MiCOM
P342, P343,
P344, P345 & P391

Generator Protection Relay

Software Version 33
Hardware Suffix J (P342/3/4)
Hardware Suffix K (P345)
Hardware Suffix A (P391)

Technical Data Sheet
P34x/EN TDS/E22

This Document Should be Read Alongside the Technical Manual
The MiCOM generator protection relays provide flexible and reliable integration of protection, control, monitoring and measurement functions.

Extensive functionality is available to provide complete protection and control with four models for a wide range of applications, covering most installations from small generators up to sophisticated systems.

The variable number of opto inputs and output contacts available allow complex protection schemes to be created using the relay’s powerful but easy to use “Programmable Scheme Logic” (PSL).

A customer choice of industry standard protocols are available on the relay, facilitating an easier integration into both new and existing network control systems.

**Customer Benefits**

- Extensive protection functionality to meet the requirements for most generator protection applications
- Programmable Scheme Logic allows easy customisation of the protection and control functions
- Flexible communications options with a number of protocols and communications ports available including IEC 61850
- High break output contact capability internal to main protection - no reliance on auxiliary devices
The MiCOM P342 is suitable for protection of generators which require cost effective high quality protection. Protection includes overcurrent, ground fault, neutral voltage displacement, sensitive or restricted ground fault, voltage dependent overcurrent or underimpedance, under and overvoltage, under and overfrequency, reverse, low forward or overpower, field failure, negative phase sequence thermal, negative phase sequence overcurrent and overvoltage, turbine abnormal frequency, thermal and overfluxing, rotor ground fault as well as VT and CT supervision.

The MiCOM P343 is suitable for protection of larger or more important generators, providing generator differential, 100% stator ground fault via a 3rd harmonic measuring technique, pole slipping and unintentional energisation at standstill protection in addition to the features of the P342. The P344 is similar to the P343 but includes a second neutral voltage input for ground fault / interturn protection. The P345 is similar to the P344 but includes 100% stator ground fault protection via a low frequency injection technique.

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GLOBAL FUNCTIONS

The following global functions are generally available in all devices:

- 4 setting groups
- Metering
- Event recording
- Disturbance recording
- Fault recording
- Trip circuit supervision via PSL
- Breaker state and condition monitoring

MAIN PROTECTION FUNCTIONS

The main protection functions are autonomous and can be individually enabled or disabled to suit a particular application. Each protection function is available in 4 separate setting groups which can be individually enabled or disabled. Three phase tripping with faulted phase indication is provided for all protection functions.

FUNCTIONAL OVERVIEW

![Functional Overview Diagram]

MiCOM P342/3/4/5: Comprehensive protection for all your generator protection requirements
> Generator differential (P343/4/5 only)

Three phase generator differential protection is provided to detect stator phase faults. This can be set as either a percentage bias scheme with a dual slope characteristic or as a high impedance scheme. When high impedance is used, additional stabilising resistance and metrosil will be required.

> Interturn (split phase) differential (P343/4/5 only)

On generators with multi-turn coils and two or more windings per phase, such as hydrogenerators, interturn (split phase) differential may be used to detect turn to turn faults.

The element operates as a definite time overcurrent function with independent current setting per phase. It should be noted that when using this function the generator differential protection is not available.

> Interturn (residual overvoltage)

On generators with multi-turn or single turn coils interturn protection can be provided by measuring the residual voltage across the 3 phase windings. To prevent operation for external faults a negative phase sequence apparent power and a directional negative phase sequence overcurrent element can be used to interlock the residual overvoltage element in PSL.

> 100% stator ground fault 3rd harmonic method (P343/4/5 only)

Third harmonic neutral undervoltage protection covers the final 15% of the stator winding and, in conjunction with the other ground fault elements, provides 100% ground fault protection for the stator. This is supervised by a three phase undervoltage element. Additional supervision using three phase active, reactive and apparent power can be enabled if required. A third harmonic neutral over voltage protection is also provided for applications where the measurement is available at the terminal end of the generator. The blocking features of the under voltage element are not required for this application.

> 100% stator ground fault low frequency injection method (P345 only)

Injecting a 20 Hz voltage to detect ground faults at the neutral point or terminals of generators is a reliable method for detecting ground faults in the entire generator and all electrically connected equipment. It has an advantage over the third harmonic method in that it is independent of the generator’s characteristics and the mode of operation. Also, protection is possible at generator standstill.

The protection relay measures the injected 20 Hz voltage and the flowing 20 Hz current. When the generator is operating normally only a small amount of 20Hz current will flow as a result of the stator capacitance to ground. When a ground fault occurs on the generator stator windings the 20Hz current will increase. Two underresistance and one overcurrent stages of definite time protection are available. The measurement circuit is also monitored with a 20Hz undervoltage and undercurrent element which can be used to block the protection.

> Phase overcurrent

Four independent stages are available for each phase overcurrent element. Each stage may be selected as non-directional or directional (forward/reverse). All stages have definite time (DT) delayed characteristics, two of the stages may also be independently set to one of nine inverse definite minimum time (IDMT) curves (IEC and IEEE).

The IDMT stages have a programmable reset timer for grading with electromechanical relays 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 (Vn = 110/120V) or 2.0V (Vn = 380/440V). 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 three phase faults.

> Standard ground fault

The standard ground fault element operates from an ground fault input connection to measure the fault current in the ground path of the generator. Two independent stages are available for each phase overcurrent. Both stages have definite time (DT) delayed characteristics, the first stage may also be independently set to one of nine inverse definite minimum time (IDMT) curves IEC and IEEE).
> **Sensitive ground fault**

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

> **Wattmetric**

The sensitive ground fault protection is also suitable for Petersen Coiled grounded systems by enabling a wattmetric element. This form of protection uses the sensitive ground fault protection directional characteristic, but with a directional residual power threshold providing an additional constraint on operation.

> **Restricted ground fault**

The restricted ground fault protection may be configured as either high impedance or low impedance biased differential. When high impedance is used, additional stabilising resistance and a metrosil will be required.

> **Voltage dependent overcurrent/underimpedance**

In order to provide backup protection for phase faults, an element is included which can be set as either voltage controlled overcurrent, voltage restrained overcurrent or underimpedance. If selected as voltage controlled or voltage restrained overcurrent, the timing characteristic can be set as either definite time or IDMT. If selected as underimpedance, a 2 stage three phase non-directional underimpedance element is provided.

> **Neutral displacement/residual overvoltage**

Residual overvoltage protection is available for detecting ground faults where there is an isolated or high impedance ground. The residual voltage can be measured from a broken delta VT, from the secondary winding of a distribution transformer ground at the generator neutral, or can be calculated from the three phase to neutral voltage measurements. Each stage can be set with a definite time delay or an inverse time delay characteristic. The P342/3/4/5 have 2 measured and 2 calculated stages of residual overvoltage protection. The P344/5 have an additional neutral voltage input and so has an additional 2 stages of measured residual overvoltage protection.

> **Under/overvoltage**

Under/overvoltage protection may be configured to operate from either phase-phase or phase-neutral voltage elements. Two independent stages with definite time elements are available. The first stage can also be configured to an inverse characteristic.

> **Under/overfrequency**

Two independent stages of overfrequency and four of under frequency are provided. Each stage functions as a definite time element.

> **Turbine abnormal frequency**

Turbine abnormal frequency protection is included to protect the turbine blade from potential damage due to prolonged under/over frequency operation of generators. Up to six frequency bands can be programmed, each having an integrating timer to record the time spent within the band. The time in each band is stored in battery backed memory so that loss of auxiliary supply to the relay does not lead to a loss of the recorded time. When the time within a band has reached the user set limit, an alarm can be raised to initiate investigation and maintenance.

> **Power protection**

The power protection element provides two stages which may be independently configured to operate as reverse power (RP), over power (OP) or low forward power (LFP) protection. The direction of the power measured by the protection can be reversed by selecting the operating mode, generating/motoring. The power protection can be used to provide simple overload protection (OP), protection against motoring (RP, generating mode), CB interlocking to prevent overspeeding during machine shutdown (LFP, generating mode) and/or loss of load protection (LFP, motoring mode). In addition to the standard 3 phase power protection, a single phase power protection element which uses the sensitive ground fault current input is available.
> Loss of field

To detect failure of the machine excitation a two stage offset mho impedance element is provided. This allows a small instantaneous characteristic to be used to provide fast tripping for loss of excitation at high power outputs, where system stability could be affected. The second stage can be set with a larger time delayed characteristic to provide stable, secure tripping under high power conditions. Integrating timers are provided to enable the impedance characteristic to provide time delayed pole slipping protection. A power factor alarm element is also available to offer more sensitive protection for unusual operating conditions, for example a lightly loaded unit operating as an induction generator.

> Negative phase sequence thermal

To protect against unbalanced stator currents caused by external faults or unbalanced loading, two stages of negative sequence protection are provided. These comprise a definite time alarm stage and a trip stage that operates with a thermal characteristic.

> Negative phase sequence overcurrent

Four definite time negative phase sequence overcurrent stages are included. Each stage may be selected as non-directional or directional (forward/reverse) and can operate for remote phase-phase and phase-ground faults even with delta-star transformers present.

> Negative phase sequence overvoltage

One definite time stage of negative phase sequence overvoltage protection is provided. Negative phase sequence overvoltage protection can be used for the detection of voltage unbalance which will quickly lead to overheating and damage of generators.

> Overfluxing

To protect the generator, or connected transformer, against overexcitation a five stage V/Hz element is provided. The first stage is a definite time alarm, the second stage can be used to provide an inverse/definite time trip characteristic and stages 3/4/5 are definite time.

> Unintentional energisation at standstill (P343/4/5 only)

If the machine circuit breaker is closed accidentally, when the machine is not running, very high current will result. A voltage supervised overcurrent scheme is available to protect against this condition. When the machine voltage is low, that is, the machine is not running, an instantaneous overcurrent element is enabled. Timers ensure that the element will be stable for normal voltage dips that could occur for system faults or machine reconnection.

> Pole slipping (P343/4/5 only)

The pole slipping protection uses the variation in "apparent" impedance as seen at the generator's terminals to detect pole slipping. If the measured impedance crosses the two halves of the lens characteristic and spends longer than a specified time in each half a pole slip is counted. Two zones are created by a reactance line which is used to distinguish whether the impedance centre of the pole slip is located in the power system or in the generator. Separate counters are used to count pole slips in the 2 zones. A setting is also provided to determine whether the protection operates in a generating mode, motoring mode or both.

> Resistance temperature detectors (RTDs)

In order to monitor temperature accurately, an option allowing measurement of temperatures using up to 10 platinum RTDs is available. This provides an instantaneous alarm and time delayed trip output for each RTD.

> Thermal overload

To monitor the thermal state of a generator, a thermal replica protection is provided. The thermal element has a trip and an alarm stage. Positive and negative sequence currents are taken into account so that any unbalance condition can be detected and any abnormal heating of the rotor can be avoided. There are separate time constants for heating and cooling and in the event of a loss of auxiliary supply the thermal state is stored in non-volatile memory.
> **Blocked overcurrent logic**

Each stage of overcurrent and ground fault protection can be blocked by an optically isolated input. This enables the overcurrent and ground fault protection to be integrated into a blocked overcurrent busbar protection scheme.

> **Analog (Current Loop) Inputs and Outputs (CLIO)**

Four analog (or current loop) inputs are provided for transducers with ranges of 0-1mA, 0-10mA, 0-20mA or 4-20mA. The analog inputs can be used for various transducers such as vibration monitors, tachometers and pressure transducers. Associated with each input there are two time delayed protection stages, one for alarm and one for trip. Each stage can be set for ‘Over’ or ‘Under’ operation.

Four analog (or current loop) outputs are provided with ranges of 0-1mA, 0-10mA, 0-20mA or 4-20mA which can alleviate the need for separate transducers. These may be used to feed standard moving coil ammeters for analog indication of certain measured quantities or into a SCADA using an existing analog RTU.

> **Rotor ground fault**

Rotor ground fault protection is used to detect ground faults in the excitation circuit of synchronous machines. The rotor ground resistance is measured using an external low frequency square wave injection, coupling and measurement unit, P391, connected to the rotor circuit. The measurement of the rotor resistance is passed to the P342/3/4/5 via a current loop output (0-20mA) on the P391 connected to one of the 4 current loop inputs on the P342/3/4/5. The rotor ground fault protection is only available if the relay includes the CLIO hardware option. Two under resistance stages of definite time protection are available for alarm and trip. The injection frequency is selectable 0.25/0.5/1Hz via a jumper link in the P391.

> **Phase Rotation**

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

The phase rotation for all 3 phase currents and voltages can be reversed. Also, for pump storage applications where 2 phases are swapped for pumping operation, the swapping of the phases can be emulated in the relay via settings for the 3 phase currents and voltages.

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**SUPERVISORY FUNCTIONS**

> **Circuit breaker failure protection**

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. The P343/4/5 CB fail logic can be set to use current measurement from any of the 2 sets of 3 phase current inputs. Typically CB fail protection uses the CTs on the busbar side of the generator.

> **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 inhibit the operation of current dependent protection elements. CTS is provided for both sets of 3 phase CTs in the P343/4 relays.

**PLANT SUPERVISION**

> **Trip circuit monitoring**

Monitoring of the trip circuit in both breaker open and closed states can be realised using the programmable scheme logic.

> **Circuit breaker state monitoring**

An alarm will be generated if there is a discrepancy between the open and closed contacts of the circuit breaker.

> **Circuit breaker condition monitoring**

The circuit breaker condition monitoring features include:

- monitoring the number of breaker trip operations
- recording the sum of the broken current quantity \( I_x \times 2.0 \)
- monitoring the breaker operating time
- monitoring the fault frequency counter

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**Comprehensive Post-fault analysis and communication options**
**Technical Data**

**Mechanical Specifications**

**Design**
Modular MiCOM Px40 platform relay, P342 in 40TE or 60TE case, P343 in 60TE or 80TE case, P344/5 in 80TE case.
Mounting is front of panel flush mounting, or 19" rack mounted (ordering options).

**Enclosure Protection**
Per IEC 60529: 1992:
IP 52 Protection (front panel) against dust and dripping water,
IP 50 Protection for sides of the case, IP 10 Protection for the rear.

**Weight**
P342 (40TE): 7.9kg
P342 (60TE): 9.2kg
P343 (60TE): 11.5kg
P343/4/5 (80TE): 14kg

**Terminals**

**AC Current and Voltage Measuring Inputs**
Located on heavy duty (black) terminal block:
Threaded M4 terminals, for ring lug connection.
CT inputs have integral safety shorting, upon removal of the terminal block.

**General Input/Output Terminals**
For power supply, opto inputs, output contacts and RP1 rear communications.
Located on general purpose (grey) blocks:
Threaded M4 terminals, for ring lug connection.

**Case Protective Earth Connection**
Two rear stud connections, threaded M4.
Must be earthed (grounded) for safety, minimum earth wire size 2.5mm².

**Front Port Serial PC Interface**
EIA(RS)232 DCE, 9 pin D-type female connector Socket SK1.
Courier protocol for interface to MiCOM S1 Studio software.
Isolation to ELV (extra low voltage) level.
Maximum cable length 15m.

**Front Download/Monitor Port**
EIA(RS)232, 25 pin D-type female connector Socket SK2.
For firmware and menu text downloads.
Isolation to ELV level.

**Rear Communications Port (RP1)**
EIA(RS)485 signal levels, two wire connections located on general purpose block, M4 screw.
For screened twisted pair cable, multidrop, 1000m max.
For K-Bus, IEC-60870-5-103, MODBUS or DNP3.0 protocol (ordering options).
Isolation to SELV (safety extra low voltage) level.

**Optional Rear Fiber Connection for SCADA/DCS**
BFOC 2.5 -(ST®)-interface for glass fiber, as per IEC 874-10.
850nm short-haul fibers, one Tx and one Rx.
For Courier, IEC-60870-5-103, MODBUS or DNP3.0 (Ordering options).

**Optional Second Rear Communications Port (RP2)**
EIA(RS)232, 9 pin D-type female connector, socket SK4.
Courier protocol: K-Bus, EIA(RS)232, or EIA(RS)485 connection.
Isolation to SELV level.

**Optional Rear IRIG-B Interface modulated or de-modulated**
BNC plug
Isolation to SELV level.
50 ohm coaxial cable.

**Optional Rear Ethernet Connection for IEC 61850**

**10BaseT/100BaseTX Communications**
Interface in accordance with IEEE802.3 and IEC 61850
Isolation: 1.5kV
Connector type: RJ45
Cable type: Screened Twisted Pair (STP)
Max. cable length: 100m

**100 Base FX Interface**
Interface in accordance with IEEE802.3 and IEC 61850
Wavelength: 1300nm
Fiber: multi-mode 50/125µm or 62.5/125µm
Connector type: BFOC 2.5 -(ST®)

**Ratings**

**AC Measuring Inputs**
Nominal frequency: 50 and 60 Hz (settable)
Operating range: 5 to 70 Hz
AC Current
Nominal current (In): 1 and 5 A dual rated. (1A and 5A inputs use different transformer tap connections, check correct terminals are wired).
Nominal burden
<0.04 VA at In, <40mΩ(0-30In)In = 1A
<0.01 VA at In, <8mΩ(0-30In) In = 5A
Thermal withstand:
continuous 4 In
for 10 s: 30 In
for 1 s: 100 In
Standard: linear to 16 In (non-offset AC current).
Sensitive: linear to 2 In (non-offset AC current).

AC Voltage
Nominal voltage (Vn): 100 to 120 V or 380 to 480 V phase-phase
Nominal burden per phase: < 0.02 VA at
110/√3 V or 440/√3 V
Thermal withstand:
continuous 2 Vn
for 10s: 2.6 Vn
Linear to 200V (100V/120V), 800V (380/480V).

Power Supply
Auxiliary Voltage (Vx)
Three ordering options:
(i) Vx: 24 to 48 Vdc
(ii) Vx: 48 to 110 Vdc, and 30 to 100Vac (rms)
(iii) Vx: 110 to 250 Vdc, and 100 to 240Vac (rms)

Operating Range
(i) 19 to 65V (dc only for this variant)
(ii) 37 to 150V (dc), 24 to 110V (ac)
(iii) 87 to 300V (dc), 80 to 265V (ac).
With a tolerable ac ripple of up to 12% for a dc supply, per IEC 60255-11: 1979.

Nominal Burden
Quiescent burden: 11W or 24 VA. (Extra 1.25W when fitted with second rear communications board).
Additions for energized binary inputs/outputs:
Per opto input:
0.09W (24 to 54V)
0.12W (110/125V)
0.19W (220/250V)
Per energized output relay: 0.13W
Power-up Time
Time to power up < 11s.

Power Supply Interruption
Per IEC 60255-11: 1979:
The relay will withstand a 20ms interruption in the DC auxiliary supply, without de-energizing.
Per IEC 61000-4-11: 1994:
The relay will withstand a 20ms interruption in an AC auxiliary supply, without de-energizing.

Battery Backup
Front panel mounted
Type ½ AA, 3.6V Lithium Thionyl Chloride
Battery (SAFT advanced battery reference LS14250)
Battery life (assuming relay energized for 90% time) >10 years

Field Voltage Output
Regulated 48Vdc
Current limited at 112mA maximum output
Operating range 40 to 60V

Digital (“Opto”) Inputs
Universal opto inputs with programmable voltage thresholds (24/27, 30/34, 48/54, 110/125, 220/250V). May be energized from the 48V field voltage, or the external battery supply.
Rated nominal voltage: 24 to 250Vdc
Operating range: 19 to 265Vdc
Withstand: 300Vdc, 300Vrms.
Peak current of opto input when energized is 3.5mA (0-300V)
Nominal pick-up and reset thresholds:
Nominal battery 24/27: 60 - 80% DO/PU
(logic 0) <16.2 (logic 1) >19.2
Nominal battery 24/27: 50 - 70% DO/PU
(logic 0) <12.0 (logic 1) >16.8
Nominal battery 30/34: 60 - 80% DO/PU
(logic 0) <20.4 (logic 1) >24.0
Nominal battery 30/34: 50 - 70% DO/PU
(logic 0) <15.0 (logic 1) >21.0
Nominal battery 48/54: 60 - 80% DO/PU
(logic 0) <32.4 (logic 1) >38.4
Nominal battery 48/54: 50 - 70% DO/PU
(logic 0) <24.0 (logic 1) >33.6
Nominal battery 110/125: 60 - 80% DO/PU
(logic 0) <7.5 (logic 1) >88.0
Nominal battery 110/125: 50 - 70% DO/PU
(logic 0) <55.0 (logic 1) >77.0
Nominal battery 220/250: 60 - 80% DO/PU
(logic 0) <150.0 (logic 1) >176.0
Nominal battery 220/250: 50 - 70% DO/PU
(logic 0) <110 (logic 1) >154
Recognition time:
<2ms with long filter removed,
<12ms with half cycle ac immunity filter on
Output Contacts

Standard Contacts
General purpose relay outputs for signaling, tripping and alarming:
Continuous Carry Ratings (Not Switched):
Maximum continuous current: 10A (UL: 8A)
Short duration withstand carry: 30A for 3s
250A for 30ms
Rated voltage: 300 V

Make & Break Capacity:
DC: 50W resistive
DC: 62.5W inductive (L/R = 50ms)
AC: 2500VA resistive (cos $\phi$ = unity)
AC: 2500VA inductive (cos $\phi$ = 0.7)

Make, Carry:
30A for 3 secs, dc resistive, 10,000 operations (subject to the above limits of make / break capacity and rated voltage)

Make, Carry & Break:
30A for 3 secs, dc resistive, 2,000 operations (subject to the above limits of make / break capacity & rated voltage)
4A for 1.5 secs, dc resistive, 10,000 operations (subject to the above limits of make / break capacity & rated voltage)
0.5A for 1 sec, dc inductive, 10,000 operations (subject to the above limits of make / break capacity & rated voltage)
10A for 1.5 secs, ac resistive / inductive, 10,000 operations (subject to the above limits of make / break capacity & rated voltage)

Durability:
Loaded contact: 10 000 operations minimum,
Unloaded contact: 100 000 operations minimum.

Operate Time
Less than 0.2ms
Reset Time
Less than 8ms

High Break Contacts
Continuous Carry Ratings (Not Switched):
Maximum continuous current: 10A
Short duration withstand carry: 30A for 3s
250A for 30ms
Rated voltage: 300 V

Make & Break Capacity:
DC: 750W resistive
DC: 2500W inductive (L/R = 50ms)

Make, Carry:
30A for 3 secs, dc resistive, 10,000 operations (subject to the above limits of make / break capacity & rated voltage)

Make, Carry & Break:
30A for 3 secs, dc resistive, 5,000 operations (subject to the above limits of make / break capacity & rated voltage)
30A for 200 ms, dc resistive, 10,000 operations (subject to the above limits of make / break capacity & rated voltage)
10A (*), dc inductive, 10,000 operations (subject to the above limits of make / break capacity & rated voltage)

*Typical for repetitive shots – 2 minutes idle for thermal dissipation

## Voltage Current L/R No of shots in 1 sec

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Current</th>
<th>L/R</th>
<th>No of shots in 1 sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>65V</td>
<td>10A</td>
<td>40ms</td>
<td>5</td>
</tr>
<tr>
<td>150V</td>
<td>10A</td>
<td>40ms</td>
<td>4</td>
</tr>
<tr>
<td>250V</td>
<td>10A</td>
<td>40ms</td>
<td>2</td>
</tr>
<tr>
<td>250V</td>
<td>10A</td>
<td>20ms</td>
<td>4</td>
</tr>
</tbody>
</table>

MOV protection: Max Voltage 330V dc

Durability:
Loaded contact: 10 000 operations minimum,
Unloaded contact: 100 000 operations minimum.

Operate Time:
Less than 0.2ms
Reset Time:
Less than 8ms

Watchdog Contacts
Non-programmable contacts for relay healthy/relay fail indication:
Breaking capacity:
DC: 30W resistive
DC: 15W inductive (L/R = 40ms)
AC: 375VA inductive (cos $\phi$ = 0.7)

IRIG-B 12X Interface (Modulated)
External clock synchronization per IRIG standard 200-98, format B12x
Input impedance 6k $\Omega$ at 1000Hz
Modulation ratio: 3:1 to 6:1
Input signal, peak-peak: 200mV to 20V

IRIG-B 00X Interface (Un-modulated)
External clock synchronization per IRIG standard 200-98, format B00X.
Input signal TTL level
Input impedance at dc 10k$\Omega$
Environmental Conditions

Ambient Temperature Range
Per IEC 60255-6: 1988:
Operating temperature range:
-25°C to +55°C (or -13°F to +131°F)
Storage and transit:
-25°C to +70°C (or -13°F to +158°F)

Ambient Humidity Range
Per IEC 60068-2-3: 1969:
56 days at 93% relative humidity and +40 °C
Per IEC 60068-2-30: 1980
Damp heat cyclic, six (12 + 12) hour cycles, 93% RH, +25 to +55 °C

Type Tests

Insulation
Per IEC 60255-27: 2005
Insulation resistance > 100MΩ at 500Vdc
(Using only electronic/brushless insulation tester).

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

High Voltage (Dielectric) Withstand
(i) Per IEC 60255-27: 2005, 2 kV rms AC, 1 minute:
Between all independent circuits.
Between independent circuits and protective (earth) conductor terminal.
1kV rms AC for 1 minute, across open watchdog contacts.
1kV rms AC for 1 minute, across open contacts of changeover output relays.
1kV rms AC for 1 minute for all D-type EIA(RS)232/EIA(RS)485 ports between the communications port terminals and protective (earth) conductor terminal.
1.5 kV rms AC for 1 minute, across open contacts of normally open output relays.
1kV rms AC for 1 minute, across open watchdog contacts.
1kV rms AC for 1 minute, across open contacts of changeover output relays.

Impulse Voltage Withstand Test
Per IEC 60255-27: 2005
Front time: 1.2 µs, Time to half-value: 50 µs,
Peak value: 5 kV, 0.5J
Between all independent circuits.
Between all independent circuits and protective (earth) conductor terminal.
Between the terminals of independent circuits. EIA(RS)232 & EIA(RS)485 ports and normally open contacts of output relays excepted.

Electromagnetic Compatibility (EMC)

1 MHz Burst High Frequency Disturbance Test
Per IEC 60255-22-1: 1988, Class III,
Common-mode test voltage: 2.5 kV,
Differential test voltage: 1.0 kV,
Test duration: 2 s, Source impedance: 200 Ω (EIA(RS)232 ports excepted).

100kHz Damped Oscillatory Test
Per EN61000-4-18: 2007: Level 3
Common mode test voltage: 2.5kV
Differential mode test voltage: 1kV

Immunity to Electrostatic Discharge
Per IEC 60255-22-2: 1996, Class 4,
15kV discharge in air to user interface, display, communication port and exposed metalwork.
8kV point contact discharge to any part of the front of the product.

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

Surge Withstand Capability
Per IEEE/ANSI C37.90.1: 2002:
4kV fast transient and 2.5kV oscillatory
applied directly across each output contact, optically isolated input, and power supply circuit.
4kV fast transient and 2.5kV oscillatory
applied common mode to communications, IRIG-B.

Surge Immunity Test
(EIA(RS)232 ports excepted).
Per IEC 61000-4-5: 2005 Level 4,
Time to half-value: 1.2 / 50 µs,
Amplitude: 4kV between all groups and protective (earth) conductor terminal,
Amplitude: 2kV between terminals of each group.
Conducted/Radiated immunity
For RTDs used for tripping applications the conducted and radiated immunity performance is guaranteed only when using totally shielded RTD cables (twisted leads).

Immunity to Radiated Electromagnetic Energy
Per IEC 60255-22-3: 2000, Class III:
Test field strength, frequency band 80 to 1000 MHz:
10 V/m,
Test using AM: 1 kHz / 80%.
Spot tests at 80, 160, 450, 900 MHz
Per IEEE/ANSI C37.90.2: 2004:
80MHz to 1000MHz, 1kHz 80% am and am pulsed modulated.
Field strength of 35V/m.

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

Radiated Immunity from Digital Radio Telephones
Per IEC61000-4-3: 2002:
10 V/m, 900MHz and 1.89GHz.

Immunity to Conducted Disturbances Induced by Radio Frequency Fields
Per IEC 61000-4-6: 1996, Level 3,
Disturbing test voltage: 10 V.

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

Conducted Emissions
Per EN 55022: 1998 Class A:
0.15 - 0.5MHz, 79dBuV (quasi peak)
66dBuV (average)
0.5 - 30MHz, 73dBuV (quasi peak) 60dBuV (average).

Radiated Emissions
Per EN 55022: 1998 Class A:
30 - 230MHz, 40dBuV/m at 10m measurement distance
230 - 1GHz, 47dBuV/m at 10m measurement distance.

EU Directives

EMC Compliance
Per 2004/108/EC:
Compliance to the European Commission Directive on EMC is demonstrated using a Technical File. Product Specific Standards were used to establish conformity:
EN 50263: 2000

Product Safety
Per 2006/95/EC:
Compliance to the European Commission Low Voltage Directive. (LVD) is demonstrated using a Technical File.
A product specific standard was used to establish conformity.
EN 60255-27: 2005

R&TTE Compliance
Radio and Telecommunications Terminal Equipment (R & TTE) directive 99/5/EC.
Compliance demonstrated by compliance to both the EMC directive and the Low voltage directive, down to zero volts.
Applicable to rear communications ports.

ATEX Compliance
ATEX Potentially Explosive Atmospheres directive 94/9/EC, for equipment.
The equipment is compliant with Article 1(2) of European directive 94/9/EC.
It is approved for operation outside an ATEX hazardous area. It is however approved for connection to Increased Safety, “Ex e”, motors with rated ATEX protection, Equipment Category 2, to ensure their safe operation in gas Zones 1 and 2 hazardous areas.

CAUTION - Equipment with this marking is not itself suitable for operation within a potentially explosive atmosphere.

CAUTION - Equipment with this marking is not itself suitable for operation within a potentially explosive atmosphere.

Compliance demonstrated by Notified Body certificates of compliance.

II (2) G
Mechanical Robustness

Vibration Test
Per IEC 60255-21-1: 1996:
  Response Class 2
  Endurance Class 2

Shock and Bump
Per IEC 60255-21-2: 1996:
  Shock response Class 2
  Shock withstand Class 1
  Bump Class 1

Seismic Test
Per IEC 60255-21-3: 1995:
  Class 2

P34x THIRD PARTY COMPLIANCES

Underwriters Laboratory (UL)

[UL logo]
File Number: E202519
Original Issue Date: 05-10-2002
(Complies with Canadian and US requirements).

Energy Networks Association (ENA)

[ENA logo]
Certificate Number: 104 Issue 2
Assessment Date: 16-04-2004
Technical Data P391

Mechanical Specifications

Design
80TE case.
Mounting options are, wall mounting, front of panel flush mounting, or 19" rack mounted (ordering options)

Enclosure Protection
Per IEC 60529: 1992

Rack and Panel Mounting Options
IP 20 (Safety) Protection for the case-with the terminal safety cover fitted.

Wall Mounting Option
IP 20 (Safety) Protection for the P391 unit with the terminal safety cover fitted.

Weight
P391 (80TE): 5kg

Terminals

AC Voltage Measuring Inputs
Located on general purpose (grey) terminal blocks:
Threaded M4 terminals, for insulated ring crimped connectors.

Protective Conductor (Earth) Terminal
Two rear stud connections, threaded M4. Must be earthed (grounded) for safety, using the protective (earth) conductor, of minimum wire size 2.5mm².

Current Loop Output
Located on general purpose (grey) terminal blocks:
Threaded M4 terminals, for insulated ring crimped connectors.

Ratings

Low Frequency Measuring Inputs
Nominal frequency: 0.25, 0.5, 1 Hz (settable with an internal jumper link)

DC Field Voltage Inputs
1200V dc maximum

Power Supply

Auxiliary Voltage (Vx)
60-250V dc, or 100-230V ac (rms) 50/60Hz

Operating Range
48-300V dc, or 85-253V ac (rms) 50/60Hz
With a tolerable ac ripple of up to 12% for a dc supply, per IEC 60255-11: 1979.

Nominal Burden
Auxiliary Supply Input burden: 11W or 24VA.

Power Supply Interruption
Per IEC 60255-11: 1979
The relay will withstand a 20ms interruption in the DC auxiliary supply, without de-energizing.
Per IEC 61000-4-11: 2004
The relay will withstand a 20ms interruption in an AC auxiliary supply, without de-energizing.

Output Contacts

Watchdog Contacts
Non-programmable contacts for relay healthy/relay fail indication:
Breaking capacity:
DC: 30W resistive
DC: 15W inductive (L/R = 40ms)
AC: 375VA inductive (cos φ = 0.7)
Loaded contact: 10 000 operations
Minimum, Unloaded contact: 10 000 operations
Minimum.

Environmental Conditions

Ambient Temperature Range
Per IEC 60068-2-1: 2007: cold;
IEC 60068-2-2: 1993: dry heat
Operating temperature range:
-25°C to +55°C (or -13°F to +131°F)
Storage and transit:
-25°C to +70°C (or -13°F to +158°F)

Ambient Humidity Range
Per IEC 60068-2-78: 2001
56 days at 93% relative humidity and +40 °C

Type Tests

Insulation
Per IEC 60255-27: 2005:
Insulation resistance > 100MΩ at 500Vdc
(Using only electronic/brushless insulation tester).
Creepage Distances and Clearances
Per IEC 60664-1: 2007
Pollution degree 2,
Impulse 9.6kVp between injection resistor inputs and protective (case earth) conductor terminal.
Minimum of 10.5mm clearance and 12mm creepage distance.

High Voltage (Dielectric) Withstand
(i) Per IEC 60255-27: 2005, 2 kV rms ac, 1 minute:
Between all independent circuits.
Between independent circuits and protective (case earth) conductor terminal.
1kV rms ac for 1 minute, across open watchdog contacts.
(ii) Per ANSI/IEEE C37.90: 2005
1kV rms ac for 1 minute across open watchdog contacts.
(iii) Per 60664-1: 2007
5.8kV rms 1 minute between injection resistor inputs and protective (case earth) conductor terminal.

Impulse Voltage Withstand Test
Per IEC 60255-27 2005
Front time: 1.2 µs, Time to half-value: 50 µs,
Peak value: 5 kV, 0.5J
Between all independent circuits.
Between independent circuits and protective (case earth) conductor terminal.
Between the terminals of independent circuits.
Normally open contacts of output relays excepted.
IEC 60664-1: 2007
Impulse 9.6kV between injection resistor inputs and protective (case earth) conductor terminal

Electromagnetic Compatibility (EMC)

1 MHz Burst High Frequency Disturbance Test
Per IEC 60255-22-1: 2005, Class III,
Common-mode test voltage: 2.5 kV,
Differential test voltage: 1.0 kV,
Test duration: 2 s, Source impedance: 200 Ω

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

Amplitude: 4 kV, burst frequency 5 kHz (Class IV) applied directly to auxiliary.

Surge Withstand Capability
Per IEEE/ANSI C37.90.1: 2002
4kV fast transient and 2.5kV oscillatory applied directly across each output contact, optically isolated input, and power supply circuit.

Surge Immunity Test
(EIA(RS)232 ports excepted).
Per EN 61000-4-5: 2006 Level 4, EN 60255-22-5: 2002
Time to half-value: 1.2 / 50 µs,
Amplitude: 4kV between all groups and protective (earth) conductor terminal,
Amplitude: 2kV between terminals of each group.
Level 3: 1kV between terminals of injection resistor inputs

Immunity to Radiated Electromagnetic Energy
Per IEC 60255-22-3: 2007, Class III:
(EN61000-4-3: 2006, Level 3)
Test field strength, frequency band 80 to 1000 MHz:
10 V/m,
Test using AM: 1 kHz / 80%,
Spot tests at 80, 160, 450, 900 MHz
Per IEEE/ANSI C37.90.2: 2004:
80MHz to 1000MHz, 1kHz 80% am and am pulsed modulated.
Field strength of 35V/m.

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

Radiated Immunity from Digital Radio Telephones
Per IEC61000-4-3: 2002:
10 V/m, 900MHz and 1.89GHz.

Immunity to Conducted Disturbances Induced by Radio Frequency Fields
Per IEC 61000-4-6: 2007, Level 3,
Per IEC60255-22-6: 2001
Disturbing test voltage: 10 V.

Power Frequency Magnetic Field Immunity
Per IEC 61000-4-8: 1994, Level 5,
100A/m applied continuously,
100A/m applied for 3s.
Per IEC 61000-4-9: 1993, Level 5,
100A/m applied in all planes.
Per IEC 61000-4-10: 1993, Level 5,
100A/m applied in all planes at 100kHz/1MHz with a burst duration of 2s.
Conducted Emissions
Per EN 55022: 1998 Class A:
0.15 - 0.5MHz, 79dBμV (quasi peak)
66dBμV (average)
0.5 - 30MHz, 73dBμV (quasi peak) 60dBμV (average).

Radiated Emissions
Per EN 55022: 1998 Class A:
30 - 230MHz, 40dBμV/m at 10m measurement distance
230 - 1GHz, 47dBμV/m at 10m measurement distance.

EU Directives

EMC Compliance
Per 2004/108/EC:
Compliance to the European Commission Directive on EMC is demonstrated using a Technical File route. Product Specific Standards were used to establish conformity:
EN 50263: 2000

Product Safety
Per 2006/95/EC:
Compliance with European Commission Low Voltage Directive (LVD). A Product Specific Standard was used to establish conformity:
EN 60255-27: 2005

Mechanical Robustness

Vibration Test
Per IEC 60255-21-1: 1996:
Response Class 2
Endurance Class 2

Shock and Bump
Per IEC 60255-21-2: 1996:
Shock response Class 2
Shock withstand Class 1
Bump Class 1

Seismic Test
Per IEC 60255-21-3: 1995:
Class 2
Protection Functions

Generator Differential Protection

Accuracy
Pick-up: Formula ±5%
Drop-off: 95% of setting ±5%
Operating time: <30ms for currents applied at 4x pickup level or greater
Repeatability: <7.5%
Disengagement time: <40ms

Reverse/Low Forward/Over Power (3 Phase)

Accuracy
Pick-up: Setting ±10%
Reverse/Over Power Drop-off:
0.95 of setting ±10%
Low forward power Drop-off:
1.05 of setting ±10%
Angle variation Pick-up:
Expected pick-up angle ±2 degree
Angle variation Drop-off:
Expected drop-off angle ±2.5 degree
Operating time: ±2% or 50ms whichever is greater
Repeatability: <5%
Disengagement time: <50ms
tRESET: ±5%
Instantaneous operating time: <50ms

Sensitive Reverse/Low Forward/Over Power (1 Phase)

Accuracy
Pick-up: Setting ±10%
Reverse/Over power Drop-off:
0.9 of setting ±10%
Low forward power Drop-off:
1.1 of Setting ±10%
Angle variation Pick-up:
Expected pick-up angle ±2 degree
Angle variation Drop-off:
Expected drop-off angle ±2.5 degree
Operating time: ±2% or 50ms whichever is greater
Repeatability: <5%
Disengagement time: <50ms
tRESET: ±5%
Instantaneous operating time: <50ms

Negative Phase Sequence Over Power

Accuracy
Pick-up: Setting ±5%
Drop-off: 0.95 of setting ±5%
Repeatability (operating threshold): <1%
Operating time: ±2% or 70ms whichever is greater
Disengagement time: <35ms
Repeatability (operating times): <10ms

Field Failure

Accuracy
Mho characteristic Pick-up:
Characteristic shape ±5%
Linear characteristic Pick-up:
Characteristic shape ±10%
Mho characteristic Drop-off:
105% of setting ±5%
Linear characteristic Drop-off:
105% of setting ±10%
Operating time: ±2% or 50ms whichever is greater
Repeatability: <1%
Disengagement time: <50ms

Negative Phase Sequence Thermal

Accuracy
Pick-up: Formula ±5%
Drop-off: 95% of pick-up ±5%
Operating time: ±5% or 55ms whichever is greater
Repeatability: <5%
Disengagement time: <50ms

System Back-up

Voltage Dependent Overcurrent

Accuracy
VCO threshold Pick-up: Setting ±5%
Overcurrent Pick-up: Formula ±5%
VCO threshold Drop-off: 1.05 x Setting ±5%
Overcurrent Drop-off: 0.95 x formula ±5%
Operating time: <50ms
Repeatability: < 2.5%
IDMT operation: ±5% or 40ms whichever is greater
Definite time operation: ±5% or 50ms whichever is greater
tRESET: ±5% or 50ms whichever is greater
Under Impedance

**Accuracy**
- Pick-up: Setting ±5%
- Drop-off: 105% of setting ±5%
- Operating time: ±2% or 50ms whichever is greater
- Repeatability: <5%
- Disengagement time: <50ms
- tRESET: ±5%
- Instantaneous operating time: <50ms

4-Stage Directional/Non-Directional Overcurrent

**Accuracy**
- Pick-up: Setting ±5%
- Drop-off: 0.95 x Setting ±5%
- Minimum trip level (IDMT): 1.05 x Setting ±5%
- IDMT characteristic shape: ±5% or 40ms whichever is greater*
- IEEE reset: ±5% or 50ms whichever is greater
- DT operation: ±2% or 50ms whichever is greater
- DT Reset: ±5%
- Directional accuracy (RCA ±90°):
  - ±2° hysteresis 2°
- Characteristic UK: IEC 6025-3…1998
- Characteristic US: IEEE C37.112…1996
* Under reference conditions

4-Stage Negative Phase Sequence Overcurrent

**Accuracy**
- I2>Pick-up: Setting ±5%
- I2> Drop-off: 0.95 x Setting ±5%
- Vpol Pick-up: Setting ±5%
- Vpol Drop-off: 0.95 x Setting ±5%
- DT operation: ±2% or 60ms whichever is greater
- Disengagement time: <35ms
- Directional accuracy (RCA ±90°):
  - ±2° hysteresis <1%
- Repeatability (operating times): <10ms

Thermal Overload

**Accuracy**
- Setting accuracy: ±5%
- Reset: 95% of thermal setting ±5%
- Thermal alarm Pick-up:
  - Calculated trip time ±5%
- Thermal overload Pick-up:
  - Calculated trip time ±5%
- Cooling time accuracy: ±5% of theoretical
- Repeatability: <2.5%

2-Stage Non-Directional Earth Fault

**Accuracy**
- Pick-up: Setting ±5%
- Drop-off: 0.95 x Setting ±5%
- IDMT trip level elements: 1.05 x Setting ±5%
- IDMT characteristic shape: ±5% or 40ms whichever is greater*
- IEEE reset: ±5% or 40ms whichever is greater
- DT operation: ±2% or 40ms whichever is greater
- DT reset: ±5%
- Repeatability: 2.5%

Rotor Earth Fault

**Accuracy**
- Pick-up: Setting ±10% (1k to 5kΩ)
  - Setting ±5% (5k to 80kΩ)
  - 1.02 x Setting ±5% (5k to 80kΩ)
- Repeatability: <1%
- DT operation for Double ended connection:
  - ±2% or 2.5/fs whichever is greater
- Disengagement time: <2.5/fs
- DT operation for Single ended connection:
  - Field voltage 0 to 600V DC
    - ±2% or 2.5/fs whichever is greater
  - Field voltage 601 to 1200V DC
    - ±2% or 3.5/fs whichever is greater
  - Disengagement time: <3.5/fs
  (fs – injection frequency, 0.25/0.5/1 Hz)

Sensitive Directional Earth Fault

**SEF Accuracy**
- Pick-up: Setting ±5%
- Drop-off: 0.95 x Setting ±5%
- DT operation: ±2% or 50ms whichever is greater
- DT reset: ±5%
- Repeatability: 5%

**Wattmetric SEF Accuracy**
- P = 0W Pick-up: ISEF> ±5%
- P > 0W Pick-up: P> ±5%
- P = 0W Drop-off: (0.95 x ISEF>) ±5%
- P > 0W Drop-off: 0.9 x P> ±5%
- Boundary accuracy: ±5% with 1° hysteresis
- Repeatability: 5%

Polarizing Quantities Accuracy

**Operating boundary Pick-up:** ±2° of RCA ±90°
- Hysteresis: <3°
- ISEF>Vnpol Pick-up: Setting ±10%
- ISEF>Vnpol Drop-off: 0.9 x Setting or 0.7V
  (whichever is greater) ±10%
Restricted Earth Fault

Accuracy
Pick-up: Setting formula ±5%
Drop-off: 0.80 (or better) of calculated differential current
Low impedance operating time: <60ms
High impedance Pick-up: Setting ±5%
High impedance operating time: <30ms

Transient Overreach and Overshoot

Accuracy
Additional tolerance X/R ratios: ±5% over the X/R ratio of 1…90
Overshoot of overcurrent elements: <40ms
Disengagement time: <60ms (65ms SEF)

Neutral Displacement/Residual Overvoltage

Accuracy
DT/IDMT Pick-up: Setting ±5%
Drop-off: 0.95 x Setting ±5%
IDMT characteristic shape: ±5% or 55ms whichever is greater
DT operation: ±2% or 55ms whichever is greater
Instantaneous operation <55ms
Reset: <35ms
Repeatability: <1%

100% Stator Earth Fault (3rd Harmonic)

Accuracy
VN3H< VN3H> Pick-up: Setting ±5%
V/P/Q/S<Inh: Setting ±0.5%
VN3H< Drop-off: 95% of Pick-up ±5%
VN3H> Drop-off: 95% of Pick-up ±5%
V/P/Q/S<Inh Drop-off: 95% of Pick-up ±0.5%
Operating time: ±0.5% or 50ms whichever is greater
Repeatability: <0.5%
Disengagement/reset time: <50ms

100% Stator Earth Fault, 64S (Low Frequency Injection)

Accuracy
R<1/R<2 Pick-up: Setting ±5% (for R ≤ 300Ω), ±7.5% (for R > 300Ω) or 2Ω whichever is greater
I>1/V<1/I<1 Pick-up: Setting ±5%
R<1/R<2 Drop-off: 105% of setting ±5% (for R ≤ 300Ω), ±7.5% (for R > 300Ω)
V<1/I<1 Drop-off: 105% of setting ±5%
I<1 Drop-off: 95% of setting ±5%

Repeatability: <1%
R<1/R<2/I>1/V<1/I<1 operating time without bandpass filter: ±2% or 220ms whichever is greater
R<1/R<2/I>1/V<1/I<1 disengagement time: <120ms
Repeatability: <100ms
R<1/R<2/I>1/V<1/I<1 operating time with bandpass filter: ±2% or 1.2s whichever is greater
R<1/R<2/I>1/V<1/I<1 disengagement time: <700ms
Repeatability: <100ms

Volts/Hz

Accuracy
Pick-up: Setting ±2%
Drop-off: 98% or pick-up ±2%
Repeatability (operating threshold): <1%
IDMT operating time: ±5% or 60ms whichever is greater
Definite time: ±2% or 30ms whichever is greater
Disengagement time: <50ms
Repeatability (operating times): <10ms
V/Hz measurement: ±1%

Unintentional Energization at Standstill (Dead Machine)

Accuracy
I> Pick-up: Setting ±5%
V< Pick-up: Setting ±5%
I> Drop-off: 95% of setting ±5%
V< Drop-off: 105% of setting ±5%
Operating time: ±2% or 50ms whichever is greater
Repeatability: 2.5% or 10ms whichever is greater

Under Voltage

Accuracy
DT Pick-up: Setting ±5%
IDMT Pick-up: Setting ±5%
Drop-off: 1.02 x Setting ±5%
IDMT characteristic shape: ±2% or 50ms whichever is greater
DT operation: ±2% or 50ms whichever is greater
Reset: <75ms
Repeatability: <1%
Over Voltage

Accuracy
- DT Pick-up: Setting ±5%
- IDMT Pick-up: Setting ±5%
- Drop-off: 0.98 x Setting ±5%
- IDMT characteristic shape: ±2% or 50ms whichever is greater
- DT operation: ±2% or 50ms whichever is greater
- Reset: <75ms
- Repeatability: <1%

NPS Overvoltage

Accuracy
- Pick-up: Setting ±5%
- Drop-off: 0.95 x Setting ±5%
- Repeatability (operating threshold): <1%
- DT operation: ±2% or 50ms whichever is greater
- Instantaneous operation: <60 ms
- Disengagement time: <35ms
- Repeatability (operating times): <10ms

Under Frequency

Accuracy
- Pick-up: Setting ±0.01Hz
- Drop-off: (Setting +0.025HZ) ±0.01Hz
- DT operation: ±2% or 50ms whichever is greater
- * The operating will also include a time for the relay to frequency track 20Hz/second.

Over Frequency

Accuracy
- Pick-up: Setting ±0.01Hz
- Drop-off: (Setting -0.025Hz) ±0.01Hz
- DT operation: ±2% or 50ms whichever is greater
- * The operating will also include a time for the relay to frequency track 20Hz/second.

Resistive Temperature Detectors

Accuracy
- Pick-up: Setting ±1°C
- Drop-off: (Setting -1°C)
- Operating time: ±2% or <3s

CB Fail

Timer Accuracy
- Timers: ±2% or 40ms whichever is greater
- Reset time: <30ms

Undercurrent Accuracy
- Pick-up: ±10% or 25mA whichever is greater
- Operating time: <12ms (Typical <10ms)
- Reset: <15ms (Typical <10ms)

Pole Slipping

Accuracy
- Lens Characteristic Pick-up: Setting ±5%
- Blinder Pick-up: ±1°
- Reactance line Pick-up: Setting ±5%
- Lens DO characteristic Lens Angle:
  - Adjusted by -5°, (ZA+ZB) + 5%
- Lens DO Drop-off: Lens DO characteristic ±5%
- Blinder DO characteristic:
  - Blinder displaced by (ZA+ZB)/2 x tan 87.5°
- Blinder DO Drop-off:
  - Blinder DO characteristic ±1°
- Repeatability: <2.5%
- T1, T2 and Reset Timer: ±2% or 10ms whichever is greater

Hysteresis:

Hysteresis is applied to the lenticular characteristic and to the blinder as soon as they pick up individually. Hysteresis is not required for the reactance line as Zone 1 or Zone 2 is determined at a single point when the locus traverses the blinder.

For the lens, the hysteresis consists of an angle of 5° subtracted from the α setting to increase the lens size and an increment of 5% applied to ZA and ZB to extend the reach. Hysteresis for the blinder is dependent on the mode of operation. For generating mode, the blinder is adjusted to the right, for motoring mode, the blinder is adjusted to the left, with a distance which is equivalent to an angle separation of 175°.
This is shown in the diagram below. This distance is equivalent to \((ZA + ZB)/2 \tan 87.5°\).

For both characteristics the hysteresis is reset when the impedance locus leaves the lens.

### Programmatic Scheme Logic

#### Accuracy

- Output conditioner timer: Setting \(\pm 2\%\) or 50ms whichever is greater
- Dwell conditioner timer: Setting \(\pm 2\%\) or 50ms whichever is greater
- Pulse conditioner timer: Setting \(\pm 2\%\) or 50ms whichever is greater

### Measurements and Recording Facilities

#### Measurements

- **Accuracy**
  - Current: 0.05…3 \(I_n\): \(\pm 1\%\) of reading
  - Voltage: 0.05…2 \(V_n\): \(\pm 5\%\) of reading
  - Power (W): 0.2…2 \(V_n\), 0.05…3 \(I_n\): \(\pm 5\%\) of reading at unity power factor
  - Reactive Power (VARs): 0.2…2 \(V_n\), 0.05…3 \(I_n\): \(\pm 5\%\) of reading at zero power factor
  - Apparent Power (VA): 0.2…2 \(V_n\), 0.05…3 \(I_n\): \(\pm 5\%\) of reading
  - Energy (Wh): 0.2…2 \(V_n\), 0.05…3 \(I_n\): \(\pm 5\%\) of reading at unity power factor
  - Energy (VAh): 0.2…2 \(V_n\), 0.05…3 \(I_n\): \(\pm 5\%\) of reading at zero power factor
  - Phase accuracy: 0°…360°: \(\pm 5\%\)
  - Frequency: 5…70Hz: \(\pm 0.025Hz\)

### IRIG-B and Real Time Clock

#### Performance

- Year 2000: Compliant
- Real time accuracy: \(< \pm 1\) second / day

#### Features

- Real time 24 hour clock settable in hours, minutes and seconds
- Calendar settable from January 1994 to December 2092
- Clock and calendar maintained via battery after loss of auxiliary supply
- Internal clock synchronization using IRIG-B
- Interface for IRIG-B signal is BNC

### Current Loop Input and Outputs

#### Accuracy

- Current loop input accuracy: \(\pm 1\%\) of full scale
- CLI drop-off threshold Under: setting \(\pm 1\%\) of full scale
- CLI drop-off threshold Over: setting \(\pm 1\%\) of full scale
- CLI sampling interval: 50ms
- CLI instantaneous operating time: \(< 250ms\)
CLI DT operating time: ±2% setting or 200ms whichever is the greater
CLO conversion interval: 50ms
CLO latency: < 1.07s or <70ms depending on CLO output parameter’s internal refresh rate - (1s or 0.5 cycle)
Current loop output accuracy: ±0.5% of full scale
Repeatability: <5%
CLI - Current Loop Input
CLO - Current Loop Output

Other Specifications
CLI load resistance 0-1 mA: < 4kΩ
CLI load resistance 0-1mA/0-20mA/4 20mA: <300Ω
Isolation between common input channels: zero
Isolation between input channels and case earth/other circuits: 2kV rms for 1 minute
CLO compliance voltage 0-1mA/0 10mA: 10V
CLO compliance voltage 0-20mA/4 20mA: 8.8V
Isolation between common output channels: zero
Isolation between output channels and case earth/other circuits: 2kV rms for 1 minute

Disturbance Records

Accuracy
Magnitude and relative phases: ±5% of applied quantities
Duration: ±2%
Trigger Position: ±2% (minimum 100ms)
Record length: 50 records each 1.5s duration (75s total memory) with 8 analog channels and 32 digital channels (Courier, MODBUS, DNP 3.0), 8 records each 3s (50Hz) or 2.5s (60Hz) duration (IEC60870-5-103).

Event, Fault & Maintenance Records
Maximum 512 events in a cyclic memory
Maximum 5 fault records
Maximum 10 maintenance records

Accuracy
Event time stamp resolution: 1ms

IEC 61850 Ethernet Data

100 Base FX Interface

Transmitter Optical Characteristics
(TA = 0°C to 70°C, VCC = 4.75 V to 5.25 V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sym</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Optical Power BOL 62.5/125 µm, NA = 0.275 Fiber EOL</td>
<td>PO</td>
<td>-19</td>
<td>-16.8</td>
<td>-14</td>
<td>dBm avg.</td>
</tr>
<tr>
<td>Output Optical Power BOL 50/125 µm, NA = 0.20 Fiber EOL</td>
<td>PO</td>
<td>-22.5</td>
<td>-20.3</td>
<td>-14</td>
<td>dBm avg.</td>
</tr>
<tr>
<td>Optical Extinction Ratio</td>
<td></td>
<td>10</td>
<td>% dB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Optical Power at Logic “0” State</td>
<td>PO (‘0’</td>
<td>-45</td>
<td>dBm avg.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

BOL - Beginning of life
EOL - End of life

Receiver Optical Characteristics
(TA = 0°C to 70°C, VCC = 4.75 V to 5.25 V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sym</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Optical Power Minimum at Window Edge</td>
<td>PIN Min. (W)</td>
<td>-33.5</td>
<td>-31</td>
<td>dBm avg.</td>
<td></td>
</tr>
<tr>
<td>Input Optical Power Minimum at Eye Center</td>
<td>PIN Min. (C)</td>
<td>-34.5</td>
<td>-31.8</td>
<td>Bm avg.</td>
<td></td>
</tr>
<tr>
<td>Input Optical Power Maximum</td>
<td>PIN Max.</td>
<td>-14</td>
<td>-11.8</td>
<td>dBm avg.</td>
<td></td>
</tr>
</tbody>
</table>

Note: The 10BaseFL connection will no longer be supported as IEC 61850 does not specify this interface.
Settings, Measurements and Records List

Settings List

Global Settings (System Data)
Language: English/French/German/Spanish
Frequency: 50/60Hz

Circuit Breaker Control (CB Control):
Reset Lockout by: User Interface/CB Close
Man Close RstDly: 0.10…600.00s
CB Status Input:
None
52A
52B
Both 52A & 52B

Date and Time
IRIG-B Sync: Disabled/Enabled
Battery Alarm: Disabled/Enabled
LocalTime Enable: Disabled/Fixed/Flexible
LocalTime Offset: -720 min…720min
DST Enable: Disabled/Enabled
DST Offset: 30min…60min
DST Start: First/Second/Third/Fourth/Last
DST Start Day: Sun/Mon/Tues/Wed/Thurs/Fri/Sat
DST Start Month: Jan/Feb/Mar/Apr/May/Jun/Jul/Aug/Sept/Oct/Nov/Dec
DST Start Mins: 0min…1425min
DST End: First/Second/Third/Fourth/Last
DST End Day: Sun/Mon/Tues/Wed/Thurs/Fri/Sat
DST End Month: Jan/Feb/Mar/Apr/May/Jun/Jul/Aug/Sept/Oct/Nov/Dec
DST End Mins: 0min…1425min
RP1 Time Zone: UTC/Local
RP2 Time Zone: UTC/Local
Tunnel Time Zone: UTC/Local

Configuration
Setting Group:
Select via Menu
Select via Opto
Active Settings: Group 1/2/3/4
Setting Group 1: Disabled/Enabled
Setting Group 2: Disabled/Enabled
Setting Group 3: Disabled/Enabled
Setting Group 4: Disabled/Enabled
System Config: Invisible/Visible

CT and VT Ratios
Main VT Primary: 100…1000000V
Main VT Sec’y: 80…140V (100/120V) 320…560V (380/480V)
VN1 Primary: 100…1000000V
VN1 VT Sec’y: 80…140V (100/120V) 320…560V (380/480V)
VN2 Primary (P344/5): 100…1000000V
VN2 VT Sec’y (P344/5): 80…140V (100/120V) 320…560V (380/480V)
Phase CT Primary: 1A…30kA
Phase CT Sec’y: 1A/5A
E/F CT Primary: 1A…30kA
E/F CT Sec’y: 1A/5A
ISen CT Primary: 1A…30kA
ISen CT Sec’y: 1A/5A

Power: Disabled/Enabled
Field Failure: Disabled/Enabled
NPS Thermal: Disabled/Enabled
System Back-up: Disabled/Enabled
Overcurrent: Disabled/Enabled
Thermal Overload: Disabled/Enabled
Gen Differential: Disabled/Enabled
Earth Fault: Disabled/Enabled
Rotar EF: Disabled/Enabled
SEF/REF/Spower: Disabled or SEF/REF or Sensitive Power
Residual O/V NVD: Disabled/Enabled
100% Stator EF: Disabled/Enabled
V/Hz: Disabled/Enabled
Dead Machine: Disabled/Enabled
Volt Protection: Disabled/Enabled
Freq Protection: Disabled/Enabled
RTD Inputs: Disabled/Enabled
CB Fail: Disabled/Enabled
Supervision: Disabled/Enabled
Pole Slipping: Disabled/Enabled
Input Labels: Invisible/Visible
Output Labels: Invisible/Visible
RTD Labels: Invisible/Visible
CT & VT Ratios: Invisible/Visible
Event Recorder: Invisible/Visible
Disturb Recorder: Invisible/Visible
Measure’t Setup: Invisible/Visible
Comms Settings: Invisible/Visible
Commission Tests: Invisible/Visible
Setting Values: Primary/Secondary
Control Inputs: Invisible/Visible
CLIO Inputs: Disabled/Enabled
CLIO Outputs: Disabled/Enabled
Ctrl I/P Config: Invisible/Visible
Ctrl I/P Labels: Invisible/Visible
Direct Access: Disabled/Enabled
Function Keys: Invisible/Visible
LCD Contrast: 0…31
Sequence of Event Recorder  
(Record Control)

<table>
<thead>
<tr>
<th>Event Type</th>
<th>Disabled/Enabled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alarm Event</td>
<td></td>
</tr>
<tr>
<td>Relay O/P Event</td>
<td></td>
</tr>
<tr>
<td>Opto Input Event</td>
<td></td>
</tr>
<tr>
<td>General Event</td>
<td></td>
</tr>
<tr>
<td>Fault Rec Event</td>
<td></td>
</tr>
<tr>
<td>Maint Rec Event</td>
<td></td>
</tr>
<tr>
<td>Protection Event</td>
<td></td>
</tr>
<tr>
<td>DDB 31 - 0 (up to):</td>
<td></td>
</tr>
<tr>
<td>DDB 1022 - 992:</td>
<td></td>
</tr>
</tbody>
</table>

*Binary function link strings, selecting which DDB signals will be stored as events, and which will be filtered out.*

Oscillography  
(Disturbance Recorder)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td>0.10...10.50s</td>
</tr>
<tr>
<td>Trigger Position</td>
<td>0.0...100.0%</td>
</tr>
<tr>
<td>Trigger Mode</td>
<td>Single/Extended</td>
</tr>
<tr>
<td>Analog Channel 1 (up to):</td>
<td></td>
</tr>
<tr>
<td>Analog Channel 15 (depending on model):</td>
<td></td>
</tr>
<tr>
<td>Disturbance channels selected from:</td>
<td>IA-1/IB-1/IC-1/IA-2/IB-2/IC-2/IN/VA/VB/VC/ VN1/VN2/ISensitive/ 164S/ V64S/ Frequency/ 64R CL Input Raw/ 64R R Fault Raw/ 64R R Fault (depending on model)</td>
</tr>
</tbody>
</table>

Digital Input 1 (up to):  
Digital Input 32:  
Selected binary channel assignment from any DDB status point within the relay (opto input, output contact, alarms, starts, trips, controls, logic...).  
Input 1 Trigger: No Trigger/Trigger/LH (Low to High)/Trigger H/L (High to Low)  
(up to):  
Input 32 Trigger: No Trigger/Trigger L/H/Trigger H/L

Measured Operating Data  
(Measure't Setup)

<table>
<thead>
<tr>
<th>Default Display:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Access Level</td>
<td></td>
</tr>
<tr>
<td>3Ph + N Current</td>
<td></td>
</tr>
<tr>
<td>3Ph Voltage</td>
<td></td>
</tr>
<tr>
<td>Power</td>
<td></td>
</tr>
<tr>
<td>Date and Time</td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>Plant Reference</td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td></td>
</tr>
<tr>
<td>Local Values:</td>
<td>Primary/Secondary</td>
</tr>
<tr>
<td>Remote Values:</td>
<td>Primary/Secondary</td>
</tr>
<tr>
<td>Measurement Ref:</td>
<td>VA/VB/VC/IA/IB/IC</td>
</tr>
<tr>
<td>Measurement Mode:</td>
<td>0/1/2/3</td>
</tr>
<tr>
<td>Fix Dem Period:</td>
<td>1...99mins</td>
</tr>
<tr>
<td>Roll Sub Period:</td>
<td>1...99mins</td>
</tr>
<tr>
<td>Num Sub Periods:</td>
<td>1...15</td>
</tr>
<tr>
<td>Remote2 Values:</td>
<td>Primary/Secondary</td>
</tr>
</tbody>
</table>

Communications

RP1 Address:  
(Courier or IEC870-5-103):  
0...255

RP1 Address:  
(DNP3.0):  
0...65534

RP1 Address:  
(MODBUS):  
1...247

RP1 InactivTimer:  
1...30mins

RP1 Baud Rate:  
(IEC870-5-103):  
9600/19200 bits/s

RP1 Baud Rate:  
(MODBUS, Courier):  
9600/19200/38400 bits/s

RP1 Baud Rate:  
(DNP3.0):  
1200/2400/4800/9600/19200/38400 bits/s

RP1 Parity:  
Odd/Even/None  
(MODBUS, DNP3.0)

RP1 Meas Period:  
1...60s  
(IEC870-5-103)

RP1 PhysicalLink:  
Copper (EIA(RS)485/K bus) or Fiber Optic

RP1 Time Sync:  
Disabled/Enabled

MODBUS IEC Timer:  
Standard/Reverse

RP1 CS103Blocking:  
Disabled
Monitor Blocking
Command Blocking

RP1 Port Config:  
(Courier):  
K Bus
EIA485 (RS485)

RP1 Comms Mode:  
(Courier):  
IEC60870 FT1.2
IEC60870 10-Bit No parity

Note: If RP1 Port Config is K Bus the baud rate is fixed at 64 kbits/s

Optional Ethernet Port

NIC Tunl Timeout: 1...30mins
NIC Link Report: Alarm, Event, None
NIC Link Timeout: 0.1...60s

Optional Additional Second Rear Communication  
(Rear Port2 (RP2))

RP2 Port Config:  
EIA(RS)232
EIA(RS)485
K-Bus

RP2 Comms Mode:  
IEC60870 FT1.2
IEC60870 10-Bit No parity

RP2 Address:  
0...255

RP2 InactivTimer:  
1...30mins

RP2 Baud Rate:  
9600/19200/38400 bits/s

Note: If RP2 Port Config is K Bus the baud rate is fixed at 64 kbits/s
Commission Tests
Monitor Bit 1:
(up to):
Monitor Bit 8:
Binary function link strings, selecting which
DDB signals have their status visible in the
Commissioning menu, for test purposes
Test Mode:
Disabled
Test Mode
Blocked Contacts
Test Pattern:
Configuration of which output contacts are to
be energized when the contact test is
applied

Circuit Breaker Condition
Monitoring
(CB Monitor Setup)
Broken I^: 1.0…2.0
I^ Maintenance: Alarm Disabled/Enabled
I^ Maintenance: 1…25000
I^ Lockout: Alarm Disabled/Enabled
I^ Lockout: 1…25000
No. CB Ops Maint: Alarm Disabled/Enabled
No. CB Ops Maint: 1…10000
No. CB Ops Lock: Alarm Disabled/Enabled
No. CB Ops Lock: 1…10000
CB Time Maint: Alarm Disabled/Enabled
CB Time Maint: 0.005…0.500s
CB Time Lockout: Alarm Disabled/Enabled
CB Time Lockout: 0.005…0.500s
Fault Freq Lock: Alarm Disabled/Enabled
Fault Freq Count: 1…9999
Fault Freq Time: 0…9999s

Opto Coupled Binary Inputs
(Opto Config)
Global Nominal V:
24 - 27V
30 - 34V
48 - 54V
110 - 125V
220 - 250V
Custom
Opto Input 1:
(up to):
Opto Input #. (# = max. opto no. fitted):
Custom options allow independent
thresholds to be set per opto, from the same
range as above.
Opto Filter Control:
Binary function link string, selecting which
optos will have an extra 1/2 cycle noise filter,
and which will not.
Characteristics:
Standard 60% - 80%
50% - 70%

Control Inputs into PSL
(Ctrl. I/P Config.)
Hotkey Enabled:
Binary function link string, selecting which
of the control inputs will be driven from
Hotkeys.
Control Input 1: Latched/Pulsed
(up to):
Control Input 32: Latched/Pulsed
Ctrl Command 1:
(up to):
Ctrl Command 32:
ON/OFF
SET/RESET
IN/OUT
ENABLED/DISABLED

Function Keys
Fn. Key Status 1:
(up to):
Fn. Key Status 10
Disable
Lock
Unlock/Enable
Fn. Key 1 Mode: Toggled/Normal
(up to):
Fn. Key 10 Mode: Toggled/Normal
Fn. Key 1 Label:
(up to):
Fn. Key 10 Label:
User defined text string to describe the
function of the particular function key

IED Configurator
Switch Conf. Bank: No Action/Switch Banks

IEC 61850 GOOSE
GoEna: Disabled/Enabled
Test Mode: Disabled/Pass Through/Forced
VOP Test Pattern: 0x00000000...
0xFFFFFFFF
Ignore Test Flag: No/Yes

Control Input User Labels
(Ctrl. I/P Labels)
Control Input 1:
(up to):
Control Input 32:
User defined text string to describe the
function of the particular control input

Settings in Multiple Groups
Note: All settings here onwards apply for
setting groups # = 1 to 4.
Protection Functions

System Config
Phase Sequence: Standard ABC/Reverse ACB
VT Reversal: No Swap/A-B Swapped/B-C Swapped/C-A Swapped
CT1 Reversal: No Swap/A-B Swapped/B-C Swapped/C-A Swapped
CT2 Reversal: No Swap/A-B Swapped/B-C Swapped/C-A Swapped

Generator Differential Protection
GenDiff Function:
Disabled/Percentage Bias
High Impedance

Intertime
Gen Diff Is1: 0.05…0.50In
Gen Diff k1: 0…20%
Gen Diff Is2: 1…5.0ln
Gen Diff k2: 20…150.00%

Intertime Is_A: 0.05…2.0ln
Intertime Is_B: 0.05…2.0ln
Intertime Is_C: 0.05…2.0ln
Intertime Delay: 0.00…100.0s

Reverse/Forward/Over Power (3 Phase)
Operating mode:
Generating
Motoring

Power 1 Function:
Reverse
Low forward
Over

-P>1 Setting (reverse power/P<1
Setting (Low forward power)/P>1
Setting (Overpower):
1…300.0W (1A, 100V/120V)
4…1200.0W (1A, 380V/480V)
5…1500.0W (5A, 100V/120V)
20…6000.0W (5A, 380V/480V)

Equivalent range in %Pn 0.5%…157%
Power 1 Time Delay: 0.00…100.0s
Power 1 DO Timer: 0.00…100.0s
P1 Poledead Inh: Disabled/Enabled

Sensitive/Reverse/Forward/Over Power (1 Phase)
Operating mode:
Generating
Motoring

Sen Power1 Func:
Reverse
Low forward
Over

Sen -P>1 Setting (Reverse Power)/Sen <P
Setting (Low Forward Power)/Sen >P Setting

NPS Overpower
S2>1 Status: Disabled/Enabled
S2>1 Setting: 0.10…30.00 ln VA (100/120V)
0.40…120.00 ln VA (380/480V)
S2>1 Time Delay: 0.00…100.0s

Field Failure
FFail Alm Status: Disabled/Enabled
FFail Alm Angle: 15°…75°
FFail Alm Delay: 0.00…100.0s
FFail 1 Status: Disabled/Enabled
FFail 1 -Xa1:
0.0…40.0Ω (1A, 100/120V)
0.0…8.0Ω (5A, 100/120V)
0…160Ω (1A, 380/480V)
0.0…32.0Ω (5A, 380/480V)

FFail 1 Xb1:
25…325.0Ω (1A, 100/120V)
5…65.0Ω (5A, 100/120V)
100…1300Ω (1A, 380/480V)
20…260.0Ω (5A, 380/480V)

FFail 1 Time Delay: 0…100s
FFail 1 DO Timer: 0…100s
FFail 2 as FFail1

NPS Thermal
l2therm>1 Alarm: Disabled/Enabled
l2therm>1 Set: 0.03…0.5ln
l2therm>1 Delay: 0.00…100s
l2therm>2 Trip: Disabled/Enabled
l2therm>2 Set: 0.05…0.5ln
l2therm>2 k: 2…40.0s
l2therm>2 kRESET: 2…40.0
l2therm>2 tMAX: 500…2000.00s
l2therm>2 tMIN: 0.25…40s

The P34x negative phase sequence element offers a true thermal characteristic according to the following formula:

\[ t = \left( \frac{l2>2 \text{ Current Set}}{l2>2 \text{ k Setting}} \right)^2 \log_e \left( 1 - \left( \frac{l2>2 \text{ Current Set}}{l2} \right)^2 \right) \]

Note: All current terms are in per-unit, based on the relay rated current, In.
Negative phase sequence thermal characteristic

**System Backup**

**Voltage Dependent Overcurrent and Underimpedance**

Backup Function:
- Disabled
- Voltage Controlled
- Voltage Restrained
- Under Impedance

Vector Rotation: None/Delta-Star

V Dep OC Char:
- DT
- IEC S Inverse
- IEC V Inverse
- IEC E Inverse
- UK LT Inverse
- UK Rectifier
- RI
- IEEE M Inverse
- IEEE V Inverse
- IEEE E Inverse
- US Inverse
- US ST Inverse

V Dep OC l > Set: 0.8...4ln
V Dep OC T Dial: 0.01...100
V Dep OC Reset: DT or Inverse
V Dep OC Delay: 0...100s
V Dep OC TMS: 0.025...1.2
V Dep OC K(RI): 0.1...10
V Dep OC tRESET: 0...100s
V Dep OC V<1/2 Set: 5...120V (100/120V)
V Dep OC V<1/2 Set: 20...480V (380/480V)
V Dep OC K Set: 0.1...1

Z<1 Setting:
- 2...120.0Ω (100/120V, 1A)
- 0.4...24.0Ω (100/120V, 5A)
- 8...480Ω (380/440V, 1A)
- 1.60...96.0Ω (380/440V, 5A)

Z<1 Time Delay: 0.00...100.0s
Z<1 tRESET: 0...100s
Z<2 as Z<1

Inverse time (IDMT) characteristic

IDMT characteristics are selectable from a choice of four IEC/UK and five IEEE/US curves as shown in the table below.

The IEC/UK IDMT curves conform to the following formula:

\[ t = T \times \left( \frac{K}{(l/l_s)^\alpha - 1} + L \right) \]

The IEEE/US IDMT curves conform to the following formula:

\[ t = TD \times \left( \frac{K}{(l/l_s)^\alpha - 1} + L \right) \]

Where:
- \( t \) = Operation time
- \( K \) = Constant
- \( l \) = Measured current
- \( l_s \) = Current threshold setting
- \( \alpha \) = Constant
- \( L \) = ANSI/IEEE constant (zero for IEC/UK curves)
- \( T \) = Time multiplier setting for IEC/UK curves
- \( TD \) = Time dial setting for IEEE/US curves

<table>
<thead>
<tr>
<th>IDMT curve</th>
<th>Stand.</th>
<th>( K )</th>
<th>( \alpha )</th>
<th>( L )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard inverse IEC</td>
<td>0.14</td>
<td>0.02</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Very inverse IEC</td>
<td>13.5</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Extremely inverse IEC</td>
<td>80</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Long time inverse UK</td>
<td>120</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Rectifier UK</td>
<td>45900</td>
<td>5.6</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Moderately inverse IEEE</td>
<td>0.0515</td>
<td>0.02</td>
<td>0.114</td>
<td></td>
</tr>
<tr>
<td>Very inverse IEEE</td>
<td>19.61</td>
<td>2</td>
<td>0.491</td>
<td></td>
</tr>
<tr>
<td>Extremely inverse IEEE</td>
<td>28.2</td>
<td>2</td>
<td>0.1217</td>
<td></td>
</tr>
<tr>
<td>Inverse US-C08</td>
<td>5.95</td>
<td>2</td>
<td>0.18</td>
<td></td>
</tr>
<tr>
<td>Short time inverse US-C02</td>
<td>0.16758</td>
<td>0.02</td>
<td>0.11858</td>
<td></td>
</tr>
</tbody>
</table>

The IEC extremely inverse curve becomes definite time at currents greater than 20 x setting. The IEC standard, very and long time inverse curves become definite time at currents greater than 30 x setting.

The definite time part of the IEC inverse time characteristics at currents greater than 20x and 30x setting are only relevant for currents in the operating range of the relay.
The operating range of the P342/3/4/5 current inputs is 0 - 16In for the standard current inputs and is 0 - 2In for the sensitive current input.

For all IEC/UK curves, the reset characteristic is definite time only.

For all IEEE/US curves, the reset characteristic can be selected as either inverse curve or definite time.

The inverse reset characteristics are dependent upon the selected IEEE/US IDMT curve as shown in the table below.

All inverse reset curves conform to the following formula:

\[ t_{\text{RESET}} = \frac{\text{TD} \times S}{(1 - M^2)} \] in seconds

Where:

- \( \text{TD} \) = Time dial setting for IEEE curves
- \( S \) = Constant
- \( M = \frac{I}{I_{\text{ns}}} \)

<table>
<thead>
<tr>
<th>Curve Description</th>
<th>Standard</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderately inverse</td>
<td>IEEE</td>
<td>4.85</td>
</tr>
<tr>
<td>Very inverse</td>
<td>IEEE</td>
<td>21.6</td>
</tr>
<tr>
<td>Extremely inverse</td>
<td>IEEE</td>
<td>29.1</td>
</tr>
<tr>
<td>Inverse</td>
<td>US</td>
<td>5.95</td>
</tr>
<tr>
<td>Short time inverse</td>
<td>US</td>
<td>2.261</td>
</tr>
</tbody>
</table>

The RI curve (electromechanical) has been included in the first stage characteristic setting options for Phase Overcurrent and Earth Fault protections. The curve is represented by the following equation:

\[ t = K \times \left( \frac{1}{0.339 - \left(0.236/M\right)} \right) \] in seconds

With \( K \) adjustable from 0.1 to 10 in steps of 0.05

\[ M = \frac{I}{I_{\text{ns}}} \]
Phase Overcurrent (Overcurrent)
Phase O/C: Sub Heading
I>1 Function:
  Disabled
  DT
  IEC S Inverse
  IEC V Inverse
  IEC E Inverse
  UK LT Inverse
  UK Rectifier
  RI
  IEEE M Inverse
  IEEE V Inverse
  IEEE E Inverse
  US Inverse
  US ST Inverse
I>1 Direction:
  Non-Directional
  Directional Fwd
  Directional Rev
I>1 Current Set: 0.08…4.00 In
I>1 Time Delay: 0.00…100.00s
I>1 TMS: 0.025…1.200
I>1 Time Dial: 0.01…100.00
I>1 K (RI): 0.10…10.00
I>1 Reset Char: DT/Inverse
I>1 tRESET: 0.00…100.00s
I>2 as I>1
I>3 Status: Disabled/Enabled
I>3 Direction:
  Non-Directional
  Directional Fwd
  Directional Rev
I>3 Current Set: 0.08…10.00 In
I>3 Time Delay: 0.00…100.00s
I>4 as I>3
I> Char Angle: -95°…+95°
I> Function Link:
  Bit 0 = VTS Blocks I>1
  Bit 1 = VTS Blocks I>2
  Bit 2 = VTS Blocks I>3
  Bit 4, 5, 6 & 7 are not used

Binary function link string, selecting which overcurrent elements (stages 1 to 4) will be blocked if VTS detection of fuse failure occurs.

NPS Overcurrent
I2>1 Status: Disabled/Enabled
I2>1 Direction:
  Non-Directional
  Directional Fwd
  Directional Rev
I2> Current Set: 0.08…4.00 In
I2> Time Delay: 0.00…100.00s
I2>2/3/4 as for I2>1
I2> VTS Block:
  Bit 0 = VTS Blocks I2>1
  Bit 1 = VTS Blocks I2>2
  Bit 2 = VTS Blocks I2>3

Bit 3 = VTS Blocks I2>4
Bits 4, 5, 6 & 7 are not used

Binary function link string, selecting which NPS overcurrent elements (stages 1 to 4) will be blocked if VTS detection of fuse failure occurs.

I2> V2pol Set: 0.5…25.0 (100V 120V)
  2…100V (380/480V)
I2> Char Angle: -95°…+95°

Thermal Overload
Thermal I>: 0.50…2.50 In
Thermal Alarm: 20…100%
T-heating: 1…200 minutes
T-cooling: 1…200 minutes
M Factor: 0…10

The thermal time characteristic is given by:

\[ t = \tau \loge \left( \frac{I_{eq2} - I_\text{P2}}{I_{eq2} - (\text{Thermal } I >)^2} \right) \]

Where:

\[ K = \frac{I_{eq}}{\text{Thermal } I >} \]
\[ A = \frac{I_p}{\text{Thermal } I >} \]

\[ t = \tau \cdot \loge \left( \frac{K^2 - A^2}{(K^2 - 1)} \right) \]

\[ I_\text{eq} = \sqrt{I_1^2 + M I_2^2} \]
\[ I_1 = \text{Positive sequence current} \]
\[ I_2 = \text{Negative sequence current} \]
\[ M = \text{A user settable constant proportional to the thermal capacity of the machine} \]

2-Stage Non-Directional Earth Fault
IN>1 Function:
  Disabled
  DT
  IEC S Inverse
  IEC V Inverse
  IEC E Inverse
  UK LT Inverse
  RI
  IEEE M Inverse
  IEEE V Inverse
  IEEE E Inverse
  US Inverse
  US ST Inverse
  IDG
IN>1 Current: 0.02…4ln
IN>1 IDG Is: 1…4ln
IN>1 Time Delay: 0.00…200.0s
IN>1 TMS: 0.025...1.200
IN>1 Time Dial: 0.01...100.00
IN>1 K(R): 0.1...10.00
IN>1 Reset Char: DT, Inverse
IN>1 Time Delay: 0.00...200.00s

The IDG curve is commonly used for time delayed earth fault protection in the Swedish market. This curve is available in stage 1 of the Earth Fault protection.

The IDG curve is represented by the following equation:

\[ t = 5.8 - 1.35 \log_{10} \left( \frac{I}{I_{N>\text{Setting}}} \right) \text{ in seconds} \]

Where:

\( I \) = Measured current
\( I_{N>\text{Setting}} \) = An adjustable setting which defines the start point of the characteristic

Although the start point of the characteristic is defined by the "\( I_{N>\text{Setting}} \)" setting, the actual relay current threshold is a different setting called "IDG Is". The "IDG Is" setting is set as a multiple of "\( I_{N>\text{Setting}} \)".

An additional setting "IDG Time" is also used to set the minimum operating time at high levels of fault current.

The IDG curve is shown in the diagram below.

---

**SEF/REF Prot'n**

**SEF/REF Options:**
- SEF
- SEF Cos (PHI)
- SEF Sin (PHI)
- Wattmetric
- Hi Z REF
- Lo Z REF
- Lo Z REF + SEF
- Lo Z REF + Watt

**ISEF>1 Function:**
- Disabled
- DT

**ISEF>1 Directional:**
- Non-Directional
- Directional Fwd
- Directional Rev

**ISEF>1 Current:**
- 0.005...0.1000In A
- 0.00..200.00s

**ISEF> Func Link:**
- Bit 0 - Block
- ISEF> from VTS

**ISEF > Char Angle:**
- -95°...95°

**ISEF > VNpol Input:**
- Measured/Derived

**WATTMETRIC SEF:**
- PN> Setting: 0.00...20.00In W (100/120V)
- 0.00...80.00In W (380/480V)

---

**Residual O/V NVD**

**VN>1 Status:**
- Disabled/Enabled
- VN>1 Input: Derived

**VN>1 Function:**
- Disabled
- DT
- IDMT

**VN>1 Voltage Set:**
- 1...80V (100/120V)
- 4...320V (380/480V)

**VN>1 Time Delay:**
- 0.00...100.00s

**VN>1 TMS:**
- 0.5...100.0

---

**100% Stator Earth Fault (3rd Harmonic)**

**100% St EF Status:**
- Disabled, VN3H<
- Enabled, VN3H> Enabled

**100% St EF VN3H<:**
- 0.3...20.0V

**VN3H< Delay:**
- 0.00..100.00s

**V < Inhibit Set:**
- 30...120V (100/120V)
- 120...480V (380/440V)

**P < Inhibit:**
- Disabled/Enabled

---

P342, P343, P344, P345 & P391 Technical Data Sheet
16...800 In W (380/480V)
Q < Inhibit: Disabled/Enabled
Q < Inhibit: Set:
4...200.0 In W (100/120V)
16...800 In W (380/480V)
S < Inhibit: Disabled/Enabled
S < Inhibit Set:
100% St EF VN3H>:
0.3...20.0V (100/120V)
1.20...80.0V (380/480V)
VN3H> Delay: 0.00...100.0s

100% Stator Earth Fault
(Low Frequency Injection)
64S LF Injection: Disabled/Enabled
64S R Factor: 0.01...200
64S R<1 Alarm: Disabled/Enabled
64S R<1 Alm Set: 10...700Ω
64S R<1 Alm Delay: 0.00...100.0s
64S R<2 Trip: Disabled/Enabled
64S R<2 Trip Set: 10...700Ω
64S R<2 Trip Delay: 0.00...100.0s
64S Angle Comp: -60°...60°
64S Series R: 0...700Ω
64S Series X: 0...700Ω
64S Parallel G: 0.00...0.1S
64S Overcurrent: Disabled/Enabled
64S I>1 TripSet: 0.02...1.5A
64S I>1 TripDly: 0.00...100.0s
64S Supervision: Disabled/Enabled
64S V<1 Set: 0.3...25V
64S I<1 Set: 0.005...0.04A
64S Supern’n Dly: 0.00...100.0s

Volts/Hz
V/Hz Alarm Status: Disabled/Enabled
V/Hz Alarm Set:
1.50...3.500 V/Hz (100/120V)
6...14.00 V/Hz (380/480V)
V/Hz Alarm Delay: 0.00...100.0s
V/Hz>1 Status: Disabled/Enabled
V/Hz Trip Func:
DT
IDMT
V/Hz> 1 Trip Set:
1.500...3.500 V/Hz (100/120V)
6...14.00 V/Hz (380/480V)
V/Hz> 1 Trip TMS: 0.01...12.00
V/Hz> 1 Trip Delay: 0.00...600.0s
V/Hz>2 Status: Disabled/Enabled
V/Hz>2 Trip Set:
1.500...3.500 V/Hz (100/120V)
6...14.00 V/Hz (380/480V)
V/Hz>2 Trip Delay: 0.00...600.0s
V/Hz>3/4 as V/Hz>2

The inverse time characteristic has the following formula:

\[ t = \frac{TMS}{(M - 1)^2} \]

Where:
\[ V/Hz = \frac{V}{f} \]
\[ M = \left(\frac{V}{f}\right)_{\text{Trip Setting}} \]
\[ V = \text{Measured voltage} \]
\[ F = \text{Measured frequency} \]

Note: The IDMT characteristic has been changed in the 31 version software. The new characteristic is compatible with the old one and allows the option of future expansion of the number of characteristics with different exponents of (M-1).

Inverse time characteristic in software version 30 and lower is as shown below:

\[ t = 0.8 + \frac{0.18 \times TMS}{(M - 1)^2} \]

Dead Machine
Dead Mach Status: Disabled/Enabled
Dead Mach I>: 0.08...4.00 In A
Dead Mach V <:
10...120V (100/120V)
40...480V (380/480V)
Dead Mach IPU: 0.0...10.0s
Dead Mach tDO: 0.0...10.0s

Voltage Protection

Under Voltage
V< Measur’r Mode:
Phase-Phase
Phase-Neutral
V< Operate Mode:
Any Phase
Three Phase
V< 1 Function:
Disabled
DT
IDMT
V<1 Voltage Set:
10...120V (100/120V)
40...480V (380/480V)
V<1 Time Delay: 0.00...100.00s
V<1 TMS: 0.05...100.0
V<1 Poledead Inh: Disabled/Enabled
V<2 Function:
Disabled
DT
V<2 Voltage Set:
10...120V (100/120V)
40...480V (380/480V)
V<2 Time Delay: 0.00…100.00s
V<2 Poledead Inh: Disabled/Enabled

The inverse characteristic is given by the following formula:
\[ t = \frac{K}{(1 - M)} \]

Where:
- \( K \) = Time multiplier setting
- \( t \) = Operating time in seconds
- \( M \) = Applied input voltage/relay setting voltage

Over Voltage
V> Measur’t Mode:
  - Phase-Phase
  - Phase-Neutral
V> Operate Mode:
  - Any Phase
  - Three Phase

V> 1 Function:
  - Disabled
  - DT
  - IDMT
V>1 Voltage Set:
  - 60…185V (100/120V)
  - 240…740V (380/480V)
V>1 Time Delay: 0.00…100.00s
V>1 TMS: 0.05…100.0
V>2 Status: Disabled/Enabled
V>2 Voltage Set:
  - 60…185V (100/120V)
  - 240…740V (380/480V)
V>2 Time Delay: 0.00…100.00s

The inverse characteristic is given by the following formula:
\[ t = \frac{K}{(M - 1)} \]

Where:
- \( K \) = Time multiplier setting
- \( t \) = Operating time in seconds
- \( M \) = Applied input voltage/relay setting voltage

NPS Over Voltage
V>2 Time Delay: 0.00…100.00s
V>2 Poledead Inh: Disabled/Enabled

Over Frequency
F> Status: Disabled/Enabled
F> Setting: 45.00…68.00 Hz
F> Time Delay: 0.1…100.0s
F as F>

Generator Turbine Abnormal Frequency
Turbine F Status: Disabled/Enabled
Band 1 Status: Disabled/Enabled
Band 1 Freq Low: 20.00…70.00 Hz
Band 1 Freq High: 20.00…70.00 Hz
Band 1 Duration: 0.00…3600000.00s
Band 1 Dead Time: 0.00…200.00s
Band 2/3/4 as Band 1

RTD Protection
Select RTD:
  - Bit 0 - Select RTD 1
  - Bit 1 - Select RTD 2
  - Bit 2 - Select RTD 3
  - Bit 3 - Select RTD 4
  - Bit 4 - Select RTD 5
  - Bit 5 - Select RTD 6
  - Bit 6 - Select RTD 7
  - Bit 7 - Select RTD 8
  - Bit 8 - Select RTD 9
  - Bit 9 - Select RTD 10

Binary function link string, selecting which RTDs (1 - 10) are enabled.
RTD 1 Alarm Set: 0°C…200°C
RTD 1 Alarm Dly: 0s…100s
RTD 1 Trip Set: 0°C…200°C
RTD 1 Trip Dly: 0s…100s
RTD2/3/4/5/6/7/8/9/10 as RTD1

CB Fail
CB Fail 1 Status: Disabled/Enabled
CB Fail 1 Timer: 0.00…10.00s
CB Fail 2 Status: Disabled/Enabled
CB Fail 2 Timer: 0.00…10.00s
CBF Non I Reset: I< Only, CB Open & I<, Prot & I<
CBF Ext Reset: I< Only, CB Open & I<, Prot & I<
I< Current Set: 0.02…3.200In
IN< Current Set: 0.02…3.200In
ISEF< Current: 0.0010…0.8000In
Remove I> Start: Disabled/Enabled
Remove IN< Start: Disabled/Enabled
I< CT Source: IA-1, IB-1, IC-1/IA-2, IB-2, IC-2

Under Frequency
F< Status: Disabled/Enabled
F< Setting: 45.00…65.00 Hz
F< Time Delay: 0.1…100.0s
**Pole Slipping**

PSlip Function: Disabled/Enabled

PSlip Za Forward:
- 0.5…350.0/In\(^\circ\) (100/120V)
- 2.0…1400.0/In\(^\circ\) (380/480V)

PSlip Zb Reverse:
- 0.5…350.0/In\(^\circ\) (100/120V)
- 2.0…1400/In\(^\circ\) (380/480V)

Lens Angle: 90°…150°

PSlip Timer T1: 0.00…1.00s

PSlip Timer T2: 0.00…1.00s

PSlip Za Forward:
- 0.5…350.0/In\(^\circ\) (100/120V)
- 2.0…1400/In\(^\circ\) (380/480V)

PSlip Zb Reverse:
- 0.5…350.0/In\(^\circ\) (100/120V)
- 2.0…1400/In\(^\circ\) (380/480V)

PSlip Timer T1: 0.00…1.00s

PSlip Timer T2: 0.00…1.00s

PSlip Za Forward:
- 0.5…350.0/In\(^\circ\) (100/120V)
- 2.0…1400/In\(^\circ\) (380/480V)

PSlip Zb Reverse:
- 0.5…350.0/In\(^\circ\) (100/120V)
- 2.0…1400/In\(^\circ\) (380/480V)

PSlip Za Forward:
- 0.5…350.0/In\(^\circ\) (100/120V)
- 2.0…1400/In\(^\circ\) (380/480V)

PSlip Za Forward:
- 0.5…350.0/In\(^\circ\) (100/120V)
- 2.0…1400/In\(^\circ\) (380/480V)

PSlip Za Forward:
- 0.5…350.0/In\(^\circ\) (100/120V)
- 2.0…1400/In\(^\circ\) (380/480V)

Supervisory Functions

**Voltage Transformer Supervision**

VTS Status: Blocking/Indication

VTS Reset Mode: Manual/Auto

VTS Time Delay: 1.0…10.0s

VTS I> Inhibit: 0.08 In…32.0 In

VTS VN< Inhibit: 0.05 In…0.50 In

Negative phase sequence voltage (V2):
- 10V (100/120V)
- 40V (380/480V)

Phase overvoltage:
- Pick-up 30V,
- Drop-off 10V (100/120V)
- Pick-up 120V,
- Drop-off 40V (380/480V)

Superimposed Current: 0.1 In

**Current Transformer Supervision**

CTS 1 Status: Disabled/Enabled

CTS 1 VN Input: Measured/Derived

CTS 1 VN< Inhibit:
- 0.5…22V (100/120V)
- 2…88V (380/480V)

CTS 1 VN< Set: 0.08…4In

Current Loop Input

CLIO1 Input 1: Disabled/Enabled

CL11 Input Type:
- 0 - 1mA
- 0 - 10mA
- 0 - 20mA

CL11 Input Label: 16 characters (CLIO input 1)

CL11 Minimum: -9999…+9999

CL11 Maximum: -9999…+9999

CL11 Alarm: Disabled/Enabled

CL11 Alarm Fn: Over/Under

CL11 Alarm Set: CL11 min…CL11 max

CL11 Alarm Delay: 0.0…100.0s

CL11 Trip: Disabled/Enabled

CL11 Trip Fn: Over/Under

CL11 Trip From: CL11 min…CL11 max

Plant Supervision

**CB State Monitoring Control and Condition Monitoring**

Broken I^: 1…2.0

I^ Maintenance:
- Alarm disabled
- Alarm enabled

I^ Maintenance: 1In^…25000In^
CLI1 Trip Delay: 0.0…100.0s

CLI1 I< Alarm (4…20 mA input only):
   Disabled/Enabled

CLI1 I< Alm Set (4…20 mA input only):
   0.0…4.0mA

CLI2/3/4 as CLI1

Current Loop Output
CLO1 Output 1: Disabled/Enabled
CLO1 Output Type:
   0 - 1mA
   0 - 10mA
   0 - 20mA
   4 - 20mA
CLO1 Set Values: Primary/Secondary
CLO1 Parameter: As shown below*
   *CLO1 Min: Range, step size and unit
   *CLO1 Max: Same as CLO1 Min
CLO2/3/4 as CLO1

Current Loop Output Parameters
Current Magnitude:
   IA Magnitude
   IB Magnitude
   IC Magnitude
   IN Measured Mag (P342)
   IN-1 Measured Mag (P343/4/5)
   IN-2 Measured Mag (P343/4/5)
   I Sen Mag: 0.00… 2.0A
Phase Sequence Components:
   I1 Magnitude
   I2 Magnitude
   I0 Magnitude:
   0.00…16.0A
Phase Currents:
   IA RMS*
   IB RMS*
   IC RMS*
   0.00…16.0A
P-P Voltage Magnitude:
   VAB Magnitude
   VBC Magnitude
   VCA Magnitude
   0.0…200.0V
P-N Voltage Magnitude:
   VAN Magnitude
   VBN Magnitude
   VCN Magnitude
   0.0…200.0V
Neutral Voltage Magnitude:
   VN1 Measured Mag
   VN Derived Mag
   VN2 Measured Mag(P344/5)
   0.0…200.0V
VN 3rd Harmonic: 0.0…200.0V (P343/4/5)
Phase Sequence Voltage Components:
   V1 Magnitude
   V2 Magnitude
   V0 Magnitude:
   0.0…200.0V
RMS Phase Voltages:
   VAN RMS*
   VBN RMS*
   VCN RMS*
   0.0…200.0V
Frequency: 0.00…70.0Hz
3 Phase Watts*: -6000W…6000W
3 Phase Vars*: -6000Var…6000Var
3 Phase VA*: 0…6000VA
3Ph Power Factor*: -1…1

Single Phase Active Power:
   A Phase Watts*:
   B Phase Watts*:
   C Phase Watts*:
   -2000W…2000W

Single Phase Reactive Power:
   A Phase Vars*:
   B Phase Vars*:
   C Phase Vars*:
   -2000Var…2000Var

Single Phase Apparent Power:
   A Phase VA*:
   B Phase VA*:
   C Phase VA*:
   0…2000VA

Single Phase Power Factor:
   Aph Power Factor*
   BPh Power Factor*
   CPh Power Factor*
   -1…1

3 Phase Current Demands:
   IA Fixed/Roll/Peak Demand*
   IB Fixed/Roll/Peak Demand*
   IC Fixed/Roll/Peak Demand*
   0.00…16.0A
3ph Active Power Demands:
   3Ph W Fix/Roll/Peak Demand*
   -6000W…6000W
3ph Reactive Power Demands:
   3Ph Vars Fix/Roll/Peak Dem*
   -6000Var…6000Var
NPS Thermal: 0.00…200.0%
Thermal Overload: 0.00…200.0%
RTD 1-10*: -40°C…300.0°C
CL Input 1-4: -9999…9999.0
Volts/Hz: 0…20 V/Hz

Note 1: Measurements marked with an asterisk, the internal refresh rate is nominally 1s, others are 0.5 power system cycles or less.

Note 2: The polarity of Watts, Var and power factor is affected by the measurements Mode setting.

Note 3: These settings are for nominal 1A and 100/120V versions only. For other versions they need to be multiplied accordingly.
### Measurements List

#### Measurements 1

<table>
<thead>
<tr>
<th>Measurement Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iφ Magnitude</td>
<td>Per phase ($\phi = A/A-1, B/B-1, C/C-1$) current measurements</td>
</tr>
<tr>
<td>Iφ Phase Angle</td>
<td></td>
</tr>
<tr>
<td>IN Measured Mag</td>
<td></td>
</tr>
<tr>
<td>IN Measured Angle</td>
<td></td>
</tr>
<tr>
<td>IN Derived Mag</td>
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</tr>
<tr>
<td>IN Derived Angle</td>
<td></td>
</tr>
<tr>
<td>ISen Mag</td>
<td></td>
</tr>
<tr>
<td>ISen Angle</td>
<td></td>
</tr>
<tr>
<td>I1 Magnitude</td>
<td></td>
</tr>
<tr>
<td>I2 Magnitude</td>
<td></td>
</tr>
<tr>
<td>I0 Magnitude</td>
<td></td>
</tr>
<tr>
<td>Iφ RMS</td>
<td>Per phase ($\phi = A, B, C$) RMS current measurements</td>
</tr>
<tr>
<td>IN -2 Derived</td>
<td></td>
</tr>
<tr>
<td>Vω-ω Magnitude</td>
<td></td>
</tr>
<tr>
<td>Vω-ω Phase Angle</td>
<td></td>
</tr>
<tr>
<td>Vφ Magnitude</td>
<td></td>
</tr>
<tr>
<td>Vφ Phase Angle</td>
<td>All phase-phase and phase-neutral voltages ($\varphi = A, B, C$).</td>
</tr>
<tr>
<td>VN/VN1 Measured Mag</td>
<td></td>
</tr>
<tr>
<td>VN/VN1 Measured Ang</td>
<td></td>
</tr>
<tr>
<td>VN Derived Mag</td>
<td></td>
</tr>
<tr>
<td>V1 Magnitude</td>
<td></td>
</tr>
<tr>
<td>V2 Magnitude</td>
<td></td>
</tr>
<tr>
<td>V0 Magnitude</td>
<td></td>
</tr>
<tr>
<td>Vφ RMS</td>
<td>All phase-neutral voltages ($\varphi = A, B, C$).</td>
</tr>
<tr>
<td>Frequency</td>
<td></td>
</tr>
<tr>
<td>I1 Magnitude</td>
<td></td>
</tr>
<tr>
<td>I1 Angle</td>
<td></td>
</tr>
<tr>
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<td>I2 Angle</td>
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<tr>
<td>I0 Magnitude</td>
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<td>V1 Magnitude</td>
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<td>V0 Magnitude</td>
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<tr>
<td>V0 Angle</td>
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<tr>
<td>VN2 Measured Mag</td>
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<tr>
<td>VN2 Measured Ang</td>
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#### Measurements 2

<table>
<thead>
<tr>
<th>Measurement Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\phi$ Phase Watts</td>
<td>All phase segregated power measurements, real, reactive and apparent ($\varphi = A, B, C$).</td>
</tr>
<tr>
<td>$\phi$ Phase VArS</td>
<td>3 Phase Watts</td>
</tr>
<tr>
<td>$\phi$ Phase VA</td>
<td>3 Phase VArS</td>
</tr>
<tr>
<td>64S Magnitude</td>
<td>3 Phase VA</td>
</tr>
<tr>
<td>64S I Magnitude</td>
<td>NPS Power S2</td>
</tr>
<tr>
<td>64S I Angle</td>
<td>3Ph Power Factor</td>
</tr>
<tr>
<td>64S R secondary</td>
<td>$\phi$Ph Power Factor</td>
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<tr>
<td>64S R primary</td>
<td></td>
</tr>
<tr>
<td>64R CL Input</td>
<td></td>
</tr>
<tr>
<td>64R R Fault</td>
<td></td>
</tr>
<tr>
<td>64S R secondary</td>
<td></td>
</tr>
</tbody>
</table>

---

*Independent power factor measurements for all three phases ($\varphi = A, B, C$).*

*Maximum demand currents measured on a per phase basis ($\varphi = A, B, C$).*

*Reset Demand: No/Yes*
Circuit Breaker Monitoring Statistics
CB Operations
Total $I_{\phi}$ Broken
Cumulative breaker interruption duty on a per phase basis ($\phi = A, B, C$).
CB Operate Time
Reset CB Data: No/Yes
CASE DIMENSIONS

A = Clearance holes
B = Mounting holes

Flush mounting panel
Panel cut-out detail

Note: If mounting plate is required use flush mounting cut out dimensions

All dimensions in mm

P342 case dimensions (40TE case)
P342/3 case dimensions (60TE case)

P343/4 case dimensions (80TE case)
P345 case dimensions (80TE case)

A = Clearance holes
B = Mounting holes

All dimensions in mm
OUTLINE FOR GN0461001

FRONT VIEW U = 44.45

TOP VIEW

PERFORATED TOP & BOTTOM

(SEE NOTE 3)

PANEL

REMOVABLE TERMINAL COVER
TO BE RE-ASSEMBLED AFTER WIRING

SIDE VIEW

WIRING ENTRY

REAR TERMINAL BLOCK POSITIONS

EARTH CONNECTION M4

BLOCK 'A'

BLOCK 'B'

BLOCK 'C'

TERMINAL BLOCK DETAIL

FLUSH MOUNTING PANEL CUT OUT DETAIL

EACH TERMINATION ACCEPTS 2 x M4 RING TERMINALS

TERMINAL BLOCK DETAIL

NOTES

1. MOUNTING SCREWS : M4 x 8 PAN HEAD TAPTITE SCREWS OR M4 x 10 SLOTTED CH HD SCREWS WITH NUTS & WASHERS ARE PROVIDED. (PRE PACK ZA000506 - 2 PACKS)

2. TERMINAL SCREWS : M4 x 7 BRASS CHEESE HEAD SCREWS WITH LOCK WASHERS PROVIDED.

3. TO ACHIEVE ADEQUATE VENTILATION A MINIMUM AIR GAP OF 90mm (2U NOM) BETWEEN THE TOP OF THE CASE & 45mm (1U NOM) AT THE BOTTOM OF THE CASE IS REQUIRED TO ANY ADJACENT EQUIPMENT.

OUTLINE FOR GN0461001

FRONT VIEW U = 44.45

SIDE VIEW WIRING ENTRY

REMOVABLE TERMINAL COVER TO BE RE-ASSEMBLED AFTER WIRING
NOTES

1. MOUNTING SCREWS: M6 x 16 PAN HD SCREWS AND CAGE NUTS (NOT PROVIDED)

2. TERMINAL SCREWS: M4 x 7 BRASS CHEESE HEAD SCREWS WITH LOCK WASHERS PROVIDED.
   (PRE PACK ZA000500) +1 PACK

3. TO ACHIEVE ADEQUATE VENTILATION A MINIMUM AIR GAP OF 50mm (2U NOM) BETWEEN THE
   TOP OF THE CASE & 45mm (1U NOM) AT THE BOTTOM OF THE CASE IS REQUIRED TO ANY
   ADJACENT EQUIPMENT.

REFER TO SHEET 1 FOR DETAILS OF REAR TERMINAL COVER AND POSITION OF TERMINAL BLOCKS

OUTLINE FOR GN0481002
NOTES

1. MOUNTING SCREWS: M6 ANCHOR BOLT OR SIMILAR (NOT PROVIDED).

2. TERMINAL SCREWS: M4 x 7 BRASS CHEESE HEAD SCREWS WITH LOCK WASHERS PROVIDED.

3. TO ACHIEVE ADEQUATE VENTILATION A MINIMUM AIR GAP OF 90mm (0.4IN) BETWEEN THE TOP OF THE CASE & 45mm (1.8IN) AT THE BOTTOM OF THE CASE IS REQUIRED TO ANY ADJACENT EQUIPMENT.

4. TERMINAL COVER REMOVED BEFORE WIRING AND MUST BE RE-FITTED ON COMPLETION OF WIRING.

5. REFER TO SHEET 1 FOR DETAILS OF REAR TERMINAL COVER AND POSITIONS OF TERMINAL BLOCKS.

6. WIRING ENTRY THROUGH GROMMETS TOP & BOTTOM.

7. PERFORATED TOP & BOTTOM (SEE NOTE 2).

8. VIEW ON ARROW ‘A’

9. MOUNTING ARRANGEMENT

10. SCALE 2:1

P391 outline and wall mounting details (80TE case)
CONNECTION DIAGRAMS

(For a full set of connection diagrams for all hardware configurations, see technical manual P34x/EN IN)

Generator Protection Relay (40TE) for Small Generator (8 I/P & 7 O/P & RTD's)
Generator Protection Relay (60TE) with Biased Differential (16 I/P & 14 O/P & RTD's)
Generator Protection Relay (80TE) with Biased Differential and Zero Sequence Voltage Interturn (24 I/P & 24 O/P & RTD's & CLIO)
Generator Protection Relay (80TE) with 100% Stator Earth Fault Protection Via Terminal Earthing Transformer Broken Delta with Secondary Loading Resistor (24 I/P & 24 O/P + CLIO + RTD)
Double ended field winding connection

NOTES:
1. **P** - TERMINAL (P.C.TYPE)
2. DANGER: UP TO 1200V DC POSSIBLE AT REAR OF P391 CASE.
3. TERMINAL SAFETY COVER TO BE FITTED AT ALL TIMES TO REAR OF P391.
4. SUPPLIES MUST BE ISOLATED BEFORE REMOVAL OF TERMINAL SAFETY COVER OR FRONT PANEL.
5. REFER TO MANUAL FOR CLOD INPUT OPTIONS AND INJECTION FREQUENCY SELECTION.
6. REMOVE FRONT PANEL OF P391 TO GAIN ACCESS TO "JUMPER" AND SELECT REQUIRED POSITION.
7. CAUTION: HAZARDOUS VOLTAGES ACCESSIBLE.

AC OR DC AUX SUPPLY

PROTECTIVE SEPARATE CONDUCTOR TERMINAL

VIEW SHOWN PLX FREQUENCY OPTIONS FOR JUMPER OPTIONS

REMOVABLE CONDUCTOR TERMINAL
**Ordering Information**

**MiCOM P342 Generator Protection Relay Nomenclature**

| Character Type (A=Alpha, N=Numeric, X=Alpha-numeric) | A | N | N | A | X | X | X | A | X | X | N | N | X | A |
|------------------------------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Character Numbering (Maximum = 15)                   |   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10|11|12|13|14|
| P 3 4 2 * * * * * M 0 * * 0 *                    |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

**Vx Aux Rating**

- 24-48 Vdc: 1
- 48-110 Vdc, 30-100 Vac: 2
- 110-250 Vdc, 100-240 Vac: 3

**In/Vn Rating**

<table>
<thead>
<tr>
<th>In/Vn Rating</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>In=1A/5A, Vn=100/120V</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>In=1A/5A, Vn=380/480V</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

**Hardware Options**

<table>
<thead>
<tr>
<th>Nothing</th>
<th>IRIG-B only (modulated)</th>
<th>Fiber Optic Converter Only</th>
<th>IRIG-B (modulated) + Fiber Optic Converter</th>
<th>Ethernet (100Mbps)**</th>
<th>2nd Rear Comms. Board*</th>
<th>IRIG-B* (modulated) + 2nd Rear Comms Board</th>
<th>Ethernet (100Mbps) + IRIG-B (modulated)**</th>
<th>Ethernet (100Mbps) + IRIG-B (de-modulated) **</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>A</td>
<td>B</td>
</tr>
</tbody>
</table>

**Product Specific**

| Size 40TE Case, No Option (8 Optos + 7 Relays) | A | B | C | D | E | F | G | H | I | J |
| Size 40TE Case, 8 Optos + 7 Relays + RTD* | 1 |
| Size 40TE Case, 8 Optos + 7 Relays + CLIO* | 2 |
| Size 40TE Case, 16 Optos + 7 Relays* | 3 |
| Size 40TE Case, 12 Optos + 11 Relays* | 4 |
| Size 60TE Case, 16 Optos + 16 Relays* | 5 |
| Size 60TE Case, 16 Optos + 16 Relays + RTD* | 6 |
| Size 60TE Case, 16 Optos + 16 Relays + CLIO* | 7 |
| Size 60TE Case, 24 Optos + 16 Relays* | 8 |
| Size 60TE Case, 16 Optos + 24 Relays + RTD* | 9 |
| Size 60TE Case, 16 Optos + 24 Relays + CLIO* | 10 |
| Size 60TE Case, 16 Optos + 24 Relays + CLIO + RTD* | 11 |
| Size 60TE Case, 16 Optos + 8 Relays + 4 Relays HB** | 12 |
| Size 60TE Case, 16 Optos + 8 Relays + 4 Relays HB + RTD** | 13 |
| Size 60TE Case, 16 Optos + 8 Relays + 4 Relays HB + CLIO** | 14 |
| Size 60TE Case, 16 Optos + 8 Relays + 4 Relays HB + RTD + CLIO** | 15 |

**Protocol Options**

<table>
<thead>
<tr>
<th>K-Bus</th>
<th>MODBUS</th>
<th>IEC870</th>
<th>DNP3.0</th>
<th>IEC 61850 + Courier via rear EIA(RS)485 port</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

**Mounting**

<table>
<thead>
<tr>
<th>Panel Mounting</th>
<th>M</th>
</tr>
</thead>
</table>

**Language Options**

| Multilingual English, French, German, Spanish | 0 |
| Multilingual English, French, German, Russian | 5 |

**Software**

| 33 |

**Setting Files**

| Default | 0 |
| Customer | 1 |

**Design Suffix**

<table>
<thead>
<tr>
<th>Original</th>
<th>Phase 2 Hardware</th>
<th>Phase 2 CPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>C</td>
<td>J</td>
</tr>
</tbody>
</table>

Note on Design Suffix:

- A = Original hardware (48V opto inputs only, lower contact rating, no I/O expansion available)
- C = Universal optics, new relays, new power supply
- J = Phase 2 CPU and front panel with 2 hotkeys and dual characteristic optics

* Not available in design suffix A relays
** Not available in design suffix A,B,C

Note on Mounting:
For rack mounting assembled single rack frames and blanking plates are available.
### MiCOM P343 GENERATOR PROTECTION RELAY NOMENCLATURE

<table>
<thead>
<tr>
<th>Character Type (A=Alpha, N=Numeric, X=Alpha-numeric)</th>
<th>A</th>
<th>N</th>
<th>N</th>
<th>A</th>
<th>X</th>
<th>X</th>
<th>X</th>
<th>A</th>
<th>X</th>
<th>X</th>
<th>N</th>
<th>N</th>
<th>X</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Character Numbering (Maximum = 15)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
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<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>P343* * * * * * M0 * * 0 *</td>
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<td></td>
</tr>
</tbody>
</table>

#### Vx Aux Rating
- 24-48 Vdc: 1
- 46-110 Vdc, 30-100 Vac: 2
- 110-250 Vdc, 100-240 Vac: 3

#### In/Vn Rating
- In=1A/5A, Vn=100/120V: 1
- In=1A/5A, Vn=380/480V: 2

#### Hardware Options
- Nothing: 1
- IRIG-B only: 2
- Fiber Optic Converter Only: 3
- IRIG-B (modulated) + Fiber Optic Converter: 4
- Ethernet (100Mbps)**: 6
- 2nd Rear Comms. Board*: 7
- IRIG-B (modulated) + 2nd Rear Comms Board*: 8
- Ethernet (100Mbps) + IRIG-B (modulated)**: 9
- Ethernet (100Mbps) + IRIG-B (de-modulated) **: A
- IRIG-B (de-modulated) **: C

#### Product Specific
- Size 60TE Case, No Option (16 Optos + 14 Relays): A
- Size 60TE Case, 16 Optos + 14 Relays + RTD: B
- Size 60TE Case, 16 Optos + 14 Relays + CLIO*: C
- Size 60TE Case, 24 Optos + 14 Relays*: D
- Size 60TE Case, 16 Optos + 22 Relays*: E
- Size 80TE Case, 24 Optos + 24 Relays*: F
- Size 80TE Case, 24 Optos + 24 Relays + RTD*: G
- Size 80TE Case, 24 Optos + 24 Relays + CLIO*: H
- Size 80TE Case, 32 Optos + 24 Relays*: J
- Size 80TE Case, 24 Optos + 32 Relays*: K
- Size 80TE Case, 24 Optos + 24 Relays + RTD + CLIO*: L
- Size 80TE Case, 32 Optos + 32 Relays + RTD*: M
- Size 80TE Case, 32 Optos + 32 Relays + CLIO*: N
- Size 80TE Case, 16 Optos + 16 Relays + RTD + CLIO*: P
- Size 80TE Case, 16 Optos + 32 Relays + RTD + CLIO*: Q
- Size 80TE Case, 16 Optos + 14 Relays + 4 Relays HB**: R
- Size 60TE Case, 16 Optos + 7 Relays + 4 Relays HB + RTD**: S
- Size 60TE Case, 16 Optos + 7 Relays + 4 Relays HB + CLIO**: T
- Size 80TE Case, 16 Optos + 16 Relays + 8 Relays HB: U
- Size 80TE Case, 16 Optos + 16 Relays + 8 Relays HB + RTD**: V
- Size 80TE Case, 16 Optos + 16 Relays + 8 Relays HB + CLIO**: W
- Size 80TE Case, 16 Optos + 16 Relays + 8 Relays HB + RTD + CLIO**: X

Note: HB = High Break, CLIO required for Rotor EF

#### Protocol Options
- K-Bus: 1
- MODBUS: 2
- IEC61850: 3
- DNP3.0: 4
- IEC 61850 + Courier via rear EIA(RS)485 port: 6

#### Mounting
- Panel Mounting: M
- Rack Mounting (80TE case only): N

#### Language Options
- Multilingual English, French, German, Spanish: 0
- Multilingual English, French, German, Russian: 5

#### Software
- 33

#### Setting Files
- Default: 0
- Customer: 1

#### Design Suffix
- Original Universal: A
- Phase 2 Hardware: B
- Phase 2 CPU: J

---

Note: HB = High Break, CLIO required for Rotor EF
### Note Design Suffix

- **A** = Original hardware (48V opto inputs only, lower contact rating, no I/O expansion available)
- **C** = Universal optos, new relays, new power supply
- **J** = Phase 2 CPU and front panel with 2 hotkeys and dual characteristic optos

* Not available in design suffix A relays
** Not available in design suffix A, B, C

### Note Mounting

For rack mounting in the 60TE case size assembled single rack frames and blanking plates are available.
**MiCOM P344 GENERATOR PROTECTION RELAY NOMENCLATURE**

**Character Type (A=Alpha, N=Numeric, X=Alpha-numeric)**

<table>
<thead>
<tr>
<th>A</th>
<th>N</th>
<th>N</th>
<th>N</th>
<th>A</th>
<th>X</th>
<th>X</th>
<th>X</th>
<th>A</th>
<th>X</th>
<th>N</th>
<th>N</th>
<th>X</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
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<td>4</td>
<td>4</td>
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<td>*</td>
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<td>M</td>
<td>0</td>
<td>*</td>
<td>*</td>
<td>0</td>
<td>*</td>
</tr>
</tbody>
</table>

**Vx Aux Rating**
- 24-48 Vdc
- 46-110 Vdc, 30-100 Vac
- 110-250 Vdc, 100-240 Vac

**In/Vn Rating**
- In=1A/5A, Vn=100/120V
- In=1A/5A, Vn=380/480V

**Hardware Options**
- Nothing
- IRIG-B only (modulated)
- Fiber Optic Converter Only
- IRIG-B (modulated) + Fiber Optic Converter
- Ethernet (100Mbps)
- 2nd Rear Comms. Board
- IRIG-B (modulated) + 2nd Rear Comms Board
- Ethernet (100Mbps) + IRIG-B (modulated)
- Ethernet (100Mbps) + IRIG-B (de-modulated)
- IRIG-B (de-modulated)

**Product Specific**
- Size 80TE Case, No Option (24 Optos + 24 Relays)
- Size 80TE Case, 24 Optos + 24 Relays + RTD
- Size 80TE Case, 24 Optos + 24 Relays + CLIO
- Size 80TE Case, 24 Optos + 24 Relays + RTD + CLIO
- Size 80TE Case, 24 Optos + 24 Relays + 16 Relays HB + RTD
- Size 80TE Case, 24 Optos + 24 Relays + 16 Relays HB + RTD + CLIO
- Size 80TE Case, 24 Optos + 24 Relays + 16 Relays HB + CLIO
- Size 80TE Case, 24 Optos + 24 Relays + 16 Relays HB + CLIO
- Size 80TE Case, 24 Optos + 24 Relays + 16 Relays HB + CLIO
- Size 80TE Case, 24 Optos + 24 Relays + 16 Relays HB + CLIO
- Size 80TE Case, 24 Optos + 24 Relays + 16 Relays HB + CLIO

**Note:** HB = High Break, CLIO required for Rotor EF

**Protocol Options**
- K-Bus
- MODBUS
- IEC61850
- IEC 61850 + Courier via rear EIA(RS)485 port

**Mounting**
- Panel Mounting
- Rack Mounting

**Language Options**
- Multilingual English, French, German, Spanish
- Multilingual English, French, German, Russian

**Software**
- 33

**Setting Files**
- Default
- Customer

**Design Suffix**
- Phase 2 CPU

**Note Design Suffix**
- J = Original hardware (phase 2 CPU and front panel with 2 hotkeys and dual characteristic optos)
### MiCOM P345 (Generator Relay with Sigma-Delta Input Module) Nomenclature

Character Type (A=Alpha, N=Numeric, X=Alpha-numeric)

<table>
<thead>
<tr>
<th>Character Numbering (Maximum = 15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vx Aux Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-48 Vdc</td>
</tr>
<tr>
<td>48-110 Vdc, 30-100 Vac</td>
</tr>
<tr>
<td>110-250 Vdc, 100-240 Vac</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>In/Vn Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>In = 1A/SA, Vn=100/120V</td>
</tr>
<tr>
<td>In = 1A/SA, Vn=380/480V</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hardware Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nothing</td>
</tr>
<tr>
<td>IRIG-B only (modulated)</td>
</tr>
<tr>
<td>Fiber Optic Converter Only</td>
</tr>
<tr>
<td>IRIG-B (modulated) + Fiber Optic Converter</td>
</tr>
<tr>
<td>Ethernet (100Mbps)</td>
</tr>
<tr>
<td>Ethernet (100Mbps) + IRIG-B (modulated)</td>
</tr>
<tr>
<td>Ethernet (100Mbps) + IRIG-B (de-modulated)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product Specific</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size 80TE Case, No Option (24 Optos + 24 Relays)</td>
</tr>
<tr>
<td>Size 80TE Case, 24 Optos + 24 Relays + RTD</td>
</tr>
<tr>
<td>Size 80TE Case, 32 Optos + 24 Relays</td>
</tr>
<tr>
<td>Size 80TE Case, 24 Optos + 32 Relays</td>
</tr>
<tr>
<td>Size 80TE Case, 24 Optos + 24 Relays + CLIO</td>
</tr>
<tr>
<td>Size 80TE Case, 32 Optos + 24 Relays + CLIO</td>
</tr>
<tr>
<td>Size 80TE Case, 24 Optos + 32 Relays + RTD + CLIO</td>
</tr>
<tr>
<td>Size 80TE Case, 32 Optos + 16 Relays + RTD + CLIO</td>
</tr>
<tr>
<td>Size 80TE Case, 16 Optos + 32 Relays + RTD</td>
</tr>
<tr>
<td>Size 80TE Case, 16 Optos + 32 Relays + 4 Relays HB + RTD</td>
</tr>
<tr>
<td>Size 80TE Case, 24 Optos + 16 Relays + 4 Relays HB</td>
</tr>
<tr>
<td>Size 80TE Case, 24 Optos + 16 Relays + 4 Relays HB + CLIO</td>
</tr>
<tr>
<td>Size 80TE Case, 24 Optos + 16 Relays + 8 Relays HB</td>
</tr>
<tr>
<td>Size 80TE Case, 24 Optos + 16 Relays + 8 Relays HB + RTD + CLIO</td>
</tr>
<tr>
<td>Size 80TE Case, 16 Optos + 16 Relays + 8 Relays HB + RTD</td>
</tr>
<tr>
<td>Size 80TE Case, 16 Optos + 16 Relays + 8 Relays HB + CLIO</td>
</tr>
<tr>
<td>Size 80TE Case, 32 Optos + 24 Relays + RTD</td>
</tr>
<tr>
<td>Size 80TE Case, 32 Optos + 24 Relays + CLIO</td>
</tr>
<tr>
<td>Size 80TE Case, 32 Optos + 24 Relays + RTD + CLIO</td>
</tr>
</tbody>
</table>

Note: HB = High Break, CLIO required for Rotor EF

<table>
<thead>
<tr>
<th>Protocol Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-Bus</td>
</tr>
<tr>
<td>MODBUS</td>
</tr>
<tr>
<td>IEC870</td>
</tr>
<tr>
<td>DNP3.0</td>
</tr>
<tr>
<td>IEC 61850 + Courier via rear EIA(RS)485 port</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mounting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel Mounting</td>
</tr>
<tr>
<td>Rack Mounting</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multilingual English, French, German, Spanish</td>
</tr>
<tr>
<td>Multilingual English, French, German, Russian</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Setting Files</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default</td>
</tr>
<tr>
<td>Customer</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Design Suffix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extended Phase 2 CPU with 10 function keys and tri-color LEDs</td>
</tr>
</tbody>
</table>

* Note Design Suffix

K = Extended phase 2 CPU (phase 2 CPU and front panel with 10 function keys and tri-color LEDs and dual characteristic optos)

Separately ordered P345 accessories for low frequency injection 100% stator earth fault protection

1. 20Hz generator (Surface/Flush/Rail Mounted)
2. Bandpass Filter (Surface/Flush/Rail Mounted)
3. 400/5A Tripping CT
### MiCOM P391 (Generator Rotor Earth Fault Module) Nomenclature

**Character Type (A=Alpha, N=Numeric, X=Alpha-numeric)**

<table>
<thead>
<tr>
<th>Character Numbering (Maximum = 15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15</td>
</tr>
</tbody>
</table>

**Software Version**

- **MiCOM P391**: 33A

**Character Numbering:**

- **P391901A0M0000A**

<table>
<thead>
<tr>
<th>Vx Aux Rating</th>
<th>In/Vn Rating</th>
<th>Hardware Options</th>
<th>Product Specific</th>
<th>Protocol Options</th>
<th>Mounting</th>
<th>Software</th>
<th>Setting Files</th>
<th>Design Suffix</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-250 Vdc, 100-230V ac</td>
<td>N/A</td>
<td>None</td>
<td>None</td>
<td>N/A</td>
<td>Panel Mounting</td>
<td>33</td>
<td>N/A</td>
<td>Original hardware</td>
</tr>
<tr>
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<td>1</td>
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<td>0</td>
<td>R</td>
<td>A</td>
<td>0</td>
<td>A</td>
</tr>
</tbody>
</table>

**Auxiliary Rating:**

- 60-250 Vdc, 100-230V ac

**In/Vn Rating:**

- N/A

**Hardware Options:**

- None

**Product Specific Options:**

- None

**Protocol Options:**

- N/A

**Mounting Options:**

- Panel Mounting
- Rack Mounting
- Wall Mounting

**Software Version:**

- 33

**Setting Files:**

- N/A

**Design Suffix:**

- Original hardware
CONTROL

> Programmable scheme logic

Programmable scheme logic allows the user to customise the protection and control functions. It is also used to programme the functionality of the optically isolated inputs, relay outputs and LED indications. The programmable scheme logic comprises gate logic and general purpose timers. The gate logic includes OR, AND and majority gate functions, with the ability to invert the inputs and outputs, and provide feedback. The system is optimised to evaluate changes to the scheme logic signals and thus minimise any delays in logic execution. The programmable scheme logic may be configured using the graphical MiCOM S1 PC based support software, as illustrated in Figure 2. The required logic is drawn as shown and is then downloaded directly into the relay. The logic may also be uploaded from the relay and then modified using MiCOM S1 support software.

> Independent protection settings groups

The settings are divided into two categories: protection settings and control and support settings. Four setting groups are provided for the protection settings to allow for different operating conditions and adaptive relaying.

> Control inputs

The ON/OFF status of 32 control inputs can be changed manually or remotely via the communications to provide user defined control functions.

> Function Keys (P345 only)

Ten function keys are available for implementing scheme control functionality. The function keys operate in two modes, normal and toggled, and activate associated signals in PSL that can easily be used to customize the application. The following examples illustrate how scheme functionality can easily be implemented for use with the function keys.
- Select Group 2 settings
- Reset thermal overload measurement
- Reset latched contacts and LEDs
- Trigger disturbance record

Each function key has an associated tri-color LED (red, green, yellow) allowing for clear indication of the associated function's state.

> Indication

Eighteen tri-color LEDs (P345) or 8 red LEDs (P342/3/4) are available for user programming. The P345 LED colors (red, green, yellow) are driven via digital databus signals in PSL and can be programmed to indicate up to four conditions/states for example.
- Off - Not in service
- Red - CB closed
- Green - CB open
- Yellow - CB not healthy

INFORMATION INTERFACES

Information exchange is done via the local control panel, the front PC interface, the main rear communications interface (COMM1/RP1) or an optional second rear interface (COMM2/RP2).

> Local communication

The front EIA(RS)232 Courier communication port has been designed for use with the MiCOM S1 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 main rear communications interface supports the five protocols listed below (selected at time of order) and is intended for integration with substation control systems.
- Courier/K-Bus
- Modbus
- IEC 60870-5-103
- DNP 3.0
- IEC61850

IEC 61850 is available when the optional Ethernet port is ordered. IEC 61850 offers high-speed data exchange, peer-to-peer communication, reporting, disturbance record extraction and time synchronization. An optional fiber optic interface is available for any of the above protocols.

An optional 2” rear communications port with the Courier protocol is available. This port is intended for central settings or remote access with MiCOM S1. Clock synchronization can be achieved using one of the protocols or using the IRIG-B input or using an opto input.

EMC COMPLIANCE

Compliance with the European Commission Directive on EMC

PRODUCT SAFETY

Compliance with the European Commission Low voltage directive

P34X THIRD PARTY COMPLIANCES

File Number: E020519
Original Issue Date: 05-10-2002
(Complies with Canadian and US requirements)
Certificate Number: 104 Issue 2
Assessment Date: 16-04-2004

AREVA TRACK RECORD - GENERATOR PROTECTION


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