The corresponding reading can then be checked in the IED's MEASUREMENTS 1 column and value displayed recorded.

The measured current values displayed on the IED LCD or a portable PC connected to the front communication port will either be in primary or secondary Amperes. If cell [0D02: MEASURE'T SETUP, Local Values] is set to **Primary**, the values displayed should be equal to the applied current multiplied by the corresponding current transformer ratio set in the **CT and VT RATIOS** menu column (see Table 8). If cell [0D02: MEASURE'T SETUP, Local Values] is set to **Secondary**, the value displayed should be equal to the applied current.

> ***Note:*** *If a PC connected to the IED using the rear communications port is being used to display the measured current, the process will be similar. However, the setting of cell [0D03: MEASURE'T SETUP, Remote Values] will determine whether the displayed values are in primary or secondary Amperes.*

Cell in MEASUREMENTS 1 column (02)	Corresponding CT ratio (in 'CT and VT RATIOS' column(0A) of menu)
[0201: IA Magnitude]	**Error! Bookmark not defined.**[0A07 : Phase CT1A Pri'y] [0A08 : Phase CT1A Sec'y]
[0203: IB Magnitude]	**Error! Bookmark not defined.**[0A09 : Phase CT1B Pri'y] [0A0A : Phase CT1B Sec'y]
[0205: IC Magnitude]	**Error! Bookmark not defined.**[0A0B : Phase CT1C Pri'y] [0A0C : Phase CT1C Sec'y]
[0251: IA2 Magnitude]	**Error! Bookmark not defined.**[0A0D : Phase CT2A Pri'y] [0A0E : Phase CT2A Sec'y]
[0253: IB2 Magnitude]	**Error! Bookmark not defined.**[0A0F : Phase CT2B Pri'y] [0A10 : Phase CT2B Sec'y]
[0255: IC2 Magnitude]	[0A11 : Phase CT2C Pri'y] [0A12 : Phase CT2C Sec'y]
[0257: IA3 Magnitude]	**Error! Bookmark not defined.**[0A13 : Phase CT3A Pri'y] [0A14 : Phase CT3A Sec'y]
[0259: IB3 Magnitude]	**Error! Bookmark not defined.**[0A15 : Phase CT3B Pri'y] [0A16 : Phase CT3B Sec'y]
[025B: IC3 Magnitude]	**Error! Bookmark not defined.**[0A17 : Phase CT3C Pri'y] [0A18 : Phase CT3C Sec'y]
[025D: IA4 Magnitude]	**Error! Bookmark not defined.**[0A18 : Phase CT4A Pri'y] [0A1A : Phase CT4A Sec'y]
[025F: IB4 Magnitude]	**Error! Bookmark not defined.**[0A1B : Phase CT4B Pri'y] [0A1C : Phase CT4B Sec'y]
[0261: IC4 Magnitude]	**Error! Bookmark not defined.**[0A1D : Phase CT4C Pri'y] [0A1E : Phase CT4C Sec'y]

Table 8: CT ratio settings P847B&C Models B and C

8.2.13 Voltage Inputs

This test verifies that the voltage measurement inputs are configured correctly.

Apply rated voltage to each voltage transformer input in turn, checking its magnitude using a multimeter/test set readout. Refer to Table 9 and Table 10 for the corresponding reading in the MEASUREMENTS 1 column and record the value displayed.

Cell in MEASUREMENTS 1 column	Voltage input terminals
[021A: VAN Magnitude]	D1 – D2
[021C: VBN Magnitude]	D3 – D4
[021E: VCN Magnitude]	F1 – F2

Table 9: Voltage input terminals P847B&C Models B and C

The measured voltage values on the IED LCD or a portable PC connected to the front communication port will either be in primary or secondary volts. If cell [0D02: MEASURE'T SETUP, Local Values] is set to **Primary**, the values displayed should be equal to the applied voltage multiplied by the corresponding voltage transformer ratio set in the **VT and CT RATIOS** menu column (see Table 10). If cell [0D02: MEASURE'T SETUP, Local Values] is set to **Secondary**, the value displayed should be equal to the applied voltage.

Note: *If a PC connected to the IED using the rear communications port is being used to display the measured voltage, the process will be similar. However, the setting of cell [0D03: MEASURE'T SETUP, Remote Values] will determine whether the displayed values are in primary or secondary Volts.*

Cell in MEASUREMENTS 1 column (02)	Corresponding VT ratio (in 'CT and VT RATIOS' column(0A) of menu)
[021A: VAN Magnitude]	**Error! Bookmark not defined.**[0A01 : Main VT A Pri'y] **Error! Bookmark not defined.**[0A02 : Main VT A Sec'y]
[021C: VBN Magnitude]	**Error! Bookmark not defined.**[0A03 : Main VT B Pri'y] **Error! Bookmark not defined.**[0A04 : Main VT B Sec'y]
[021E: VCN Magnitude]	**Error! Bookmark not defined.**[0A05 : Main VT C Pri'y] **Error! Bookmark not defined.**[0A06 : Main VT C Sec'y]

Table 10: Voltage ratio settings

9 SETTING CHECKS

The setting checks ensure that all of the application-specific IED settings (i.e. both the IED's function and programmable scheme logic settings), for the particular installation, have been correctly applied to the IED.

If the application-specific settings are not available, ignore sections 9.1.

> **Note:** *If applicable, the trip circuit should remain isolated during these checks to prevent accidental operation of the associated circuit breaker.*

9.1 Apply Application-Specific Settings

There are different methods of applying the settings to the IED:

- Transferring settings from a pre-prepared setting file to the IED using a portable PC running the appropriate software using the IED's front EIA(RS)232 port, located under the bottom access cover, or rear communications port (with a KITZ protocol converter connected if necessary).

  This method is preferred for transferring function settings as it is much faster, and there is a lower margin for error.

  If a Programmable Logic Scheme (PSL) is used, which is different from that defined by the default settings, this should be the only way of changing the settings.

- If a setting file has been created for the particular application, this further reduces the commissioning time, especially where application-specific programmable scheme logic is to be applied to the IED.
- Enter the settings manually using the IED's operator interface. This method is not suitable for changing the programmable scheme logic.

> **Warning:** **It is essential that where the installation needs application-specific PSL, that the appropriate .psl file, is downloaded (sent) to the IED, for each and every setting group that will be used. If the user fails to download the required .psl file to any setting group that may be brought into service, then factory default PSL will still be resident. This may have severe operational and safety consequences**

9.2 Disable all Commissioning Testing Options

> **Warning:** **Ensure that the Test Mode Test option has been disabled. Clear, then re-read any alarms present to be certain that no alarms relating to these test options remain.**

9.3 Check Application Settings

The settings applied should be carefully checked against the required application-specific settings to ensure that they are correct, and have not been mistakenly altered during the injection test.

There are two methods of checking the settings:

- Extract the settings from the relay using a portable PC running the appropriate software using the front EIA(RS)232 port, located under the bottom access cover, or rear communications port (with a KITZ protocol converter connected if necessary). Compare the settings transferred from the IED with the original written application-specific setting record. (For cases where the customer has only provided a printed copy of the required settings but a portable PC is available).

- Step through the settings using the IED’s operator interface and compare them with the original application-specific setting record. Ensure that all protection elements required have been ENABLED in the CONFIGURATION column.

Unless previously agreed to the contrary, the application-specific PSL will not be checked as part of the commissioning tests.

10 PMU FUNCTIONALITY TEST

10.1 Prerequisites

These instructions are for a P847B&C featuring the Ethernet communications option that has electrical (CAT5) and fiber-optic connections (with no redundancy).

If the P847B&C being commissioned features the redundant Ethernet option (two fiber-optic channels), please use the "Redundant Ethernet chapter" in conjunction with these instructions to set up and check the communications.

10.2 Connections

Warning: The P847B&C must be connected to a 1pps fibre optic synchronizing signal, a demodulated IRIG-B signal and equipment able to supply single phase volts along with single phase current.

Connect the current and voltage outputs of the test set to the appropriate terminals of the first voltage and current channel (IA/IA1, VA) and apply nominal voltage and current with the current lagging the voltage by 90 degrees.

10.3 Setup of P847B&C for Ethernet Communication

Firstly the IP PARAMETERS such as those shown in Table 11 must be set. Please see the IED Configurator tool online help for detailed instructions. The IP address must be a valid non-conflicting address.

Setting	Example
IP address	192.168.0.2
Subnet mask	255.255.255.0
Gateway	192.168.0.1

Table 11: Example IP PARAMETERS

Secondly the protocol settings such as those shown in Table 12 must be set or checked. These are available in the Communications column. They should be set in accordance with the communication network settings provided. The PC being used to test the P847B&C functionality will need to connect to this network. If the P847B&C is being installed as a stand-alone device that will be integrated into a system at a later date, the example settings shown below may be used.

The applicable settings in the communications column are shown in Table 12:

Setting	Example
Protocol Type	PMU over TCP
Port Number	4712

Table 12: Example protocol settings

Table 13 shows the application specific settings are dependent on a number of factors and should be defined by the system integrator (typical settings are shown). They are available in the menu under the **PMU CONFIG** column.

Menu text	Example setting
Device ID Code	1
Datarate Select.	50 per second (50 Hz) or 60 per second (60 Hz)
Phasor Format	Rectangular
Filter Length	5

Table 13: PMU Configuration

> ***Note:*** *50 Hz/60 Hz data rate selection is dependent on system nominal frequency under the* ***System Data*** *column.*

10.3.1 Confirmation from P847B&C Front Panel

Scroll to the **MEASUREMENTS 1** column and verify that the synchrophasor measurements for the A phase voltage and current are correct in magnitude and the relative phase angle between the Voltage and current is correct. The absolute phase angles are governed by the GPS 1 pulse per second and cannot be verified in a simplistic manner.

The test may be repeated for other inputs using these instructions.

10.3.2 Confirmation from Phasor Terminal Test Tool

Please see the Phasor Terminal User Guide for detailed instructions. For the example settings shown in previous sections, create a new device configuration with these settings:

- Name – PMU Test
- Device ID – 1
- Protocol – TCP
- Device Host - 192.168.0.2
- Device Port - 4712

Alternatively, use the network settings provided. A dialog box will appear confirming device creation.

1. Click Connect to device or click **Yes** to connect to the device after creation
2. Create the Magnitude Time charts for **A** phase Voltage and Current
3. Create the Phase Angle Time charts for **A** phase Voltage and Current
4. The Magnitude and phase angle measurements should be same as the **Measurements 1** on the front panel.

11 ON-LOAD CHECKS

The objective of the on-load checks is to confirm the external wiring to the current and voltage inputs is correct

However, these checks can only be carried out if there are no restrictions preventing the energization of the plant being monitored and the other P847B&C IEDs in the group have been commissioned.

Warning: Remove all test leads, temporary shorting leads, etc. and replace any external wiring that was removed to allow testing.

If any of the external wiring was disconnected from the IED to perform any of the wiring verification tests, replace all such connections (wiring, fuses and links) in accordance with the relevant external connection or scheme diagram.

11.1 Confirm Current and Voltage Transformer Wiring

Voltage Connections

Warning: Using a multimeter, measure the voltage transformer secondary voltages to ensure they are correctly rated. Check that the system phase rotation is correct using a phase rotation meter

Compare the values of the secondary phase voltages with the IED's measured values, which can be found in the MEASURE'T SETUP menu column.

- If cell [0D02: MEASURE'T. SETUP, Local Values] is set to **Secondary**, the values displayed on the IED LCD or a portable PC connected to the front EIA(RS)232 communication port should be equal to the applied secondary voltage. The values should be within 1% of the applied secondary voltages. However, an additional allowance must be made for the accuracy of the test equipment being used.
- If cell [0D02: MEASURE'T. SETUP, Local Values] is set to **Primary**, the values displayed should be equal to the applied secondary voltage multiplied by the corresponding voltage transformer ratio set in the **CT & VT RATIOS** menu column (see Table 10). Again the values should be within 1% of the expected value, plus an additional allowance for the accuracy of the test equipment being used.

Current Connections

Warning: Measure the current transformer secondary values for each input using a multimeter connected in series with the corresponding relay current input.

Check that the current transformer polarities are correct by measuring the phase angle between the current and voltage, either against a phase meter already installed on site and known to be correct or by determining the direction of power flow by contacting the system control center.

Ensure the current flowing in the neutral circuit of the current transformers is negligible.

Compare the values of the secondary phase currents and phase angle with the IED's measured values, which can be found in the MEASUREMENTS 1 menu column.

- If cell [0D02: MEASURE'T. SETUP, Local Values] is set to **Secondary**, the currents displayed on the LCD or a portable PC connected to the front EIA(RS)232 communication port of the IED should be equal to the applied secondary current. The values should be within 1% of the applied secondary currents. However, an additional allowance must be made for the accuracy of the test equipment being used.

- If cell [0D02: MEASURE'T. SETUP, Local Values] is set to **Primary**, the currents displayed on the IED should be equal to the applied secondary current multiplied by the corresponding current transformer ratio set in **CT & VT RATIOS** menu column. Again the values should be within 1% of the expected value, plus an additional allowance for the accuracy of the test equipment being used.

12 FINAL CHECKS

The tests are now complete.

Remove all test leads, temporary shorting leads, etc. and replace any external wiring that was removed to allow testing. If any of the external wiring was disconnected from the IED to perform any of the wiring verification tests, replace all such connections (wiring, fuses and links) in accordance with the relevant external connection or scheme diagram.

Ensure any Ethernet communications link is connected.

Ensure that the IED has been restored to service by checking that cell
[0F0D: COMMISSION TESTS, Test Mode] is set to **Disabled**.

If the menu language has been changed to allow accurate testing it should be restored to the customer's preferred language.

If a P991/MMLG test block is installed, remove the P992/MMLB test plug and replace the cover so that the product is put into service.

Ensure that all event records, fault records, disturbance records, alarms and LEDs have been reset before leaving the IED.

If applicable, replace the secondary front cover on the IED.

MAINTENANCE & TROUBLESHOOTING

CHAPTER 16

1 CHAPTER OVERVIEW

The Maintenance and Troubleshooting chapter provides details of how to maintain and troubleshoot products based on the Px40 platform. It is important to heed the warning signs in this chapter, as not do so may result injury or defective equipment.

Caution **Before carrying out any work on the equipment you should be familiar with the contents of the Safety Section or the Safety Guide SFTY/4LM and the ratings on the equipment's rating label.**

The troubleshooting part of the chapter allows an error condition on the IED to be identified so that appropriate corrective action can be taken.

If the IED develops a fault, usually it is possible to identify which IED module needs replacing. It is not possible to perform an on-site repair to a faulty module.

If a faulty unit or module is returned to the manufacturer or one of their approved service centers, include a completed copy of the Repair or Modification Return Authorization (RMA) form.

This chapter consists of the following sections:

2 MAINTENANCE

2.1 Maintenance Checks

We recommend that Alstom Grid products receive periodic monitoring after installation. In view of the critical nature of the application, they should be checked at regular intervals to confirm they are operating correctly.

Alstom Grid IEDs are designed for a life in excess of 20 years.

MiCOM ALSTOM IEDs are self-supervising and so require less maintenance than earlier designs of protection devices. Most problems will result in an alarm, indicating that remedial action should be taken. However, some periodic tests should be carried out to ensure that the device is functioning correctly and that the external wiring is intact.

If the customer's organization has a Preventative Maintenance Policy, the recommended product checks should be included in the regular program. Maintenance periods depend on many factors, such as:

- The operating environment
- The accessibility of the site
- The amount of available manpower
- The importance of the installation in the power system
- The consequences of failure

Although some functionality checks can be performed from a remote location, these are predominantly restricted to checking that the unit is measuring the applied currents and voltages accurately, and checking the circuit breaker maintenance counters. For this reason, maintenance checks should also be performed locally at the substation.

Caution **Before carrying out any work on the equipment you should be familiar with the contents of the Safety Section or the Safety Guide SFTY/4LM and the ratings on the equipment's rating label.**

2.1.1 Alarms

First check the alarm status LED to see if any alarm conditions exist. If so, press the Read key repeatedly to step through the alarms.

Clear the alarms to extinguish the LED.

2.1.2 Opto-isolators

Check the opto-inputs by repeating the commissioning test detailed in the Commissioning chapter.

2.1.3 Output relays

Check the output relays by repeating the commissioning test detailed in the Commissioning chapter.

2.1.4 Measurement accuracy

If the power system is energized, the measured values can be compared with known system values to check that they are in the approximate range that is expected. If they are within a set range, this indicates that the analog to digital conversion and the calculations are being performed correctly. Suitable test methods can be found in Commissioning chapter.

Alternatively, the measured values can be checked against known values injected into the device using the test block, (if fitted) or injected directly into the IED's terminals. Suitable test methods can be found in the Commissioning chapter. These tests will prove the calibration accuracy is being maintained.

2.2 Replacing the unit

If your product should develop a fault while in service, depending on the nature of the fault, the watchdog contacts will change state and an alarm condition will be flagged. In the case of a fault, either the complete unit or just the faulty PCB, identified by the in-built diagnostic software, should be replaced.

If possible you should replace the complete unit, as this reduces the chance of damage due to electrostatic discharge and also eliminates the risk of fitting an incompatible replacement PCB. However, we understand it may be difficult to remove an installed product and you may be forced to replace the faulty PCB on-site.

Caution **Replacing PCBs requires the correct on-site environment (clean and dry) as well as suitably trained personnel.**

Caution **If the repair is not performed by an approved service center, the warranty will be invalidated.**

Caution **Before carrying out any work on the equipment, you should be familiar with the contents of the Safety Information section of this guide or the Safety Guide SFTY/4LM, as well as the ratings on the equipment's rating label. This should ensure that no damage is caused by incorrect handling of the electronic components. .**

The case and rear terminal blocks are designed to ease removal of the complete unit, without disconnecting the scheme wiring.

Warning **Before working at the rear of the unit, isolate all voltage and current supplying it.**

Note: The MiCOM ALSTOM products have integral current transformer shorting switches which will close, for safety reasons, when the heavy duty and/or MiDOS terminal block is removed

To replace the complete unit:

1. Carefully disconnect the cables not connected to the terminal blocks (e.g. IRIG-B, Fiber optic cables, ground), as appropriate, from the rear of the unit.
2. Remove the terminal block screws using a magnetic bladed screwdriver to minimize the risk of losing the screws or leaving them in the terminal block.

Note: There are four types of terminal block: RTD/CLIO input, heavy duty, medium duty, and MiDOS. The terminal blocks are fastened to the rear panel using slotted screws on the RTD/CLIO input blocks and crosshead screws on the heavy and medium duty blocks. See Figure 1.

3. Without exerting excessive force or damaging the scheme wiring, pull the terminal blocks away from their internal connectors.
4. Remove the terminal block screws that fasten the relay to the panel and rack. These are the screws with the larger diameter heads that are accessible when the access covers are fitted and open.

   If the top and bottom access covers have been removed, some more screws with smaller diameter heads are made accessible. Do NOT remove these screws, as they secure the front panel to the unit.

5. Withdraw the unit from the panel and rack. Take care, as the unit will be heavy due to the internal transformers.
6. To reinstall the unit, follow the above instructions in reverse, ensuring that each terminal block is relocated in the correct position and the chassis ground, IRIG-B and fiber optic connections are replaced. The terminal blocks are labeled alphabetically with ‘A’ on the left hand side when viewed from the rear.

Once the unit has been reinstalled, it should be re-commissioned as set out in the Commissioning chapter.

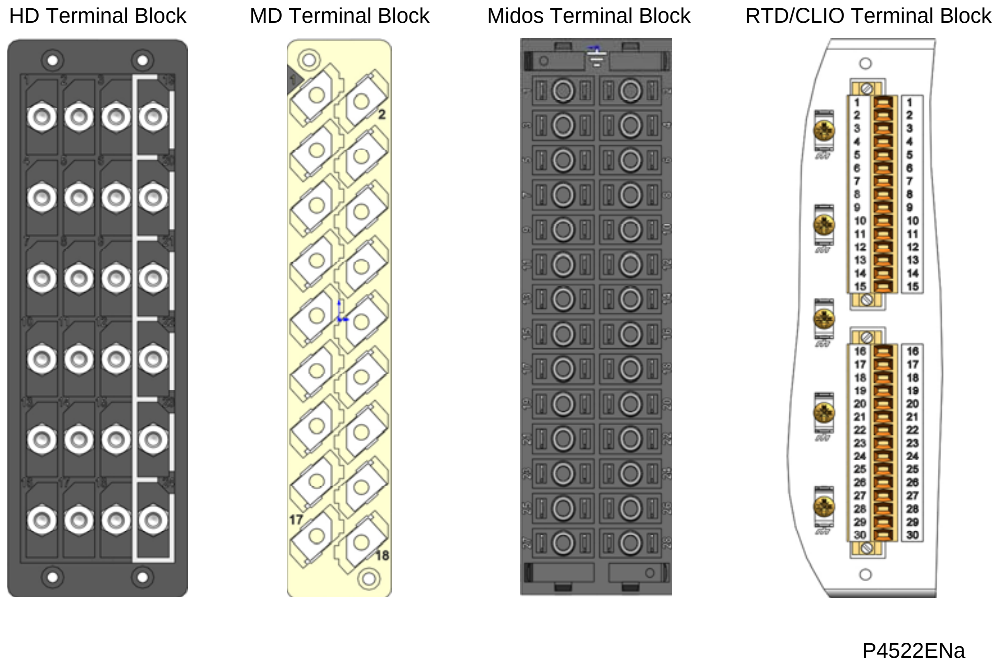


Figure 1: Terminal block types

2.3 Repairing the unit

If your product should develop a fault while in service, depending on the nature of the fault, the watchdog contacts will change state and an alarm condition will be flagged. In the case of a fault, either the complete unit or just the faulty PCB, identified by the in-built diagnostic software, should be replaced.

Replacement of printed circuit boards and other internal components must be undertaken by Alstom Grid-approved Service Centers. Failure to obtain the authorization of Alstom Grid after-sales engineers prior to commencing work may invalidate the product warranty.

We recommend that you entrust any repairs to Alstom Grid Automation Support teams, which are available world-wide.

2.4 Removing the front panel

Warning **Before removing the front panel to replace a PCB, you must first remove the auxiliary power supply and wait 5 seconds for the internal capacitors to discharge. You should also isolate voltage and current transformer connections and trip circuit.**

Caution **Before removing the front panel, you should be familiar with the contents of the Safety Information section of this guide or the Safety Guide SFTY/4LM, as well as the ratings on the equipment's rating label.**

To remove the front panel:

1. Open the top and bottom access covers. (The access covers of size 60TE/80TE cases have two hinge-assistance T-pieces. These clear the front panel molding when the access covers are opened by more than 90°, allowing their removal.)
2. If fitted, remove the transparent secondary front cover.
3. Apply outward pressure to the middle of the access covers to bow them and disengage the hinge lug, so the access cover can be removed. The screws that fasten the front panel to the case are now accessible.
4. Undo and remove the screws. The 40TE case has four crosshead screws fastening the front panel to the case, one in each corner, in recessed holes. The 60TE/80TE cases have an additional two screws, one midway along each of the top and bottom edges of the front plate.

   Do not remove the screws with the larger diameter heads which are accessible when the access covers are fitted and open. These screws hold the relay in its mounting (panel or cubicle).
5. When the screws have been removed, pull the complete front panel forward to separate it from the metal case. The front panel is connected to the rest of the circuitry by a 64-way ribbon cable.

   The internal circuitry is now exposed and is not protected against electrostatic discharge and dust ingress. Therefore ESD precautions and clean working conditions must be maintained at all times.
6. The ribbon cable is fastened to the front panel using an IDC connector; a socket on the cable and a plug with locking latches on the front panel. Gently push the two locking latches outwards which eject the connector socket slightly. Remove the socket from the plug to disconnect the front panel.

2.5 Replacing PCBs

1. To replace any of the PCBs, first remove the front panel.
2. Once the front panel has been removed, the PCBs are accessible. The numbers above the case outline identify the guide slot reference for each printed circuit board. Each printed circuit board has a label stating the corresponding guide slot number to ensure correct relocation after removal. To serve as a reminder of the slot numbering there is a label on the rear of the front panel metallic screen.
3. Remove the 64-way ribbon cable from the PCB that needs replacing

4. Remove the PCB in accordance with the board-specific instructions detailed later in this section.

Note:	*To ensure compatibility, always replace a faulty PCB with one of an identical part number.*

2.5.1 Replacing the main processor board

The main processor board is situated in the front panel. This board contains application-specific settings in its non-volatile memory. You may wish to take a backup copy of these settings. This could save time in the re-commissioning process.

To replace the main processor board:

1. Remove front panel.
2. Place the front panel with the user interface face down and remove the six screws from the metallic screen, as shown in Figure 2. Remove the metal plate.
3. Remove the two screws either side of the rear of the battery compartment recess. These are the screws that hold the main processor board in position.
4. Carefully disconnect the ribbon cable. Take care as this could easily be damaged by excessive twisting.
5. Replace the main processor board
6. Reassemble the front panel using the reverse procedure. Make sure the ribbon cable is reconnected to the main processor board and that all eight screws are refitted.
7. Refit the front panel. On size 60TE and 80TE cases, refit and close the access covers then press the hinge assistance T-pieces so they click back into the front panel molding.
8. Once the unit has been reassembled, carry out the standard commissioning procedure as defined in the Commissioning chapter.

Note:	*After replacing the main processor board, all the settings required for the application need to be re-entered. This may be done either manually or by downloading a settings file.*

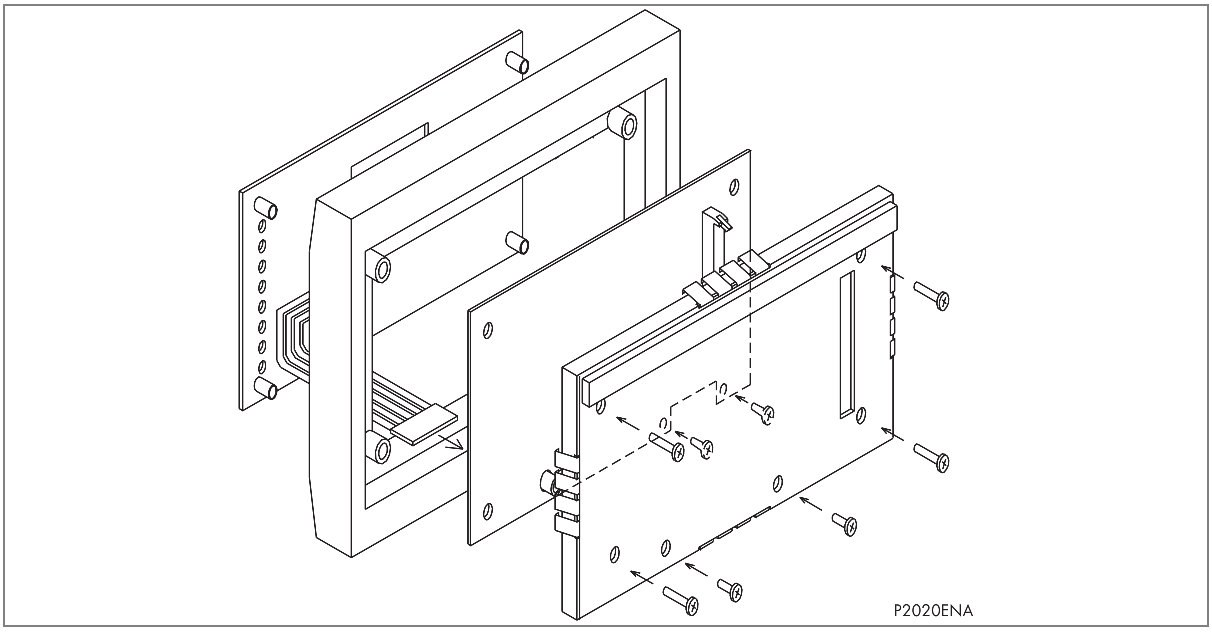


Figure 2: Front panel assembly

2.5.2 Replacement of communications boards

Most products will have at least one communications board of some sort fitted. There are several different boards available offering various functionality, depending on the application. Some products may even be fitted two boards of different types.

To replace a faulty communications board:

1. Remove front panel.
2. Disconnect all connections at the rear.
3. The board is secured in the relay case by two screws, one at the top and another at the bottom. Remove these screws carefully as they are not captive in the rear panel.
4. Gently pull the communications board forward and out of the case.
5. Before fitting the replacement PCB check that the number on the round label next to the front edge of the PCB matches the slot number into which it will be fitted. If the slot number is missing or incorrect, write the correct slot number on the label.
6. Fit the replacement PCB carefully into the correct slot. Make sure it is pushed fully back and that the securing screws are refitted.
7. Reconnect all connections at the rear.
8. Refit the front panel.
9. On size 60TE/80TE cases, refit and close the access covers then press the hinge assistance T-pieces so they click back into the front panel molding.
10. Once the unit has been reassembled, commission it according to the Commissioning chapter.

2.5.3 Replacement of the input module

Depending on the product, the input module consists of two or three boards fastened together and is contained within a metal housing. One board contains the transformers and one contains the analog to digital conversion and processsing electronics. Some devices have an additional auxiliary transformer contained on a third board.

To replace an input module:

1. Remove front panel.
2. The module is secured in the case by two screws on its right-hand side, accessible from the front, as shown below. Move these screws carefully as they are not captive in the front plate of the module.
3. On the right-hand side of the module there is a small metal tab which brings out a handle (on some modules there is also a tab on the left). Grasp the handle(s) and pull the module firmly forward, away from the rear terminal blocks. A reasonable amount of force is needed due to the friction between the contacts of the terminal blocks.

   With non-mounted IEDs, the case needs to be held firmly while the module is withdrawn. Withdraw the input module with care as it suddenly comes loose once the friction of the terminal blocks is overcome.
4. Remove the module from the case. The module may be heavy, because it contains the input voltage and current transformers.
5. Slot in the replacement module and push it fully back onto the rear terminal blocks. To check that the module is fully inserted, make sure the v-shaped cut-out in the bottom plate of the case is fully visible.
6. Refit the securing screws.
7. Refit the front panel (adapt the procedure described in Section 2.4).
8. On size 60TE/80TE cases, refit and close the access covers then press the hinge assistance T-pieces so they click back into the front panel molding.
9. Once the unit has been reassembled, commission it according to the Commissioning chapter.

Note: If individual boards within the input module are replaced, recalibration will be necessary. We therefore recommend replacement of the complete module to avoid on-site recalibration.

2.5.4 Replacement of the power supply board

Caution Before removing the front panel, you should be familiar with the contents of the Safety Information section of this guide or the Safety Guide SFTY/4LM, as well as the ratings on the equipment's rating label.

The power supply board is fastened to an output relay board with push fit nylon pillars. This doubled-up board is secured on the extreme left hand side, looking from the front of the unit.

1. Remove front panel.
2. Pull the power supply module forward, away from the rear terminal blocks and out of the case. A reasonable amount of force is needed due to the friction between the contacts of the terminal blocks.
3. Separate the boards by pulling them apart carefully. The power supply board is the one with two large electrolytic capacitors.
4. Before reassembling the module, check that the number on the round label next to the front edge of the PCB matches the slot number into which it will be fitted. If the slot number is missing or incorrect, write the correct slot number on the label
5. Reassemble the module with a replacement PCB. Push the inter-board connectors firmly together. Fit the four push fit nylon pillars securely in their respective holes in each PCB.

6. Slot the power supply module back into the housing. Push it fully back onto the rear terminal blocks.
7. Refit the front panel.
8. On size 60TE/80TE cases, refit and close the access covers then press the hinge assistance T-pieces so they click back into the front panel molding.
9. Once the unit has been reassembled, commission it according to the Commissioning chapter.

2.5.5 Replacement of the I/O boards

There are several different types of I/O boards, which can be used, depending on the product and application. Some boards have opto-inputs, some have relay outputs and others have a mixture of both.

1. Remove front panel.
2. Gently pull the board forward and out of the case
3. If replacing the I/O board, make sure the setting of the link above IDC connector on the replacement board is the same as the one being replaced.
4. Before fitting the replacement board check the number on the round label next to the front edge of the board matches the slot number into which it will be fitted. If the slot number is missing or incorrect, write the correct slot number on the label.
5. Carefully slide the replacement board into the appropriate slot, ensuring that it is pushed fully back onto the rear terminal blocks.
6. Refit the front panel.
7. On size 60TE/80TE cases, refit and close the access covers then press at the hinge assistance T-pieces so they click back into the front panel molding.
8. Once the unit has been reassembled, commission it according to the Commissioning chapter.

2.6 Recalibration

Recalibration is not needed when a PCB is replaced, unless it is one of the boards in the input module.

If any of the boards in the input module is replaced, the unit must be recalibrated

Although it is possible to carry out recalibration on site, this requires special test equipment and software. We therefore recommend that the work be carried out by the manufacturer, or entrusted to an approved service centre.

2.7 Changing the battery

Each IED has a battery to maintain status data and the correct time when the auxiliary supply voltage fails. The data maintained includes event, fault and disturbance records and the thermal state at the time of failure.

As part of the product's continuous self-monitoring, an alarm is given if the battery condition becomes poor. Nevertheless, you should change the battery periodically to ensure reliability.

To replace the battery:

1. Open the bottom access cover on the front of the relay.
2. Gently remove the battery. If necessary, use a small insulated screwdriver.
3. Make sure the metal terminals in the battery socket are free from corrosion, grease and dust.

4. Remove the replacement battery from its packaging and insert it in the battery holder, ensuring correct polarity.

   Only use a type ½AA Lithium battery with a nominal voltage of 3.6 V and safety approvals such as UL (Underwriters Laboratory), CSA (Canadian Standards Association) or VDE (Vereinigung Deutscher Elektrizitätswerke).

5. Ensure that the battery is held securely in its socket and that the battery terminals make good contact with the socket terminals.
6. Close the bottom access cover.

2.7.1 Post Modification Tests

To ensure that the replacement battery maintains the time and status data if the auxiliary supply fails, scroll across to the DATE and TIME cell, then scroll down to Battery Status which should read Healthy.

2.7.2 Battery Disposal

Dispose of the removed battery according to the disposal procedure for Lithium batteries in the country in which the relay is installed.

2.8 Cleaning

Warning **Before cleaning the IED, ensure that all AC and DC supplies and current and transformer connections are isolated, to prevent any chance of an electric shock while cleaning.**

Only clean the equipment with a lint-free cloth dampened with clean water. Do not use detergents, solvents or abrasive cleaners as they may damage the product's surfaces and leave a conductive residue.

3 TROUBLESHOOTING

3.1 Problem Identification

Use Table 1 to find the description that best matches the problem, and then consult the referenced section for a more detailed analysis of the problem.

Symptom	Refer to
IED fails to power up	Section 3.2
IED powers up but indicates an error and halts during the power-up sequence	Section 3.3
IED Powers up but the Out of Service LED is ON	Section 3.4
Error during normal operation	Section 3.5
Mal-operation of the IED during testing	Section 3.6

Table 1: Problem Identification

3.2 Power-up Errors

If the IED does not appear to power up, use the procedure in Table 2 to determine whether the fault is in the external wiring, auxiliary fuse, and IED power supply module or IED front panel.

Test	Check	Action
1	Measure the auxiliary voltage on terminals 1 and 2. Verify the voltage level and polarity against the rating label on the front. Terminal 1 is –dc, 2 is +dc	If the auxiliary voltage is correct, go to test 2. Otherwise check the wiring and fuses in the auxiliary supply.
2	Check the LEDs and LCD backlight switch ON at power-up. Also check the N/O watchdog contact for closing.	If the LEDs and LCD backlight switch ON or the contact closes and no error code is displayed, the error is probably on the main processor board in the front panel. If the LEDs and LCD backlight do not switch ON and the contact does not close, go to test 3.
3	Check the field voltage output (nominally 48 V DC)	If there is no field voltage, the fault is probably in the IED power supply module.

Table 2: Power-up errors Identification

3.3 Error Message or Code on Power-up

The IED performs a self-test during power-up. If it detects an error, a message appears on the LCD and the power-up sequence stops. If the error occurs when the IED application software is running, a maintenance record is created and the IED reboots.

Test	Check	Action
1	Is an error message or code permanently displayed during power up?	If the IED locks up and displays an error code permanently, go to test 2. If the IED prompts for user input, go to test 4. If the IED reboots automatically, go to test 5.
2	Record displayed error, and then remove and re-apply IED auxiliary supply.	Record whether the same error code is displayed when the IED is rebooted. If no error code is displayed, contact the local service center stating the error code and IED information. If the same code is displayed, go to test 3.

Test	Check	Action
3	Error Code Identification The following text messages (in English) are displayed if a fundamental problem is detected, preventing the system from booting: Bus Fail– address lines SRAM Fail – data lines FLASH Fail format error FLASH Fail checksum Code Verify Fail The following hex error codes relate to errors detected in specific IED modules:	These messages indicate that a problem has been detected on the IED's main processor board in the front panel.
3.1	0c140005/0c0d0000	Input Module (including opto-isolated inputs)
3.2	0c140006/0c0e0000	Output IED Cards
3.3	The last four digits provide details on the actual error.	Other error codes relate to hardware or software problems on the main processor board. Contact Alstom Grid with details of the problem for a full analysis.
4	The IED displays a message for corrupt settings and prompts for the default values to be restored for the affected settings.	The power-up tests have detected corrupted IED settings. Restore the default settings to allow the power-up to complete, and then reapply the application-specific settings.
5	The IED resets when the power-up is complete. A record error code is displayed	Error 0x0E080000, programmable scheme logic error due to excessive execution time. Restore the default settings by powering up with the ⇐ and ⇒ keys pressed, then confirm restoration of defaults at the prompt using the ↵ key. If the IED powers up successfully, check the programmable logic for feedback paths. Other error codes relate to software errors on the main processor board, contact Alstom Grid.

Table 3: Power on self test up error

3.4 Out of Service LED on at power-up

Test	Check	Action	
1	Using the IED menu, confirm the Commission Test or Test Mode setting is Enabled. If it is not Enabled, go to test 2.	If the setting is Enabled, disable the test mode and make sure the Out of Service LED is OFF.	
2	Select View Records, then view the last maintenance record from the menu.	Check for H/W Verify Fail. This indicates a discrepancy between the IED model number and the hardware. Examine the Maint. Data; this indicates the causes of the failure using bit fields: Bit Meaning	
		0	The application type field in the model number does not match the software ID
		1	The application field in the model number does not match the software ID
		2	The variant 1 field in the model number does not match the software ID
		3	The variant 2 field in the model number does not match the software ID
		4	The protocol field in the model number does not match the software ID

Test	Check	Action	
		5	The language field in the model number does not match the software ID
		6	The VT type field in the model number is incorrect (110 V VTs fitted)
		7	The VT type field in the model number is incorrect (440 V VTs fitted)
		8	The VT type field in the model number is incorrect (no VTs fitted)

Table 4: Out of service LED illuminated

3.5 Error Code During Operation

The IED performs continuous self-checking. If the IED detects an error it displays an error message, logs a maintenance record and after a 1.6 second delay the IED resets. A permanent problem (for example due to a hardware fault) is usually detected in the power-up sequence, then the IED displays an error code and halts. If the problem was transient, the IED reboots correctly and continues operation. By examining the maintenance record logged, the nature of the detected fault can be determined.

If the IED's self-check detects a failure of the field voltage or the lithium battery, the IED displays an alarm message and logs a maintenance record but the IED does not reset.

If the IED detects the field voltage has dropped below threshold, a scheme logic signal is set. This allows the scheme logic to be adapted specifically for this failure (for example if a blocking scheme is being used).

To prevent the IED from issuing an alarm when there is a battery failure, select **Date and Time** then **Battery Alarm** then **Disabled**. The IED can then be used without a battery and no battery alarm message appears.

3.6 Mal-operation of the Relay during Testing

3.6.1 Failure of Output Contacts

An apparent failure of the relay output contacts can be caused by the relay configuration. Perform the following tests to identify the real cause of the failure. The relay self-tests verify that the coil of the contact has been energized. An error is displayed if there is a fault in the output relay board.

Test	Check	Action
1	Is the Out of Service LED ON?	If this LED is ON, the relay may be in test mode or the protection has been disabled due to a hardware verify error (see Table 4).
2	Examine the Contact status in the Commissioning section of the menu.	If the relevant bits of the contact status are operated, go to test 4; if not, go to test 3.
3	Examine the fault record or use the test port to check the protection element is operating correctly.	If the protection element does not operate, check the test is correctly applied. If the protection element operates, check the programmable logic to make sure the protection element is correctly mapped to the contacts.

Test	Check	Action
4	Using the Commissioning or Test mode function, apply a test pattern to the relevant relay output contacts. Consult the correct external connection diagram and use a continuity tester at the rear of the relay to check the relay output contacts operate.	If the output relay operates, the problem must be in the external wiring to the relay. If the output relay does not operate the output relay contacts may have failed (the self-tests verify that the relay coil is being energized). Ensure the closed resistance is not too high for the continuity tester to detect.

Table 5: Failure of output contacts

The opto-isolated inputs are mapped onto the relay internal signals using the programmable scheme logic. If an input does not appear to be recognized by the relay scheme logic, use the Commission Tests or Opto Status menu option to check whether the problem is in the opto-isolated input or the mapping of its signal to the scheme logic functions. If the opto-isolated input does appear to be read correctly, examine its mapping in the programmable logic.

If the relay does not correctly read the opto-isolated input state, test the applied signal. Verify the connections to the opto-isolated input using the correct wiring diagram and the nominal voltage settings in the **Opto Config.** menu. In the **Opto Config.** menu select the nominal battery voltage for all opto inputs by selecting one of the five standard ratings in the **Global Nominal V** settings. Select **Custom** to set each opto input individually to a nominal voltage. Using a voltmeter, check the voltage on its input terminals is greater than the minimum pick-up level. See the Technical Specifications chapter for opto pick-up levels. If the signal is correctly applied to the relay, the failure may be on the input card. Depending on which opto-isolated input has failed, the complete analog input module or a separate opto board may need to be replaced. The board in the analog input module cannot be individually replaced without recalibrating the relay.

3.6.2 Incorrect Analog Signals

The measurements can be configured in primary or secondary to assist. If the analog quantities measured by the relay do not seem correct, use the measurement function of the relay to determine the type of problem. Compare the measured values displayed by the relay with the actual magnitudes at the relay terminals. Check the correct terminals are used (in particular the dual-rated CT inputs) and check the CT and VT ratios set on the relay are correct. Use the correct 120 degree displacement of the phase measurements to confirm the inputs are correctly connected.

3.7 PSL Editor Troubleshooting

A failure to open a connection could be due to one or more of the following:

- The relay address is not valid (this address is always 1 for the front port)
- Password in not valid
- Communication set-up (COM port, Baud rate, or Framing) is not correct
- Transaction values are not suitable for the relay or the type of connection
- The connection cable is not wired correctly or broken. See S1 Studio connection configurations
- The option switches on any KITZ101/102 in use may be incorrectly set

3.7.1 Diagram reconstruction after recovered from relay

Although a scheme can be extracted from a relay, the facility is provided to recover a scheme if the original file is unobtainable.

A recovered scheme is logically correct but much of the original graphical information is lost. Many signals are drawn in a vertical line down the left side of the canvas. Links are drawn orthogonally using the shortest path from A to B.

Any annotation added to the original diagram such as titles and notes are lost.

Sometimes a gate type does not appear as expected. For example, a 1-input AND gate in the original scheme appears as an OR gate when uploaded. Programmable gates with an inputs-to-trigger value of 1 also appear as OR gates.

3.7.2 PSL Version Check

The PSL is saved with a version reference, time stamp and CRC check. This gives a visual check whether the default PSL is in place or whether a new application has been downloaded.

3.8 GPS Synchronization

The P847 Phasor Measurement Unit requires accurate time synchronization. This is achieved by using it in conjunction with a P594 time synchronizing unit. The P594 provides a one-pulse-per-second fiber optic signal for the precise alignment of the synchrophasors as well as an IRIG-B input for time synchronisation of events. Both of which are required for the correct operation of the P847. The P847 and the P594 can be set to compensate for the difference between local time and Co-ordinated Universal Time (UTC).

If the P847 does not synchronize correctly or the **GPS Fail** flag is set the following should be checked:

1. The P594 has been commissioned correctly and that the P594 **SYNC LED** is illuminated (this can take up to 15 minutes from power up).
2. The P847 is connected to a P594 using both a 50 ohm co-axial IRIG-B connection and a fiber optic one-pulse-per-second connection.
3. The **BNC O/P Mode** in the **IRIG-B CONFIG** menu of the P594 is set to **Un-modulated.**
4. The appropriate **Fiber Output *x*** in the **FIBER CONFIG** menu of the P594 is set to **P54x Sync** or **‘1PPS SYNC’D’**.
5. The correct UTC offset is applied in either the P847 or the P594.

The P847 will not output synchronized phasor measurements until it is properly synchronized with the P594.

4 REPAIR AND MODIFICATION PROCEDURE

Please follow these steps to return an Automation product to us:

- Get the Repair and Modification Return Authorization (RMA) form
  There is a copy of the RMA form at the end of this section.

  For an electronic version of the RMA form for e-mailing, go to the following url:

  http://www.areva-td.com/scripts/solutions/publigen/content/templates/Show.asp?P=1224&L=US

6. Fill in the RMA form
   Fill in only the white part of the form.

   Please ensure that all fields marked **(M)** are completed such as:

   - Equipment model
   - Model No. and Serial No.
   - Description of failure or modification required (please be specific)
   - Value for customs (in case the product requires export)
   - Delivery and invoice addresses
   - Contact details
7. Send the RMA form to your local contact
   For a list of local service contacts worldwide, go to following url:

   http://www.areva-td.com/worldwide/us_170_Worldwide+Presence.html
8. The local service contact provides the shipping information
   Your local service contact provides you with all the information needed to ship the product:

   - Pricing details
   - RMA number
   - Repair center address

   If required, an acceptance of the quote must be delivered before going to the next stage.
9. Send the product to the repair center
   - Address the shipment to the repair center specified by your local contact
   - Make sure all items are packaged in an anti-static bag and foam protection
   - Make sure a copy of the import invoice is attached with the returned unit
   - Make sure a copy of the RMA form is attached with the returned unit
   - E-mail or fax a copy of the import invoice and airway bill document to your local contact.

5 SELF-TESTING AND DIAGNOSTICS

The unit includes several self-monitoring functions to check the operation of its hardware and software while in service. If there is a problem with the unit's hardware or software, it should be able to detect and report the problem, and attempt to resolve the problem by performing a reboot. In this case, the unit would be out of service for a short time, during which the 'Healthy' LED on the front of the unit is switched OFF and the watchdog contact at the rear is ON. If the restart fails to resolve the problem, the unit takes itself permanently out of service; the 'Healthy' LED stays OFF and watchdog contact stays ON.

If a problem is detected by the self-monitoring functions, the unit attempts to store a maintenance record in battery-backed SRAM to allow the nature of the problem to be communicated to the user.

The self-monitoring is implemented in two stages: firstly a thorough diagnostic check which is performed when the unit is booted-up, and secondly a continuous self-checking operation which checks the operation of the critical functions whilst it is in service.

5.1 Start-up Self-Testing

The self-testing takes a few seconds to complete, during which time the unit's measurement, recording, control, and protection functions are unavailable. On a successful start-up and self-test, the 'health-state' LED on the front of the unit is switched on. If a problem is detected during the start-up testing, the unit remains out of service until it is manually restored to working order.

The operations that are performed at start-up are as follows:

5.1.1 System Boot

The integrity of the Flash memory is verified using a checksum before the program code and stored data is loaded into SRAM for execution by the processor. When the loading has been completed, the data held in SRAM is compared to that held in the Flash memory to ensure that no errors have occurred in the data transfer and that the two are the same. The entry point of the software code in SRAM is then called. This is the unit's initialization code.

5.1.2 Initialization Software

The initialization process initializes the processor registers and interrupts, starts the watchdog timers (used by the hardware to determine whether the software is still running), starts the real-time operating system and creates and starts the supervisor task. In the initialization process the unit checks the following:

- The status of the battery
- The integrity of the battery backed-up SRAM that is used to store event, fault and disturbance records
- The voltage level of the field voltage supply which is used to drive the opto-isolated inputs
- The operation of the LCD controller
- The watchdog operation
- At the conclusion of the initialization software the supervisor task begins the process of starting the platform software. The checking that is made in the process of starting the co-processor board is as follows:
- A check is made for the presence of, and a valid response from, the co-processor board
- The SRAM on the co-processor board is checked with a test bit pattern before the co-processor code is transferred from the flash EPROM

If any of these checks produce an error, the co-processor board remains out of service and the synchrophasor software is suspended.

5.1.3 Platform Software Initialization & Monitoring

When starting the platform software, the unit checks the following:

- The integrity of the data held in non-volatile memory (using a checksum)
- The operation of the real-time clock
- The IRIG-B function
- The presence and condition of the input board
- The analog data acquisition system (by sampling the reference voltage)

At the successful conclusion of all of these tests the unit is entered into service and the application software is started up.

5.2 Continuous Self-Testing

When the unit is in service, it continually checks the operation of the critical parts of its hardware and software. The checking is carried out by the system services software and the results are reported to the platform software. The functions that are checked are as follows:

- The flash EPROM containing all program code and language text is verified by a checksum
- The code and constant data held in SRAM is checked against the corresponding data in flash EPROM to check for data corruption
- The SRAM containing all data other than the code and constant data is verified with a checksum
- The battery status
- The level of the 48 V field voltage
- The integrity of the digital signal I/O data from the opto-isolated inputs and the relay contacts is checked by the data acquisition function every time it is executed.
- The operation of the analogue data acquisition system is continuously checked by the acquisition function every time it is executed. This is done by sampling the reference voltages
- The operation of the Ethernet board is checked by the software on the main processor card. If the Ethernet board fails to respond an alarm is raised and the card is reset in an attempt to resolve the problem.
- The operation of the IRIG-B function is checked by the software that reads the time and date from the board

In the event that one of the checks detects an error in any of the unit’s subsystems, the platform software is notified and it attempts to log a maintenance record in battery-backed SRAM.

If the problem is with the battery status or the IRIG-B board, the unit continues in operation. For problems detected in any other area, the unit initiates a shutdown and re-boot, resulting in a period of up to 5 seconds when the protection and synchrophasors are unavailable.

The complete restart of the unit including all initializations should clear most problems that may occur. If, however, the diagnostic self-check detects the same problem that caused the unit to restart, it is clear that the restart has not cleared the problem, and the unit takes itself permanently out of service. This is indicated by the ‘’health-state’ LED on the front of the unit, which switches OFF, and the watchdog contact which switches ON.

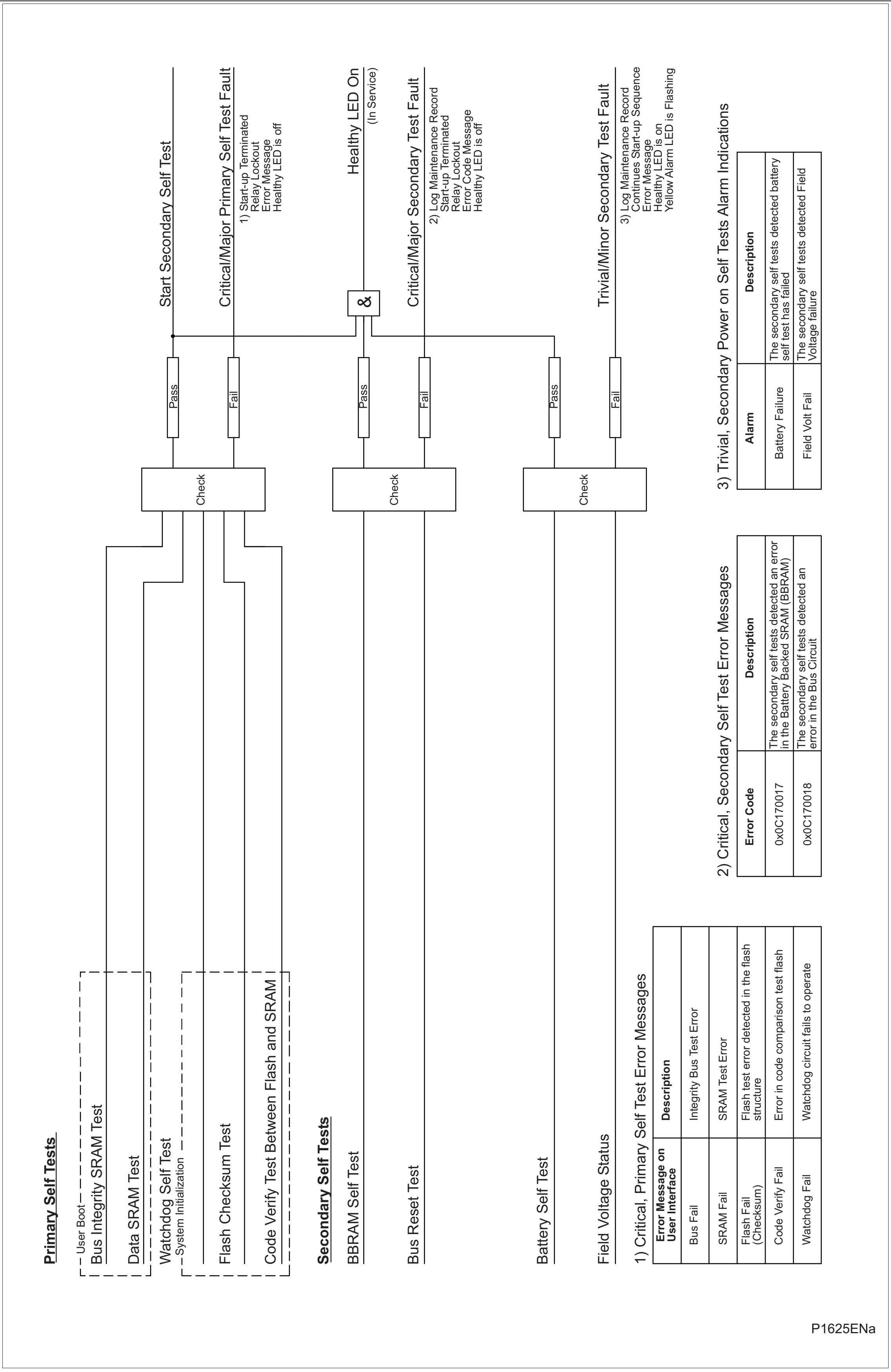
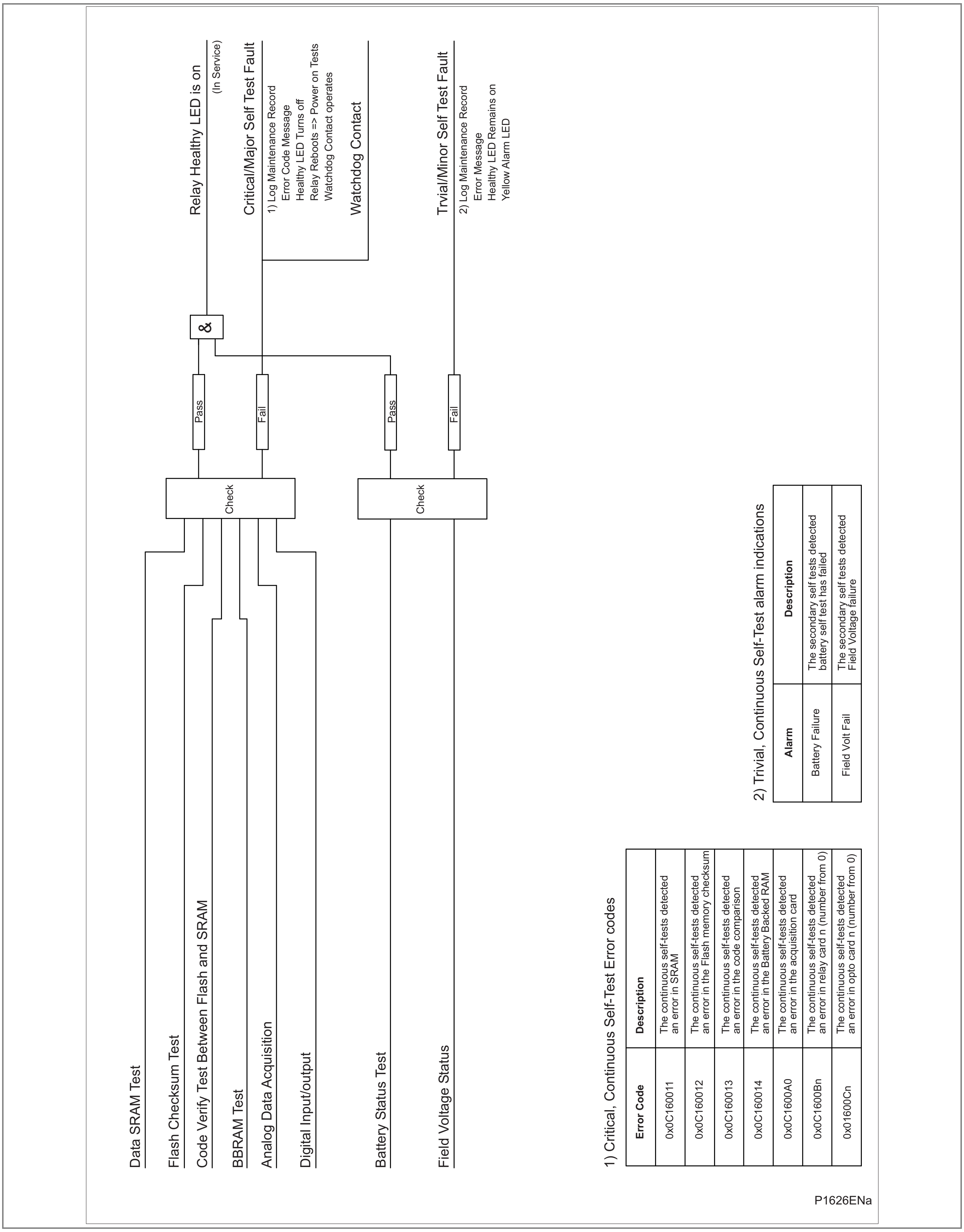


Figure 3: Start-up self-test logic



1) Critical, Continuous Self-Test Error codes

Error Code	Description
0x0C160011	The continuous self-tests detected an error in SRAM
0x0C160012	The continuous self-tests detected an error in the Flash memory checksum
0x0C160013	The continuous self-tests detected an error in the code comparison
0x0C160014	The continuous self-tests detected an error in the Battery Backed RAM
0x0C1600A0	The continuous self-tests detected an error in the acquisition card
0x0C1600Bn	The continuous self-tests detected an error in relay card n (number from 0)
0x01600Cn	The continuous self-tests detected an error in opto card n (number from 0)

2) Trivial, Continuous Self-Test alarm indications

Alarm	Description
Battery Failure	The secondary self tests detected battery self test has failed
Field Volt Fail	The secondary self tests detected Field Voltage failure

Figure 4: Continuous self-test logic

SYMBOLS AND GLOSSARY

CHAPTER 17

1 CHAPTER OVERVIEW

This chapter consists of the following sections:

2 ACRONYMS AND ABBREVIATIONS

Term	Description
<	Less than: Used to indicate an “under” threshold, such as undercurrent (current dropout).
>	Greater than: Used to indicate an “over” threshold, such as overcurrent (current overload)
A	Ampere
AA	Application Association
AC / ac	Alternating Current
ACSI	Abstract Communication Service Interface
ACSR	Aluminum Conductor Steel Reinforced
ALF	Accuracy Limit Factor
AM	Amplitude Modulation
ANSI	American National Standards Institute
AR	Auto-Reclose.
ARIP	Auto-Reclose In Progress
ASCII	American Standard Code for Information Interchange
AUX / Aux	Auxiliary
AWG	American Wire Gauge
BAR	Block Auto-Reclose signal.
BCD	Binary Coded Decimal
BCR	Binary Counter Reading
BDEW	Bundesverband der Energie- und Wasserwirtschaft | Startseite (i.e. German Association of Energy and Water Industries)
BMP	BitMaP – a file format for a computer graphic
BOP	Blocking Overreach Protection - a blocking aided-channel scheme.
BRCB	Buffered Report Control Block
BRP	Beacon Redundancy Protocol
BU	Backup: Typically a back-up protection element
C/O	A ChangeOver contact having normally-closed and normally-open connections: Often called a “form C” contact.
CB	Circuit Breaker
CB Aux.	Circuit Breaker auxiliary contacts: Indication of the breaker open/closed status.
CBF	Circuit Breaker Failure protection
CDC	Common Data Class
CF	Control Function
Ch	Channel: usually a communications or signaling channel
CIP	Critical Infrastructure Protection standards
CLK / Clk	Clock
Cls	Close - generally used in the context of close functions in circuit breaker control.
CMV	Complex Measured Value
CNV	Current No Volts
CPNI	Centre for the Protection of National Infrastructure
CRC	Cyclic Redundancy Check
CRP	Cross-network Redundancy Protocol
CRV	Curve (file format for curve information)
CRx	Channel Receive: Typically used to indicate a teleprotection signal received.

Term	Description
CS	Check Synchronism.
CSV	Comma Separated Values (a file format for database information)
CT	Current Transformer
CTRL.	Control
CTS	Current Transformer Supervision: To detect CT input failure.
CTx	Channel Transmit: Typically used to indicate a teleprotection signal send.
CVT	Capacitor-coupled Voltage Transformer - equivalent to terminology CCVT.
DAU	Data Acquisition Unit
DC	Data Concentrator
DC / dc	Direct Current
DCC	An Omicron compatible format
DDB	Digital Data Bus within the programmable scheme logic: A logic point that has a zero or 1 status. DDB signals are mapped in logic to customize the relay's operation.
DDR	Dynamic Disturbance Recorder
DEF	Directional earth fault protection: A directionalized ground fault aided scheme.
df/dt	Rate of Change of Frequency
df/dt>1	First stage of df/dt protection
DG	Distributed Generation
DHCP	Dynamic Host Configuration Protocol
DHP	Dual Homing Protocol
Diff	Differential protection.
DIN	Deutsches Institut für Normung (German standards body)
Dist	Distance protection.
DITA	Darwinian Information Typing Architecture
DLDB	Dead-Line Dead-Bus: In system synchronism check, indication that both the line and bus are de-energized.
DLLB	Dead-Line Live-Bus: In system synchronism check, indication that the line is de-energized whilst the bus is energized.
DLR	Dynamic Line Rating
DLY / Dly	Time Delay
DMT	Definite Minimum Time
DNP	Distributed Network Protocol
DPWS	Device Profile for Web Services
DST	Daylight Saving Time
DT	Definite Time: in the context of protection elements: An element which always responds with the same constant time delay on operation. Abbreviation of "Dead Time" in the context of auto-reclose:
DTD	Document Type Definition
DTOC	Definite Time Overcurrent
DTS	Date and Time Stamp
EF or E/F	Earth Fault (Directly equivalent to Ground Fault)
EIA	Electronic Industries Alliance
ELR	Environmental Lapse Rate
ER	Engineering Recommendation
FFT	Fast Fourier Transform
FIR	Finite Impulse Response

Term	Description
FLC	Full load current: The nominal rated current for the circuit.
FLT / Flt	Fault - typically used to indicate faulted phase selection.
Fn or FN	Function
FPGA	Field Programmable Gate Array
FPS	Frames Per Second
FTP	File Transfer Protocol
FWD, Fwd or Fwd.	Indicates an element responding to a flow in the “Forward” direction
GIF	Graphic Interchange Format – a file format for a computer graphic
GND / Gnd	Ground: used in distance settings to identify settings that relate to ground (earth) faults.
GOOSE	Generic Object Oriented Substation Event
GPS	Global Positioning System
GRP / Grp	Group. Typically an alternative setting group.
GSE	General Substation Event
GSSE	Generic Substation Status Event
GUI	Graphical User Interface
HMI	Human Machine Interface
HSR	High-availability Seamless Ring
HTML	Hypertext Markup Language
I	Current
I/O	Input/Output
I/P	Input
ICAO	International Civil Aviation Organization
ID	Identifier or Identification. Often a label used to track a software version installed.
IDMT	Inverse Definite Minimum Time. A characteristic whose trip time depends on the measured input (e.g. current) according to an inverse-time curve.
IEC	International Electro-technical Commission
IED	Intelligent Electronic Device
IEEE	Institute of Electrical and Electronics Engineers
IIR	Infinite Impulse Response
Inh	An Inhibit signal
Inst	An element with Instantaneous operation: i.e. having no deliberate time delay.
IP	Internet Protocol
IRIG	InterRange Instrumentation Group
ISA	International Standard Atmosphere
ISA	Instrumentation Systems and Automation Society
ISO	International Standards Organization
JPEF	Joint Photographic Experts Group – a file format for a computer graphic
L	Live
LAN	Local Area Network
LCD	Liquid Crystal Display: The front-panel text display on the relay.
LD	Level Detector: An element responding to a current or voltage below its set threshold.
LDOV	Level Detector for Overvoltage
LDUV	Level Detector for Undervoltage
LED	Light Emitting Diode: Red or green indicator on the front-panel.

Term	Description
LLDB	Live-Line Dead-Bus : In system synchronism check, indication that the line is energized whilst the bus is de-energized.
Ln	Natural logarithm
LN	Logical Node
LoL	A Loss of Load scheme, providing a fast distance trip without needing a signaling channel.
LPDU	Link Protocol Data Unit
LPHD	Logical Physical Device
MC	MultiCast
MCB	Miniature Circuit Breaker
MICS	Model Implementation Conformance Statement
MMF	Magneto-Motive Force
MMS	Manufacturing Message Specification
MRP	Media Redundancy Protocol
MU	Merging Unit
MV	Measured Value
N	Neutral
N/A	Not Applicable
N/C	A Normally Closed or “break” contact: Often called a “form B” contact.
N/O	A Normally Open or “make” contact: Often called a “form A” contact.
NERC	North American Reliability Corporation
NIST	National Institute of Standards and Technology
NPS	Negative Phase Sequence
NVD	Neutral voltage displacement: Equivalent to residual overvoltage protection.
NXT	Abbreviation of “Next”: In connection with hotkey menu navigation.
o	A small circle on the input or output of a logic gate: Indicates a NOT (invert) function.
O/C	Overcurrent
O/P	Output
Opto	An Optically coupled logic input. Alternative terminology: binary input.
OSI	Open Systems Interconnection
PCB	Printed Circuit Board
PCT	Protective Conductor Terminal (Ground)
PDC	Phasor Data Concentrator
Ph	Phase - used in distance settings to identify settings that relate to phase-phase faults.
PICS	Protocol Implementation Conformance Statement
PMU	Phasor Measurement Unit
PNG	Portable Network Graphics – a file format for a computer graphic
Pol	Polarize - typically the polarizing voltage used in making directional decisions.
POR	A Permissive OverReaching transfer trip scheme (alternative terminology: POTT).
PRP	Parallel Redundancy Protocol
PSB	Power Swing Blocking, to detect power swing/out of step functions (ANSI 78).
PSL	Programmable Scheme Logic: The part of the relay’s logic configuration that can be modified by the user, using the graphical editor within S1 Studio software.
PT	Power Transformer
PTP	Precision Time Protocol
PUR	A Permissive UnderReaching transfer trip scheme (alternative terminology: PUTT).

Term	Description
Q	Quantity defined as per unit value
R	Resistance
RBAC	Role Based Access Control
RCA	Relay Characteristic Angle - The center of the directional characteristic.
REB	Redundant Ethernet Board
REF	Restricted Earth Fault
Rev.	Indicates an element responding to a flow in the “reverse” direction
RMS / rms	Root mean square. The equivalent a.c. current: Taking into account the fundamental, plus the equivalent heating effect of any harmonics.
RP	Rear Port: The communication ports on the rear of the IED
RS232	A common serial communications standard defined by the EIA
RS485	A common serial communications standard defined by the EIA (multi-drop)
RST or Rst	Reset generally used in the context of reset functions in circuit breaker control.
RSTP	Rapid Spanning Tree Protocol
RTU	Remote Terminal Unit
Rx	Receive: Typically used to indicate a communication transmit line/pin.
SBS	Straight Binary Second
SC	Synch-Check or system Synchronism Check.
SCADA	Supervisory Control and Data Acquisition
SCL	Substation Configuration Language
SCU	Substation Control Unit
SEF	Sensitive Earth Fault
SHP	Self Healing Protocol
SIR	Source Impedance Ratio
SMV	Sampled Measured Values
SNTP	Simple Network Time Protocol
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
SOC	Second of Century
SOTF	Switch on to Fault protection. Modified protection on manual closure of the circuit breaker.
SP	Single pole.
SPAR	Single pole auto-reclose.
SPC	Single Point Controllable
SPDT	Single Pole Dead Time. The dead time used in single pole auto-reclose cycles.
SPS	Single Point Status
SQRT	Square Root
SSL	Source Impedance Ratio
STP	Spanning Tree Protocol
SV	Sampled Values
SVC	Sampled Value Model
SVM	Sampled Value Model
TAF	Turbine Abnormal Frequency
TCP	Transmission Control Protocol
TCS	Second of Century
TCS	Trip Circuit Supervision

Term	Description
TD	Time Dial. The time dial multiplier setting: Applied to inverse-time curves (ANSI/IEEE).
TE	Unit for case measurements: One inch = 5TE units
THD	Total Harmonic Distortion
TICS	Technical Issues Conformance Statement
TIFF	Tagged Image File Format – a file format for a computer graphic
TLS	Transport Layer Security protocol
TMS	Time Multiplier Setting: Applied to inverse-time curves (IEC)
TOC	Trip On Close (“line check”) protection. Offers SOTF and TOR functionality.
TOR	Trip On Reclose protection. Modified protection on autoreclosure of the circuit breaker.
TP	Two-Part
TUC	Timed UnderCurrent
TVE	Total Vector Error
Tx	Transmit
UDP	User Datagram Protocol
UPCT	User Programmable Curve Tool
UTC	Universal Time Coordinated
V	Voltage
VA	Phase A voltage: Sometimes L1, or red phase
VB	Phase B voltage: Sometimes L2, or yellow phase
VC	Phase C voltage: Sometimes L3, or blue phase
VDR	Voltage Dependant Resistor
VT	Voltage Transformer
VTS	Voltage Transformer Supervision: To detect VT input failure.
WAN	Wide Area Network
XML	Extensible Markup Language
XSD	XML Schema Definition

Table 1: Acronyms and abbreviations

3 COMPANY PROPRIETARY TERMS

Symbol	Description
Courier	Alstom Grid's proprietary SCADA communications protocol
Metrosil	Brand of non-linear resistor produced by M&I Materials Ltd.
MiCOM Alstom	Alstom Grid's brand of protection relays

Table 2: Company-proprietary terms

4 ANSI TERMS

ANSI no.	Description
3PAR	Three pole auto-reclose.
3PDT	Three pole dead time. The dead time used in three pole auto-reclose cycles.
52a	A circuit breaker closed auxiliary contact: The contact is in the same state as the breaker primary contacts
52b	A circuit breaker open auxiliary contact: The contact is in the opposite state to the breaker primary contacts

Table 3: ANSI stuff

5 CONCATENATED TERMS

Term
Undercurrent
Overcurrent
Overfrequency
Underfrequency
Undervoltage
Overvoltage

Table 4: Concatenated terms

6 UNITS FOR DIGITAL COMMUNICATIONS

Unit	Description
b	bit
B	Byte
kb	Kilobit(s)
kbps	Kilobits per second
kB	Kilobyte(s)
Mb	Megabit(s)
Mbps	Megabits per second
MB	Megabyte(s)
Gb	Gigabit(s)
Gbps	Gigabits per second
GB	Gigabyte(s)
Tb	Terabit(s)
Tbps	Terabits per second
TB	Terabyte(s)

Table 5: Units for digital communications

7 AMERICAN VS BRITISH ENGLISH TERMINOLOGY

British English	American English
…ae…	…e…
…ence	…ense
…ise	…ize
…oe…	…e…
…ogue	…og
…our	…or
…ourite	…orite
…que	…ck
…re	…er
…yse	…yze
Aluminium	Aluminum
Centre	Center
Earth	Ground
Fibre	Fiber
Ground	Earth
Speciality	Specialty

Table 6: American vs British English terminology

8 LOGIC SYMBOLS AND TERMS

Symbol	Description	Units
&	Logical “AND”: Used in logic diagrams to show an AND-gate function.	
Σ	“Sigma”: Used to indicate a summation, such as cumulative current interrupted.	
τ	“Tau”: Used to indicate a time constant, often associated with thermal characteristics.	
ω	System angular frequency	rad
<	Less than: Used to indicate an “under” threshold, such as undercurrent (current dropout).	
>	Greater than: Used to indicate an “over” threshold, such as overcurrent (current overload)	
1	Logical “OR”: Used in logic diagrams to show an OR-gate function.	
ABC	Anti-clockwise phase rotation.	
ACB	Clock-wise phase rotation.	
C	Capacitance	A
df/dt	Rate of Change of Frequency protection	Hz/s
df/dt>1	First stage of df/dt protection	Hz/s
F<1	First stage of underfrequency protection: Could be labeled 81-U in ANSI terminology.	Hz
F>1	First stage of overfrequency protection: Could be labeled 81-O in ANSI terminology.	Hz
fmax	Minimum required operating frequency	Hz
fmin	Minimum required operating frequency	Hz
fn	Nominal operating frequency	Hz
I	Current	A
I∧	Current raised to a power: Such as when breaker statistics monitor the square of ruptured current squared (∧ power = 2).	An
I’f	Maximum internal secondary fault current (may also be expressed as a multiple of In)	A
I<	An undercurrent element: Responds to current dropout.	A
I>>	Current setting of short circuit element	In
I>1	First stage of phase overcurrent protection: Could be labeled 51-1 in ANSI terminology.	A
I>2	Second stage of phase overcurrent protection: Could be labeled 51-2 in ANSI terminology.	A
I>3	Third stage of phase overcurrent protection: Could be labeled 51-3 in ANSI terminology.	A
I>4	Fourth stage of phase overcurrent protection: Could be labeled 51-4 in ANSI terminology.	A
I0	Earth fault current setting Zero sequence current: Equals one third of the measured neutral/residual current.	A
I1	Positive sequence current.	A
I2	Negative sequence current.	A
I2>	Negative sequence overcurrent protection (NPS element).	A
I2pol	Negative sequence polarizing current.	A
IA	Phase A current: Might be phase L1, red phase.. or other, in customer terminology.	A
IB	Phase B current: Might be phase L2, yellow phase.. or other, in customer terminology.	A
IC	Phase C current: Might be phase L3, blue phase.. or other, in customer terminology.	A
Idiff	Current setting of biased differential element	A
If	Maximum secondary through-fault current	A

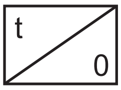
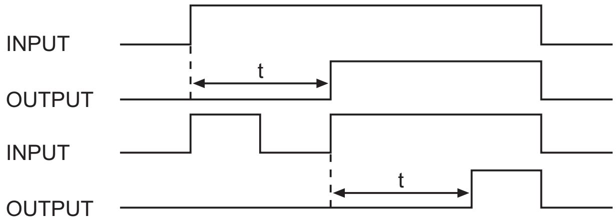
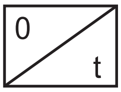
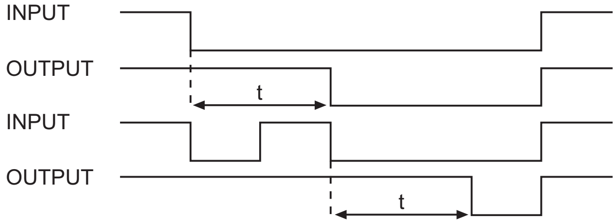
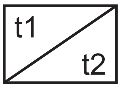
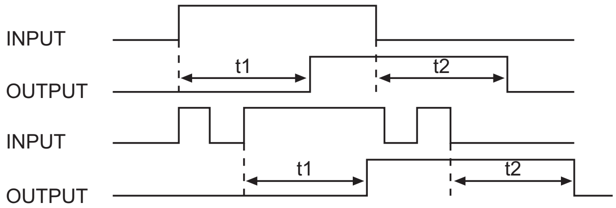
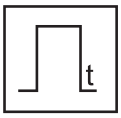
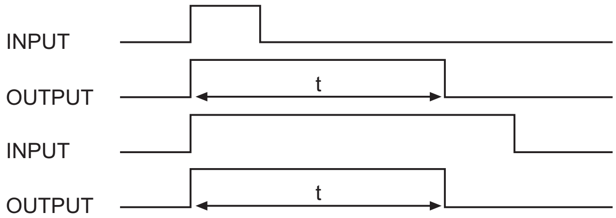
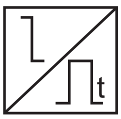
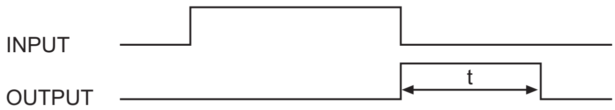
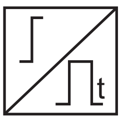
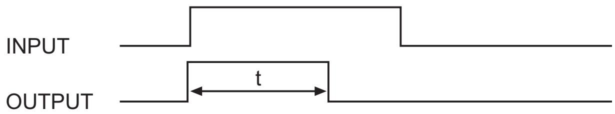
Symbol	Description	Units
If max	Maximum secondary fault current (same for all feeders)	A
If max int	Maximum secondary contribution from a feeder to an internal fault	A
If Z1	Maximum secondary phase fault current at Zone 1 reach point	A
Ife	Maximum secondary through fault earth current	A
IfeZ1	Maximum secondary earth fault current at Zone 1 reach point	A
Ifn	Maximum prospective secondary earth fault current or 31 x I> setting (whichever is lowest)	A
Ifp	Maximum prospective secondary phase fault current or 31 x I> setting (whichever is lowest)	A
Im	Mutual current	A
IM64	InterMiCOM^{64}.	
IMx	InterMiCOM^{64} bit (x=1 to 16)	
In	Current transformer nominal secondary current. The rated nominal current of the relay: Software selectable as 1 amp or 5 amp to match the line CT input.	A
IN	Neutral current, or residual current: This results from an internal summation of the three measured phase currents.	A
IN>	A neutral (residual) overcurrent element: Detects earth/ground faults.	A
IN>1	First stage of ground overcurrent protection: Could be labeled 51N-1 in ANSI terminology.	A
IN>2	Second stage of ground overcurrent protection: Could be labeled 51N-2 in ANSI terminology.	A
Iref	Reference current of P63x calculated from the reference power and nominal voltage	A
IRm2	Second knee-point bias current threshold setting of P63x biased differential element	A
Is	Value of stabilizing current	A
IS1	Differential current pick-up setting of biased differential element	A
IS2	Bias current threshold setting of biased differential element	A
ISEF>	Sensitive earth fault overcurrent element.	A
Isn	Rated secondary current (I secondary nominal)	A
Isp	Stage 2 and 3 setting	A
Ist	Motor start up current referred to CT secondary side	A
K	Dimensioning factor	
K1	Lower bias slope setting of biased differential element	%
K2	Higher bias slope setting of biased differential element	%
Ke	Dimensioning factor for earth fault	
km	Distance in kilometers	
Kmax	Maximum dimensioning factor	
Krpa	Dimensioning factor for reach point accuracy	
Ks	Dimensioning factor dependent upon through fault current	
Kssc	Short circuit current coefficient or ALF	
Kt	Dimensioning factor dependent upon operating time	
kZm	The mutual compensation factor (mutual compensation of distance elements and fault locator for parallel line coupling effects).	
kZN	The residual compensation factor: Ensuring correct reach for ground distance elements.	
L	Inductance	A
m1	Lower bias slope setting of P63x biased differential element	None

Symbol	Description	Units
m2	Higher bias slope setting of P63x biased differential element	None
mi	Distance in miles.	
N	Indication of "Neutral" involvement in a fault: i.e. a ground (earth) fault.	
P1	Used in IEC terminology to identify the primary CT terminal polarity: Replace by a dot when using ANSI standards.	
P2	Used in IEC terminology to identify the primary CT terminal polarity: The non-dot terminal.	
Pn	Rotating plant rated single phase power	W
PN>	Wattmetric earth fault protection: Calculated using residual voltage and current quantities.	
R	Resistance	Ω
R Gnd.	A distance zone resistive reach setting: Used for ground (earth) faults.	
R Ph	A distance zone resistive reach setting used for Phase-Phase faults.	
Rct	Secondary winding resistance	Ω
Rl	Resistance of single lead from relay to current transformer	Ω
Rr	Resistance of any other protective relays sharing the current transformer	Ω
Rrn	Resistance of relay neutral current input	Ω
Rrp	Resistance of relay phase current input	Ω
Rs	Value of stabilizing resistor	Ω
Rx	Receive: typically used to indicate a communication receive line/pin.	
S1	Used in IEC terminology to identify the secondary CT terminal polarity: Replace by a dot when using ANSI standards.	
S2	Used in IEC terminology to identify the secondary CT terminal polarity: The non-dot terminal.	
t	A time delay.	
t'	Duration of first current flow during auto-reclose cycle	s
T1	Primary system time constant	s
tfr	Auto-reclose dead time	s
tIdiff	Current differential operating time	s
Ts	Secondary system time constant	s
Tx	Transmit: typically used to indicate a communication transmit line/pin.	
V	Voltage.	V
V<	An undervoltage element.	V
V<1	First stage of undervoltage protection: Could be labeled 27-1 in ANSI terminology.	V
V<2	Second stage of undervoltage protection: Could be labeled 27-2 in ANSI terminology.	V
V>	An overvoltage element.	V
V>1	First stage of overvoltage protection: Could be labeled 59-1 in ANSI terminology.	V
V>2	Second stage of overvoltage protection: Could be labeled 59-2 in ANSI terminology.	V
V0	Zero sequence voltage: Equals one third of the measured neutral/residual voltage.	V
V1	Positive sequence voltage.	V
V2	Negative sequence voltage.	V
V2pol	Negative sequence polarizing voltage.	V
VA	Phase A voltage: Might be phase L1, red phase.. or other, in customer terminology.	V
VB	Phase B voltage: Might be phase L2, yellow phase.. or other, in customer terminology.	V
VC	Phase C voltage: Might be phase L3, blue phase.. or other, in customer terminology.	V

Symbol	Description	Units
Vf	Theoretical maximum voltage produced if CT saturation did not occur	V
Vin	Input voltage e.g. to an opto-input	V
Vk	Required CT knee-point voltage. IEC knee point voltage of a current transformer.	V
VN	Neutral voltage displacement, or residual voltage.	V
Vn	Nominal voltage	V
Vn	The rated nominal voltage of the relay: To match the line VT input.	V
VN>1	First stage of residual (neutral) overvoltage protection.	V
VN>2	Second stage of residual (neutral) overvoltage protection.	V
Vres.	Neutral voltage displacement, or residual voltage.	V
Vs	Value of stabilizing voltage	V
Vx	An auxiliary supply voltage: Typically the substation battery voltage used to power the relay.	V
WI	Weak Infeed logic used in teleprotection schemes.	
X	Reactance	None
X/R	Primary system reactance/resistance ratio	None
Xe/Re	Primary system reactance/resistance ratio for earth loop	None
Xt	Transformer reactance (per unit)	p.u.
Y	Admittance	p.u.
Z	Impedance	p.u.
Z0	Zero sequence impedance.	
Z1	Positive sequence impedance.	
Z1	Zone 1 distance protection.	
Z1X	Reach-stepped Zone 1X, for zone extension schemes used with auto-reclosure.	
Z2	Negative sequence impedance.	
Z2	Zone 2 distance protection.	
ZP	Programmable distance zone that can be set forward or reverse looking.	
Zs	Used to signify the source impedance behind the relay location.	
Φal	Accuracy limit flux	Wb
Ψr	Remanent flux	Wb
Ψs	Saturation flux	Wb

Table 7: Logic Symbols and Terms

9 LOGIC TIMERS

Logic symbols	Explanation	Time chart
	Delay on pick-up timer, t	
	Delay on drop-off timer, t	
	Delay on pick-up/drop-off timer	
	Pulse timer	
	Pulse pick-up falling edge	
	Pulse pick-up raising edge	

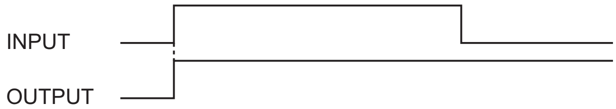
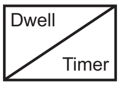
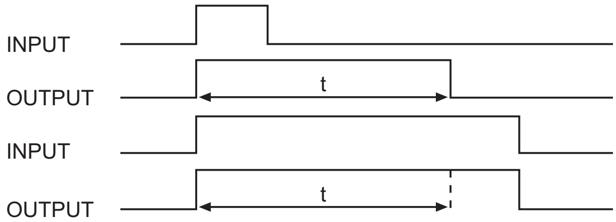
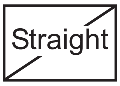
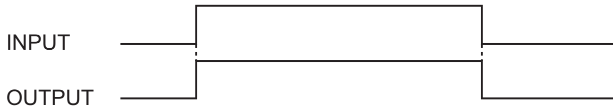
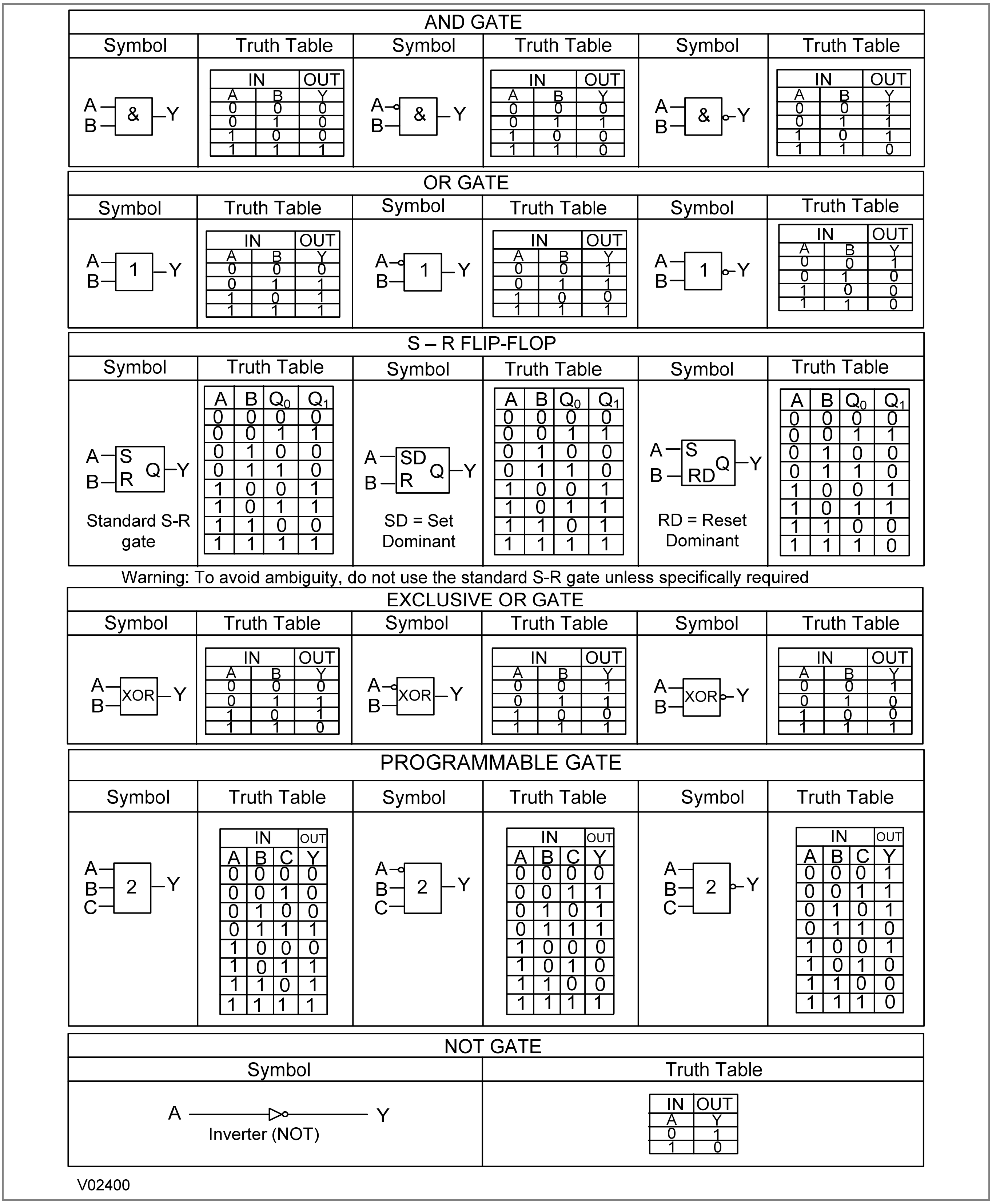
Logic symbols	Explanation	Time chart
	Latch	
	Dwell timer	
	**Straight (non latching):** Hold value until input reset signal	

Table 8: Logic Timers

10 LOGIC GATES



AND GATE

A	B	Y (&)	Y (& , A inverted)	Y (& , output inverted)
0	0	0	0	1
0	1	0	1	1
1	0	0	0	1
1	1	1	0	0

OR GATE

A	B	Y (1)	Y (1, A inverted)	Y (1, output inverted)
0	0	0	1	1
0	1	1	1	0
1	0	1	0	0
1	1	1	1	0

S – R FLIP-FLOP

A	B	Q_0	Q_1 (Standard S-R)	Q_1 (SD = Set Dominant)	Q_1 (RD = Reset Dominant)
0	0	0	0	0	0
0	0	1	1	1	1
0	1	0	0	0	0
0	1	1	0	0	0
1	0	0	1	1	1
1	0	1	1	1	1
1	1	0	0	1	0
1	1	1	1	1	0

Warning: To avoid ambiguity, do not use the standard S-R gate unless specifically required

EXCLUSIVE OR GATE

A	B	Y (XOR)	Y (XOR, A inverted)	Y (XOR, output inverted)
0	0	0	1	1
0	1	1	1	0
1	0	1	0	0
1	1	0	1	1

PROGRAMMABLE GATE

A	B	C	Y (2)	Y (2, A inverted)	Y (2, output inverted)
0	0	0	0	0	1
0	0	1	0	1	1
0	1	0	0	1	1
0	1	1	1	1	0
1	0	0	0	0	1
1	0	1	1	0	0
1	1	0	1	0	0
1	1	1	1	1	0

NOT GATE

IN A	OUT Y
0	1
1	0

Figure 1: Logic Gates

WIRING DIAGRAMS

CHAPTER 18

1 P847B&C CASE DIMENSIONS

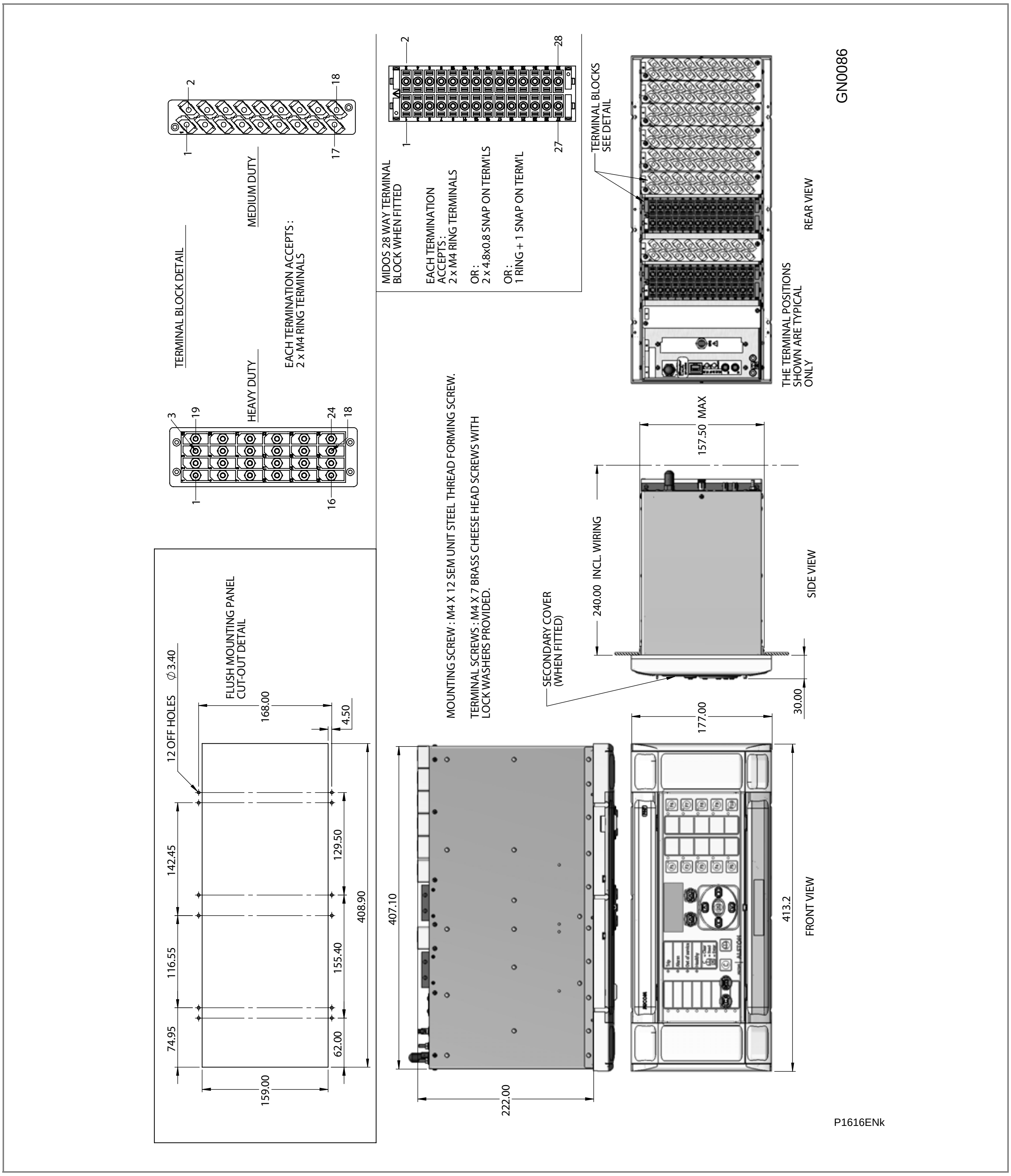


Figure 1: P847 80TE case dimensions

2 P847B&C WIRING DIAGRAMS

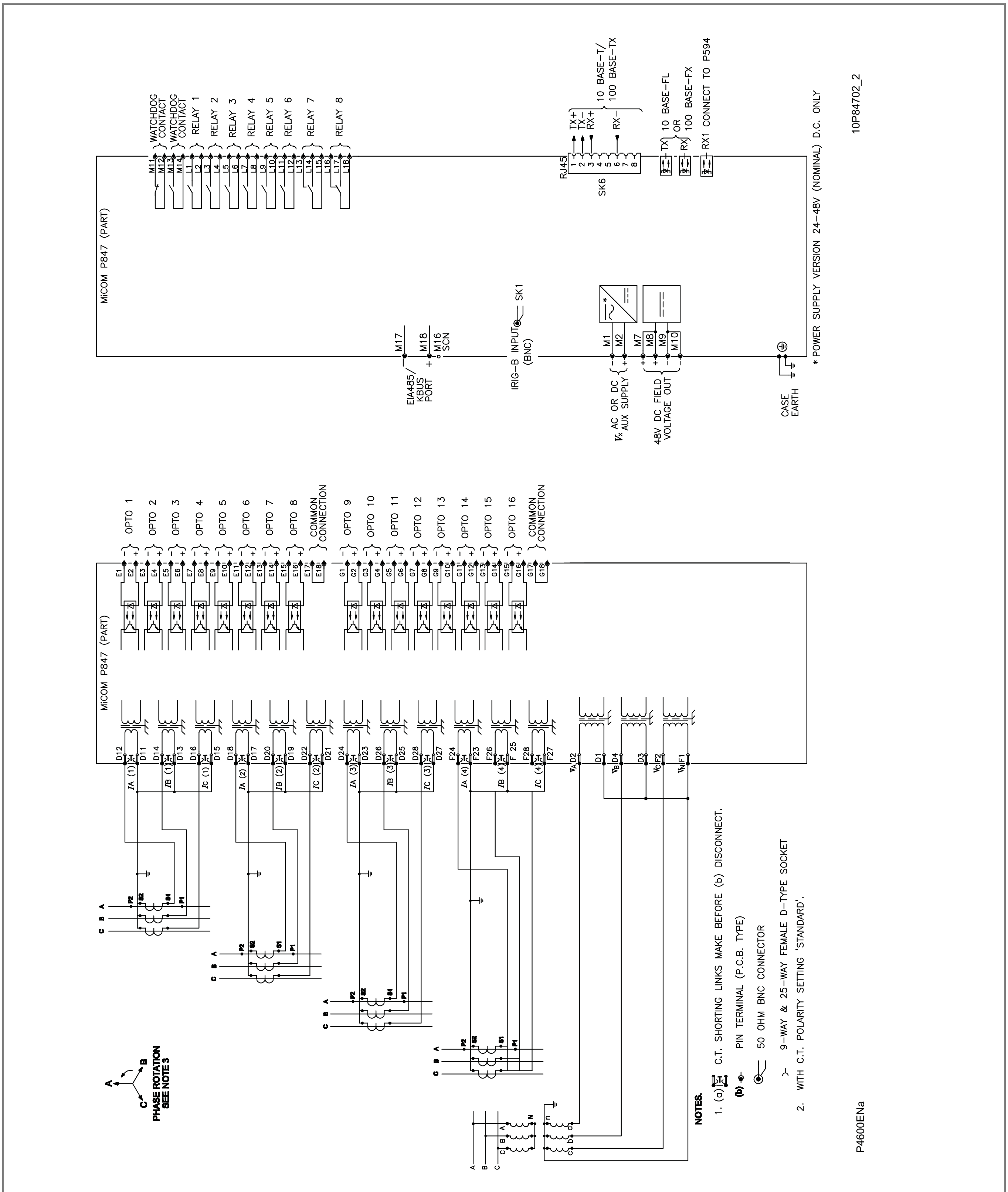


Figure 2: P847 B external connection diagram

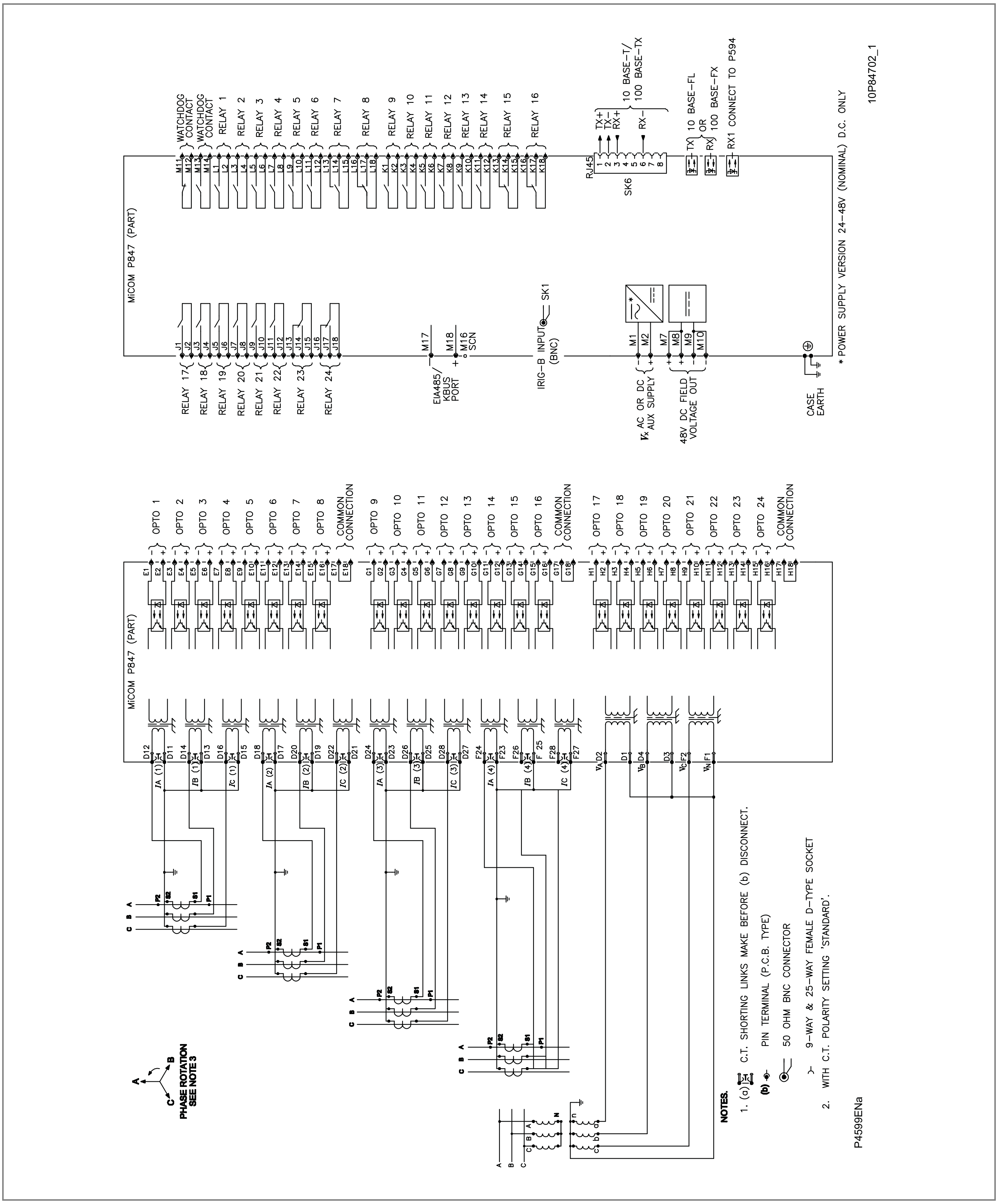


Figure 3: P847 C external connection diagram

COMMISSIONING RECORDS

APPENDIX A

1 OVERVIEW

This Appendix provides a means of recording the commissioning process. It is available at the end of the manual in an appendix or as a separate document.

It consists of the following sections:

2 COMMISSIONING TEST RECORD

2.1 Engineer Details

Date:		Engineer:	
Station:		Circuit:	
		System Frequency:	Hz
VT Ratio:	/ V	CT Ratio (tap in use):	/ A
P594 connected	Serial No.		

2.2 Front Plate Information

Phasor Measurement Unit	P847____
Model number	
Serial number	
Rated current In	1 A ☐ 5 A ☐
Rated voltage Vn	
Auxiliary voltage Vx	

2.3 Test Equipment Used

This section should be completed to allow future identification of protective devices that have been commissioned using equipment that is later found to be defective or incompatible but may not be detected during the commissioning procedure.

Injection test set	Model:	
	Serial No:	
Phase angle meter	Model:	
	Serial No:	
Phase rotation meter	Model:	
	Serial No:	
Insulation tester	Model:	
	Serial No:	
Setting software:	Type: Version:	
IED configurator software:	Type: Version:	

Phasor terminal software:	Type: Version:	

		*Delete as appropriate
	Have all relevant safety instructions been followed?	Yes* ☐ No* ☐
	Product checks	
	With the IED de-energized	
	Visual inspection	
	IED damaged?	Yes* ☐ No* ☐
	Rating information correct for installation?	Yes* ☐ No* ☐
	Case earth installed?	Yes* ☐ No* ☐
	Current transformer shorting contacts close?	Yes* ☐ No* ☐ Not checked* ☐
	Insulation resistance >100 MΩ at 500 V dc	Yes* ☐ No* ☐ Not tested* ☐
	External wiring	
	Wiring checked against diagram?	Yes* ☐ No* ☐
	Test block connections checked?	Yes* ☐ No* ☐ N/A* ☐
	Watchdog contacts (auxiliary supply off)	
	Terminals 11 and 12 Contact closed?	Yes* ☐ No* ☐
	Terminals 13 and 14 Contact open?	Yes* ☐ No* ☐
	Measured auxiliary supply	V ac/dc*
	With the IED energized	
	Watchdog contacts (auxiliary supply on)	
	Terminals 11 and 12 Contact open?	Yes* ☐ No* ☐
	Terminals 13 and 14 Contact closed?	Yes* ☐ No* ☐
	LCD front panel display	
	LCD contrast setting used	
	Date and time	
	Clock set to local time?	Yes* ☐ No* ☐
	Time maintained when auxiliary supply removed?	Yes* ☐ No* ☐
	Light emitting diodes	
	Alarm (yellow) LED working?	Yes* ☐ No* ☐

	Out of service (yellow) LED working?	Yes* ☐ No* ☐
	All 18 programmable LEDs working?	Yes* ☐ No* ☐
	Field supply voltage	
	Value measured between terminals 8 and 9	V dc
	Input opto-isolators	
	Opto input 1 working?	Yes* ☐ No* ☐
	Opto input 2 working?	Yes* ☐ No* ☐
	Opto input 3 working?	Yes* ☐ No* ☐
	Opto input 4 working?	Yes* ☐ No* ☐
	Opto input 5 working?	Yes* ☐ No* ☐
	Opto input 6 working?	Yes* ☐ No* ☐
	Opto input 7 working?	Yes* ☐ No* ☐
	Opto input 8 working?	Yes* ☐ No* ☐
	Opto input 9 working?	Yes* ☐ No* ☐
	Opto input 10 working?	Yes* ☐ No* ☐
	Opto input 11 working?	Yes* ☐ No* ☐
	Opto input 12 working?	Yes* ☐ No* ☐
	Opto input 13 working?	Yes* ☐ No* ☐
	Opto input 14 working?	Yes* ☐ No* ☐
	Opto input 15 working?	Yes* ☐ No* ☐
	Opto input 16 working?	Yes* ☐ No* ☐
	Opto input 17 working?	Yes* ☐ No* ☐ N/A* ☐
	Opto input 18 working?	Yes* ☐ No* ☐ N/A* ☐
	Opto input 19 working?	Yes* ☐ No* ☐ N/A* ☐
	Opto input 20 working?	Yes* ☐ No* ☐ N/A* ☐
	Opto input 21 working?	Yes* ☐ No* ☐ N/A* ☐
	Opto input 22 working?	Yes* ☐ No* ☐ N/A* ☐
	Opto input 23 working?	Yes* ☐ No* ☐ N/A* ☐
	Opto input 24 working?	Yes* ☐ No* ☐ N/A* ☐
	Output relays	
	Relay 1 working?	Yes* ☐ No* ☐
	Relay 2 working?	Yes* ☐ No* ☐
	Relay 3 working?	Yes* ☐ No* ☐
	Relay 4 working?	Yes* ☐ No* ☐
	Relay 5 working?	Yes* ☐ No* ☐
	Relay 6 working?	Yes* ☐ No* ☐
	Relay 7 working?	Yes* ☐ No* ☐
	Relay 8 working?	Yes* ☐ No* ☐
	Relay 9 working?	Yes* ☐ No* ☐ N/A* ☐
	Relay 10 working?	Yes* ☐ No* ☐ N/A* ☐
	Relay 11 working?	Yes* ☐ No* ☐ N/A* ☐
	Relay 12 working?	Yes* ☐ No* ☐ N/A* ☐

	Relay 13 working?		Yes* ☐ No* ☐ N/A* ☐
	Relay 14 working?		Yes* ☐ No* ☐ N/A* ☐
	Relay 15 working?		Yes* ☐ No* ☐ N/A* ☐
	Relay 16 working?		Yes* ☐ No* ☐ N/A* ☐
	Relay 17 working?		Yes* ☐ No* ☐ N/A* ☐
	Relay 18 working?		Yes* ☐ No* ☐ N/A* ☐
	Relay 19 working?		Yes* ☐ No* ☐ N/A* ☐
	Relay 20 working?		Yes* ☐ No* ☐ N/A* ☐
	Relay 21 working?		Yes* ☐ No* ☐ N/A* ☐
	Relay 22 working?		Yes* ☐ No* ☐ N/A* ☐
	Relay 23 working?		Yes* ☐ No* ☐ N/A* ☐
	Relay 24 working?		Yes* ☐ No* ☐ N/A* ☐
	Communication standard		Courier* ☐ DNP3.0* ☐ IEC61850* ☐
	Communications established?		Yes* ☐ No* ☐
	Protocol converter tested?		Yes* ☐ No* ☐ N/A* ☐
	Current inputs		
	Displayed current		Primary* ☐ Secondary* ☐
	Phase CT1A ratio		N/A* ☐
	Phase CT1B ratio		N/A* ☐
	Phase CT1C ratio		N/A* ☐
	Phase CT2A ratio		N/A* ☐
	Phase CT2B ratio		N/A* ☐
	Phase CT2C ratio		N/A* ☐
	Phase CT3A ratio		N/A* ☐
	Phase CT3B ratio		N/A* ☐
	Phase CT3C ratio		N/A* ☐
	Phase CT4A ratio		N/A* ☐
	Phase CT4B ratio		N/A* ☐
	Phase CT4C ratio		N/A* ☐
	Input CT	Applied Value	Displayed Value
	IA	A	A
	IB	A	A
	IC	A	A
	IA2	A	A

	IB2	A	A
	IC2	A	A
	IA3	A	A
	IB3	A	A
	IC3	A	A
	IA4	A	A
	IB4	A	A
	IC4	A	A
	Voltage inputs		
	Displayed voltage		Primary* ☐ Secondary* ☐
	Main VT A ratio		N/A* ☐
	Main VT B ratio		N/A* ☐
	Main VT C ratio		N/A* ☐
	Input VT	Applied Value	Displayed value
	VAN	V	V
	VBN	V	V
	VCN	V	V
	GPS synchronization using the P594 interface units		
	Setting checks		
	Application-specific function settings applied?		Yes* ☐ No* ☐
	Application-specific programmable scheme logic settings applied?		Yes* ☐ No* ☐ N/A* ☐
	PMU Functionality test		
	Confirmation from P847 front panel		Yes* ☐ No* ☐
	Confirmation from phasor test tool		Yes* ☐ No* ☐
	On-load checks		
	Test wiring removed?		Yes* ☐ No* ☐
	Voltage inputs and phase rotation OK?		Yes* ☐ No* ☐
	Current inputs and polarities OK?		Yes* ☐ No* ☐
	On-load test performed?		Yes* ☐ No* ☐
	(If No, give reason why) …		
	Final checks		
	All test equipment, leads, shorts and test blocks removed safely?		Yes* ☐ No* ☐
	Ethernet connected ?		Yes* ☐ No* ☐ N/A* ☐
	Disturbed customer wiring re-checked?		Yes* ☐ No* ☐ N/A* ☐

	All commissioning tests disabled?	Yes*	☐	No*	☐		
	Circuit breaker operations counter reset?	Yes*	☐	No*	☐	N/A*	☐
	Current counters reset?	Yes*	☐	No*	☐	N/A*	☐
	Event records reset?	Yes*	☐	No*	☐		
	Fault records reset?	Yes*	☐	No*	☐		
	Disturbance records reset?	Yes*	☐	No*	☐		
	Alarms reset?	Yes*	☐	No*	☐		
	LEDs reset?	Yes*	☐	No*	☐		
	Secondary front cover replaced?	Yes*	☐	No*	☐	N/A*	☐

COMMENTS *
* Optional; for site observations or utility-specific notes

Commissioning Engineer		Customer Witness
Date:		Date:

3 SETTING RECORD

3.1 Date Record

Date:		Engineer:	
Station:		Circuit:	
		System Frequency:	Hz
VT Ratio:	/ V	CT Ratio (tap in use):	/ A

3.2 Front Plate Information

Phasor Measurement Unit	P847____
Model number	
Serial number	
Rated current In	1A ☐ 5A ☐
Rated voltage Vn	
Auxiliary voltage Vx	

3.3 Setting Groups Used

	*Delete as appropriate
Group 1	Yes* ☐ No* ☐
Group 2	Yes* ☐ No* ☐
Group 3	Yes* ☐ No* ☐
Group 4	Yes* ☐ No* ☐

3.4 System Data

0000	SYSTEM DATA	
0001	Language	English* ☐ Francais* ☐ Deutsche* ☐ Espanol* ☐
0002	Password	
0003	Sync. Fn. links	
0004	Description	
0005	Plant reference	
0006	Model number	
0008	Serial number	
0009	Frequency	

0000	SYSTEM DATA	
000B	Relay address	
0011	Software ref. 1	
0012	Software ref. 2	
00D1	Password control	Level 0* ☐ Level 1* ☐ Level 2* ☐
00D2	Password level 1	
00D3	Password level 2	

3.5 CB Control

0700	CB CONTROL			
0701	CB Control by	Disabled* ☐ Local + Remote* ☐ Opto + Local* ☐ Opto + Remote* ☐	Local* ☐ Opto* ☐ Opto + Rem. + Local ☐	Remote* ☐
0702	Close Pulse Time			
0703	Trip Pulse Time			
0705	Man Close Delay			
0706	CB Healthy Time			
0711	CB Status Input			

3.6 Date and Time

0800	DATE AND TIME			
0805	IRIG-B Status	Card not fitted ☐ Signal healthy ☐	Card failed ☐ No signal ☐	
0806	Battery Status	Dead ☐	Healthy ☐	
0807	Battery Alarm	Disabled* ☐	Enabled* ☐	
0813	SNTP Status	Disabled ☐ Server 1 OK ☐ No valid clock ☐	Trying Server 1 ☐ Server 2 OK ☐	Trying Server 2 ☐ No response ☐
	LocalTime Enable	Disabled ☐	Fixed ☐	Flexible ☐
0821	LocalTime Offset			
0822	DST Enable	Disabled* ☐	Enabled* ☐	
0823	DST Offset			
0824	DST Start	First ☐ Fourth ☐	Second ☐ Last ☐	Third ☐

0800	DATE AND TIME						
0825	DST Start Day	Monday	☐	Tuesday	☐	Wednesday	☐
		Thursday	☐	Friday	☐	Saturday	☐
0826	DST Start Month	January	☐	February	☐	March	☐
		April	☐	May	☐	June	☐
		July	☐	August	☐	September	☐
		October	☐	November	☐	December	☐
0827							
0828	DST End	First	☐	Second	☐	Third	☐
		Fourth	☐	Last	☐		
0829	DST End Day	Monday	☐	Tuesday	☐	Wednesday	☐
		Thursday	☐	Friday	☐	Saturday	☐
082A	DST End Month	January	☐	February	☐	March	☐
		April	☐	May	☐	June	☐
		July	☐	August	☐	September	☐
		October	☐	November	☐	December	☐
082B	DST End Mins						
0830	RP1 Time Zone	UTC	☐	Local	☐		
0832	DNPOE Time Zone	UTC	☐	Local	☐		
0833	Tunnel Time Zone	UTC	☐	Local	☐		

3.7 Configuration

0900	CONFIGURATION				
0925	Input Labels	Invisible*	☐	Visible*	☐
0926	Output Labels	Invisible*	☐	Visible*	☐
0928	CT & VT Ratios	Invisible*	☐	Visible*	☐
0929	Record Control	Invisible*	☐	Visible*	☐
092A	Disturb Recorder	Invisible*	☐	Visible*	☐
092B	Measure't Setup	Invisible*	☐	Visible*	☐
092C	Comms Settings	Invisible*	☐	Visible*	☐
092D	Commission Tests	Invisible*	☐	Visible*	☐
092E	Setting Values	Primary*	☐	Secondary*	☐
092F	Control Inputs	Invisible*	☐	Visible*	☐
0935	Control I/P Config	Invisible*	☐	Visible*	☐
0936	Ctrl I/P Labels	Invisible*	☐	Visible*	☐
0939	Direct Access	Disabled*	☐	CB Control only*	☐
		Hotkey only*	☐	Enabled*	☐
0950	Function Key	Invisible*	☐	Visible*	☐
09FF	LCD Contrast				

3.8 CT and VT Ratios

0A00	CT AND VT RATIOS	
0A00	CT AND VT RATIOS	
0A01	Main VT A Pri'y	
0A02	Main VT A Sec'y	
0A03	Main VT B Pri'y	
0A04	Main VT B Sec'y	
0A05	Main VT C Pri'y	
0A06	Main VT C Sec'y	
0A07	Phase CT1A Pri'y	
0A08	Phase CT1A Sec'y	
0A09	Phase CT1B Pri'y	
0A0A	Phase CT1B Sec'y	
0A0B	Phase CT1C Pri'y	
0A0C	Phase CT1C Sec'y	
0A0D	Phase CT2A Pri'y	
0A0E	Phase CT2A Sec'y	
0A0F	Phase CT2B Pri'y	
0A10	Phase CT2B Sec'y	
0A11	Phase CT2C Pri'y	
0A12	Phase CT2C Sec'y	
0A13	Phase CT3A Pri'y	
0A14	Phase CT3A Sec'y	
0A15	Phase CT3B Pri'y	
0A16	Phase CT3B Sec'y	
0A17	Phase CT3C Pri'y	
0A18	Phase CT3C Sec'y	
0A19	Phase CT4A Pri'y	
0A1A	Phase CT4A Sec'y	
0A1B	Phase CT4B Pri'y	
0A1C	Phase CT4B Sec'y	
0A1D	Phase CT4C Pri'y	
0A1E	Phase CT4C Sec'y	

0A00	CT AND VT RATIOS				
0A11	CT Polarity	Standard*	☐	Inverted*	☐
0A18	VTs Connected				

3.9 Record Control

0B00	RECORD CONTROL				
0B04	Alarm Event	Disabled*	☐	Enabled*	☐
0B05	Relay O/P Event	Disabled*	☐	Enabled*	☐
0B06	Opto Input Event	Disabled*	☐	Enabled*	☐
0B07	General Event	Disabled*	☐	Enabled*	☐
0B08	Fault rec. Event	Disabled*	☐	Enabled*	☐
0B09	Maint. rec. Event	Disabled*	☐	Enabled*	☐
0B0A	Protection Event	Disabled*	☐	Enabled*	☐

3.10 Disturbance Recorder

0C00	DISTURB. RECORDER						
0C01	Duration						
0C02	Trigger Position						
0C03	Trigger Mode	Single* ☐	Extended* ☐				
0C04	Analog Channel 1						
0C05	Analog Channel 2						
0C06	Analog Channel 3						
0C07	Analog Channel 4						
0C08	Analog Channel 5						
0C09	Analog Channel 6						
0C0A	Analog Channel 7						
0C0B	Analog Channel 8						
0C0C	Digital Input 1						
0C0D	Input 1 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C0E	Digital Input 2						
0C0F	Input 2 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C10	Digital Input 3						
0C11	Input 3 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C12	Digital Input 4						
0C13	Input 4 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C14	Digital Input 5						

0C00	DISTURB. RECORDER						
0C15	Input 5 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C16	Digital Input 6						
0C17	Input 6 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C18	Digital Input 7						
0C19	Input 7 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C1A	Digital Input 8						
0C1B	Input 8 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C1C	Digital Input 9						
0C1D	Input 9 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C1E	Digital Input 10						
0C1F	Input 10 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C20	Digital Input 11						
0C21	Input 11 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C22	Digital Input 12						
0C23	Input 12 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C24	Digital Input 13						
0C25	Input 13 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C26	Digital Input 14						
0C27	Input 14 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C28	Digital Input 15						
0C29	Input 15 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C2A	Digital Input 16						
0C2B	Input 16 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C2C	Digital Input 17						
0C2D	Input 17 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C2E	Digital Input 18						
0C2F	Input 18 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C30	Digital Input 19						
0C31	Input 19 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C32	Digital Input 20						
0C33	Input 20 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C34	Digital Input 21						
0C35	Input 21 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C36	Digital Input 22						
0C37	Input 22 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C38	Digital Input 23						
0C39	Input 23 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐

0C00	DISTURB. RECORDER						
0C3A	Digital Input 24						
0C3B	Input 24 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C3C	Digital Input 25						
0C3D	Input 25 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C3E	Digital Input 26						
0C3F	Input 26 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C40	Digital Input 27						
0C41	Input 27 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C42	Digital Input 28						
0C43	Input 28 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C44	Digital Input 29						
0C45	Input 29 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C46	Digital Input 30						
0C47	Input 30 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C48	Digital Input 31						
0C49	Input 31 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C4A	Digital Input 32						
0C4B	Input 32 Trigger	No Trigger*	☐	Trigger L – H*	☐	Trigger H – L*	☐
0C50	Analog Channel 9						
0C51	Analog Channel 10						
0C52	Analog Channel 11						
0C53	Analog Channel 12						

3.11 Measurement Setup

0D00	MEASURE'T. SETUP				
0D01	Default Display	3Ph + N Current* Power* Description* Frequency*	☐ ☐ ☐ ☐	3h Voltage* Date & Time* Plant Reference* Access Level*	☐ ☐ ☐ ☐
0D02	Local Values	Primary*	☐	Secondary*	☐
0D03	Remote Values	Primary*	☐	Secondary*	☐
0D05	Measurement Mode				

3.12 Communications

0E00	COMMUNICATIONS						
0E01	RP1 Protocol	Courier*					
0E02	RP1 Address						
0E03	RP1 InactivTimer						
0E04	RP1 Baud Rate	1200* 9600*	☐ ☐	2400* 19200*	☐ ☐	4800* 38400*	☐ ☐
0E07	RP1 Physical Link	EIA(RS)485*	☐	Fiber Optic*			☐
0E08	RP1 Time Sync.	Disabled*	☐	Enabled*			☐
0E64	NIC Tunl Timeout						
0E6A	NIC Link Report	Alarm*	☐	Event*	☐	None*	☐
0E6B	NIC Link Timeout						
0EA1	IP Address (DNP3 only)						
0EA2	Subnet Mask (DNP3 only)						
0EA3	NIC MAC Address (DNP3 only)						
0EA4	Gateway(DNP3 only)						
0EA5	DNP Time Sync (DNP3 only)						
0EA6	Meas Scaling (DNP3 only)						
0EA7	NIC Tunnel Timeout (DNP3 only)						
0EA8	NIC Link Report(DNP3 only)						
0EA9	NIC Link Timeout (DNP3 only)						
0EAB	SNTP Server 1 (DNP3 only)						
0EAC	SNTP Server 2 (DNP3 only)						
0EAD	SNTP Poll Rate (DNP3 only)						
0ED0	PMU COMMS						
0ED1	Protocol Type						
0ED2	TCP Port Number						
0ED3	UDP Port Number						

3.13 Commission Tests

0F00	COMMISSION TESTS	
0F05	Monitor Bit 1	
0F06	Monitor Bit 2	

0F00	COMMISSION TESTS	
0F07	Monitor Bit 3	
0F08	Monitor Bit 4	
0F09	Monitor Bit 5	
0F0A	Monitor Bit 6	
0F0B	Monitor Bit 7	
0F0C	Monitor Bit 8	

3.14 Opto Config

1100	OPTO CONFIG.	
1101	Global Nominal V	
1102	Opto Input 1	
1103	Opto Input 2	
1104	Opto Input 3	
1105	Opto Input 4	
1106	Opto Input 5	
1107	Opto Input 6	
1108	Opto Input 7	
1109	Opto Input 8	
1150	Filter Control	
1180	Characteristic	Standard 60% - 80%* ☐ 50% - 70%* ☐

3.15 Control Input

1200	CONTROL INPUT.	
1201	Ctrl I/P Status	32 bit binary string. (Set = 1, Reset = 0)
1202	Control Input 1	No Operation ☐ Set ☐ Reset ☐
1203	Control Input 2	No Operation ☐ Set ☐ Reset ☐
1204	Control Input 3	No Operation ☐ Set ☐ Reset ☐
1205	Control Input 4	No Operation ☐ Set ☐ Reset ☐
1206	Control Input 5	No Operation ☐ Set ☐ Reset ☐
1207	Control Input 6	No Operation ☐ Set ☐ Reset ☐
1208	Control Input 7	No Operation ☐ Set ☐ Reset ☐
1209	Control Input 8	No Operation ☐ Set ☐ Reset ☐
120A	Control Input 9	No Operation ☐ Set ☐ Reset ☐
120B	Control Input 10	No Operation ☐ Set ☐ Reset ☐
120C	Control Input 11	No Operation ☐ Set ☐ Reset ☐

1200	CONTROL INPUT.	
120D	Control Input 12	No Operation ☐ Set ☐ Reset ☐
120E	Control Input 13	No Operation ☐ Set ☐ Reset ☐
120F	Control Input 14	No Operation ☐ Set ☐ Reset ☐
1210	Control Input 15	No Operation ☐ Set ☐ Reset ☐
1211	Control Input 16	No Operation ☐ Set ☐ Reset ☐
1212	Control Input 17	No Operation ☐ Set ☐ Reset ☐
1213	Control Input 18	No Operation ☐ Set ☐ Reset ☐
1214	Control Input 19	No Operation ☐ Set ☐ Reset ☐
1215	Control Input 20	No Operation ☐ Set ☐ Reset ☐
1216	Control Input 21	No Operation ☐ Set ☐ Reset ☐
1217	Control Input 22	No Operation ☐ Set ☐ Reset ☐
1218	Control Input 23	No Operation ☐ Set ☐ Reset ☐
1219	Control Input 24	No Operation ☐ Set ☐ Reset ☐
121A	Control Input 25	No Operation ☐ Set ☐ Reset ☐
121B	Control Input 26	No Operation ☐ Set ☐ Reset ☐
121C	Control Input 27	No Operation ☐ Set ☐ Reset ☐
121D	Control Input 28	No Operation ☐ Set ☐ Reset ☐
121E	Control Input 29	No Operation ☐ Set ☐ Reset ☐
121F	Control Input 30	No Operation ☐ Set ☐ Reset ☐
1220	Control Input 31	No Operation ☐ Set ☐ Reset ☐
1221	Control Input 32	No Operation ☐ Set ☐ Reset ☐

3.16 Ctrl. I/P Config.

1300	CTRL. I/P CONFIG.	
1301	Hotkey Enabled	
1310	Control Input 1	Latched* ☐ Pulsed* ☐
1311	Ctrl Command 1	
1314	Control Input 2	Latched* ☐ Pulsed* ☐
1315	Ctrl Command 2	
1318	Control Input 3	Latched* ☐ Pulsed* ☐
1319	Ctrl Command 3	
131C	Control Input 4	Latched* ☐ Pulsed* ☐
131D	Ctrl Command 4	
1320	Control Input 5	Latched* ☐ Pulsed* ☐
1321	Ctrl Command 5	
1324	Control Input 6	Latched* ☐ Pulsed* ☐
1325	Ctrl Command 6	
1328	Control Input 7	Latched* ☐ Pulsed* ☐
1329	Ctrl Command 7	
132C	Control Input 8	Latched* ☐ Pulsed* ☐

1300	CTRL. I/P CONFIG.		
132D	Ctrl Command 8		
1330	Control Input 9	Latched* ☐	Pulsed* ☐
1331	Ctrl Command 9		
1334	Control Input 10	Latched* ☐	Pulsed* ☐
1335	Ctrl Command 10		
1338	Control Input 11	Latched* ☐	Pulsed* ☐
1339	Ctrl Command 11		
133C	Control Input 12	Latched* ☐	Pulsed* ☐
133C	Ctrl Command 12		
1340	Control Input 13	Latched* ☐	Pulsed* ☐
1341	Ctrl Command 13		
1344	Control Input 14	Latched* ☐	Pulsed* ☐
1345	Ctrl Command 14		
1348	Control Input 15	Latched* ☐	Pulsed* ☐
1349	Ctrl Command 15		
134C	Control Input 16	Latched* ☐	Pulsed* ☐
134D	Ctrl Command 16		
1350	Control Input 17	Latched* ☐	Pulsed* ☐
1351	Ctrl Command 17		
1354	Control Input 18	Latched* ☐	Pulsed* ☐
1355	Ctrl Command 18		
1358	Control Input 19	Latched* ☐	Pulsed* ☐
1359	Ctrl Command 19		
135C	Control Input 20	Latched* ☐	Pulsed* ☐
135D	Ctrl Command 20		
1360	Control Input 21	Latched* ☐	Pulsed* ☐
1361	Ctrl Command 21		
1364	Control Input 22	Latched* ☐	Pulsed* ☐
1365	Ctrl Command 22		
1368	Control Input 23	Latched* ☐	Pulsed* ☐
1369	Ctrl Command 23		
136C	Control Input 24	Latched* ☐	Pulsed* ☐
136D	Ctrl Command 24		
1370	Control Input 25	Latched* ☐	Pulsed* ☐
1371	Ctrl Command 25		
1374	Control Input 26	Latched* ☐	Pulsed* ☐
1375	Ctrl Command 26		

1300	CTRL. I/P CONFIG.		
1378	Control Input 27	Latched* ☐	Pulsed* ☐
1379	Ctrl Command 27		
137C	Control Input 28	Latched* ☐	Pulsed* ☐
137D	Ctrl Command 28		
1380	Control Input 29	Latched* ☐	Pulsed* ☐
1381	Ctrl Command 29		
1384	Control Input 30	Latched* ☐	Pulsed* ☐
1385	Ctrl Command 30		
1388	Control Input 31	Latched* ☐	Pulsed* ☐
1389	Ctrl Command 31		
138C	Control Input 32	Latched* ☐	Pulsed* ☐
138D	Ctrl Command 32		

3.17 Function Keys

1700	FUNCTION KEYS		
1702	Fn. Key 1 Status	Unlock* ☐	Enable* ☐
1703	Fn. Key 1 Mode	Normal* ☐	Toggle* ☐
1704	Fn. Key 1 Label		
1705	Fn. Key 2 Status	Unlock* ☐	Enable* ☐
1706	Fn. Key 2 Mode	Normal* ☐	Toggle* ☐
1707	Fn. Key 2 Label		
1708	Fn. Key 3 Status	Unlock* ☐	Enable* ☐
1709	Fn. Key 3 Mode	Normal* ☐	Toggle* ☐
170A	Fn. Key 3 Label		
170B	Fn. Key 4 Status	Unlock* ☐	Enable* ☐
170C	Fn. Key 4 Mode	Normal* ☐	Toggle* ☐
170D	Fn. Key 4 Label		
170E	Fn. Key 5 Status	Unlock* ☐	Enable* ☐
170F	Fn. Key 5 Mode	Normal* ☐	Toggle* ☐
1710	Fn. Key 5 Label		
1711	Fn. Key 6 Status	Unlock* ☐	Enable* ☐
1712	Fn. Key 6 Mode	Normal* ☐	Toggle* ☐
1713	Fn. Key 6 Label		
1714	Fn. Key 7 Status	Unlock* ☐	Enable* ☐
1715	Fn. Key 7 Mode	Normal* ☐	Toggle* ☐
1716	Fn. Key 7 Label		
1717	Fn. Key 8 Status	Unlock* ☐	Enable* ☐
1718	Fn. Key 8 Mode	Normal* ☐	Toggle* ☐

1700	FUNCTION KEYS						
1719	Fn. Key 8 Label						
171A	Fn. Key 9 Status	Unlock*	☐	Enable*	☐		
171B	Fn. Key 9 Mode	Normal*	☐	Toggle*	☐		
171C	Fn. Key 9 Label						
171D	Fn. Key 10 Status	Unlock*	☐	Enable*	☐		
171E	Fn. Key 10 Mode	Normal*	☐	Toggle*	☐		
171F	Fn. Key 10 Label						

3.18 IED Configurator

1900	IED CONFIGURATOR						
1905	Switch Conf. Bank	No Action*	☐	Switch Banks*	☐		
1970	GoEna	Disabled*	☐	Enabled*	☐		
1971	Test Mode	Disabled*	☐	Pass Through*	☐	Forced*	☐
1972	VOP Test Pattern						
1973	Ignore Test Flag	No*	☐	Yes*	☐		

3.19 Cntrl I/P Labels

2900	CNTRL. I/P LABELS	
2901	Control Input 1	
2902	Control Input 2	
2903	Control Input 3	
2904	Control Input 4	
2905	Control Input 5	
2906	Control Input 6	
2907	Control Input 7	
2908	Control Input 8	
2909	Control Input 9	
290A	Control Input 10	
290B	Control Input11	
290C	Control Input 12	
290D	Control Input 13	
290E	Control Input 14	
290F	Control Input 15	

2900	CNTRL. I/P LABELS	
2910	Control Input 16	
2911	Control Input 17	
2912	Control Input 18	
2913	Control Input 19	
2914	Control Input 20	
2915	Control Input 21	
2916	Control Input 22	
2917	Control Input 23	
2918	Control Input 24	
2919	Control Input 25	
291A	Control Input 26	
291B	Control Input 27	
291C	Control Input 28	
291D	Control Input 29	
291E	Control Input 30	
291F	Control Input 31	
2920	Control Input 32	

3.20 PMU Config

2A00	PMU FRAME CONFIG	
2A01	Device ID Code	
2A02	Data rate select (50Hz)	
2A03	Data rate select (60Hz)	
2A04	Phasor format	
2A05	Filter length	
2A10	VA	
2A11	VB	
2A12	VC	
2A13	V1	
2A14	V2	
2A15	V0	
2A16	IA	

2A00	PMU FRAME CONFIG	
2A17	IB	
2A18	IC	
2A19	I1	
2A1A	I2	
2A1B	I0	
2A16	IA2	
2A17	IB2	
2A18	IC2	
2A19	I1_2	
2A1A	I2_2	
2A1B	I0_2	
2A16	IA3	
2A17	IB3	
2A18	IC3	
2A19	I1_3	
2A1A	I2_3	
2A1B	I0_3	
2A16	IA4	
2A17	IB4	
2A18	IC4	
2A19	I1_4	
2A1A	I2_4	
2A1B	I0_4	
2A30	Digital Input 1	
2A31	Input 1 Enabled	
2A32	Digital Input 2	
2A33	Input 2 Enabled	
2A34	Digital Input 3	
2A35	Input 3 Enabled	
2A36	Digital Input 4	
2A37	Input 4 Enabled	
2A38	Digital Input 5	

2A00	PMU FRAME CONFIG	
2A39	Input 5 Enabled	
2A3A	Digital Input 6	
2A3B	Input 6 Enabled	
2A3C	Digital Input 7	
2A3D	Input 7 Enabled	
2A3E	Digital Input 8	
2A3F	Input 8 Enabled	
2A45	GPS Fail Timer	
2A46	GPS Trans Fail	
2A47	GPS Trans Count	
2A48	GPS Trans Timer	

3.21 Input Labels

4A00	INPUT LABELS				
Group 1 settings		Group 1 settings	Group 2 settings	Group 3 settings	Group 4 settings
4A01	Opto Input 1				
4A02	Opto Input 2				
4A03	Opto Input 3				
4A04	Opto Input 4				
4A05	Opto Input 5				
4A06	Opto Input 6				
4A07	Opto Input 7				
4A08	Opto Input 8				
4A09	Opto Input 9				
4A0A	Opto Input 10				
4A0B	Opto Input 11				
4A0C	Opto Input 12				
4A0D	Opto Input 13				
4A0E	Opto Input 14				
4A0F	Opto Input 15				
4A10	Opto Input 16				
4A11	Opto Input 17				

4A00	INPUT LABELS				
Group 1 settings		Group 1 settings	Group 2 settings	Group 3 settings	Group 4 settings
4A12	Opto Input 18				
4A13	Opto Input 19				
4A14	Opto Input 20				
4A15	Opto Input 21				
4A16	Opto Input 22				
4A17	Opto Input 23				
4A18	Opto Input 24				

3.22 Output Labels

4B00	OUTPUT LABELS				
Group 1 settings		Group 1 settings	Group 2 settings	Group 3 settings	Group 4 settings
4B01	Relay 1				
4B02	Relay 2				
4B03	Relay 3				
4B04	Relay 4				
4B05	Relay 5				
4B06	Relay 6				
4B07	Relay 7				
4B08	Relay 8				
4B09	Relay 9				
4B0A	Relay 10				
4B0B	Relay 11				
4B0C	Relay 12				
4B0D	Relay 13				
4B0E	Relay 14				
4B0F	Relay 15				
4B10	Relay 16				
4B11	Relay 17				
4B12	Relay 18				
4B13	Relay 19				
4B14	Relay 20				

4B00	OUTPUT LABELS				
Group 1 settings		Group 1 settings	Group 2 settings	Group 3 settings	Group 4 settings
4B15	Relay 21				
4B16	Relay 22				
4B17	Relay 23				
4B18	Relay 24				

Commissioning Engineer		Customer Witness
Date:		Date:

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