

# MiCOM AGILE P84



## 5<sup>th</sup> Generation Feeder and Backup Protection

The MiCOM Agile P84 provides unparalleled protection and control of overhead lines and underground cables, accommodating any method of system earthing, and extending to cover the most onerous applications. One device reaches from distribution and sub- transmission up to the highest transmission voltage applications.

In all applications, supervision of correct breaker functioning and management of autoreclose cycles for power restoration after a fault are critical. Internal circuit breaker fail elements, autoreclose control and check synchronism ensure that these primary goals are achieved.

The logic capability of P84 devices is extremely versatile, for instance managing leader - follower reclosing schemes in the case of dual breaker applications. Single-pole and 3-pole breaker operation is supported, with independent supervision and condition monitoring statistics per pole. Trip circuit supervision, control and interlocking schemes can be designed in graphical support software.

One-box bay control capabilities for up to two circuit breakers and up to eight other controllable switchgear items are presented using a full colour graphical HMI screen. Use the function keys to replace control scheme switches and save on engineering time and wiring costs.

### Key Features

- Serial and Ethernet concurrent protocols, switchable by settings
- Advanced IEC 61850 Edition 2.1 implementation
- Advanced Security including AAA, RADIUS, RBAC, and Syslog
- With fast start up time of less than 10s, resulting in protection, control and communications without the need to wait
- Improved system stability by CB failure fast reset element (< 0.75 cycle)

### Applications

- Single circuit breaker applications
- Breaker and a half, or mesh feeding with two sets of CT inputs, with settable independent CT ratios
- All applications where feeder main or backup overcurrent protection is required - suitable for solidly earthed, impedance earthed, Petersen coil earthed and isolated systems.

### Protection & Control

- Specialist autoreclose control and check synchronism device
- Feeder protection for solidly, impedance, Petersen coil earthed and isolated systems
- Use as main or backup protection
- Single circuit breaker applications (P84 model A)
- Breaker and a half, double bus or ring bus with dual breaker control (P84 model B)

### Advanced Communications

- Redundant communications with zero downtime using optional PRP/HSR protocols
- Latest communication protocol implementation with IEEE 1588 precision- time (PTP)

### Cybersecurity

- Designed with an IEC 62443-4-1: 2018 certified Secure Development Lifecycle Process
- Provides the necessary capabilities to build an IEC 62443-3-3: 2013 compliant solution

### One-Box Concept

- Integrated full colour display, for single-line diagram control of the protected bay
- Open, close, local/remote and direct function key access facilitate the control of connected switchgear – two circuit breakers plus eight other controllable plant items
- Select-before-operate, breaker health checks and interlocking capabilities



GE VERNOVA

## Applications

The configuration column of the menu is used to control which functions the user requires in the intended application, and which may be disabled. Disabled functions are completely removed from the menu, to reduce configuration effort. Intelligent dependencies between settings further supervise visibility, serving to declutter and accelerate the configuration experience.

## Functional Overview

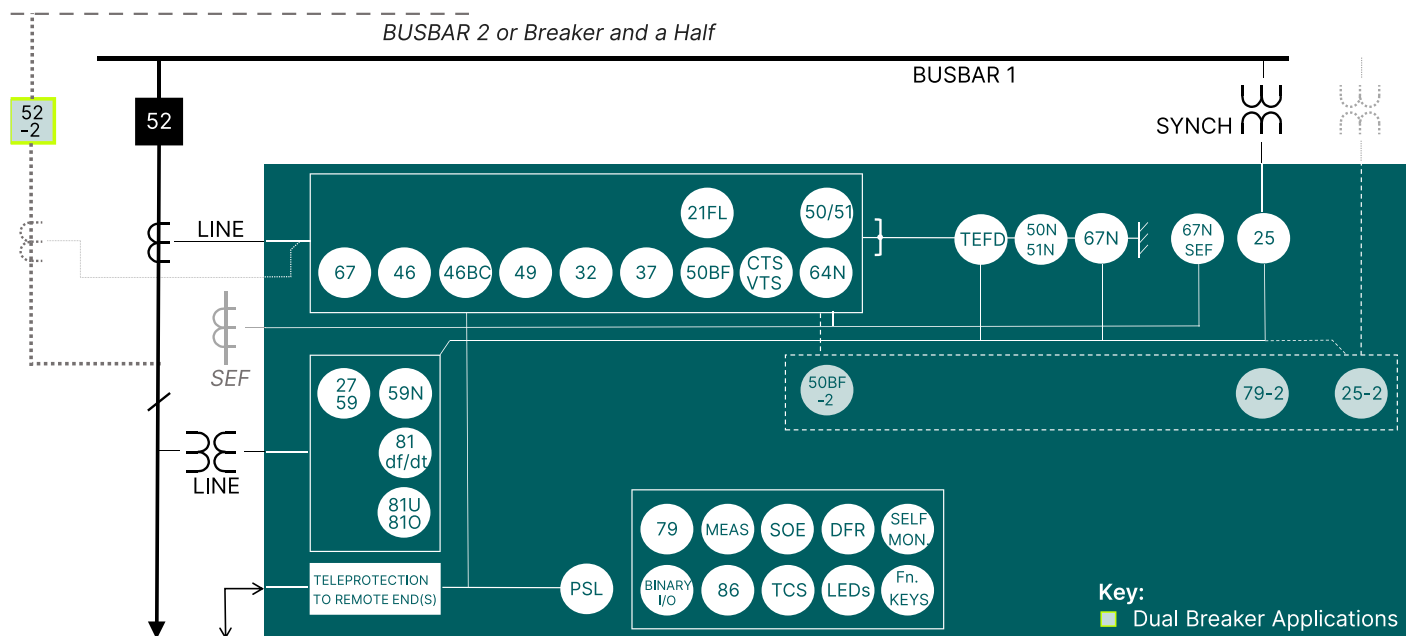


Figure 1: System overview example

## ANSI® Device Numbers & Functions

DEVICE NUMBER	FUNCTION
25	Check Synchronising
27	Phase and Line Undervoltage
37	Undercurrent
46	Negative Sequence Overcurrent
49	Thermal Overload
50	Phase Definite Time Overcurrent
51	Phase Inverse-Time Overcurrent
52	Circuit Breaker Control
59	Phase and Line Overvoltage
67	Directional Phase Overcurrent

DEVICE NUMBER	FUNCTION
79	Autoreclose/Adaptive Autoreclose
86	Latching/Lockout Contacts
21FL	Fault Locator
46BC	Broken Conductor
50BF	CB Failure
50N	Earth Fault Definite Time Overcurrent
51N	Neutral/Ground IDMT Overcurrent
59N	Neutral Voltage Displacement
64N	Restricted Earth Fault

DEVICE NUMBER	FUNCTION
67N	Directional Neutral/ Ground Overcurrent
81df/dt	Rate of Change of Frequency
81O	Overfrequency
81U	Underfrequency
CTS	CT Supervision
PSL	Programmable Logic
SEF	Sensitive Earth Fault
TEFD	Transient Earth Fault Detection
TCS	Trip Circuit Supervision
VTS	VT Supervision

## Feeder Main and Backup Protection

The P84 is exceptionally versatile and may be used as a feeder main protection relay, as back-up protection such as in transmission applications, and/or as an autoreclose control device. The rich set of features that the P84 offers makes it suitable for a multitude of feeder and control applications.

### Phase, Earth and Negative Sequence Overcurrent

Four stages of both phase and earth fault protection are provided, each selectable as non-directional or directional (forward/reverse). In addition to definite time and predefined IDMT curve selection (see Figure 2), the P84 supports user programmable curves for customised operation and resetting. The profile can be chosen to optimise the protection, without constraining loadability. If a standard curve is not suitable for the application, the user can program and upload a custom variant.

The IDMT stages have a programmable reset timer for grading with electromechanical relays, to reduce autoreclose dead times and to reduce clearance times where intermittent faults occur. The phase fault directional elements are internally polarised by quadrature phase - phase voltages and will make a correct directional decision down to 0.5V.

A synchronous polarising signal is maintained for 3.2s after voltage collapse to ensure that the instantaneous and time delayed overcurrent elements operate correctly for close-up 3-phase faults.

The directionality of the earth fault elements is provided by either residual voltage or negative sequence voltage.

Negative sequence overcurrent is also provided.

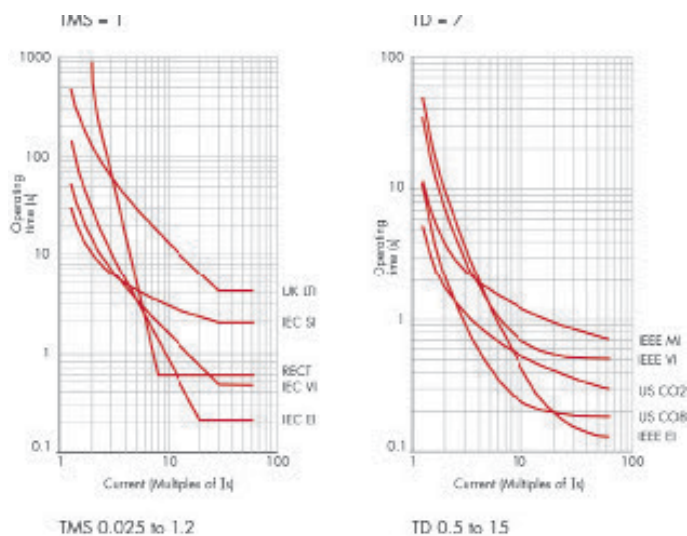


Figure 2: Standard IDMT curve types

### Sensitive Earth Fault

Sensitive earth fault (SEF) with  $0.5\% \times I_n$  sensitivity is also provided.

A core balance CT should be used to drive the sensitive earth fault function. The directionality of the sensitive earth fault element is provided by the residual voltage

### Autoreclose and Check Synchronism

The P84 excels in its ability to manage high speed and delayed autoreclose schemes at any system voltage, for single breaker and dual breaker topologies. The latter caters for double-bus and breaker and a half applications.

#### Dual Breaker Autoreclose (model B)

The following additional features are offered, to permit two breaker reclosing in a leader/follower scheme:

- Two CB Control - CB1 and CB2 are assigned
- Individual selection of recloser 'on or off'
- Leader-follower configuration
- Independent lockout and reset per breaker

#### Both P84 models offer:

- Single-pole autoreclose - One single-pole shot, followed by up to three 3-pole shots with independent dead times
- 3-pole autoreclose - Up to 4 shots, independent dead times
- BAR for 2 and 3-phase faults - Logic to decide whether A/R should proceed for multiphase faults
- Unlatching - Safety interlock to ensure the CB was closed prior to the A/R sequence
- Dead Time Start - Protection Operation, Protection Reset, CB Trip or Dead Line
- AR in progress - Segregated indication that a single-pole (1P) or 3-pole (3P) cycle is in progress
- Discrimination timer - To decide whether a fault affecting another phase during the single-pole dead time is an evolution of the trip, or is a new fault appearance
- CB health - Energy monitor to check that the breaker is OK to perform a close
- Reclaim timer
- A/R successful - Indication of a successful close
- Sequence counter - Status indication, so that special protection logic may be assigned for each reclose shot number

## Adaptive Reclosing (Single Pole Tripping Applications)

The MiCOM P84 has adaptive reclosing, allowing the instant of fault arc extinction to be detected. Reclosing is made possible without having to wait for a regular long, fixed dead time. In so doing, synchronising power is flowing in all three phases quicker, lessening the stability risk to weakly-interconnected systems and/or those with long transmission corridors. Conversely, it allows better identification of persistent faults, allowing a drive to lockout response. Unnecessary operations of switchgear can be prevented, avoiding an extra close and trip shot, thus avoiding additional circuit breaker wear.

The principle of adaptive reclosing is shown in Figure 3.

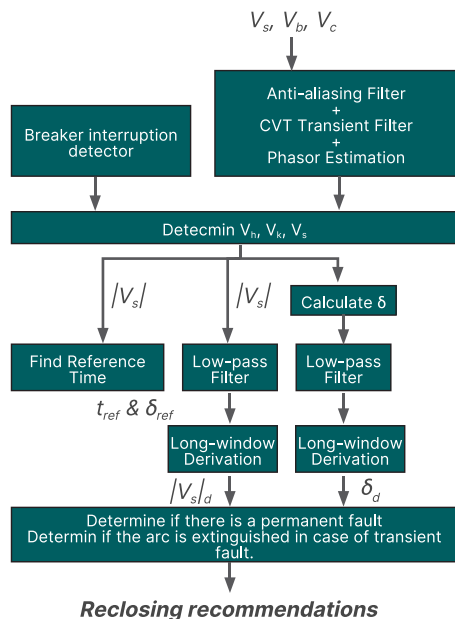


Figure 3: Adaptive reclose logic processing

The algorithm uses the rate of change of the faulted phase voltage and angle to distinguish between transient and persistent faults and to detect the time when the arc is extinguished. Typically, the transient fault dead time can adapt to less than 0.25s – half of a traditional fixed dead time – to be ready to reclose as soon as the circuit breaker's trip-free mechanism has reset.

## Check Synchronism

Operating capabilities include:

- Check synch time - A wait period for check synch to pick up, if not already OK at the end of the dead time.
- Delta V, delta f, angle, t - Four conditions possible: voltage magnitude difference, slip frequency, angle and time.
- CS voltage window - Limiting the CS function to operate only when line and bus voltages are within a specific range.
- Dead/Live Line/Bus - All setting permutations of dead and live (hot) reclosing: DLLB, LLDB, LLLB, DLDB.
- AR immediate - Fast closing possible, without waiting for the expiry of the dead time. Allows reclosing if the remote end closes successfully first.

- Check on shot 1 - To decide whether a high speed 3-pole reclose (shot 1) can happen without a synchrocheck. This assumes the dead time is short, and no drift out of phase could have occurred.

## Other Protection Functions

### Circuit Breaker Failure

Two-stage, phase-segregated circuit-breaker failure protection may be used for tripping upstream circuit-breakers and for re-tripping the local circuit-breaker if required. The undercurrent elements used in the CB fail reset mechanism detect the breaker opening in real-time, even when there are subsidence currents in the CT secondary caused by the remnant flux.

### Breaker and a Half, Double Bus or Ring/Mesh Feeding

The model B order code offers two sets of CT inputs. The two CTs may have different ratios, which are independently settable in the relay. In the event of breaker failure, the relays will identify the individual failed breaker. If the line is disconnected (line isolator open), the relay provides protection for the stub bus zone.

### Voltage Protection

Under/overvoltage protection may be configured to operate from either phase-phase or phase-neutral quantities. Four independent stages are provided, with a mix of definite time and inverse-time characteristics. A compensated overvoltage function protects the line from Ferranti overvoltages by calculating the positive sequence voltage at the remote terminal.

Residual overvoltage protection is available for detecting earth faults in high impedance earthed or isolated systems.

### Broken Conductor

The broken conductor protection detects unbalanced conditions caused by broken conductors, or maloperation of a single phase of switchgear. It operates on the ratio of I2 to I1.

### Thermal Overload

A single time constant characteristic as per IEC 60255-8 is provided to protect cables, dry type transformers and capacitor banks. An additional dual time constant characteristic is suitable to protect in-zone oil-filled transformers, serving to protect the winding insulation from ageing and to minimise gas production by overheated oil.

### Power Protection

Four stages of directional power protection are provided and each stage can be independently configured to operate as overpower or underpower and forward or reverse direction.

### Frequency Protection

Nine stages each of: overfrequency, underfrequency, rate of change of frequency, frequency supervised rate of change of frequency, average rate of change of frequency – for frequency-based load shedding during severe system disturbances.

## Restricted Earth Fault

Restricted earth fault (REF) provides protection for transformer winding faults on the protected feeder, avoiding the need to install a separate discrete relay.

## Supervisory Functions

### VT Supervision (Fuse Fail)

Voltage transformer supervision is provided to detect loss of one, two or three VT signals for line VTs.

### CT inputs – Safety and Supervision

All CT inputs are dual-rated at 1 A and 5 A to simplify ordering and strategic spares inventories. The terminal block features integral shorting to prevent dangerous voltages being present should the block be removed. This affords additional safety to personnel who may be working near live apparatus.

Current transformer supervision is provided to detect loss of phase CT input signals.

## IEC 61850-9-2 LE Process Bus Interface

An optional process bus interface is available, allowing the relay to receive current and voltage sampled data from digital instrument transformers. In other digital substation architectures, the -9-2 data is generated by merging units in the yard which digitise conventional 1 A/5 A and 100/120 V secondaries, for safer and more economical cross-site communications to IEDs via fibre optics.

Grid Solutions' -9-2 LE implementation is designed to be especially resilient and reliable in the presence of "noise", such as latency, jitter or missing/suspect data.

## Control and Logic

### User Interface

Ten function keys in 60 and 80TE case sizes operate in two modes, normal and toggled, with integrated tricolour programmable LEDs. These replace traditional hardwired control scheme switches and annunciation, saving on engineering time and wiring costs. Thirteen further tricolour LEDs are available, freely-configurable, in addition to five fixed-function LEDs

In addition to support of English, French, German, Spanish, Italian, Portuguese and Polish languages, the ability to customise the menu text and alarm descriptions is available. Easily switch between English and an additional language on the local display without uploading new firmware.

A USB front port offers ready access by field personnel's laptop computers.

### One-Box Switchgear Control

Circuit-breaker control is available from the front panel user interface, optically isolated inputs and remotely via the substation communications. 8 sets of switch control logic, LN CSWI/XSWI for controlling/monitoring of disconnectors and earth switches are also available.

Operation of the bay is greatly assisted using the colour graphical HMI, open/close buttons and local/remote control mode switching.

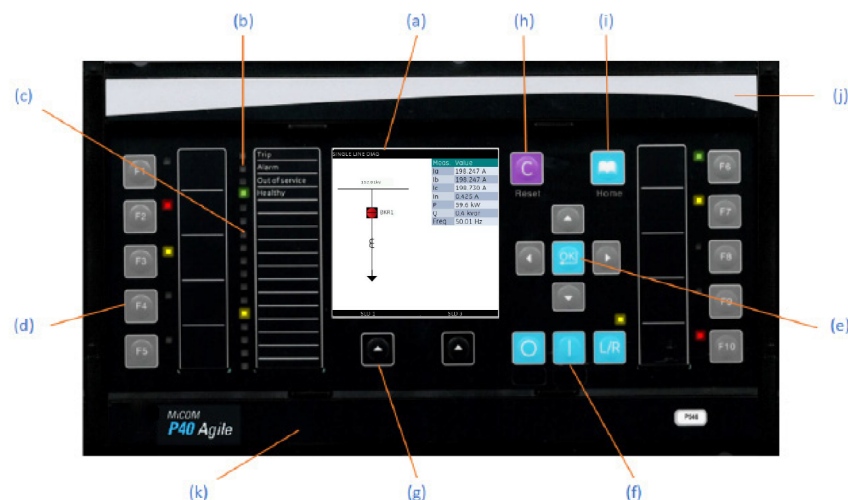


Figure 4: Front fascia view

- a. Colour Screen
- b. Four Fixed-Function LEDs
- c. 13 Tricolour Programmable LEDs
- d. Ten Function Keys with Tricolour LEDs
- e. Menu Navigation and Data Entry
- f. Bay Control and Local/Remote with LED
- g. Context-Sensitive Keys
- h. Clear Key – Long Press to Reset
- i. Read Key – Long Press to Return to Home Screen
- j. Top Flap Conceals CORTEC and Rating Labels
- k. Bottom Flap Conceals USB(B) Access Port



## Programmable Scheme Logic (PSL)

Powerful graphical logic allows the user to customise the protection and control functions (see Figure 5). The logic includes 32 timers, 32 counters, 512 gates (OR, AND, MAJORITY) and set/reset latch functions, with the ability to invert the inputs and outputs and provide feedback. Each gate can support a large array of inputs, with a simple right-click of inputs or outputs serving to invert the signal. Output contacts have optional latching (lockout) functionality.

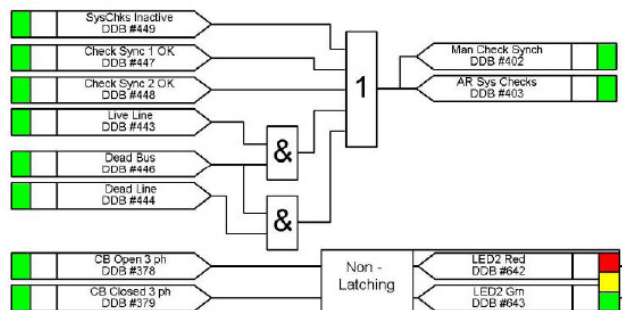


Figure 5: Programmable Scheme Logic

The PSL can be used to implement trip circuit supervision or implement complex logic such as frequency restoration schemes. Schemes are developed capable of supervising the trip coil and circuit with the circuit breaker open or closed, achieving full 'H7' performance.

GE Vernova's MiCOM Agile is deterministic – intensive logic and multiple nested gates do not affect the speed of protection tripping, I/O processing, measured or sampled values acquisition nor GOOSE response. The logic gates are processed concurrently, such that logic 'race' scenarios are eliminated.

All aspects of MiCOM P40 IED configuration are managed using the S1 Agile software (see Figure 6). The software is license-free, and able to support interfacing with .xrio and CAPE simulation environments, and easy Excel import/export where required.



Figure 6: S1 Agile: a powerful and intuitive PC-toolsuite

## Binary Inputs and Outputs

Opto-isolated binary inputs comply to the ESI 48-4 EB2 standard and are immune to inductive fields created in substations where wiring runs for hundreds of metres in the yard and neighbouring wires, busbars and power conductors create strong fields. The inputs support programmable pickup with no spurious pickup during battery ground faults or capacitive discharges, thereby making them perfect for plant status monitoring.

Each output relay module provides normally-open (form A) and a generous mix of changeover (form C) contacts. Optional high-speed/ high-break contacts are available, with 30A high break rupturing ensuring no burn-out of contacts during normal operations or situations such as breaker failure or defective CB auxiliary contacts.

## Measurement and Recording

All event, fault and disturbance records are time tagged to a resolution of 1 ms. IEEE 1588, NTP or an optional IRIG-B port are available for accurate time synchronisation.

## Power System Measurements

Instantaneous and time integrated voltage, current and power measurements are provided. These may be viewed in primary, or secondary values.

## Post-Fault Analysis

### Fault Location

A fault location algorithm provides distance to fault in miles, kilometres, ohms or percentage of the line length. The innovative algorithm employed tolerates prefault loading and fault arc resistance.

### Event Records (SOE)

Up to 5000 time-tagged event records can be stored.

### Fault Records

The last 100 fault records are stored as minimum.

### Disturbance Records

The oscillography has 16 analogue channels, 128 digitals and 1 time channel, all at a high resolution of 48 samples/ cycle. With 1050s of recording capability, ability to store 100 waveforms of maximum duration of upto 10.5 second duration can be stored.

## Circuit-Breaker Condition Monitoring

- Monitors the number of breaker trip operations
- Records the sum of broken current quantity (wear, interruption duty)
- $\sum I_x, 1.0 \leq x \leq 2.0$
- Monitors the breaker operating time

## Communications with Remote Operators and Substation Automation

The following protocols are available:

- Courier/K-Bus
- IEC 60870-5-103
- DNP 3.0 (EAI-485 serial)
- IEC 61850 Edition 2.1 station bus
- IEC 61850-9-2LE process bus
- IEEE 1588 precision-time protocol
- SNTP time synchronisation
- IRIG-B time synch, modulated or demodulated
- RSTP, or PRP and HSR as per IEC 62439-3
- SNMP v2c and v3
- USB front-port communication

P84 devices can be enhanced with an optional redundant Ethernet board. The redundancy is managed by the market's fastest recovery time protocols: IEC 62439-3 PRP and HSR allowing bumpless redundancy and RSTP, offering multi-vendor interoperability.

The Ethernet boards include a dedicated RJ45 engineering port, typically for engineering access by protection engineers/operators when the main Ethernet ports are reserved for SCADA traffic.

To help smooth transition from the existing protocol to IEC 61850, the P84 relay has been designed to provide Courier, -103 or DNP3 on the RS485 port, whilst providing IEC 61850 on the Ethernet port(s). This allows customers to future-proof their investment, getting ready for any future SCADA/DCS upgrade.

### Second Rear Serial Port

An additional second rear Courier port can be ordered as an option, designed typically for engineering access by protection engineers/operators when the main port is reserved for SCADA traffic.

## Asset Life Extension

In addition to new-build, GE Vernova's 5th generation MiCOM relays can be used to refurbish time-served protection schemes. As the P84 is pin-pin compatible with forerunner P141, P142, P143, P145 and P841 relays from AREVA and GE Vernova, they can be interchanged in minutes for an easy upgrade. This dramatically reduces the retrofit time and cost.

## Environmental Responsibility

The Relays are manufactured in a lead-free soldering process using lead-free components. Power dissipation is low, for smaller station batteries and to reduce the global warming potential (GWP) during the installed life.

GE Vernova-branded MiCOM P40 relays have no resident battery, to ease airfreight logistics and dispense with a maintenance item.

## Cybersecurity

The sophistication of protection schemes, coupled with the advancement of technology, increasingly leads to devices and substations being networked. This introduces a potential

security risk making the grid vulnerable to cyber-attack. To secure communication within such environments, MiCOM Agile P84 offers NERC®-compliant cyber security.

## Quality Built-In (QBi)

Parts stress analysis in R&D, rigorous component supplier selection, and a shipping carton compliant with ISTA protection requirements all are examples of best-practice to maximise long-life reliability. All circuit boards have harsh environmental coating, to resist moisture, salt, corrosive atmosphere and industrial ambient pollution – as standard. The relay's case offers full encapsulation, with no ventilation holes for dust ingress.

Circuit board production uses in-circuit tests, boundary scanning, built-in self-test, automated optical inspection, and X-ray scanning to achieve maximum test coverage.

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.

All MiCOM models offer power-up diagnostics and continuous self-monitoring for high availability.

All of GE Vernova's MiCOM range is manufactured in ISO 27001 certified factories.

## Case Parameters

CASE TYPES	40 TE / 60 TE / 80 TE
Weight (40TE case)	7 kg - 8 kg*
Weight (60TE case)	9 kg - 12 kg*
Weight (80TE case)	13 kg - 16 kg*
Dimensions in (40TE case)	W: 206.0 mm H: 177.0 mm D: 243.1 mm
Dimensions in (60TE case)	W: 309.6 mm H: 177.0 mm D: 243.1 mm
Dimensions in (80TE case)	W: 413.2 mm H: 177.0 mm D: 243.1 mm
Mounting	Panel, rack or retrofit

\* Depending on chosen options



GE VERNOVA'S MICOM TRACK RECORD	
400000	MiCOM P40 relays shipped from GE Vernova's plants
75000	P44x line and cable distance shipped
160000	Feeder manager and line terminal relays shipped

## Ordering Options

### Ordering Information

CORTEC ORDER CODE MATRIX											1-3	4	5	6	7	8	9	#	#	12-13	#	#
<b>Multi-Functional Line Terminal with Autoreclose / Check Synchronising</b>											P84	1								**		
Model A: Single Breaker Application																						
Model B: Breaker and a Half or Dual Breaker Application																						
<b>Nominal Auxiliary Supply Voltage</b>																						
24-54 Vdc													7									
48125 Vdc (40-100 Vac)													8									
110-250 Vdc (100-240 Vac)													9									
<b>CT and VT Ratings</b>																						
Model A: Autoreclose for one CB Dual rated CT(1/5A :100-120V)																						
Model B: Autoreclose for one/two CB Dual rated CT(1/5A :100-120V)																						
IEC 61850-9-2LE Redundant Sampled Analogue Values Ethernet - process bus model *																						
<b>Hardware Options</b>																						
Standard - 1 x RS485 rear serial communications port provided with all ordering options (Courier, -103, DNP3 ready)																						
With additional IRIG-B (Modulated)																						
With additional IRIG-B (Modulated) & Serial Fibre Optic comms																						
With 2nd Courier protocol Rear Port + IRIG-B modulated *																						
Redundant Ethernet PRP/HSR/RSTP/Failover: 2 multi-mode fibre ports + Modulated/Un-Modulated IRIG-B *																						
Redundant Ethernet PRP/HSR/RSTP/Failover: 2 copper ports RJ45 + Modulated/Un-Modulated IRIG-B *																						
Single and Redundant Ethernet Failover: 1 copper port RJ45 + 1 multi-mode fibre port+ Modulated/Un-Modulated IRIG-B *																						
Single Ethernet 1 LC Duplex port + Universal IRIG-B + 1588 + 1 RJ45 Maintenance Port **																						
Redundant Ethernet PRP/HSR/RSTP/Failover 2 LC Duplex port + IEC870-103 Serial Fibre ST ports+ Universal IRIG-B + 1588 + 1 RJ45 Maintenance Port **																						
Redundant Ethernet PRP/HSR/RSTP/Failover 2 RJ45 + Universal IRIG-B + 1588 + 1 RJ45 Maintenance Port **																						
Redundant Ethernet PRP/HSR/RSTP/Failover 2 LC Duplex ports+ Universal IRIG-B + 1588 + 1 RJ45 Maintenance Port **																						
* only available with SW AA																						
** only available with SW AB																						
<b>Input/Output Options</b>																						
8 inputs, 7 outputs																						
8 inputs, 8 outputs																						
8 inputs, 14 outputs																						
12 inputs, 12 outputs																						
16 inputs, 14 outputs																						
16 inputs, 16 outputs																						
16 inputs, 16 outputs + 4 High-Speed High-Break																						
16 inputs, 21 outputs																						
16 inputs, 24 outputs																						
20 inputs, 20 outputs **																						
24 inputs, 16 outputs **																						
24 inputs, 16 outputs + 8 High-Speed High-Break																						
24 inputs, 24 outputs **																						
24 inputs, 32 outputs																						
28 inputs, 43 outputs																						
32 inputs, 24 outputs **																						
32 inputs, 32 outputs																						
40 inputs, 24 outputs																						
40 inputs, 32 outputs **																						
<b>Product Specific Options</b>																						
Standard Version																						
<b>Case Size and Mounting</b>																						
80TE Case - Flush/Panel Mounting with Harsh Env. Coating, with USB Port and 10 Function Keys																						
80TE Case - 19" Rack Mounting with Harsh Env. Coating, with USB Port and 10 Function Keys																						
40TE Case - Flush/Panel Mounting with Harsh Env. Coating, with USB Port, without Function Keys																						
60TE Case - Flush/Panel Mounting with Harsh Env. Coating, with USB Port and 10 Function Keys																						
<b>Product Features</b>																						
Single Breaker																						
Breaker and Half or Dual Breaker Application																						
<b>Software Version</b>																						
Major Version - please Visit Online store to select																						
<b>Customer-Specific Additions</b>																						
Standard version																						
Customer-specific configuration/options																						
<b>Hardware Version</b>																						
5th Generation Hardware, Graphical Colour HMI with High Performance Processing																						



For more information, visit  
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