

# Agile P24xM

## Motor Management Series

GE's Agile P24xM Motor Management Series, a member of the field proven P40 Agile protective relay platform, and has been designed for the protection, control, and management of medium voltage motors in industrial applications. The P24xM series offers a small, flexible form factor, advanced and redundant communications, multiple I/O options, and is available with current inputs (P24NM) or with current and voltage inputs (P24DM).

The P24NM (with current inputs) and P24DM (with current and voltage inputs) motor protection devices bring the design rigour and technology of transmission applications to the entire utility and to the industrial market. The footprint of both the device's physical size and the lifecycle environmental impact have been minimised using state-of-the-art design, component, and process selection. Agile solutions from GE are ideal for new-build and retrofit alike.

## Application Flexibility for Low to Medium Sized Motors

With a compact design (4U height), multiple frame widths (4", 6" and 8"), and redundant communications, including support for IEC 61850, the P24xM offers the flexibility needed to support a wide variety of applications including protection and control of pumps, conveyors, fans, compressors and others in process or manufacturing industries.

## Key Benefits

- Cost-effective, flexible protection and control device for medium voltage motors
- Field-proven algorithms and reliable protection to avoid unwanted trips or under-protection
- Ease of integration and standardisation with universal CT inputs and versatile 4U case sizes
- Time stamped event reports and waveform capture
- Powerful security and hierarchical password control
- Advanced power system and switchgear diagnostics
- User programmable motor overload curve
- Drawout design simplifies testing, commissioning and maintenance, increasing process uptime
- Flexible communications with multiple ports and protocols allowing seamless integration
- Intuitive configuration software and user-friendly logic configuration tool

## Applications

- Protection and control of small to medium sized motors (typically up to 1MW)
- Protection of pumps, conveyors, fans, compressors, and others in process or manufacturing industries
- Applications requiring fast and secure or redundant communications
- Harsh environments requiring protection against corrosive chemicals and humid environments

Model	Hardware Base	Intended Application	Case Model
P24NM	P24N	Motor Protection (current elements only)	20, 30 or 40TE
P24DM	P24D	Motor Protection (current, voltage & power elements)	20, 30 or 40TE



## Protection and Control

- Comprehensive motor protection functions
- Multi-stage independent protection elements, variety of curves in 4 setting groups
- Machine thermal image monitoring and start supervision
- Anti-backspin and Emergency Restart

## Metering and Monitoring

- Comprehensive metering and power-up diagnostics
- Two stage circuit breaker failure and breaker condition monitoring
- Plant supervision including CT/VT, DC supply, full Trip Circuit Supervision, CB failure
- Switch control and status (up to 8), up to 2048 events and 10.5 s disturbance records
- Comprehensive start sequence and re-acceleration scheme

## Advanced Communications

- Up to two Ethernet ports with options for redundancy protocols (RSTP or PRP/HSR)
- SNTP or IRIG-B time synchronization
- Multiple communication protocols including IEC 61850, Modbus, DNP 3.0, IEC 60870-5-103 and Courier/K-Bus

## Ease-of-Use

- Compact and withdrawable design with 4", 6" and 8" case width options
- Simplified standardisation via programmable binary input voltage, universal CTs and power supply
- Deploy as cable feeder protection in industrial plants - motor and feeder protection from a single device



## Functional Overview

ANSI code	Function	P24NM	P24DM
50	Definite time overcurrent protection	6	6
50N	Neutral/earth definite time overcurrent protection (Measured and derived)	4	4
51	IDMT overcurrent	3	3
51N	Neutral/Earth IDMT overcurrent protection	2	2
50/51SEF	Sensitive earth fault	4	4
68	Inrush blocking	.	.
	Cold load pick up	.	.
46	Negative sequence overcurrent	4	4
	Programmable curves	4	4
67	Directional phase overcurrent		6
	Directional neutral overcurrent		4
67N	Sensitive directional earth fault		4
	Wattmetric earth fault		.
	Blocking scheme	.	.
37	Undercurrent detection	.	.
32R	Reverse power		.
49	Thermal overload (current replica)	.	.
48/51LR	Start / Stalled protection	.	.
66	Number of starts limitation	.	.
64N	Restricted earth fault	.	.
14	Speed switch input	.	.
	Emergency restart	.	.
50BF	CB failure	2	2
27	Undervoltage		3
27V	Positive sequence undervoltage		2
59	Overvoltage		3
59V	Positive sequence overvoltage		2
59N	Residual overvoltage		3
47	Negative sequence overvoltage		2
27LV	Motor reacceleration		.
27Abs	Anti backspin		.
81O	Overfrequency		9
81U	Underfrequency		9
81V	Undervoltage blocking of frequency protection		.
81df/dt	Rate of change of frequency (dv/dt)		9
81RF	Frequency supervised rate of change of frequency		.
81RAV	Frequency supervised average rate of change of frequency		.
81R	Frequency restoration		.
PSL	Programmable scheme logic	.	.
86	Latching output contacts (Lockout)	.	.
	Switch status control	.	.
VTS	VT supervision		.
CTS	CT supervision		.
	DC supply supervision	.	.
	CB condition monitoring	.	.
	Setting groups	4	4

## Environmental Responsibility

The IEDs are manufactured in a lead-free soldering process using lead-free components. Power dissipation is the lowest among comparable products, easing concern on station batteries. Even the product weight (including packaging) has been optimized to lessen the transit carbon footprint. All such actions boost the eco-responsibility demonstrated in the Product Environment Profile (PEP). The product does not require any resident battery.

The PEP shows claims for raw material depletion, energy depletion, water depletion, global warming potential, ozone depletion, photochemical ozone creation, air acidification, and hazardous waste production.

## Quality Built-in

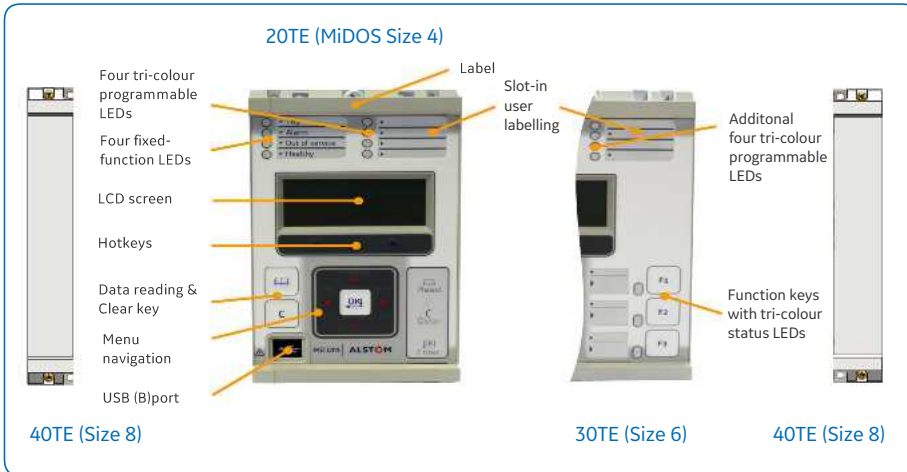
Quality Built-In methodology is applied throughout the development and manufacturing of the IEDs. Parts stress analysis in R&D, rigorous component supplier selection, and a shipping carton compliant with ISTA protection requirements all are examples of best-practice to maximise long-life reliability. All circuit boards have harsh environmental coating, to resist moisture, salt, corrosive atmosphere and industrial ambient pollution – as standard. 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.

## Cyber-Security

The sophistication of protection schemes, coupled with the advancement of technology, increasingly leads to devices and plants being interconnected with open networks, such as the internet or corporate-wide networks. This introduces a potential security risk making the plant vulnerable to cyber-attack, which could in turn lead to electrical outage. To secure communication within such environments, P24NM and P24DM Agile offer NERC-compliant cyber security.

## Intuitive User Interfaces

The front-panel interface (shown below) allows direct IED interaction. A USB front port offers enhanced access by laptop computers. Integrated user function keys and tri-colour programmable LEDs provide a cost-effective solution for control and annunciation. Numerous, optional, modern communication protocols, including IEC 61850, ensure interfacing to upper-level Supervisory, Control, Automation or Data Acquisition systems.



P40 Agile front panel interface

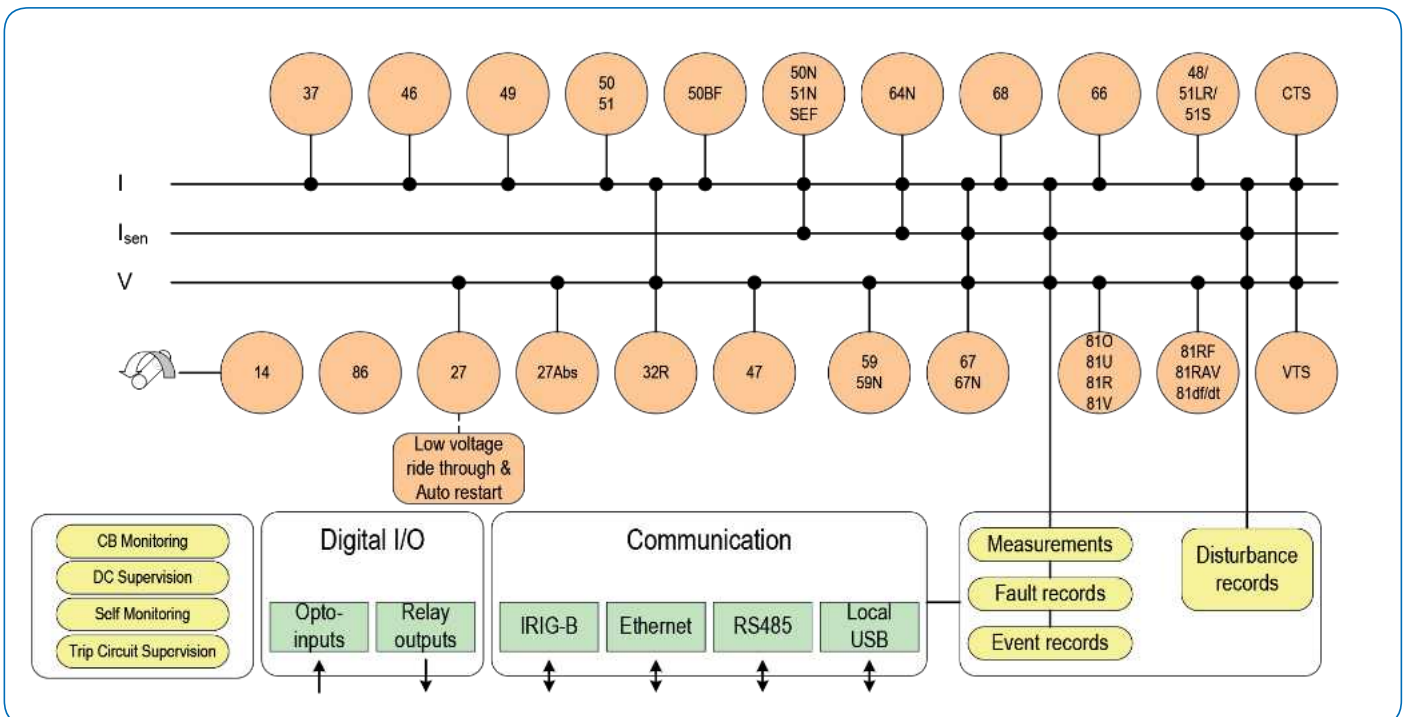
## Asset Life Extension

In addition to new-build, P40 Agile IEDs can be used to refurbish legacy protection schemes.

## Hardware

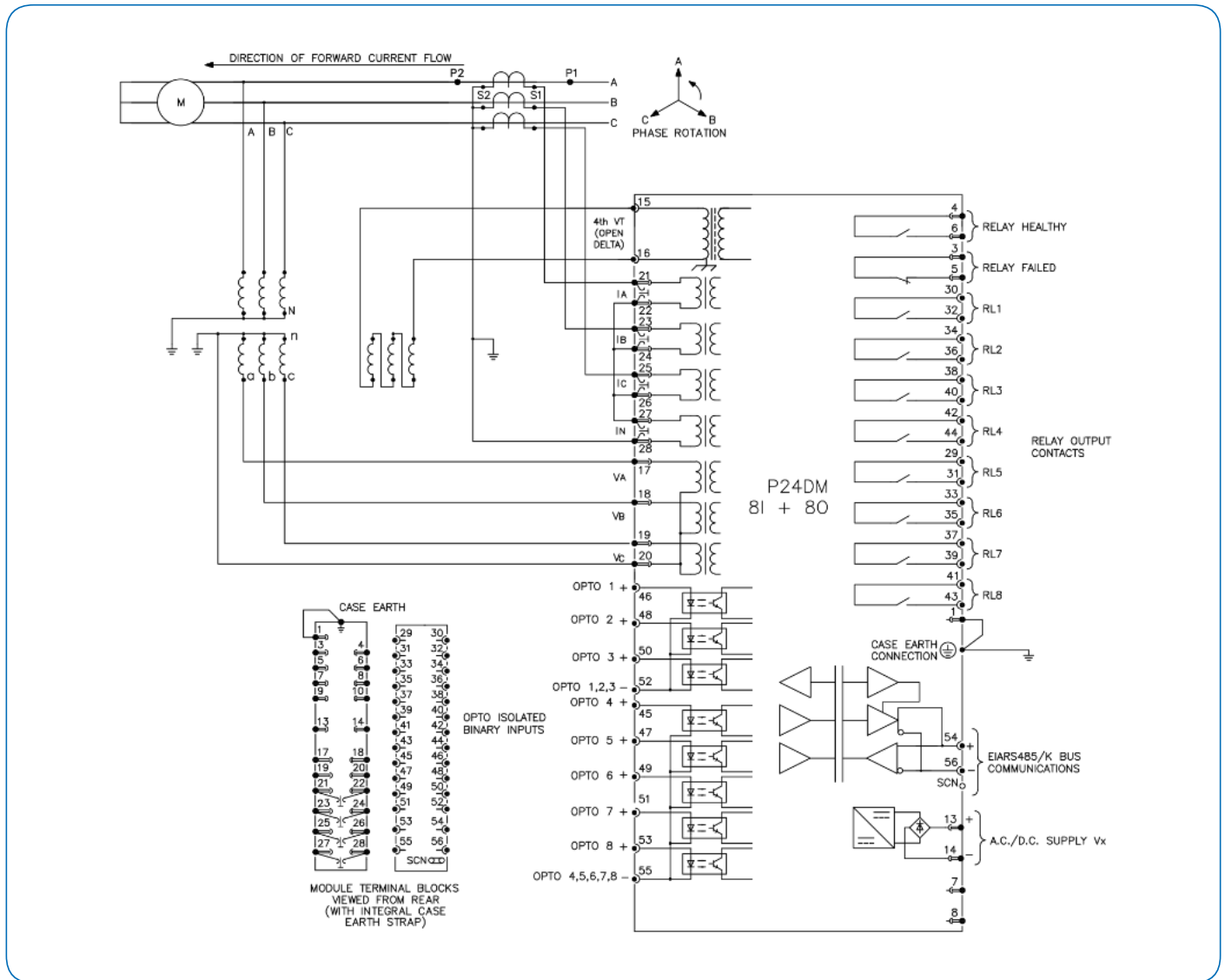
All models offer:

- Space-saving 4U height and 20TE (4"), 30TE (6") or 40TE (8") case sizes
- A front USB port and a rear RS485 port
- Power-up diagnostics and continuous self-monitoring
- Wide choice of opto-isolated binary inputs and output relays
- N/O (form A) and N/C (form B) watchdog contacts
- Field upgradeable to change the relay model avoiding costly hardware change via firmware upgrade



P40 Agile P24xM Functional Diagram

## Hardware Overview



P40 Agile standard hardware (P24DM)

### Functions

	P24NM	P24DM
Trip circuit supervision (H7 scheme)		Option
Rear communications port (software selectable to convert into demodulated IRIG-B)	RS485	RS485
2 <sup>nd</sup> Rear communications port options	RS485, FO, RJ45, dual FO or dual RJ45 Ethernet *	
Communication protocols	IEC-103, IEC 61850, Modbus, Courier, DNP3, or DNP3oE	
Digital inputs min./ max. hardware options	3 / 13	3 / 13
Output relays min./ max. hardware options	4 / 12	4 / 12
CT (AC Current) inputs: 1 and 5 A software selectable	3ph + N	3ph + N
100/120 V VT (AC voltage inputs)		4

\* Refer to the Cortec code for possible configurations.

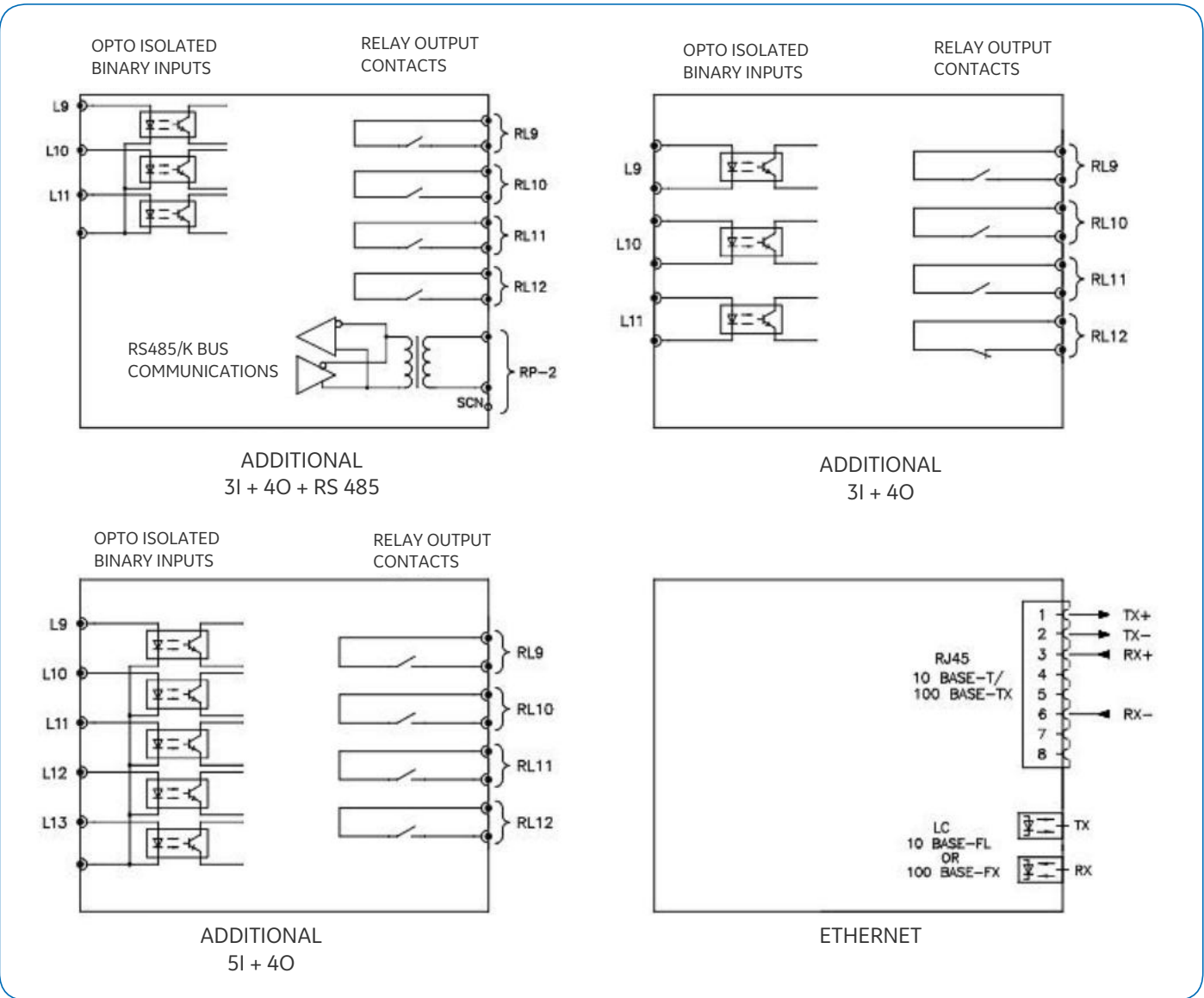
### 30TE and 40TE Models

30TE and 40TE models can accommodate:

- An optional IRIG-B port for time synchronizing
- An additional RS485/K-Bus port
- An optional single or redundant Ethernet port for IEC 61850 or DNP3.0
- Optional additional binary I/O: up to 13 binary inputs and 12 binary outputs with options for TCS, depending on the ordering code

- 40TE model supports 12 binary inputs and 12 binary outputs with TCS and redundant Ethernet communication

All CT connections have integral shorting, when the IED is withdrawn from the case. This affords additional safety to personnel who may be working near live apparatus.



Example hardware options available in case size 30TE



## Motor Protection

Ethernet, graphical programmable logic and proven protection, measurement and control algorithms from GE's modular MiCOM P24x are native in this range.

### Phase Overcurrent (50/51)

Six independent stages are available for each phase overcurrent element. In addition to definite time and predefined IDMT curve selection, P24NM and P24DM support user programmable curves for customised operation and resetting.

The profile can be chosen to optimise the protection, without constraining the loadability. If a standard curve is not suitable for the application, the user can program and upload a custom variant.

Each of the three-phase overcurrent stages of P24DM can be independently configured as directional protection and with specific characteristic angle (RCA) and boundaries.

### Stator Earth Fault (50N, 51N, 67N)

The earth fault current, which will appear during a stator earth fault, can be detected by two independent protection elements using either earth current measured from a sensitive current input, or earth current internally derived from the three phase currents. Both methods can be used simultaneously in P24xM. Each function in P24DM can be directional to ensure the selectivity for isolated neutral systems. The stator earth fault protection includes standard IEC and IEEE IDMT curves and also a user programmable curve for additional flexibility.

### Wattmetric Earth Fault

The sensitive earth fault protection is also suitable for Petersen coil earthed systems by enabling a wattmetric element. This form of protection uses the same earth fault protection directional characteristic but with a current, a voltage and a residual power threshold, providing additional qualifiers on operation.

### Circuit-Breaker Failure Protection (50BF)

Two-stage circuit-breaker failure protection may be used for tripping upstream circuit-breakers and/or the local secondary trip coil. The circuit-breaker failure logic may also be initiated externally from other protection devices if required.

### Voltage Transformer Supervision

Voltage transformer supervision (VTS) is provided to detect loss of one, two or three VT signals, providing indication and inhibition of voltage dependent protection elements. An optically isolated input may also be configured to initiate the voltage transformer supervision alarm and blocking, when used with miniature circuit-breakers (MCBs) or other external forms of voltage transformer supervision.

### Current Transformer Supervision

Current transformer supervision (CTS) is provided to detect loss of phase CT signals and to inhibit the operation of current dependent protection elements.

### Number of Starts - Time Between Starts (66)

Hot/cold starts are supervised during a settable period. In addition, a minimum time between starts can be set to avoid over-frequent start attempts and to protect against overheating of both the motor and starting system.

### Negative Sequence Overcurrent (46)

Multi stages are provided to detect a phase failure or unbalanced load. Definite time or inverse definite time characteristics can be selected.



### Reverse Power (32R)

One stage is available in the P40 Agile P24DM based on the active power measurement to detect power flow from the machine to the system when a loss of mains occurs.

### Reverse Phase Sequence Detection (47)

Both input voltage phase rotation and magnitude are monitored to ensure they are correct before allowing the machine to start

### Phase Reversal

A facility is provided to maintain correct operation of all the protection functions even when the motor is running in reverse. This is achieved through user configurable settings available in all four settings groups.

### Standard or User Programmable Thermal Overload (49)

The key characteristics are:

1. Alarm and trip stages can be selected.
2. RMS and negative sequence current elements are taken into account so that any unbalanced condition can be detected and any abnormal heating of the rotor can be avoided.
3. Standard overload thermal curve with different time constants according to the machine cycles (heating, cooling or start-up), in order to provide optimal protection.
4. A user-programmable curve feature gives the user additional flexibility. If a standard thermal overload curve is not suitable for the application, the user can program and upload a customized thermal overload curve (both operate and reset) to the relay. Applications such as induction fan drives and high inertia rotors/loads in which the motor stator and rotor thermal limits differ significantly can take advantage of this feature for optimal grading.
5. Inhibition of the function in case of extreme starting conditions (very long start, very high start current).
6. Inhibition of a new start until the machine has cooled down, immediately after a trip.

### Voltage Protection (27/59/47)

Three stages are available for under- voltages, overvoltages and two stages for negative phase sequence overvoltages. Voltage measurement can be selected as phase-phase or phase-neutral and the operation can be selected as 3-phase or any phase.

### Residual Overvoltage (59N)

Residual overvoltage protection is available for detecting earth faults in high impedance earthed or insulated systems. The neutral voltage can be derived from the 3-phase voltage inputs or measured from a residual voltage input. Two independent elements are available.

### Start / Stall Protection (48/51LR)

To monitor the starting sequence of the motor, the P40 Agile P24xM relay provides excessive start time protection / locked rotor protection. Options for start detection include monitoring the circuit-breaker state only, the starting current only, or the circuit-breaker state along with the starting current. Where the motor stall withstand time may be shorter than the starting time, a digital input is provided to accommodate a speed switch to distinguish between start and stall.

### Reacceleration (27LV) / Low Voltage Ride Through / Auto Re-start

Following a low voltage condition on the system for a fixed time, the current can exceed the stalling current threshold upon recovery of the voltage. In order to allow the motor to re-accelerate and provide improved continuity of the operating process, the stall protection is temporarily disabled when authorization of reacceleration is enabled.

When low voltage ride through is enabled, the relay allows the motor to re-accelerate if the system voltage has been restored to a settable threshold and within a settable time delay. The relay can also automatically restart the motor if the system voltage is restored within a set time after it has been stopped due to failed reacceleration. A sequential automatic restart can also be programmed to allow controlled load restoration.

### Emergency Restart

By removing all start inhibits, this function permits a hot motor restart via an opto- input, the user interface or the remote communications facility.

### Anti Backspin (27Abs)

If a motor with high inertia load (for example a fan) is stopped, the shaft continues to rotate for some time before the rotor stops completely. If the motor is switched back on while the rotor is still turning, something akin to a false coupling may occur, causing mechanical damage such as broken fan blades. The risk of such problems can be eliminated by setting a minimum time lapse between stopping the motor and re-starting it or by using a remanent voltage method.

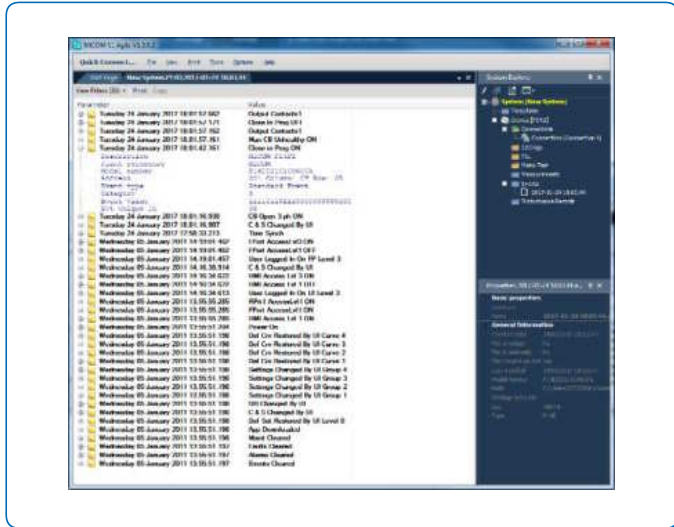
### Frequency Protection

Nine stages of frequency protection are available in P24DM. Each may measure in over, under, rate of change, frequency supervised rate of change or average rate of change mode.

The wide range of setting options permits application of frequency based islanding, load shedding and restoration to bring the system to normal.

### Logic and Control Capabilities

All aspects of MiCOM P40, and MiCOM P40 Agile IED configuration are managed using the S1 Agile software.



S1 Agile: a powerful and intuitive PC-toolsuite

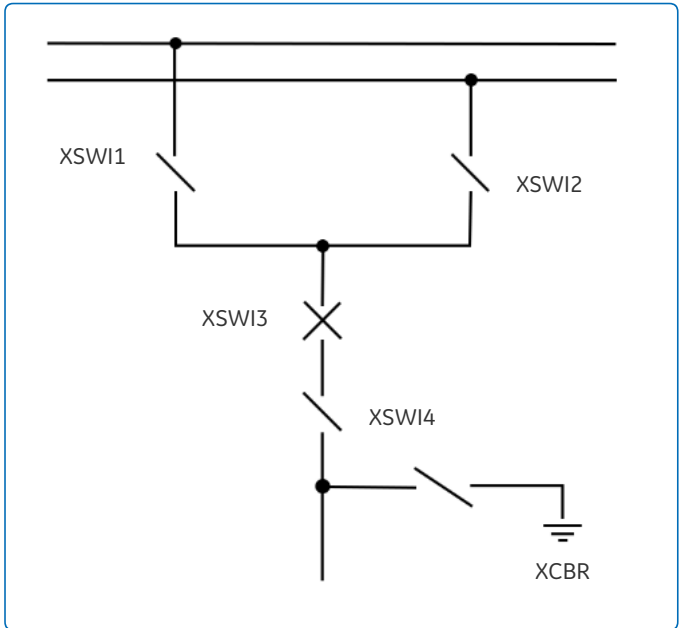
### Circuit Breaker Control

Circuit breaker control is available from the front panel user interface, optically isolated inputs and remotely via the substation communications. Three function keys are available for direct actions instigated by users. The F-keys operate in two modes, normal and toggled, and activate associated signals in PSL that are used to customize the application or operative mode.



### Switch Status and Control

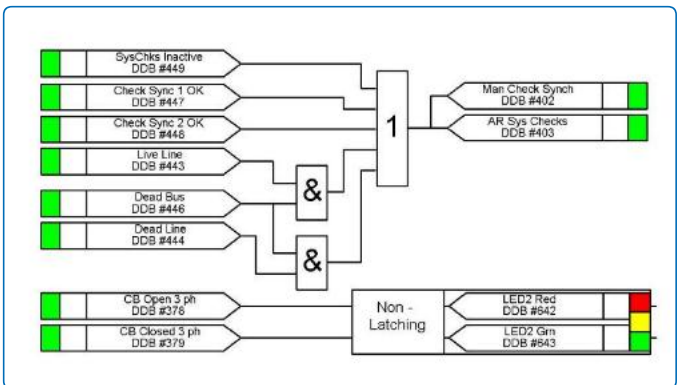
This feature provides status monitoring and control for up to eight switchgear elements. It allows double point status and control over the IEC 61850 and DNP3 protocols for various types of switching devices.



### Programmable Scheme Logic (PSL)

Powerful graphical logic allows the user to customize the protection and control functions. It is also used to program the optically isolated inputs, relay outputs and LEDs. The logic includes OR and AND gates, timers, and set/reset latch functions, with the ability to invert the inputs and outputs, and provide feedback.

The relay has 32 PSL timers which can be conveniently configured in PSL, by setting or from the relay front panel. The PSL imposes no delay on logic throughput, using concurrent processing instead of sequential equations and avoiding any logic 'race' issues.



Programmable Scheme Logic



## Supervisory and Condition Monitoring Functions

Depending on the hardware base, two stage circuit breaker failure protection, CT / VT supervision, circuit breaker condition monitoring and trip circuit supervision are available. Supervision of the trip circuit in both circuit breaker open and closed states can be realised using the optically isolated inputs and programmable scheme logic. Full compliance to the benchmark 'H7' supervision scheme is available as a hardware option.

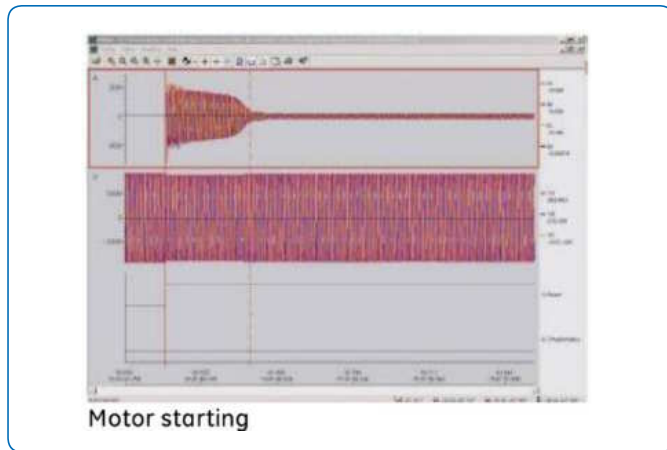
## Measurements, Recording and Post-Fault Analysis

All events, fault and disturbance records are time tagged to a resolution of 1 ms.

Up to 2048 time-tagged event records are stored in the flash memory and can be extracted using the communication ports or viewed on the front panel display. Records of the last 10 faults are stored in the flash memory. Fault data is also available via IEC 61850 protocol.

The internal disturbance recorder has up to 9 analogue channels, 64 digital channels and 1 time channel. The memory capacity is approx. 50 records for a typical 0.5 s duration.

The measurements provided, which may be viewed in primary or secondary values, can be accessed via the front panel LCD display, or the communications ports.



## Local and Remote Communications

Two communication ports are standard: a rear port providing remote communications and a front port for personnel. The front USB port allows the programming of settings, configuration of the programmable scheme logic, extraction and viewing of event, disturbance and fault records, viewing of measurements and the instigation of control functions.

Any of the protocols listed below can be chosen at the time of ordering:

- Courier / K-Bus
- Modbus
- IEC 60870-5-103
- DNP 3.0 (RS485 serial or Ethernet)
- IEC 61850 (100 Mbit/s Ethernet)

IEC 61850 or DNP 3.0 over Ethernet are available when the optional Ethernet port is ordered in 30TE and 40TE models. Redundant Ethernet protocols PRP, HSR and RSTP are also available in dual RJ45 or dual fibre. The copper physical link option uses RJ45 connectors, the fibre option uses LC connectors. IEC 61850 offers high-speed data exchange, peer-to-peer communication, reporting, disturbance record extraction and time synchronisation. To help smooth transition from a pre-existing protocol to the IEC 61850 protocol, the P40 Agile relay had been designed to provide concurrent Courier, Modbus or DNP3 on the RS485 whilst providing IEC 61850 over the Ethernet port.

MiCOM P40 Agile offers 64 virtual inputs, and best-in-class GOOSE performance. An optional second rear Courier port is available, designed typically for local engineering workstation access, or for modem access when the main port is reserved for SCADA.

## Motor and Machine Protection Device Track Record

Over 30 years of experience in numerical motor and machine protection design

MiCOM Agile Protection series (P24x) introduced in 1999. Worldwide application with over 25,000 units delivered

P40 Agile series introduced in 2012. Worldwide application with over 40,000 units delivered



## Cortec and Ordering Code

	P24*	M	*	*	*	*	*	*	*_*	*	*	Description
<b>Model Type</b>	P24D											Motor Protection IED - with Voltage and Current Inputs
	P24N											Motor Protection IED - with Current Inputs
<b>Application</b>		M										Motor
<b>Current Transformer</b>			1									Standard Earth CT
			2									SEF CT
<b>Hardware Options</b>			1									20TE/30TE - EIA RS485/IRIG-B (demodulated)
			6									30TE - EIA RS485/IRIG-B (demodulated) and Ethernet - Single channel Fibre/Copper (setting configurable as Failover*)
			8									30TE - EIA RS485/IRIG-B (demodulated) and EIA RS485
			A									30TE/40TE - EIA RS485/IRIG-B (demodulated) and Dual Redundant Copper Ethernet - 2x RJ45 Copper (setting configurable as Failover)
			B									30TE/40TE - EIA RS485/IRIG-B (demodulated) and Dual Redundant Fibre Ethernet - 2x multimode fibre (setting configurable as Failover)
			C									30TE/40TE - EIA RS485/IRIG-B (demodulated) and Dual Redundant Copper Ethernet - 2x RJ45 Copper (setting configurable as RSTP)
			D									30TE/40TE - EIA RS485/IRIG-B (demodulated) and Dual Redundant Fibre Ethernet - 2x multimode fibre (setting configurable as RSTP)
			E									30TE/40TE - EIA RS485/IRIG-B (demodulated) and Dual Redundant Copper Ethernet - 2x RJ45 Copper (setting configurable as PRP or HSR)
			F									30TE/40TE - EIA RS485/IRIG-B (demodulated) and Dual Redundant Fibre Ethernet - 2x multimode fibre (setting configurable as PRP or HSR)
			G									40TE only - EIA RS485, EIA RS485/IRIG-B (demodulated) and Dual Redundant Copper Ethernet - 2x RJ45 Copper (setting configurable as Failover)
			H									40TE only - EIA RS485, EIA RS485/IRIG-B (demodulated) and Dual Redundant Fibre Ethernet - 2x multimode fibre (setting configurable as Failover)
			J									40TE only - EIA RS485, EIA RS485/IRIG-B (demodulated) and Dual Redundant Copper Ethernet - 2x RJ45 Copper (setting configurable as RSTP)
	<b>I/O Options</b>			K								
			L									40TE only - EIA RS485, EIA RS485/IRIG-B (demodulated) and Dual Redundant Copper Ethernet - 2x RJ45 Copper (setting configurable as PRP or HSR)
			M									40TE only - EIA RS485, EIA RS485/IRIG-B (demodulated) and Dual Redundant Fibre Ethernet - 2x multimode fibre (setting configurable as PRP or HSR)
			A									20TE/30TE - Standard (8 logic inputs + 8 relay outputs)
			B									30TE/40TE - Total (11 logic inputs + 12 relay outputs)
			C									30TE/40TE - Total (11 logic inputs + 12 relay outputs) suitable for trip circuit supervision
			D									30TE/40TE - Total (13 logic inputs + 12 relay outputs)
<b>Communication Protocol</b>			E									20TE - Total (3 logic inputs + 4 relay outputs)
			F									30TE - Total (6 logic inputs + 8 relay outputs) suitable for trip circuit supervision
			H									40TE - Total (10 logic inputs + 12 relay outputs) suitable for trip circuit supervision
			J									40TE - Total (12 logic inputs + 12 relay outputs) suitable for trip circuit supervision
			1									Courier
		2									Modbus	
		3									IEC 60870-5-103 (VDEW)	
		4									DNP3.0	
		6									IEC 61850 over Ethernet and Courier via rear RS485	
		7									IEC 61850 over Ethernet and IEC60870-5-103 via rear RS485	
		8									IEC 61850 over Ethernet and Modbus via rear RS485	
		9									IEC 61850 over Ethernet and Courier via rear RS485	
		A									IEC 61850 over Ethernet and DNP3.0 via rear RS485	

## Cortec and Ordering Code Continued

	P24X	M	*	*	*	*	*	*	*_*	*	*	Description
<b>Model Type</b>	P24D											Motor Protection IED - with Voltage and Current Inputs
	P24N											Motor Protection IED - with Current Inputs
<b>Case</b>												B 20TE Flush (no function keys, 4 programmable LEDs)
												C 30TE Flush (3 function keys with LEDs, 8 programmable LEDs)
												D 40TE Flush (3 function keys with LEDs, 8 programmable LEDs)
												0 Software only
<b>Language</b>												0 Multilingual (English, French, German, Spanish)
												6 Multilingual (English, Russian, Italian, Portuguese)
												C Chinese, English or French via HMI, with English or French only via Communications port
<b>Software Reference</b>								**				Unless specified the latest version will be delivered
<b>Customisation / Regionalisation</b>											0	Default
											A	Customer specific
<b>Hardware Design Suffix</b>											A	Initial release

Refer to GE On-Line Store for possible configurations.

## Worldwide Contact Center

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Imagination at work