

MiCOM Alstom P40

Protection platform devices

The P40 range offers a suite of relay functionality and hardware to best suit the protection requirements, ready for deployment in digital substation architectures.



Typical device in small case size variant (40 TE)

Agile solutions for all power system protection applications

The 40 series platform, incorporating a full complement of utility, generation and industrial-focused models is the principal building block of Alstom's offer, hosting the wide variety of protection, control, measurement, monitoring and communication functions demanded.

The versatile hardware allows deployment with confidence and the PC tool, S1 Agile, makes for easy configuration, application and management of the installed base.

A fresh and intuitive user interface makes the 40 series ideal for any environment and suits all skillsets of headquarters and field personnel.

Numerous integrated communication protocols allow easy interfacing to substation control or SCADA systems. From simple wired serial buses, to Ethernet station and process bus architectures with IEC 61850 - MiCOM Alstom protection has the solution.

MiCOM P40 Agile

Alstom's philosophy is one of continuous improvement in our products and solutions. Our emphasis on communication in MiCOM has become a focus which secures leadership in the digital substation. To mark this phase of evolution, the P40 Agile livery is applied to the range. P40 Agile is a mark of performance and quality, proudly available from Alstom, and only from Alstom.

The P40 range offers comprehensive solutions for all power system protection applications, including:

CUSTOMER BENEFITS

- S1 Agile software manages your IEDs
- Easy specification: 1 A / 5 A dual rated inputs, universal optos
- Scalable hardware
- Readily interfaces with communication architectures and protocols

GENERATION

Integrated generator protection

INDUSTRIAL

Motor management
Feeder management
Interconnection protection

RAIL

Catenary protection
Trackside AC grids
Transformer management
Transformer-rectifier units

TRANSMISSION AND DISTRIBUTION

Distance protection
Line differential
Transformer management
Busbar protection
Feeder management
Voltage and frequency protection
Loadshedding
Breaker fail and reclosing
Line phase comparison
Phasor Measurement Units (PMU)

SCOPE

The P40 range fulfills the requirements at all voltage levels from MV to EHV/UHV for industrial, distribution, generation, rail and transmission systems.

COMMON FEATURES

- 1 A/5 A dual rated CTs for simplified inventories
- Event and disturbance recording for post-fault analysis
- Rear ports with choice of protocols, and front port for local setting
- Full programmable scheme logic for customer-specific automation
- Scalable input / output hardware depending on requirements
- Operating voltage user programmable for opto inputs
- Hardware accessories available for easy mounting in racks or panels

APPLICATIONS

Feeder protection

A full range, with directional and non-directional applications of overcurrent and earth fault at its heart:

- P14x - Feeder management relay suitable for MV systems and HV system backup, with autoreclose, and check synchronism within the model option selection
- P341 - Grid interconnection protection, at the point of coupling systems with embedded generation

Line protection

A full range extending up to the most demanding sub-cycle technology for EHV and UHV transmission:

- P44* - Full scheme distance protection relays for HV, EHV and UHV systems
- P54* - Line differential protection relays for direct fibre and multiplexed communication options as well as phase comparison protection for use with power line carrier
- P84* - Transmission line terminal devices for backup, reclose

and breaker fail with single, dual, breaker and a half and mesh circuit breaker topologies

Substation plant protection

Applicable at all voltage levels, to safeguard the most costly system assets:

- P64* - Transformer management and protection, for between two and five-ended schemes
- P74* - Numerical busbar protection (biased principle) suitable for application on MV, HV and EHV busbars
- P14* - Numerical high-impedance busbar and REF protection schemes, deployed with varistors

Rotating machine protection

Specialist devices for protection, control and monitoring of all machine types and ratings:

- P24* - Rotating machine management relay for application on a wide range of synchronous and induction machines
- P34* - Generator protection for small to sophisticated generator systems, and interconnection protection

System monitoring and stability devices

Fast-acting devices to take local decisions and input to wide area schemes:

- P14* - Voltage and frequency protection for load shedding, load restoration and generator abnormal detection
- P84* - System stability devices, including a P847 Phasor Measurement Unit (PMU) for all grid applications

Rail catenary protection

- P44T - Subcycle distance protection

PROTECTION AND CONTROL FEATURES

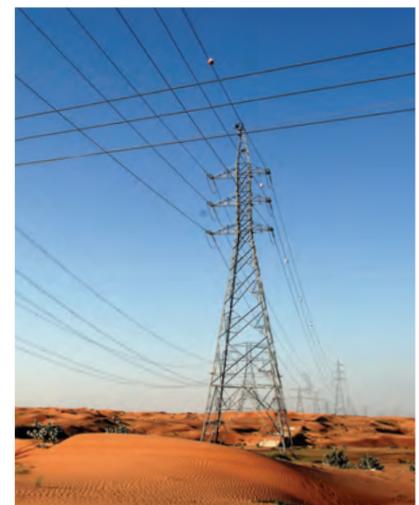
Protection elements

All algorithm and hardware know-how is the culmination of decades of advances in Alstom's centres of excellence. The platform has vast experience in test and in-service operational environments, proving the technical integrity.

The comprehensive and advanced library of protection and control functions in each device allow it to meet the exact application requirements. Multiple protection functions, logic and control functions may be enabled, without deterioration in performance – the platform is fully deterministic.

INDEPENDENT PROTECTION SETTINGS GROUPS

The 40 series can offer up to four independent settings groups. These can be activated locally, remotely or via a dedicated input and are used to allow for different system operating conditions and where adaptive relaying is applied.



PROGRAMMABLE SCHEME LOGIC

Powerful logic available in the 40 series relays allows the user to customise the protection and control functions of the relay. It is also used to program the functionality of the opto-isolated inputs, relay outputs, LED and user alarms.

The programmable scheme logic can be used to implement additional supervision features, such as trip circuit supervision or implement complex logic such as frequency restoration schemes. Schemes have been developed capable of supervising the trip coil and circuit with the circuit breaker open or closed.

The Px40 gate logic includes OR, AND, NOT and majority gate functions, with the ability to invert the inputs and outputs, and provide feedback. A number of general purpose logic timers are also available as well as those timers used to condition the relay contacts.

The system is optimised (event driven) to ensure that the protection outputs are not delayed by the PSL operation. The programmable scheme logic is configured using the graphical S1 Agile PC software, as shown in Figure 1.

MEASUREMENTS, RECORDING AND POST FAULT ANALYSIS

Measurement & post fault analysis

The relays are capable of measuring and storing a wide range of system quantities such as current, voltage, frequency, power, distance to fault etc. depending on the relay functionality. These measured values can be displayed on the front LCD display or transferred locally or remotely per user requirements.

All event, fault and disturbance records are time tagged to a resolution of 1ms using the internal real time clock and are stored in non-volatile memory. Where relays are communicating with a SCADA system, the protocol's telegrams can be used for external time synchronisation

or alternatively an optional IRIG-B port is available for accurate time synchronisation on all P40 relays. Relays can also use an opto input to synchronise the internal clock.

Event records

These are generated for status changes to logic inputs and outputs, modifications to one or more setting parameters and alarm signals. All events are time-tagged and stored in chronological order in cyclic memory. These are readily available for viewing on the LCD, or by extraction via the communication ports.

Fault records

Up to 15 records are supported for every fault (5 on some models), with the following information captured:

- A fault number
- The date and time
- The active setting group
- The function that issued the trip
- The magnitude of the current/voltage that gave rise to the trip command

Distance to fault calculation is provided on most feeder and line protection models.

Disturbance records

The internal disturbance recorder will record the sampled values of all analogue input variables such as phase currents and voltages where applicable during a fault. Oscillographic analysis can be performed using the S1 Agile PC tool which will provide the means to quickly analyse analogue and digital signals on the same time scale for convenience. (Figure 2 on next page) Disturbance records can be extracted from the relay via the communication ports and saved in the COMTRADE format.

RELAY COMMUNICATIONS

As standard, a front communication port is available for local access to the relay. An auxiliary rear communication port is available as an option on relays providing easy access to settings, records and measurements for protection engineers. A main rear communications port is also available for interface to a SCADA system. A number of protocols are available as an option for this purpose, with different media such as wired serial, fibre serial, RJ45 Ethernet, and fibre Ethernet.

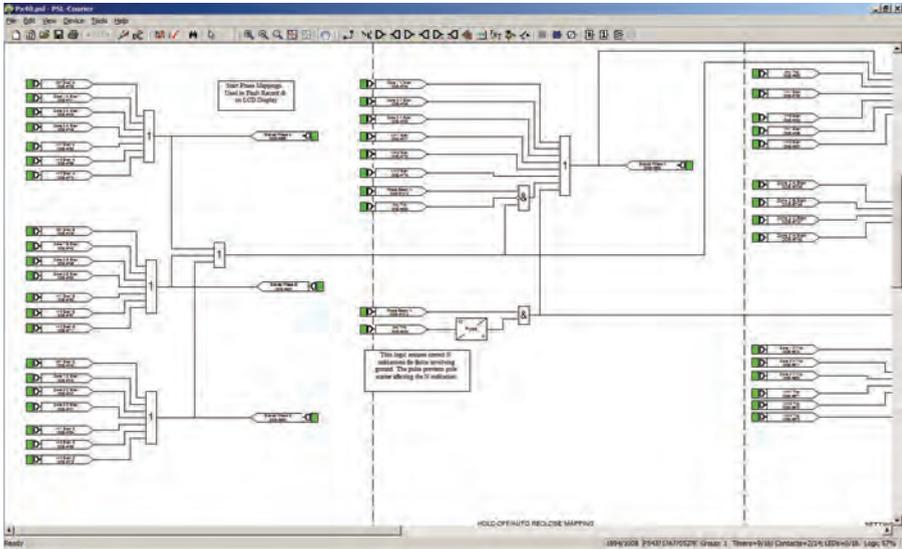


Figure 1 Programmable logic for Px40

Local communication

The front EIA(RS)232 communication port has been designed for use with the S1 Agile software and is primarily for configuring the relay settings and programmable scheme logic. It is also used to locally extract event, fault and disturbance record information and can be used as a commissioning tool by viewing all relay measurements simultaneously.

Rear communication

The rear communication port is based on EIA(RS)485 voltage levels and is designed for permanent multidrop connection to network control and data acquisition systems. Optional fibre optic and Ethernet communications ports are also supported on the 40 platform, the latter available with redundancy.

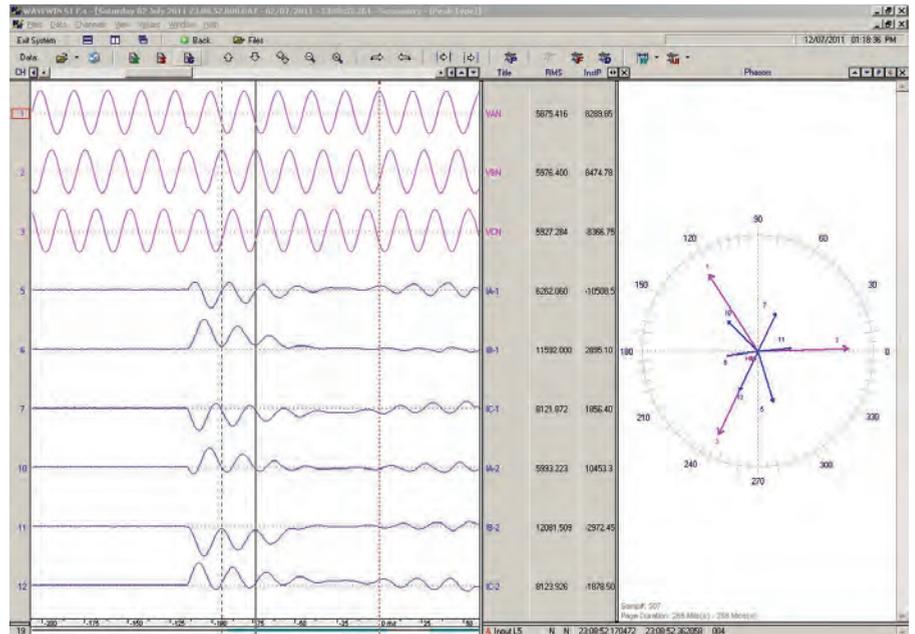


Figure 2 Oscillography analysis using S1 Agile software for optimum results

In general, the following protocols are available at the ordering stage:

- Courier/K-Bus
- Modbus
- IEC 60870-5-103
- DNP 3.0
- IEC 61850

This flexibility allows the MiCOM Alstom P40 range of relays to be integrated into a SCADA system as well as to provide engineering data for remote access by utility engineers.

Redundant Ethernet communication

MiCOM Alstom P40 series includes several redundant Ethernet options for IEC 61850 or DNP3/IP:

- Parallel Redundancy Protocol (PRP) according to IEC 62439-3
- Rapid Spanning Tree Protocol (RSTP)
- Alstom Self Healing Ring
- Alstom Dual Homing

PRP has the advantage of taking zero time to recover from a failure,

as parallel alternative paths are continually operative. All settings are configurable with the use of S1 Agile.

USER INTERFACES

The ability to customise the menu text and alarm descriptions are supported on P*40. The front panel user interfaces, as per the example shown in Figure 3 comprise:

- (1) A back-lit liquid crystal display
- (2) Four fixed function LEDs
- (3) Up to 18 user programmable LEDs
- (4) Menu navigation and data entry keys
- (5) "READ" and "CLEAR" keys for viewing and reset of alarms
- (6) An upper cover identifying the product name, which may be raised to view full product model number, serial number and rating information
- (7) A lower cover concealing the front EIA(RS)232 port and download/monitor port
- (8) Facility for fitting a security seal
- (9) Up to ten programmable function keys with tricolour LEDs – for control and test applications and easy annunciation (not visible in the 40TE example shown)



Figure 3 Px40 series user interface

SELF MONITORING

Comprehensive self-monitoring procedures within the device ensure that internal hardware and software errors are detected, thus ensuring a high degree of reliability. Automatic tests are performed during start-up and cyclic self-monitoring tests are performed during operation. Any deviations are stored in non-volatile memory and the result of the fault diagnosis determines whether a blocking of the device will occur or whether only an alarm is issued.

TRIP CIRCUIT SUPERVISION

Supervision of the trip circuit, whether the breaker is closed or open (preclosing supervision), can be implemented using opto-coupled inputs and the programmable scheme logic.

HARDWARE DESCRIPTION

Cases

The Px40 series relays are housed in a specially designed case providing a high density of functionality within the product. Communication ports and model/serial number information are concealed by upper and lower covers.

The cases are suitable for either rack or panel mounting as shown in Figure 4.

Taking into account the differing case widths, relays can be combined with or without the use of standard blanking plates to form a complete 19" mounting. This saves space and allows for a neat installation, especially in conjunction with MiCOM Alstom Px90 series interfaces, P991 and MMLG test blocks, and MIDOS auxiliary relays – all of which share the same 4U mounting dimensions.

The 40TE case width is often narrow enough to allow a retrofit of legacy vertically-mounted relays.

Wiring

External connections are made via ring type terminals, for the peace of mind of secure ring lug and screw-through fastening. Ring terminals accommodate one or two lugs per terminal.

Internal components

All printed circuit boards are cleaned, dried and harsh environmental coated (HEC) for long, reliable service. The latest CPU3 processing is embedded to ensure that Alstom P40 offers the pinnacle of MiCOM performance.



Figure 4 Typical case dimensions

	Case dimensions	A	B	C	D	E
Px40	40TE		206			
	60TE	177	309.6	240	270	157.5
	80TE		413.2	(inc wiring)	(inc wiring)	max
	80TErack		483			

Note: Maximum sizes for guidance only, for specific product information please check the relevant product documentation. (All dimensions in mm)

GENERAL SERIES DATA

General Series Data	Px40
Frequency 50/60Hz	x
Dual-rated 1A/5A	x
CT Thermal Ratings Continuous: 4 Inom for 10s: 30 Inom for 1s: 100 Inom	x
Opto Inputs	max. 48
Output Contacts	max. 46
Carry: continuous	10 A
Make and Carry	30 A for 3s
LED Indication (freely programmable)	12 (8) - plus those with function keys
Function Keys/Hot keys	10 functions/2 hotkeys (available on some models)
Settings Groups	4 (2)
Fault Records	15 (5)
Event Records	up to 1024
Disturbance Records	75 s max
Programmable Logic	Fully programmable
IRIG B	Option
LCD Display	Alphanumeric
Front Port (RS 232)	Yes
Rear Port	Yes, 2nd rear port option
Courier	K-Bus/ EIA(RS) 485 or fibre (some models only)
Modbus	EIA(RS) 485 or fibre (some models only)
IEC 60870-5-103	EIA(RS) 485 or fibre (some models only)
DNP3.0	EIA(RS) 485 or fibre (some models only)
IEC 61850	Available on most models
Terminals	Ring

TECHNICAL DATA

Measuring inputs – analogue

All CT inputs are dual-rated at 1A and 5A to simplify ordering and strategic spares inventories.

The heavy duty terminal block features integral current transformer shorting to prevent dangerous voltages being present should the block be removed; a maintenance error could otherwise lead to a potentially unsafe/lethal scenario.

Measuring inputs – process bus IEC 61850-9.2

Many models in the range are available with an IEC 61850-9.2 process bus interface to replace traditional analogue inputs. This facilitates interoperability with non-conventional instrument transformers and merging units, with the measuring signals marshalled via Ethernet.

Power supplies

Three ranges of power supply options are available at the ordering stage to balance ease of deployment with energy efficiency.

	Nominal Voltage Vx	DC	AC
Px40	24-48 DC	19-65	-
	48-125	37-150	24-110
	110-250	87-300	80-265

Digital inputs (Optos)

The digital status input pickup thresholds are programmable, so specifying the inputs is just a question of counting how many are needed.

Intelligent burden switching and compliance with the ESI48-4EB2 standard provides immunity to false wiring pickup equivalent to the level offered by high burden trip relays such as MVAJ.

	Auxiliary Voltage Vmin / Vmax thresholds
Px40	24/27, 30/34, 48/54, 110/125 and 220/250 (software selectable)

Extended temperature range operation

In addition to the standard -25° C to +55° C operating temperatures claim as per IEC 60255-6, the Px40 range has proven withstand capability at extremes of temperature as per IEC 60068-2. These onerous tests were passed at -40° C and +85° C for 96 continuous hours in each case.



OVERCURRENT AND FEEDER MANAGEMENT RELAYS

	Device	P141	P142	P143	P145
CT inputs		5	5	5	5
VT inputs		3	3	3/4	3/4
Opto inputs (max) ¹		8	16	32	32
Output contacts (max) ¹		7	15	30	32
Function keys/Hotkeys		2	2	2	12
Interlocking logic		x	x	x	x
Protection					
Autoreclose	79	-	x	x	x
Check synchronising	25	-	-	x	x
3 Phase overcurrent	50/51P	x	x	x	x
Ground fault	50/51N	x	x	x	x
Phase directional	67P	x	x	x	x
Ground fault directional	67N	x	x	x	x
Sensitive directional Earth fault	67N	x	x	x	x
Wattmetric Earth Fault	67W	x	x	x	x
Neutral Admittance	YN	x	x	x	x
Restricted Earth fault	64	x	x	x	x
Voltage dependent overcurrent	51V	x	x	x	x
Negative sequence overcurrent	46	x	x	x	x
Thermal overload	49	x	x	x	x
Undercurrent	37	x	x	x	x
Over/Under Voltage	27/59	x	x	x	x
Residual overvoltage	59N	x	x	x	x
Negative sequence overvoltage	47	x	x	x	x
Over/Under Frequency	810/U	x	x	x	x
Rate of Change of Frequency	87R	x	x	x	x
Lock-out	86	x	x	x	x
Directional power	32	x	x	x	x
Circuit breaker failure	50BF	x	x	x	x
Broken conductor	46BC	x	x	x	x
Voltage Transformer Supervision	VTS	x	x	x	x
Current Transformer Supervision	CTS	x	x	x	x
Cold load pick-up		x	x	x	x
Inrush Blocking		x	x	x	x
Switch On To Fault	SOTF	x	x	x	x
Circuit breaker monitoring		x	x	x	x
Trip Circuit Supervision	TCS	x	x	x	x
InterMicom		x	x	x	x

1. Please note that some relays may have a limit on max. I/O when used as a combination.
2. Refer to the P40 Agile brochure for details on compact feeder management relay types P14N, P14D and P94V.

APPLICATION TIPS:

- **P141** - for cable feeders and overhead line circuits without reclosing
- **P142** - for radial overhead line circuits employing reclosing
- **P143** - used where reclosing is used with check synchronism, or in applications where the larger case width is required to accommodate a larger binary I/O count
- **P145** - used where F-keys assist engineering of the scheme
- **P841** - used for process bus feeder management with IEC 61850-9-2



MOTOR AND GENERATOR MANAGEMENT RELAYS

	Device	P241	P242	P243	P341	P342	P343	P344	P345	P346
CT Inputs		4	4	7	4	5	8	8	9	8
VT Inputs		3	3	3	4	4	4	5	6	4
Opto Inputs(max) ¹		8	16	16	16	24	32	32	32	32
Output Contacts(max) ¹		7	16	16	15	24	32	32	32	32
RTDs(option)		10	10	10	-	10	10	10	10	10
Analogue I/O(option)		4/4	4/4	4/4	4/4	4/4	4/4	4/4	4/4	4/4
Function Keys/Hotkeys		X	X	X	X	X	X	X	X	X
Interlocking logic		X	X	X	X	X	X	X	X	X
Protection										
Motor Protection										
Short circuit	50/51	X	X	X						
Motor differential	87M			X						
Locked rotor	50S/51LR/51S	X	X	X	-	-	-	-	-	-
Reverse power	32R	X	X	X	-	-	-	-	-	-
Reacceleration/LV ride-through/Autorestart	27LV	X	X	X	-	-	-	-	-	-
Startup monitoring/Excessive long start	66/48/51	X	X	X	-	-	-	-	-	-
Negative sequence overvoltage	47	X	X	X	-	-	-	-	-	-
Out of step	55	X	X	X	-	-	-	-	-	-
Loss of load	37	X	X	X	-	-	-	-	-	-
Undercurrent	37P/37N	X	X	X	-	-	-	-	-	-
Unbalance/Lock-out	30/46/86	X	X	X	-	-	-	-	-	-
Speed switch inputs	14	X	X	X	-	-	-	-	-	-
Anti backspin	27ABS	X	X	X						
Generator Protection										
Generator/Transformer differential	87G/T	-	-	-	-	-	X	X	X	X
Check synchronising	25	-	-	-	-	X	X	X	X	X
Interturn/split phase	50DT	-	-	-	-	-	X	X	X	X
Underimpedance	21	-	-	-	-	X	X	X	X	X
Pole slipping	78	-	-	-	-	-	X	X	X	-
Directional power	32	-	-	-	X	X	X	X	X	X
Loss of field	40	X	X	X	-	X	X	X	X	X
Restricted earthfault	64	-	-	-	X	X	X	X	X	X
100% stator earth fault (3rd harmonic)	27TN/59TN	-	-	-	-	-	X	X	X	-
100% stator earth fault (Low Freq. Injection)	64S	-	-	-	-	-	-	-	X	-
Overfluxing	24	-	-	-	-	X	X	X	X	X
Unintentional energisation at standstill	50/27	-	-	-	-	X	X	X	X	-
Voltage dependent O/C	51V	-	-	-	-	X	X	X	X	X
Rotor earth fault	64R	-	-	-	-	X	X	X	X	X
Ancillary Functions										
Phase overcurrent	50/51P	X	X	X	X	X	X	X	X	X
Phase directional	67P	-	-	-	X	X	X	X	X	X
Ground fault	50N/51N	X	X	X	X	X	X	X	X	X
Sensitive directional earth fault	67N	X	X	X	X	X	X	X	X	X
Wattmetric earth fault	64N/32N	X	X	X	X	X	X	X	X	X
Negative sequence overcurrent	460C	X	X	X	-	X	X	X	X	X
Negative sequence thermal	46T	-	-	-	-	X	X	X	X	X
Thermal overload	38/49	X	X	X	X	X	X	X	X	X
Under/Over voltage	27/59	X	X	X	X	X	X	X	X	X
Residual overvoltage	59N	X	X	X	X	X	X	X	X	X
Negative sequence overvoltage	47	X	X	X	X	X	X	X	X	X
Under frequency	81U	X	X	X	X	X	X	X	X	X
Over frequency	81O	-	-	-	X	X	X	X	X	X
Turbine abnormal frequency	81AB	-	-	-	-	X	X	X	X	X
Voltage vector shift	dV	-	-	-	X	-	-	-	-	-
Rate of change of frequency	81R	-	-	-	X	X	X	X	X	X
Circuit breaker fail and monitoring	50BF	X	X	X	X	X	X	X	X	X
Loss of life/Thru fault monitor	LoL/Thru	-	-	-	X	X	X	X	X	X
Dynamic line rating	49DLR	-	-	-	X	-	-	-	-	-
Trip circuit supervision	TCS	X	X	X	X	X	X	X	X	X

APPLICATION TIPS:

- **P241** - for small/medium motors where the scheme requires only a small binary I/O count
- **P242** - used in applications where the larger case width is required to accommodate a larger binary I/O count
- **P243** - for motor applications requiring differential protection
- **P341** - used at a grid main interface to a local network having embedded generation
- **P342** - for smaller generators not requiring per phase differential protection
- **P343** - the standard choice for large generator protection
- **P345** - for large generators, where the customer requires 100% stator earth fault by low frequency injection
- **P346** - for smaller generators requiring differential protection



DISTANCE AND PHASOR MEASUREMENT

	Device	P441	P442	P443	P444	P445	P446	P44T	P847
CT inputs		4	4	4	4	4	8	2	3/12
VT inputs		4	4	4	4	4	5	3	3
Opto inputs (max) ¹		8	16	32	24	16	24	24	24
Output contacts (max) ¹		14	21	32	46	16	32	32	24
Function key/Hotkeys		X	X	X	X	X	X	X	X
IEC 61850-9-2 process bus		-	-	-	X	-	X	-	-
Protection									
Distance protection	21/21N	X	X	X	X	X	X	X	-
- Phase Mho/Quad	21P	- / X	- / X	X / X	- / X	X / -	X / X	- / X	-
- Ground Mho/Quad	21G	- / X	- / X	X / X	- / X	X / X	X / X	- / X	-
- Autoreclose	79								
	3 pole	X	-	-	-	X	-	X	-
	1/3 pole	-	X	X	X	-	2	-	-
- Power swing blocking	78	X	X	X	X	X	X	-	-
- Out-of-step tripping	68	-	-	X	-	-	X	-	-
- Check synchronising	25	X	X	X	X	X	2	X	-
- Switch on to Fault	50/27	X	X	X	X	X	X	X	-
- Mutual compensation		X	X	X	X	-	X	-	-
Phasor measurement	PMU	-	-	-	-	-	-	-	X
Ancillary functions									
Defrost protection		-	-	-	-	-	-	X	-
Phase overcurrent	50/51P	X	X	X	X	X	X	X	X
Phase directional	67P	X	X	X	X	X	X	X	X
Delta directional comparsion	I/V	-	-	X	-	-	X	-	-
Ground fault	50/51N	X	X	X	X	X	X	-	X
Ground fault directional	67N	X	X	X	X	X	X	-	X
Negative sequence overcurrent	46	X	X	X	X	X	X	-	X
Directional negative sequence	46/67	X	X	X	X	X	X	-	X
Thermal overload	49	X	X	X	X	X	X	X	X
Under/Over voltage	27/59	X	X	X	X	X	X	X	X
Residual over voltage	59N	X	X	X	X	X	X	-	X
Under/Over frequency	81U/O	-	X	X	X	X	X	-	X
Rate of change of frequency	81R	-	-	X	-	X	X	-	X
Circuit Breaker Failure	50BF	X	X	X	X	X	2	X	X
Broken Conductor	46BC	X	X	X	X	X	X	-	X
Stub Bus Protection	50ST	X	X	X	X	X	X	-	X
Voltage/Current Transformer Supervision	VTS/CTS	X	X	X	X	X	X	X/-	X
Capacitive Voltage Transformer Supervision	CVTS	X	X	-	X	-	-	-	-
Channel Aided Scheme Logic	85	X	X	X	X	X	X	X	-
Trip Circuit Supervision	TCS	X	X	X	X	X	X	X	X
InterMiCOM		-	X	X	X	X	X	X	-

APPLICATION TIPS:

- **P441** and **P445** – for smaller device size and optimum functionality for subtransmission and distribution
- **P442** and **P444** – distance relay for transmission applications
- **P443** – distance relay with subcycle tripping for fastest fault clearance
- **P446** – for subcycle tripping applications with dual circuit breaker topologies (eg. breaker and a half)
- **P44T** – Railway catenary with subcycle tripping for fastest fault clearance
- **P847** – for phasor measurement applications



1. Please note that some relays may have a limit on max. I/O when used as a combination
2. Denotes functionality for two circuit breakers per line

LINE DIFFERENTIAL, TRANSFORMER AND BUSBAR PROTECTION RELAYS

	Device	P541	P542	P543	P544	P545	P546	P547	P642	P643	P645	P741	P742	P743	P746	P747
CT Inputs		4	4	5	8	5	8	4	8	12	18	4	4	4	18	18
VT Inputs (max)		-	-	4	5	4	5	4	1	4	4	-	-	-	3	3
Opto Inputs (max) ¹		8	16	16	16	32	24	8	12	40	40	8	16	24	40	48
Output Contacts (max) ¹		7	14	14	14	32	32	8	12	24	24	8	8	21	32	32
Analogue I/O (option) ¹		-	-	-	-	-	-	-	4/4	4/4	4/4	-	-	-	-	-
RTDs (option) ¹		-	-	-	-	-	-	-	10	10	10	-	-	-	-	-
Function Keys/Hotkeys		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
IEC 61850-9-2 process bus		-	-	-	-	-	X	-	-	-	X	-	-	X	X	-
Protection																
Line differential - 2 terminal	87P	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-
- Neutral differential - 2/3 terminal	87N	-	-	X	X	X	X	-	-	-	-	-	-	-	-	-
- Subcycle differential		-	-	X	-	X	-	-	-	-	-	-	-	-	-	-
- FO signalling		X	X	X	X	X	X	-	-	-	-	-	-	-	-	-
- SDH/Sonet networks		-	-	X	X	X	X	-	-	-	-	-	-	-	-	-
- In-zone transformer		X	X	X	-	X	-	-	-	-	-	-	-	-	-	-
- 2nd harmonic restraint		X	X	X	-	X	-	-	-	-	-	-	-	-	-	-
- Vector compensation		X	X	X	-	X	-	-	-	-	-	-	-	-	-	-
2 breaker configuration		-	-	-	X	-	X	-	-	-	-	-	-	-	-	-
- Direct/permissive intertripping		X	X	X	X	X	X	-	-	-	-	-	-	-	-	-
Phase comparison	87PC	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
- PLC signalling		-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
Transformer Differential	87T	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-
- Windings/Bias inputs		-	-	-	-	-	-	-	2	3	5	-	-	-	-	-
Restricted Earth fault	87G/64	-	-	-	-	-	-	-	2	3	3	-	-	-	-	-
- Overfluxing/5th harmonic		-	-	-	-	-	-	-	X	X	X	-	-	-	-	-
- Overexcitation	24	-	-	-	-	-	-	-	X	2	2	-	-	-	-	-
- 2nd harmonic restraint		-	-	-	-	-	-	-	X	X	X	-	-	-	-	-
Busbar Protection	87BB	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X
- Central unit feeders		-	-	-	-	-	-	-	-	-	-	28	-	-	6/18	18
- Peripheral units		-	-	-	-	-	-	-	-	-	-	-	X	X	-	-
- Phase-segregated differential zones	87P	-	-	-	-	-	-	-	-	-	-	8	-	-	2	4
- Sensitive Earth fault differential zones	87N	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-
- Check zone	87CZ	-	-	-	-	-	-	-	-	-	-	8	-	-	X	X
- CT supervision	CTS	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X
- CT saturation immunisation		-	-	-	-	-	-	-	-	-	-	-	X	X	X	X
- Fibre optic signalling		-	-	-	-	-	-	-	-	-	-	X	X	X	-	-

Continued on next page...

LINE DIFFERENTIAL, TRANSFORMER AND BUSBAR PROTECTION RELAYS (...CONTINUED)

	Device	P541	P542	P543	P544	P545	P546	P547	P642	P643	P645	P741	P742	P743	P746	P747
Ancillary functions																
Phase overcurrent	50/51P	x	x	x	x	x	x	x	x	x	x	-	x	x	x	x
Phase directional	67P	-	-	x	x	x	x	x	-	x	x	-	-	-	-	-
Ground fault	50/51N	x	x	x	x	x	x	x	x	x	x	-	x	x	x	x
Ground fault directional	67N	-	-	x	x	x	x	x	-	x	x	-	-	-	-	-
CT supervision/ differential CTS	CTS	-	-	x	x	x	x	x	x	x	x	x	x	x	x	x
Sensitive directional earth fault	67N	-	-	x	x	x	x	x	-	-	-	-	-	-	-	-
Wattmetric earth fault	64W	-	-	x	x	x	x	x	-	-	-	-	-	-	-	-
Distance protection	21	-	-	x	x	x	x	x	-	-	-	-	-	-	-	-
Power swing blocking	78	-	-	x	x	x	x	x	-	-	-	-	-	-	-	-
Check sync	25	-	-	x	-	x	-	x	-	-	-	-	-	-	-	-
Negative sequence overcurrent	46	-	-	x	x	x	x	x	x	x	x	-	-	-	-	-
Thermal overload	49	x	x	x	x	x	x	x	x	x	x	-	-	-	-	-
Loss of life and Through fault	LOL	-	-	-	-	-	-	-	x	x	x	-	-	-	-	-
Under/Over frequency	81U/O	-	-	x	x	x	x	x	x	x	x	-	-	-	-	-
Circuit breaker failure	50BF	x	x	x	2	x	2	x	2	3	5	x	x	x	6/18	18
Autoreclose	79	-	3 pole	1/3 pole	-	1/3 pole	-	-	-	-	-	-	-	-	-	-
Over/Under voltage	27/59	-	-	x	x	x	x	-	-	x	x	-	-	-	x	x
Trip circuit supervision	TCS	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

1. Please note that some relays may have a limit on max. I/O when used as a combination
2. Denotes functionality for two circuit breakers per line

APPLICATION TIPS:

- **P145** – the typical high impedance busbar protection choice
- **P541** – for cable and line differential in an economical device size for distribution
- **P543** – the standard choice line differential for subtransmission and transmission applications (s/w 63 with subcycle)
- **P545** – used in applications where the larger case width is required to accommodate a larger binary I/O count (s/w 63 with subcycle)
- **P546** – transmission line differential for breaker and a half and ring bus (mesh) feeding topologies
- **P547** – for phase comparison line unit protection operating via power line carrier
- **P642** – for two winding transformer differential with one set of CTs per side
- **P643** – for three sets of phase CTs in a transformer differential scheme, or where 3-phase voltage-based functionality is required
- **P645** – for transformers requiring four or five CT bias input sets to the scheme
- **P741** – central unit in a decentralised busbar scheme
- **P742** – the typical busbar protection peripheral unit used per feeder bay
- **P746** – for simple busbar topologies with one or two discrete protection zones
- **P747** – centralised busbar protection for up to four zones



AUTORECLOSE RELAYS

	Device	P841	P842
CT Inputs		4/9	-
VT Inputs		4/5	4
Opto Inputs (max)		32	48
Output Contracts (max)		32	32
IEC 61850-9-2 process bus option		X	-
Protection			
Breaker failure protection	50BF	X/2	-
- 2-stage		X	-
- Pole discrepancy		X	-
Autoreclose	79	X/2	X
- Mesh corner/ Single switch		-	X
- Check sync	25	X/2	X
- Ferroresonance suppression		-	X
Voltage and Frequency Protection			
- Undervoltage	27	X	-
- Overvoltage	59	X	-
- Residual overvoltage	59N	X	-
- Under/Over frequency	81U/O	X	-
- Rate of change of frequency (df/dt)	81R	X	-
- Frequency supervised rate of change of frequency (f+df/dt)	81RF	X	-
- Frequency supervised average rate of change of frequency (f+ Δf/ Δt)	81RAV	X	-
- Trip circuit supervision	TCS	X	X

1. Please note that some relays may have a limit on max. I/O when used as a combination.
2. Denotes functionality for two circuit breakers per line

TYPICAL APPLICATION ADVICE:

- **P841** – for autoreclose, check synchronism, breaker fail and backup protection of transmission and subtransmission circuits.
- **P842** – UK-specific mesh corner reclosing device

VOLTAGE AND FREQUENCY RELAYS

Refer to the P40 Agile brochure for details on the P94V compact relays, or deploy a MiCOM Alstom P141-P145 modular IED.

Device track record

P14x series introduced in 1999. Worldwide application, with over 100 000 units delivered.

P24x series introduced in 1999. Worldwide application, with over 14 500 units delivered.

P34x series introduced in 1999. Worldwide application, with over 14 000 units delivered.

P44x series introduced in 1999. Worldwide application, with over 39 000 units delivered.

P54x series introduced in 1999. Worldwide application, with over 29 000 units delivered.

P64x series introduced in 2009. Worldwide application, with over 7 000 units delivered.

P74x series introduced in 2002. Worldwide application, with over 24 500 units delivered.

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