



# MiCOM P40 Agile

## Modular Protection Platform For all Power System Protection applications

The P40 range offers a suite of precision relay functionality and robust hardware ready for deployment in digital substations.

Incorporating a full complement of utility, generation and industrial-focused models the P40 series platform is a principal building block of GE's offer, hosting the wide variety of protection, control, measurement, monitoring and communication functions demanded.

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 P40 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 - GE's MiCOM protection is the answer.

### MiCOM P40 Agile

GE's philosophy is one of continuous improvement in our products and solutions. The 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 GE, and only from GE.

### Customer Benefits

- Intuitive 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
- High speed, subcycle applications

## Comprehensive Solutions

- Generation
  - Integrated generator protection
- Transmission and Distribution
  - Distance protection
  - Line differential
  - Transformer management
  - Busbar protection
  - Feeder management
  - Voltage and frequency protection
  - Load-shedding
  - Breaker fail and reclosing
  - Line phase comparison
  - Phasor Measurement Units (PMU)
- Industrial
  - Motor management
  - Feeder management
  - Interconnection protection
- Rail
  - Catenary protection
  - Trackside AC grids
  - Transformer management
  - Transformer-rectifier units

## 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:

- P14\* - 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 multiplexed and IP 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\* - Motor 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 WAMS applications

### Rail Catenary Protection

- P44T - Subcycle distance protection

## Protection and Control Features

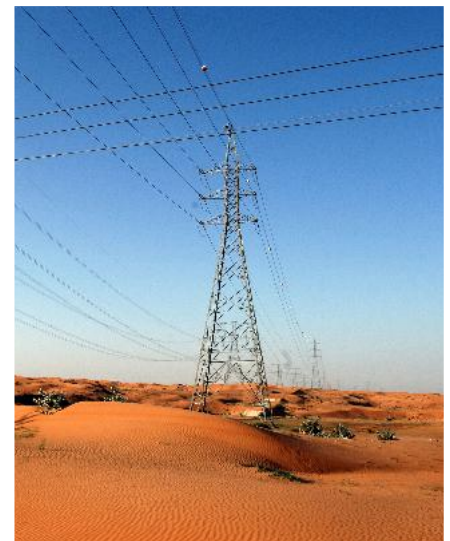
### Protection Elements

All algorithm and hardware know-how is the culmination of decades of advances in GE'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 P40 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.



Designed for reliability and performance

## Programmable Scheme Logic

Powerful logic available in the P40 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 P40 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). 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.

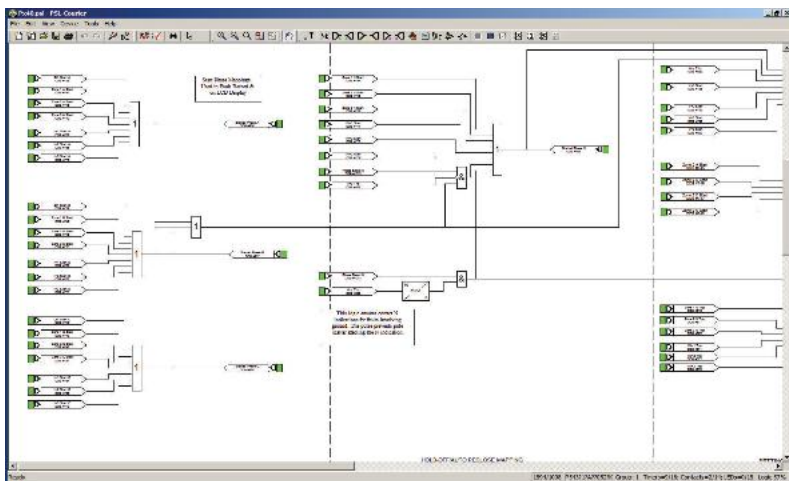


Figure 1 Programmable logic for P40

### 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 P40 platform, the latter available with redundancy.

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

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

PRP has the advantage of taking zero time to recover from a failure, as parallel alternative paths are continually operative. HSR offers zero switchover time in a ring architecture in applications where downtime cannot be tolerated. All settings are configurable with the use of S1 Agile.

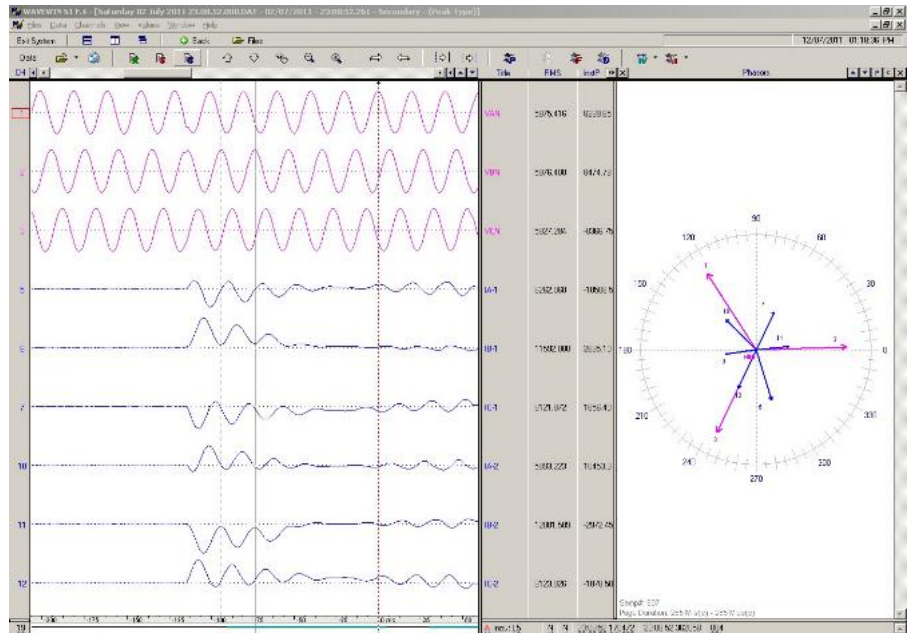


Figure 2 Oscillography analysis using S1 Agile software for optimum results

### User Interfaces

The ability to customise the menu text and alarm descriptions are supported on P40. The front panel user interfaces, as per the example shown in Figure 3 comprise:

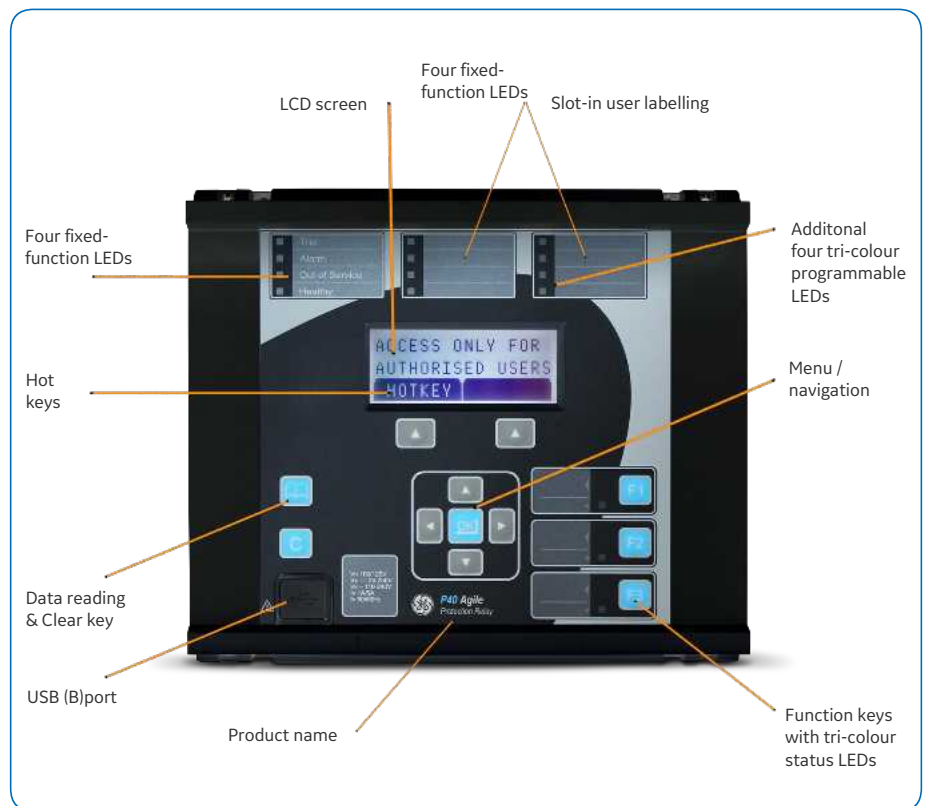


Figure 3 Px40 series user interface

## 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 P40 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 Agile 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.



Figure 4 Typical case dimensions

	Case dimensions	A	B	C	D	E
P40	40TE	177	206	240 (inc wiring)	270 (inc wiring)	157.5 max
	60TE		309.6			
	80TE		413.2			
	80TErack		483			

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

### 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 P40 Agile offers the pinnacle of MiCOM performance.

Interoperable, easy to integrate

## General Series Data Px40

Frequency 50/60 Hz	x
Dual-rated 1 A/5 A	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 3 s
LED Indication (freely programmable)	12 (8) - plus 10 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 (most models)
IEC 60870-5-103	EIA(RS) 485 or fibre (most models)
DNP3.0	EIA(RS) 485 or fibre (most models)
IEC 61850	Available on most models
Terminals	Ring

### Extended Temperature Range Operation

In addition to the standard -25°C to +55°C operating temperatures claim as per IEC 60255-6, the P40 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.

## Technical Data

### Measuring Inputs - Analogue

All CT inputs are dual-rated at 1 A and 5 A 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 digital 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 48-125 110-250	19-65 37-150 87-300	- 24-110 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	
P40	24/27, 30/34, 48/54, 110/125 and 220/250 (software selectable)

## Overcurrent and Feeder Management Relays

### 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

**P144** - used where novel transient earth fault detection algorithm for isolated/Petersen coil systems is required

**P145** - used where F-keys assist engineering of the scheme

**P841** - used for process bus feeder management with IEC 61850-9-2

Standardised ratings,  
standardised inventory

## Overcurrent and Feeder Management Relays

	Device	P141	P142	P143	P144	P145	(P14 NB)	(P14 NZ)	(P14 DB)	(P14 DG)	(P14 DL)	(P14 DZ) <sup>3</sup>
CT inputs		5	5	5	5	5	4	4	4	4	4	4
VT inputs		3	3	4	4	4	-	-	4	4	4	4
Opto inputs (max) <sup>1</sup>		8	16	48	16	32	13	13	13	13	13	13
Output contacts (max) <sup>1</sup>		8	15	32	15	32	12	12	12	12	12	12
Function keys/Hotkeys(Max)		0/2	0/2	0/2	0/2	10/2	3/2	3/2	3/2	3/2	3/2	3/2
Interlocking logic		x	x	x	x	x	x	x	x	x	x	x
<b>Protection</b>												
Autoreclose	79	-	x	x	x	x	-	x	-	-	x	x
Check synchronising	25	-	-	x	-	x	-	-	-	x	x	x
3 Phase overcurrent	50/51P	x	x	x	x	x	x	x	x	x	x	x
Ground fault	50/51N	x	x	x	x	x	x	x	x	x	x	x
Phase directional	67P	x	x	x	x	x	-	-	x	x	x	x
Ground fault directional	67N	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	67W	x	x	x	x	x	-	-	x	x	x	x
Transient Earth fault	TGFD	-	-	-	x	-	-	-	-	-	-	-
Restricted Earth fault	64	x	x	x	x	x	x	-	x	x	x	-
Voltage dependent overcurrent	51V	x	x	x	x	x	-	-	-	x	x	x
Negative sequence overcurrent	46	x	x	x	x	x	x	x	x	x	x	x
Thermal overload	49	x	x	x	x	x	x	x	x	x	x	x
Undercurrent	37	x	x	x	x	x	x	x	x	x	x	x
Over / Under Voltage	27/59	x	x	x	x	x	-	-	x	x	x	x
Residual overvoltage	59N	x	x	x	x	x	-	-	x	x	x	x
Rate of change of voltage	dv/dt	x	x	x	x	x	-	-	-	-	x	x
Negative sequence overvoltage	47	x	x	x	x	x	-	-	x	x	x	x
Over/Under Frequency	810/U	x	x	x	x	x	-	-	-	-	x	x
Rate of Change of Frequency	87R	x	x	x	x	x	-	-	-	-	x	x
Lock-out	86	x	x	x	x	x	x	x	x	x	x	x
Directional power	32	x	x	x	x	x	-	-	-	x	x	x
Circuit breaker failure	50BF	x	x	x	x	x	x	x	x	x	x	x
Broken conductor	46BC	x	x	x	x	x	x	x	x	x	x	x
Voltage Transformer Supervision	VTS	x	x	x	x	x	-	-	x	x	x	x
Current Transformer Supervision	CTS	x	x	x	x	x	-	-	x	x	x	x
Cold load pick-up		x	x	x	x	x	x	x	x	x	x	x
Inrush Blocking		x	x	x	x	x	x	x	x	x	x	x
Switch On To Fault	SOTF	x	x	x	x	x	x	x	x	x	x	x
Circuit breaker monitoring		x	x	x	x	x	x	x	x	x	x	x
Trip Circuit Supervision	TCS	x	x	x	x	x	x	x	x	x	x	x
Fault Locator	21FL	x	x	x	x	x	-	-	-	-	x	x
High Impedance Busbar <sup>4</sup>	87B	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. Refer to the MiCOM Agile P14x and P40 Agile brochure for details on each product model variant.

3. Bracketed relay types show the complementarity with P40 Agile compact family. Note that the platform features and form factor of these compact devices are not described in this brochure.

4. Including sensitive overvoltage buswire supervision.

## Motor and Generator Management Relays

### 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



Device	P241	P242	P243	P341	P342	P343	P344	P345	P346
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CT Inputs	4	4	7	4	5	8	8	10	8
VT Inputs	3	3	3	4	4	4	5	6	4
Opto Inputs (max) <sup>1</sup>	12	16	16	24	24	32	32	32	32
Output Contacts (max) <sup>1</sup>	11	16	16	24	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		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
Loss of field	40	X	X	X	-	X	X	X	X
Restricted earthfault	64	-	-	-	X	X	X	X	X
100% stator earth fault (3rd harmonic)	27TN/59TN	-	-	-	-	-	X	X	-
100% stator earth fault (Low Freq. Injection)	64S	-	-	-	-	-	-	X	-
Overfluxing	24	-	-	-	-	X	X	X	X
Unintentional energisation at standstill	50/27	-	-	-	-	X	X	X	-
Voltage dependent O/C	51V	-	-	-	-	X	X	X	X
Rotor earth fault	64R	-	-	-	-	X	X	X	X

#### Ancillary Functions

Phase overcurrent	50/51P	X	X	X	X	X	X	X	X
Phase directional	67P	-	-	-	X	X	X	X	X
Ground fault	50N/51N	X	X	X	X	X	X	X	X
Sensitive directional earth fault	67N	X	X	X	X	X	X	X	X
Wattmetric earth fault	64N/32N	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
Thermal overload	38/49	X	X	X	X	X	X	X	X
Under/Over voltage	27/59	X	X	X	X	X	X	X	X
Residual overvoltage	59N	X	X	X	X	X	X	X	X
Negative sequence overvoltage	47	X	X	X	X	X	X	X	X
Under frequency	81U	X	X	X	X	X	X	X	X
Over frequency	81O	-	-	-	X	X	X	X	X
Turbine abnormal frequency	81AB	-	-	-	-	X	X	X	X
Voltage vector shift	dV	-	-	-	X	-	-	-	-
Rate of change of frequency	81R	-	-	-	X	X	X	X	X
Circuit breaker fail and monitoring	50BF	X	X	X	X	X	X	X	X
Loss of life/Thru fault monitor	LoL/Thru	-	-	-	X	X	X	X	X
Dynamic line rating	49DLR	-	-	-	X	-	-	-	-
Trip circuit supervision	TCS	X	X	X	X	X	X	X	X



## Distance and Phasor Measurements

Device	P441	P442	P443	P444	P445	P446	P44T	P847
CT inputs	4	4	5	4	4	8	2	3/6/12
VT inputs	4	4	4	4	4	5	3	3/6
Opto inputs (max) <sup>1</sup>	8	16	32	24	16	24	24	24
Output contacts (max) <sup>1</sup>	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	(3)	-	-	X	-	X	-	-
<b>Protection</b>								
Distance protection	21/21N	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	(3)	X	X	X	-	2
- Power swing blocking	78	X	X	X	X	X	X	-
- Out-of-step tripping	68	X	X	X	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
<b>Ancillary functions</b>								
Defrost protection		-	-	-	-	-	-	X
Phase overcurrent	50/51P	X	X	X	X	X	X	X
Phase directional	67P	X	X	X	X	X	X	X
Delta directional comparison	I/V	-	-	X	-	-	X	-
Ground fault	50/51N	X	X	X	X	X	X	-
Ground fault directional	67N	X	X	X	X	X	X	-
Negative sequence overcurrent	46	X	X	X	X	X	X	-
Directional negative sequence	46/67	X	X	X	X	X	X	-
Thermal overload	49	X	X	X	X	X	X	X
Under/Over voltage	27/59	X	X	X	X	X	X	X
Residual over voltage	59N	X	X	X	X	X	X	-
Under/Over frequency	81U/O	-	X	X	X	X	X	-
Rate of change of frequency	81R	-	-	X	-	X	X	-
Circuit Breaker Failure	50BF	X	X	X	X	X	2	X
Broken Conductor	46BC	X	X	X	X	X	X	-
Stub Bus Protection	50ST	X	X	X	X	X	X	-
Voltage/Current Transformer Supervision	VTS/CTS	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
InterMiCOM		-	X	X	X	X	X	X

## Application Tips

**P441 and P445** – for smaller device size and optimum functionality for sub-transmission and distribution

**P442 and P444** – distance relay for transmission applications

**P443** – distance relay with subcycle tripping fastest fault clearance. Model options extend to solid, resistive and Petersen/isolated earth applications.

**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

(3). Only in P441 sw80, all other versions do not have this option

## 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	5	8	12	18	4	4	4	18	18	
VT Inputs (max)	-	-	4	5	4	5	4	2	4	4	-	-	-	3	3	
Opto Inputs (max) <sup>1</sup>	8	16	16	16	32	24	24	12	40	40	8	16	24	40	48	
Output Contacts (max) <sup>1</sup>	7	14	14	14	32	32	32	12	24	24	8	8	21	32	32	
Analogue I/O (option) <sup>1</sup>	-	-	-	-	-	-	-	4/4	4/4	4/4	-	-	-	-	-	
RTDs (option) <sup>1</sup>	-	-	-	-	-	-	-	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	-	
<b>Protection</b>																
<b>Line differential</b>	87P	x	x	x	x	x	x	-	-	-	-	-	-	-	-	
- 2 terminal																
- Neutral differential	87N	-	-	x	x	x	x	-	-	-	-	-	-	-	-	
- 2/3 terminal		x	x	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	-	-	-	-	-	-	-	-	
<b>Phase comparison</b>	87PC	-	-	-	-	-	x	-	-	-	-	-	-	-	-	
- PLC signalling		-	-	-	-	-	x	-	-	-	-	-	-	-	-	
<b>Transformer Differential</b>	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	-	-	-	-	-	-	1	2	2	-	-	-	-	-	
- 2nd harmonic restraint		-	-	-	-	-	-	x	x	x	-	-	-	-	-	
<b>Busbar Protection</b>	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
<b>Ancillary functions</b>																
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	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	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

**P545** – used in applications where the larger case width is required to accommodate a larger binary I/O count

**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	(P94VR)
CT Inputs		5/	-	-
VT Inputs		4/5	4	4
Opto Inputs (max)		32	48	13
Output Contracts (max)		32	32	12
IEC 61850-9-2 process bus option		X	-	-
<b>Protection</b>				
<b>Breaker failure protection</b>	50BF	X/2	-	-
- 2-stage		X	-	-
- Pole discrepancy		X	-	-
<b>Autoreclose</b>	79	X/2	X	
- Mesh corner/ Single switch		-	X	-
- Check sync	25	X/2	X	x
- Ferroresonance suppression		-	X	-
<b>Voltage and Frequency Protection</b>				-
- Undervoltage	27	X	-	x
- Overvoltage	59	X	-	x
- Residual overvoltage	59N	X	-	x
- Under/Over frequency	81U/O	X	-	x
- Rate of change of frequency (df/dt+t)	81R	X	-	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.

3. Bracketed relay type P94VR shows the complementarity with P40 Agile compact family. Note that the platform features and form factor of this device is not described in this brochure.

## Device track record

P14x series introduced in 1999. Worldwide application, with over 130,000 units delivered.

P24x series introduced in 1999. Worldwide application, with over 17,000 units delivered.

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

P44x series introduced in 1999. Worldwide application, with over 50,000 units delivered.

P54x series introduced in 1999. Worldwide application, with over 37,000 units delivered.

P64x series introduced in 2009. Worldwide application, with over 14,000 units delivered.

P74x series introduced in 2002. Worldwide application, with over 32,000 units delivered.

## Typical Application Advice

**P841** – for autoreclose, check synchronism, breaker fail and backup protection of transmission and sub-transmission 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 Agile P141-P145 modular IED.

For more information please contact  
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