

Metering Devices, Protective Relays, Software and Connectivity

9.1 Metering Devices

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Metering Products Family



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Description

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Product Overview

Eaton's metering products provide solutions needed to monitor and manage all aspects of an electrical distribution system.

When greater reliability, increased productivity and significant cost savings are called for to remain competitive in today's market, Eaton's metering products fit the bill. These innovative meters and communications systems, along with Power Management software, make it possible to successfully take control of the electrical distribution system.

Power Xpert Meters

Power Xpert® Meters are the benchmark for intelligent web-enabled top-quality metering devices for the power system. Power Xpert Meters provide measurement of the critical elements found in the power system, whether that be voltage, power, current, transients, harmonics or even time. Power Xpert Meters provide web-enabled communications for use with the Power Xpert Insight™. All Power Xpert Meters provide a standard communications protocol for easy integration into other systems.

Features and Benefits

Greater Reliability

Eaton's metering products give the ability to receive an early warning of potential problems, eliminate unnecessary trips, isolate faults to ensure minimum downtime and shed or equalize loads while a problem is being corrected.

Increased Productivity

Equipment downtime resulting from voltage or frequency variations can be very costly to an operation. Monitoring power quality with Eaton's metering products throughout the electrical distribution system provides data to identify, isolate and correct problems quickly and efficiently.

Reduced Energy and Operating Costs

When we think about meters and power quality, the common thread throughout the basket of solutions is information. Collecting, monitoring and managing data from the electrical distribution system can help reduce costs for those facilities prepared to define and analyze present electrical energy usage levels and patterns. Data provided by Eaton's metering products comprise the data for verifying utility bills for energy management and lowering operating costs. Deregulation in some geographical locations permits energy users to select a utility provider and negotiate rate structures. For large users with heavy utility bills, this may be an incentive to verify the utility bill, identify an opportunity for savings, negotiate a better utility rate and apply the savings directly to the bottom line. Users are also empowered to decrease energy consumption, thereby lowering peak demand charges and decreasing operating costs.

When an Eaton meter is used with Eaton trip units and relays incorporating built-in metering capabilities, the entire electrical distribution system can be cost-effectively managed.

Eaton is an industry leader offering a complete integrated solution to oversee your entire electrical distribution system. As a global manufacturer of low and medium voltage electrical distribution system equipment and components, Eaton is an experienced innovator of metering products that incorporate cutting-edge technology. These innovations result from our scientific and engineering expertise, physical resources and the ongoing R&D programs at our technology centers.

Product Selection Guide

Metering Selection Chart

PXM350



Power Xpert Energy Meter



PXQ Event Analysis System (Power Quality Meter)



Section	Page Number	V3-T9-7	V3-T9-14	V3-T9-22
Electrical Parameters				
Volts		±0.5% of RV	±0.1% RV	IEC 61557-12 Class 0.1
Amperes		±0.5% of RV	±0.1% RV	IEC 61557-12 Class 0.1
Current range (% of nominal)		0.1–200%	0.1–200%	Up to 400% continuous (5A CT)
Watts		±0.5% of RV	±0.1% of RV	IEC 61557-12 Class 0.1
Vars		±0.5% of RV	±0.1% of RV	IEC 61557-12 Class 1
VA		±0.5% of RV	±0.1% of RV	IEC 61557-12 Class 0.2
PF-apparent		±0.5% of RV	±0.1% of RV	Yes
PF-displacement		±0.5% of RV	—	Yes
Frequency		0.12 Hz	±0.001 Hz	±0.01 Hz
THD-voltage		—	63rd ^{①②}	85th
THD-current		—	63rd ^{①②}	85th
Wathours		±0.5% per ANSI C12.20 0.5 Class	±0.1% per ANSI C12.20 0.1 Class	ANSI C12.1:2022 Class 0.1
Varhours		±0.5%	±0.1%	IEC 62053-24 Class 0.5 S
VA-hours		±0.5%	±0.1%	IEC 61557-12 Class 0.2
Ampere-demand		±0.5%	±0.1%	IEC 61557-12 Class 0.1
Watt-demand		±0.5% per ANSI C12.20 0.5 Class	±0.1% per ANSI C12.20 0.1 Class	IEC 61557-12 Class 0.1
Var-demand		±0.5%	±0.1%	IEC 61557-12 Class 1
VA-demand		±0.5%	±0.1%	IEC 61557-12 Class 0.2
Revenue accuracy		—	—	IEC 62053-22 Class 0.1 S ANSI C12.20:2015 Class 0.1 ANSI C12.1:2022 Class 0.1
Individual ampere harmonics		—	63rd (50 Hz or 60 Hz), 15th ^{①②}	85th ^③ , trendable
Individual voltage harmonics		—	63rd (50 Hz or 60 Hz), 15th ^{①②}	85th ^③ , trendable
Interharmonics		—	—	Yes
Minimum and/or Maximum Values				
Volts		—	L-L, L-N	L-L, L-N, N-G (RMS and symmetric components)
Current		—	A, B, C, N	A, B, C, N/G (measure one, calculate the other; (RMS and symmetric components)
Power		—	Watt, var, VA	Watt, var, VA (4-quadrant)
Power factor		—	Apparent	Apparent/displacement
Frequency		—	Hertz	Hertz
THD		—	Amperes/volts	Amperes/volts/% (L-L, L-N)
Demand values		kW, kvar, kVA, amperes	kW, kvar, kVA, amperes, TOU	kW, kvar, kVA, amperes (bi-directional)
Trend analysis		—	16 MB ^② / 8 GB ^③	Hundreds of preconfigured metering trends, including 200 ms RMS, min, max, 5-minute average
Event logging		20 alarms/15 events with timestamp	16 alarms/50,000 events with timestamp	Sags and swells on ITIC or SEMI-F47 curve, transients (17 µs standard, 100 ns optional), trigger learning
Disturbance recording		—	16 MB ^② , 20 cycles per waveform	Up to 2 minutes of event sequence data accompanied by high resolution waveforms (60 or 120 cycles)

Notes

- ① PXE1 only.
- ② PXE2 only.
- ③ Optional communication module PXM1K-ETHMULTI.
- ④ Under typical operating conditions.
- ⑤ Individual values reported to 85th harmonic; anti-alias filtering prevents higher frequencies from distorting readings (see IEC 61000-4-7).

Legend: PG = Programmable
FS = Full scale
RV = Read value

Metering Selection Chart, continued

PXM350



Power Xpert Energy Meter



PXQ Event Analysis System (Power Quality Meter)



Section Page Number

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V3-T9-22

Other Features

Storage	8 KB	16 MB ^① / Additional 8 GB to the meter ^②	4 GB or 32 GB
PG output relays	Form A, 5 A	5 A ^③	2 Form C solid-state outputs
PG analog outputs	—	Optional 0–20 mA or 4–20 mA or 0–5 V or 1–5 V ^③	—
Discrete contact inputs	—	Optional 4 or 6, 2 mA ^③	8 standard, expandable to 40
Analog inputs	—	Optional 0–20 mA or 4–20 mA or 0–5 V or 1–5 V ^③	—
Synch-input kW utility	—	Via end of interval pulse with optional digital inputs	Via status input
Auxiliary voltage ^③	—	—	—
kWh pulse initiator	Yes, 10 mA, 250 Vac	Yes	Yes
Waveform display	—	Web pages ^{①②}	Local display, webpages, COMTRADE
Waveform capture, samples/cycle	—	Yes, up to 512 ^①	512 samples/cycle for 60 cycles or 1024 samples/cycle for 120 cycles
Frequency distribution display	—	—	—
Display type	Backlit LCD	Backlit LCD ^④	Optional 7-inch touchscreen
Display lines/character	1 line, 7 characters	5 line, 4 characters	Color graphic
Display character height	7.85 mm	10 mm	—
Communications	Serial: Modbus RTU, BACnet MS/TP	Serial: Modbus RTU, DNP3.0, BACnet MS/TP Network ^{②⑤} : Modbus TCP/IP, BACnet/IP, EtherNet/IP, HTTPS, HTTPS Post, FTP, sFTP, IPV6, SNMP, NTP, COMTRADE, IEC 61850, PROFINET, DNP3.0 over IP, and MQTT 8 GB datalogging, trendlog display	Industrial communication: Modbus TCP/RTU, BACnet/IP Network communications: SNMP v1, SNMP v3, HTTP, HTTPS, SMTP Network addressing: IPv4, IPv6, DHCP Time synchronization: NTP/SNTP, PTP File transfer sFTP: (secure FTP) Authentication: LDAP for OpenLDAP systems Cryptography: TLS 1.2, SSL
Setup configuration	Via configuration software/display	Via configuration software/display Via web browser	Via web browser or display
Dimensions	3.54 (90.0) H x 4.25 (108.0) W x 2.46 (62.5) D	Meter: 3.77 (96.0) H x 3.77 (96.0) W x 2.50 (63.5) D Display: 3.77 (96.0) H x 3.77 (96.0) W x 2.31 (58.7) D	7.20 H x 5.40 W x 5.10 D
Operating temperature range	–25 °C to +70 °C	–25 °C to +70 °C	–20 °C to +70 °C
Reference literature	TD150024EN	TD150048EN	TD150038EN

Notes

- ^① PXE2 only.
^② Optional communication module PXM1K-ETHMULTI.
^③ 2 I/O modules plus the comm module can be installed, or 3 I/O modules with no comm module (ETHMULTI)
 Relay outputs—up to 6 total
 Analog outputs—up to 6 total
 Discrete contact inputs—up to 16 total
 Analog inputs—up to 6 total
^④ Available transducer version with remote display.
^⑤ Optional.

Legend: PG = Programmable
 FS = Full scale
 RV = Read value

Metering Selection Chart, continued

Power Xpert
Branch Circuit Monitor (PXBCM)

V3-T9-27

Power Xpert
Multi-Point Meter

V3-T9-31

Section Page Number

Electrical Parameters

Volts	±0.2% RV
Amperes	±0.2% RV
Current range (% of nominal)	—
Watts	±0.5% RV
Vars	±0.5% RV
VA	±0.5% RV
PF-apparent	±0.5% RV
PF-displacement	—
Frequency	±0.1 Hz
THD-voltage	—
THD-current	—
Watt-hours	±0.5% per ANSI C12.20 0.5 class
Var-hours	±0.5% per ANSI C12.20 0.5 class
VA-hours	±0.5% per ANSI C12.20 0.5 class
Ampere-demand	—
Watt-demand	±0.5% per ANSI C12.20 0.5 class
Var-demand	±0.5% per ANSI C12.20 0.5 class
VA-demand	±0.5% per ANSI C12.20 0.5 class
Revenue accuracy	ANSI C12.20 (0.5%)
Individual ampere harmonics	—
Individual voltage harmonics	—
Interharmonics	—

Minimum and/or Maximum Values

Volts	L-L, L-N
Current	A, B, C
Power	Watts, vars, VA
Power factor	Apparent
Frequency	Hertz
THD	—
Demand values	Watts (Delivered & Received), Watts (Q1–Q4), VA (Q1, Q4), VA (Q2, Q3)
Trend analysis	Interval data
Event logging	20 latest events and historical
Disturbance recording	—

Notes

- ① From 3–300% of FS.
- ② At unity power factor and 5–300% of FS.
- ③ At a power factor ≤ 0.5 and 5–300% of FS.
- ④ At computer only.

Legend: PG = Programmable
 FS = Full scale
 RV = Read value

Metering Selection Chart, continued

**Power Xpert
Branch Circuit Monitor (PXBCM)**



V3-T9-27

**Power Xpert
Multi-Point Meter**



V3-T9-31

Section Page Number

Other Features

Storage	256 MB standard, 2 GB optional
PG output relays	1 standard, 8 each module ^①
PG analog outputs	3 standard, 8 each module ^①
Discrete contact inputs	—
Analog inputs	Via communications and digital input
Synch-input kW Utility	—
Auxiliary voltage	Aggregate or main-digital output, LED output on meter modules (accuracy check)
kWh pulse initiator	—
Waveform display	—
Waveform capture, samples/cycle	—
Frequency distribution display	—
Display type	LCD color touchscreen ^①
Display lines/character	6-inch diagonal
Display character height	Graphics
Communications	Serial: Modbus RTU ^① Network: Modbus TCP, BACnet/IP, Ethernet TCP/IP, HTTP, HTTPS, SNMP, SMTP, SFTP
Setup configuration	Via PXMP configuration software
Dimensions	Refer to TD150006EN (see Page V3-T9-110)
Operating temperature range	–20 °C to +70 °C
Reference literature	TD150006EN

Notes

- ^① Relays programmable to operate on any measured function.
- ^② Optional.
- ^③ An IPQNI is required.
- ^④ IQ 230M only.

Legend: PG = Programmable
FS = Full scale
RV = Read value

PXM350



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Current Transformers (CTs)	V3-T9-43
Panel Mounting Adapter Kit	V3-T9-52



PXM350

Product Description

Eaton's Power Xpert Meter 350 (PXM350) is a compact and powerful revenue-grade energy meter. It combines exceptional performance with easy installation to deliver a cost-effective solution for energy and power monitoring applications, as well as submetering applications.

This DIN rail mounted, three-phase energy meter provides high accuracy in a small form factor, making it an ideal solution for panelboard applications to monitor the main power coming into the panelboard. Multiple current sensor options make the PXM350 ideal for energy code monitoring field retrofit installations using split core 333 mV or Rogowski coil current sensors.

The PXM350 comes with a built-in LCD display for local reading. The Modbus RTU and BACnet MS/TP communications allow for a seamless integration with building management and data acquisition systems. A NEMA® 4X enclosure is available as an accessory. This combination is perfect for retrofit metering applications.

Application Description

The PXM350 delivers you a cost-effective solution for energy and submetering applications.

- Commercial submetering
- Energy management
- Industrial monitoring
- Cost allocation
- Data center
- Light commercial
- Industrial
- Institutions

The PXM350 helps meet the Measurement and Verification points required by the LEED® and U.S. Green Building Council. The PXM350 can be factory installed in panelboards to help comply with ASHRAE 90.1, ASHRAE 189.1, IECC and IGCC

Features and Benefits

- Economical and compact watt-hour meter with demand measurement
- Revenue grade accuracy—IEC 62053-22 0.5s Class/ANSI C12.20 0.5 Class
- Multiple current sensor input options compatible with any current transformer: 5 A/1 A, 333 mV, flexible Rogowski coil, 80/100/200 mA
- 10–690 Vac direct voltage input, one model for most low voltage circuits
- Compatible with both 50 Hz and 60 Hz systems
- Built-in energy pulse output and alarm output
- Compatible with the Power Xpert Gateway for remote monitoring
- Monitors:
 - Voltage, current, power factor, frequency
 - Power: real, reactive and apparent
 - Energy: real, reactive and apparent
- Demand measurement of current, real power, reactive power and apparent power
- Peak demand
- Built-in Modbus RTU, BACnet MS/TP and pulse output

Additional Features

Four channel CT input

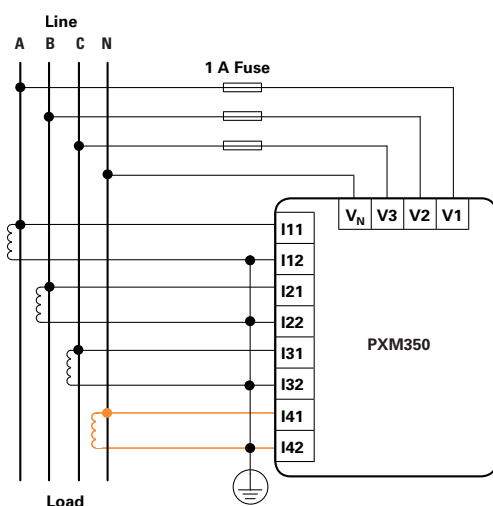
Accurately measure neutral current with 4th CT and provide residual current measurement.

Auto phase-check

Designed to automatically check most common wiring mistakes such as CT polarity, voltage and current phase alignment.

Supports standard electrical system configurations

Three-phase three-wire (3P3W), three-phase four-wire (3P4W), single-phase three-wire (1P3W two element), single-phase two-wire (1P2W one element) and more.



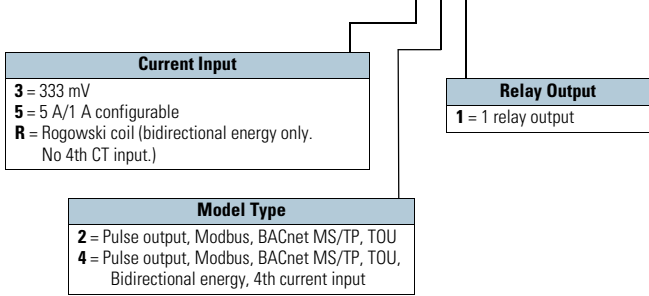
Features of PXM350 MA 6x2x and PXM350 MA 6x4x

Feature	PXM350 MA 6x2x	PXM350 MA 6x4x
Bi-directional energy measurement	■	■
Active energy	■	■
Reactive energy	■	■
Apparent energy	■	■
Time-of-use	■	■
Power demand	■	■
Peak power demand	■	■
Predictive demand	■	■
Current demand	■	■
Peak current demand	■	■
Voltage	■	■
Current	■	■
Neutral current	Calculated	■
Residual current	■	Calculated
Active power	■	■
Reactive power	■	■
Apparent power	■	■
Power factor	■	■
Frequency	■	■
Clock	■	■
Running time	■	■
Energy pulse output	■	■
Relay output (alarm or control)	■	■
RS-485 Modbus-RTU or BACnet MS/TP	■	■
Wiring check	■	■
Temperature (internal)	■	■
SunSpec	■	■
Current transformer (CT) input	5 A/1 A: Field-configurable CT input 333 mV: CT Input flexible Rogowski coil CT Input 80/100/200 mA: field-configurable CT input	5 A/1 A: Field-configurable CT input 333 mV: CT Input flexible Rogowski coil CT Input 80/100/200 mA: field-configurable CT input
I/O	One relay output for alarm or remote control	One relay output for alarm or remote control

Catalog Number Selection

Power Xpert Meter 350

PXM 350 MA 6 3 2 1



Accessories

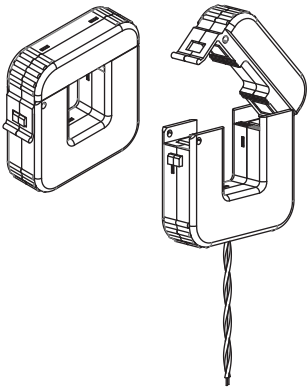
PXM350 Plastic NEMA 4X Enclosure

The PXM350-ENC enclosure offers a mounting option for PXM350 series energy meters that helps protect from tampering and the elements. The enclosure is equipped with DIN rail mounting hardware for easy installation, and a NEMA 4X rating ensures durability. The swing panel kit and multiple locking options provide additional security from unwanted tampering.

Description	Dimension in Inches	Catalog Number
PXM350 Enclosure, NEMA 4X_	6x6x4	PXM350-ENC

Current Sensors

333 mV Current Sensors



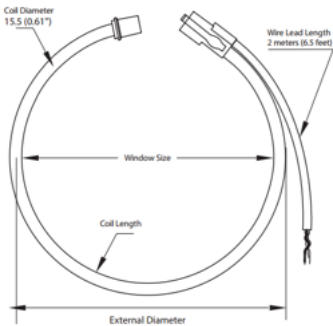
PXM350 is compatible with 333 mV output current transformer for low-cost energy efficiency and energy management systems. A variety of window sizes and ratios are available for split-core 333 mV sensors. Refer to the Current Sensors section of this catalog for ordering information.

5A/1A Current Sensors

Field-configurable CT input that suits any industrial and revenue-grade current transformer.

A variety of window sizes and ratios are available. Refer to the Current Sensors section of this catalog for ordering information.

Rogowski Coil



Rogowski coils are available in multiple lengths and flexible, rope-like form factor is ideal for measurement around irregularly shaped conductors or in crowded electrical panels.

A variety of window sizes, length of coils and ratios are available. Refer to the Current Sensors section of this catalog for ordering information.

Technical Data and Specifications

Metering

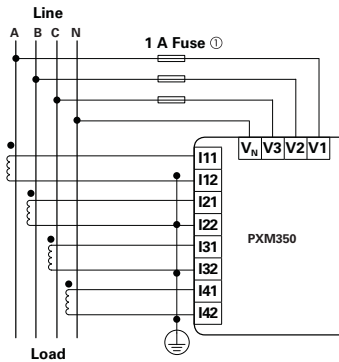
Parameter	Accuracy	Resolution	Range
Active energy	0.5%	1 Wh	0–999999999
Reactive energy	0.5%	1 varh	0–999999999
Apparent energy	0.5%	1 VAh	0–999999999
Voltage	0.5%	0.1	10 V—1000 kV
Current	0.5%	0.001 A	10 mA—500000 A
Active power	0.5%	1 W	–99–99 MW
Reactive power	0.5%	1 var	–99–99 Mvar
Apparent power	0.5%	1 VA	–99–99 MVA
Power factor	0.5%	0.001	–0.001 to 1.000 to +0.001
Frequency	0.5%	0.01 Hz	50/60
Power demand	0.5%	1 W/var/VA	99 MW/Mvar/MVA
Current demand	0.5%	0.001 A	10 mA—5000 A

Specifications

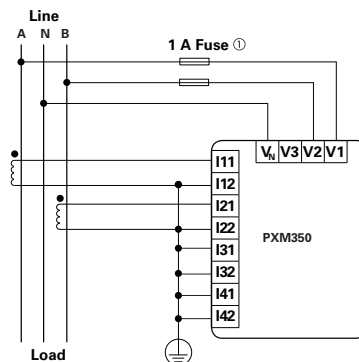
Description	Specification
Voltage	
Rated voltage	400 Vac L-N 690 Vac L-L
Input impedance	2 MΩ/phase
Measurement frequency	50/60 Hz
Accuracy	0.5%
Current Input	
Stated current (I _N)	5 A _{ac} /1 A _{ac}
Start current	10 mA
Accuracy	0.5%
Pulse Output	
Isolation voltage	2500 Vac
Load voltage	0–250 Vac
Load current	100 mA (maximum)
Power Supply	
Working power supply	100–415 Vac, 50/60 Hz, 100–300 Vdc
Power consumption	<2 W or 10 VA
Relay Output	
Load voltage	250 Vac 30 Vdc
Max. load current	5 A (resistant load)
Isolation voltage	2000 Vac (1 minimum.)
Action time	10 ms
Mechanical life	20 million times
Electrical life	Above 50,000 times (5 A, 250 Vac, resistant load)
Communication	
RS-485 baud rate	1200–34800
Communication protocol	Modbus-RTU or BACnet MS/TP
Environment	
Operating temperature	–25 to +70 °C (–13 to +158 °F)
Storage temperature	–40 to +85 °C (–40 to +185 °F)

Wiring Diagrams

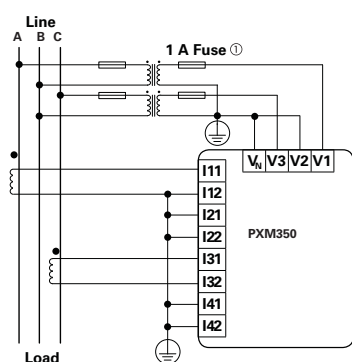
Typical Wiring for 5 A/1 A Current Input



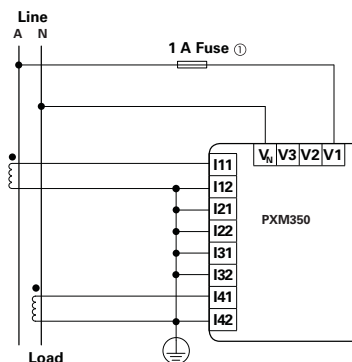
Select 3LN, 3CT configuration option.



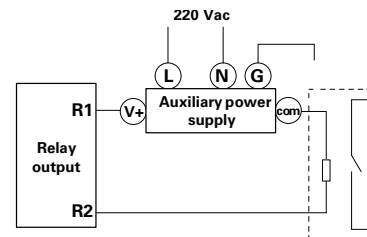
Select 1LL, 2CT configuration option.



Select 2LL, 2CT configuration option.

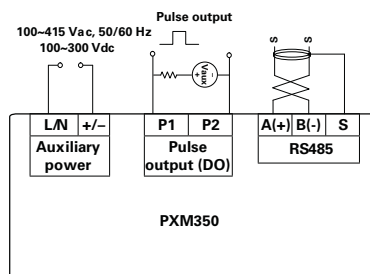


Select 1LN, 1CT configuration option.

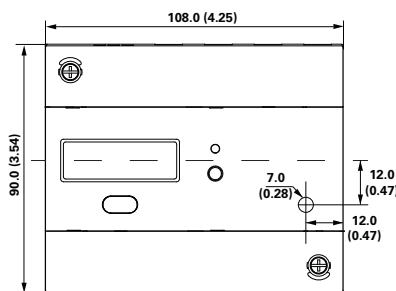


Relay output

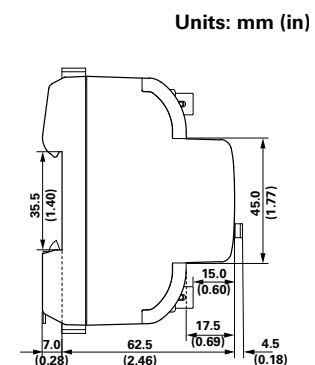
Note: Optional interposing relay, not included with meter.



Auxiliary power + pulse + RS485



Dimensions

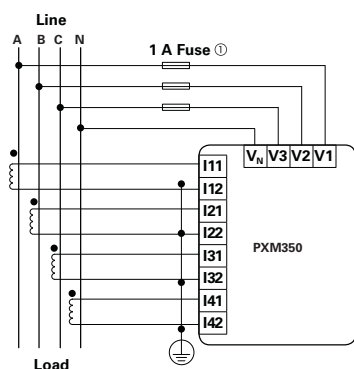


Units: mm (in)

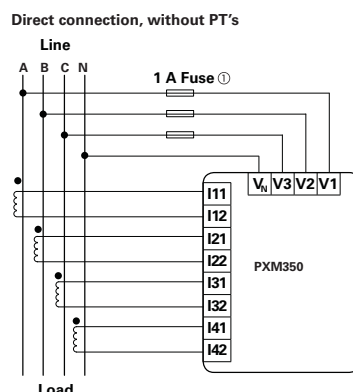
① Fuse rating should be selected to protect the secondary instrumentation wiring.

Note: CT shorting terminal blocks are required but not shown in the diagrams.

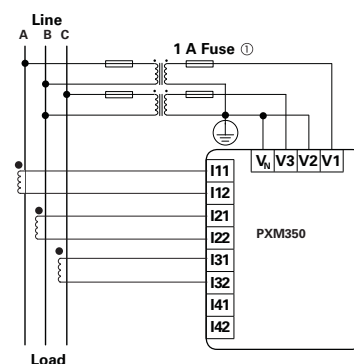
Typical Wiring for RCT/mV/mA Current Input



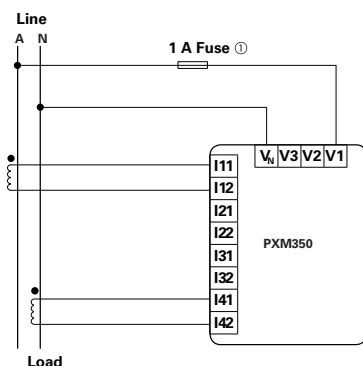
Select 3LN, 3CT configuration option.



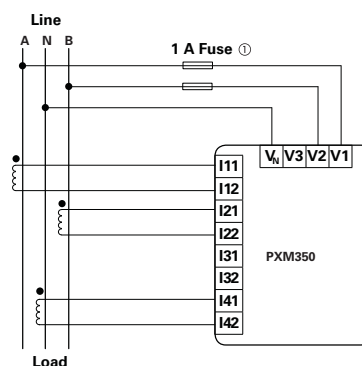
Select 3LN, 3CT configuration option.



Select 2LL, 3CT configuration option.



Select 1LN, 1CT configuration option.



Select 1LL, 2CT configuration option.

① Fuse rating should be selected to protect the secondary instrumentation wiring.

Note: CT shorting terminal blocks are required when using mA output current sensors, but are not shown in the diagrams..

Approximate Dimensions in Inches (mm)

Technical drawing of the top view of the cover removed. The drawing shows a square frame with various dimensions and components labeled.

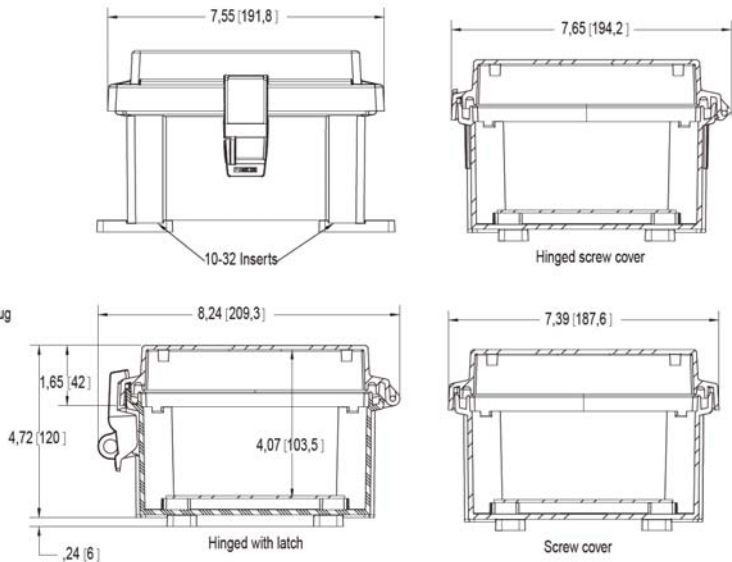
Dimensions (mm):

- Overall width: 7,32 [186]
- Overall height: 7,16 [181,9]
- Inner width: 6,06 [153,9]
- Inner height: 4,88 [124]
- Distance from top edge to inner width line: 7,04 [178,9]
- Distance from left edge to inner height line: 4,00 [101,6]
- Distance from inner width line to right edge: 4,88 [124]
- Distance from inner height line to bottom edge: 6,10 [155]

Components labeled:

- 10-32 inserts
- Wall fastening lug

Top View - cover removed



Power Xpert Energy Meter



Contents

Description	Page
Metering Products Family	V3-T9-2
PXM350	V3-T9-7
Power Xpert Energy Meter	
Power Xpert Quality (PXQ) Event Analysis System (Power Quality Meter)	V3-T9-22
Power Xpert Branch Circuit Monitor (PXBCM)	V3-T9-27
Current Transformers (CTs)	V3-T9-43
Panel Mounting Adapter Kit.	V3-T9-52



Power Xpert Energy Meter

Product Description

The Power Xpert energy meter (PXE) monitors the most critical aspects of an electrical distribution system. This premier metering instrument uses the latest in advanced technology to make it simple to use, powerful, scalable and highly flexible.

The PXE offers a new level of accessibility to the critical information required to manage electrical distribution systems from anywhere in the world. This three-phase meter provides high accuracy and advanced features in the standard 4-inch form factor and can be expanded with multiple modular analog and digital I/O options.

Application Description

Identify power quality problems to help:

- Protect motors from damage
- Preserve the integrity of processes and batches
- Prevent blown capacitor bank fuses
- Protect transformers and conductors from overheating

Monitor circuit loading to help:

- Avoid overloads and nuisance overload trips
- Maximize equipment utilization
- Manage emergency overloads

Manage energy utilization to help:

- Reduce peak demand charges and power factor penalties
- Identify excessive energy consumption

Features and Benefits

- ANSI C12.20 (0.1 Class) and IEC 61000-4-30 (Class S)
- 100 ms refresh, true rms measurement
- Measure individual harmonics from 2nd to 63rd
- Modular design with three optional I/O and communication modules
- Power quality analysis and waveform capture
- Data logging
- Over/under limit alarm

- Rated frequency is adjusted automatically to local frequency such as 50 Hz or 60 Hz
- TOU (time of use), 4 tariffs, 12 seasons, 14 schedules
- Compatible with different current transformers such as 5 A, 1 A, 333 mV and Rogowski
- Up to 8 GB memory

Input Output Modules

Integrate data to/from other devices with field-expandable plug-in I/O modules. A maximum of three I/O cards may be added to the PXE. Different I/O cards available:

- Six digital inputs, 24 Vdc power for digital inputs, two relay outputs
- Four digital inputs, two digital outputs, two analog outputs
- Four digital inputs, two relay outputs, two analog inputs
- Analog inputs and outputs are available in:
 - 4–20 mA
 - 0–20 mA
 - 1–5 V
 - 0–5 V

Communications Capabilities

- Standard Modbus RTU, DNP3.0 and BACnet MS/TP
- With addition of communication cards—Optional Modbus TCP/IP, BACnet/IP, HTTP/HTTPS, EtherNet/IP, IPv6, PROFINET, IEC 61850, DNP3.0 over IP, MQTT, Wi-Fi, SMTP (Simple Mail Transfer Protocol) and SNMP (Simple Network Management Protocol), V2, V3 can be available
- Ability to connect to Eaton's cloud and Power Xpert Gateway 1000

Displayed Information

- Monitored information is available locally through the display, the web browser or system power management software
- True rms values through 63rd harmonic
- ANSI C12.20 Class 0.1% revenue metering specification

Display

- Clear and large character LCD screen display with white backlight
- 7-inch enhanced color touchscreen PX-ENHANCED-DISP
- Wide environmental temperature endurance
- Display load percentage, four quadrant power and load nature outline
- Small size 96 × 96 DIN or 4-inch ANSI round

Additional Features

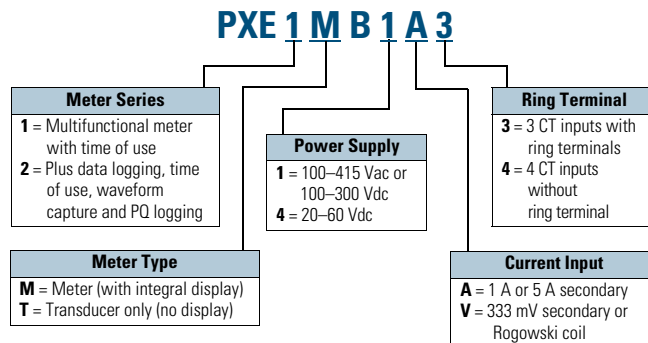
Features of PXE1 and PXE2

Category	Item	Parameters	PXE1	PXE2
Metering			■	■
Real-time metering	Phase voltage	V1, V2, V3, VLavg	■	■
	Line voltage	V12, V23, V31, Vllavg	■	■
	Current	I1, I2, I3, In, Iavg	■	■
	Power	P1, P2, P3, Psum	■	■
	Reactive power	Q1, Q2, Q3, Qsum	■	■
	Apparent power	S1, S2, S3, Ssum	■	■
	Power factor	PF1, PF2, PF3, PF	■	■
	Frequency	F	■	■
Energy and demand	Energy	Ep_imp, Ep_exp, Ep_total, Ep_net, Epa_imp, Epa_exp, Epb_imp, Epb_exp, Epc_imp, Epc_exp	■	■
	Reactive energy	Eq_imp, Eq_exp, Eq_total, Eq_net, Eqa_imp, Eqa_exp, Eqb_imp, Eqb_exp, Eqc_imp, Eqc_exp	■	■
	Apparent energy	Es, Esa, Esb, Esc	■	■
	Demand	Dmd_P, Dmd_Q, Dmd_S, Dmd_I1, Dmd_I2, Dmd_I3	■	■
TOU			■	■
Time of use	Energy/max. demand	TOU, 4 tariffs, 12 seasons, 14 schedules	■	■
Daylight saving time	Two adjustable formats	Month/day/hour/minute Month/week/first few weeks/hour/minute	■	■
Monitoring			■	■
Waveform capture	Voltage and current waveform ①	Trigger, manual, DI change, sag/dips, swell, overcurrent	■	■
Power quality	Voltage unbalance factor	U_unbl	■	■
	Current unbalance factor	I_unbl	■	■
	Voltage THD	THD_V1, THD_V2, THD_V3, THD_Vavg	■	■
	Current THD	THD_I1, THD_I2, THD_I, THD_Iavg	■	■
	Individual harmonics	Harmonics 2nd to 63rd (50 Hz or 60 Hz) Harmonics 2nd to 15th (400 Hz)	■	■
	Voltage crest factor	Crest factor	■	■
	TIF	Telephone Interference Factor	■	■
	Current K factor	K factor	■	■
Statistics	MAX with time stamp MIN with time stamp	Each phase of V & I; Total of P, Q, S, PF & F; demand of I1, I2, I3, P, Q&S; each phase THD of V & I; unbalance factor of V and I	■	■
Others			■	■
Alarm	Over/under limit alarm	V, I, P, Q, S, PF, V_THD and I_THD each phase and total or average; unbalance factor of V and I; load type; analog input of each channel; demand of I1, I2, I3, P, Q&S; reverse phase sequence; DI1~DI28	■	■
Power quality event logging	Sag/dips, swell	Voltage	—	■
Data logging	Data logging 1 Data logging 2 Data logging 3	F, V1/2/3/avg, V12/23/13/avg, I1/2/3/n/avg, P1/2/3/ sum, Q1/2/3/sum, S1/2/3/sum, PF1/2/3, PF, U_unbl, I_unbl, Load Type, Ep_imp, Ep_exp, Ep_total, Ep_net, Eq_imp, Eq_exp, Eq_total, Eq_net, Es, Epa_imp, Epa_exp, Epb_imp, Epb_exp, Epc_imp, Epc_exp, Eqa_imp, Eqa_exp, Eqb_imp, Eqb_exp, Eqc_imp, Eqc_exp, Esa, Esb, Esc, THD_V1/2/3/avg, THD_I1/2/3/avg, harmonics 2nd to 63rd, crest factor, THFF, K factor, sequence and phase angles, DI counter, AI, AO, Dmd P/Q/S, Dmd I1/2/3	—	■
Onboard memory size	Memory	Bytes	—	16 MB
	Optional communication modules	PXM1K-ETHMULTI 8GB	■	■
	Optional communication modules	PXM1K-ETHMULT-NW 8GB (non Wi-Fi)	■	■
Communication	RS-485 port, half duplex, optical isolated	BACnet MS/TP, Modbus-RTU protocol/DNP3.0	■	■
Time	Real-time clock	Year, month, date, hour, minute, second	■	■

① The PXE2 takes 512 samples per cycle. For the waveform capture function on the PXE2 the sample rate is 512 samples per cycle.

Standards and Certifications

- Measurement standard: IEC 61000-4-30; ANSI C12.20
- Environmental standard: IEC 60068-2
- Safety standard: IEC 61010-1, UL 61010-1, IEC 61557-12
- EMC standard: IEC 61000-4/-2-3-4-5-6-8-11, CISPR 22, IEC 61000-3-2, IEC 61000-6-2/4
- Outlines standard: DIN 43700, ANSI C39.1

Catalog Number Selection**Power Xpert Energy Meters****Ordering Information**

To order a Power Xpert energy meter, the catalog number shall be determined using the table above. The table illustrates how to include the desired factory options as part of a catalog number. I/O and communication option modules are separate and field installable. Up to three I/O modules per meter can be installed. While installing communication module up to two I/O modules per meter can be installed.

Power Xpert energy meter modules include panel mounting brackets.

Example 1: PXE1MB1A3 (PXE multifunctional meter/integral display, 100–415 Vac (or 100–300 Vdc), 1A or 5A secondary, 3 CT inputs with ring terminals)

Example 2: PXE2TB4V4 (PXE multifunctional meter plus/transducer only (no display), 20–60 Vdc, 333 mV secondary, 4 CT inputs without ring terminal)

Accessories**Power Xpert Energy Meter Accessories**

Description	Catalog Number
Panel-mount remote display for DIN rail mount transducer version; include one 6 ft cable	PXE-DISPLAY
DIN rail mounting adapter	PXM1K-DINADPT
Terminal plug kit PXM1K-TPK	PXM1K-TPK
Display cable (15 ft)	PXM1K-DISPCBL-15
7-inch enhanced color touchscreen	PX-ENHANCED-DISP

Power Xpert Energy Meter I/O Modules

Integrate data to/from other devices with field-expandable plug-in I/O modules. A maximum of three I/O cards may be added to the PXE meter or two I/O modules plus one communication module.

Description	Catalog Number
PXE I/O module, logic address configurable (1, 2) 2 RO, 6 DI, with DI power supply 24 Vdc	PXE-I01
PXE I/O module, logic address configurable (1, 2) 4 DI, 2 DO, 2 AO configurable (0–20 mA, 4–20 mA, 0–5 V, 1–5 V)	PXE-I02
PXE I/O module, logic address configurable (1, 2) 4 DI, 2 RO, 2 AI configurable (0–20 mA, 4–20 mA, 0–5 V, 1–5 V)	PXE-I03

Communications Modules

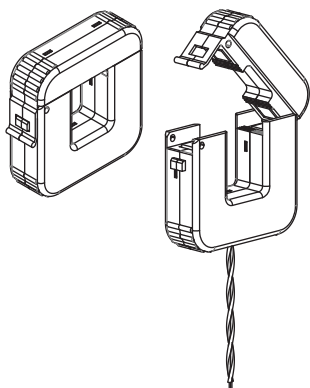
Description	Catalog Number
Dual-port Ethernet accessory module ^①	PXM1K-ETHMULTI
Dual-port Ethernet accessory module ^②	PXM1K-ETHMULT-NW

Notes

- ^① Antenna is not included with the module. An antenna with RP-SMA(f) connector and supporting 2.4 GHz will work. Additional details are available in the user manual (MN150013EN).
- ^② Identical to PXM1K-MULTI except without Wi-Fi capability.

Current Sensors

333 mV Current Sensors



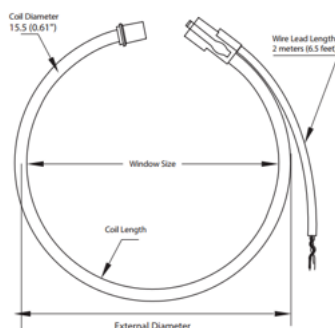
PXM350 is compatible with 333 mV output current transformer for low-cost energy efficiency and energy management systems. A variety of window sizes and ratios are available for split-core 333 mV sensors. Refer to the Current Sensors section of this catalog for ordering information.

5A/1A Current Sensors

Field-configurable CT input that suits any industrial and revenue-grade current transformer.

A variety of window sizes and ratios are available. Refer to the Current Sensors section of this catalog for ordering information.

Rogowski Coil



Rogowski coils are available in multiple lengths and flexible, rope-like form factor is ideal for measurement around irregularly shaped conductors or in crowded electrical panels.

A variety of window sizes, length of coils and ratios are available. Refer to the Current Sensors section of this catalog for ordering information.

Technical Data and Specifications

Current Inputs (Each Channel)

Nominal secondary sensor settings:

Current Sensor Input Options	5 A	1 A	333 mV	100 mV Rope CT
Nominal configuration selection	5 A	1 A	1 A	1 A
Metering range (% of nominal)	200%	200%	120%	120%
Pickup current (% of nominal)	0.1%	0.1%	0.5%	0.5%

Specifications

Description	Specification
Input	
Withstand	20 A rms continuous, 100 A rms for 1 second, non-recurring
Burden	0.05 VA (typical) at 5 A rms
Accuracy	0.2% full scale
Voltage Inputs (Each Channel)	
Nominal full scale	400 Vac L-N, 690 Vac L-L (+20%)
Withstand	1500 Vac continuous, 2500 Vac, 50/60 Hz for 1 minute
Input impedance	2 mohm per phase
Metering frequency	45–65 Hz, 300–500 Hz
Pickup voltage	10 Vac
Accuracy	0.2 full scale
Energy Accuracy	
Active	Class 0.2 s (according to IEC 62053-22), Class 0.2 s (according to ANSI C12.20)
Reactive	Class 2 (according to IEC 62053-23)
Harmonic Resolution	
Metered value	63rd harmonic (50 Hz or 60 Hz type), 15th harmonic (400 Hz type)
Communication	
RS-485 (Standard)	
Modbus RTU and DNP3.0	
Two-wire shielded twisted pair cable connection	
Baud rate: 1200–38,400 bps	
Ethernet (optional)	
10M/100MBASE-T	
Modbus TCP/IP	
BACnet-IP	
EtherNet/IP	
IPv6	
SNMP	
HTTP/HTTPS Webserver	
HTTP/HTTPS, FTP data post	
SMTP	
NTP	
Standard Compliance	
Measurement standard	IEC 62053-22; ANSI C12.20
Environmental standard	IEC 60068-2
Safety standard	IEC 61010-1, UL 61010-1, IEC 61557-12
EMC standard	IEC 61000-4/-2-3-4-5-6-8-11, CISPR 22, IEC 61000-3-2, IEC 61000-6-2/4
Outlines standard	DIN 43700, ANSI C39.1

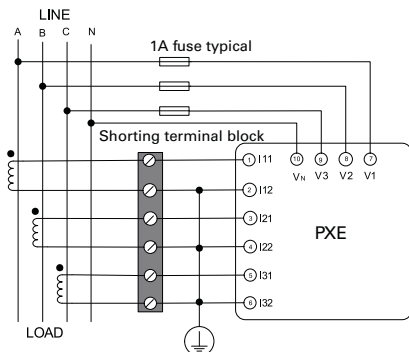
Specifications

Description	Specification
Operating Environment	
Operation temperature	–25 °C to +70 °C
Storage temperature	–40 °C to +85 °C
Relative humidity	5% to 95% noncondensing
Protection level	IP54 (front), IP30 (cover)
I/O Option	
Input voltage range	20–160 Vac/Vdc
Input current (max.)	2 mA
Start voltage	15 V
Stop voltage	5 V
Pulse frequency (max.)	100 Hz, 50% duty ratio (5 ms ON and 5 ms OFF)
SOE resolution	2 ms
Digital Output (DO) (Photo-MOS)	
Voltage range	0–250 Vac/Vdc
Load current	100 mA (max.)
Output frequency	25 Hz, 50% duty ratio (20 ms ON, 20 ms OFF)
Isolation voltage	2500 Vac
Relay Output (RO)	
Switching voltage (max.)	250 Vac, 30 Vdc
Load current	5 A (resistive), 2 A (inductive)
Set time	10 ms (max.)
Contact resistance	30 mohm (max.)
Isolation voltage	2500 Vac
Mechanical life	1.5 x 10 ⁷
Analog Output (AO)	
Output range	0–5 V / 1–5 V, 0–20 mA / 4–20 mA (optional)
Accuracy	0.5%
Temperature drift	50 ppm / °C typical
Isolation voltage	500 Vdc
Open circuit voltage	15 V
Analog Input (AI)	
Input range	0–5 V / 1–5 V, 0–20 mA / 4–20 mA (optional)
Accuracy	0.2%
Temperature drift	50 ppm / °C typical
Isolation voltage	500 Vdc
Power Supply for DI (24 Vdc)	
Output voltage	24 Vdc
Output current	42 mA
Load (max.)	21 DIs
Control Power	
Universal	AC or DC
AC/DC Control Power	
Operating range	100–415 Vac, 50/60 Hz; 100–300 Vdc
Burden	5 W
Frequency	50/60 Hz
Withstand	3250 Vac, 50/60 Hz for 1 minute
Installation Category III (distribution)	
Low Voltage DC Control Power (Optional)	
Operating range	20–60 Vdc
Burden	5 W

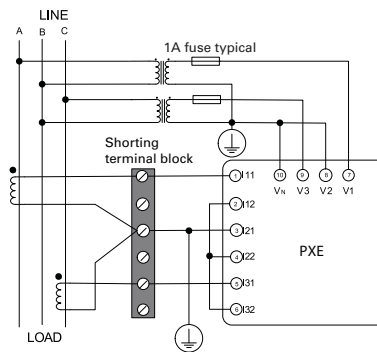
Wiring Diagrams

Meter Input Wiring

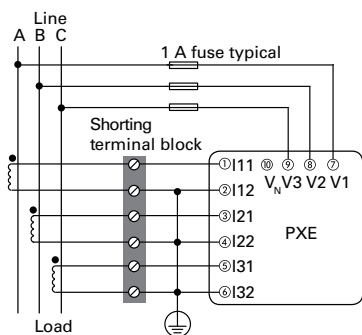
Three-Phase, Four-Wire (3LN, 3CT)



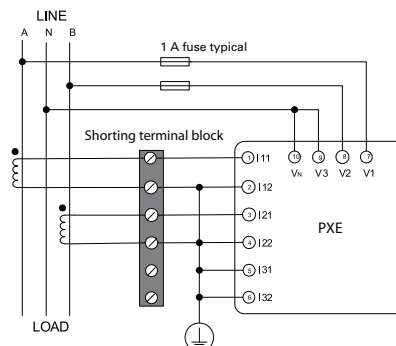
Three-Phase, Three-Wire with PT and 2CT (2LL, 3CT)



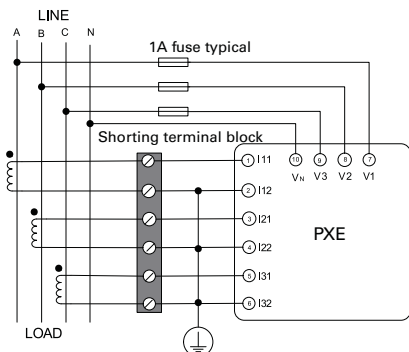
Three-Phase, Three-Wire (3LL, 3CT)



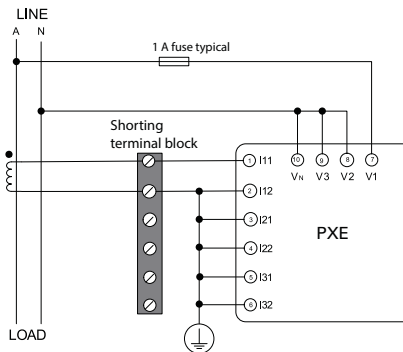
Single-Phase, Three-Wire (1LL, 2CT)



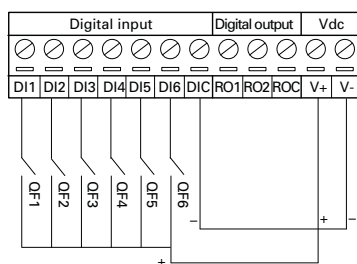
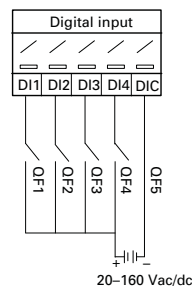
Three-Phase, Four-Wire with PT (3LN, 3CT)



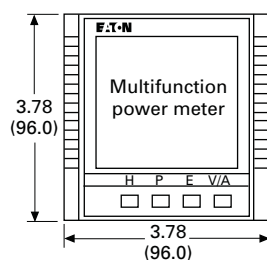
Single-Phase, Two-Wire (1LN, 1CT)



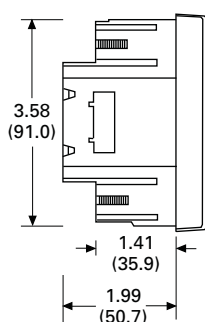
Note: Shorting terminal block not required when used with voltage input current sensors. For meters used with voltage input current sensors, unused channels need to be tied to ground as shown in the figures. If meters are used with amperage input current sensors, then the unused channels do not need to be tied to ground.

I/O Cards Wiring**PXE-IO1****PXE-IO2/IO3****Dimensions**

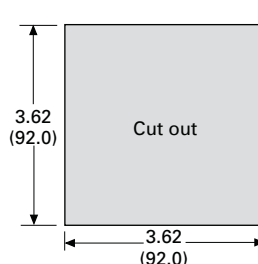
Approximate Dimensions in Inches (mm)

9**PXE Front and Side View**

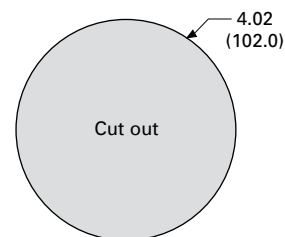
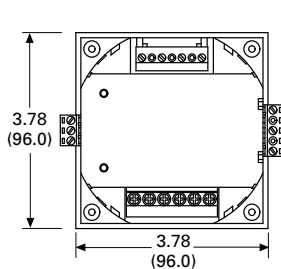
Front view



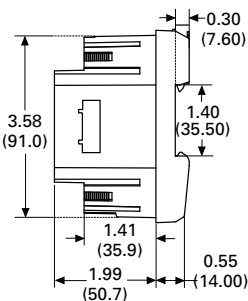
Side view



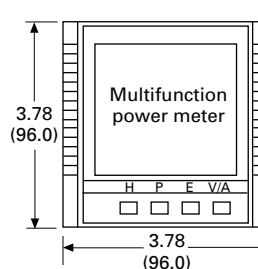
Cut out

**DIN Mount Meter Rear and Side View**

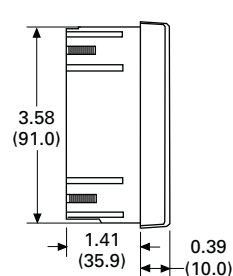
Rear view



Side view

External Display Module Front and Side View

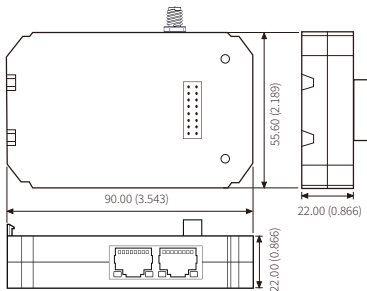
Front view



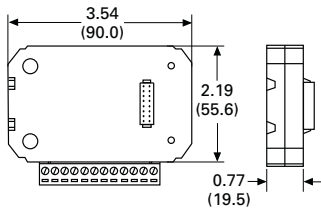
Side view

Note: Display module is connected with a 6 ft 10-pin RJ50 cable. Display module opening size and PXM 1000 body openings are exactly the same size.

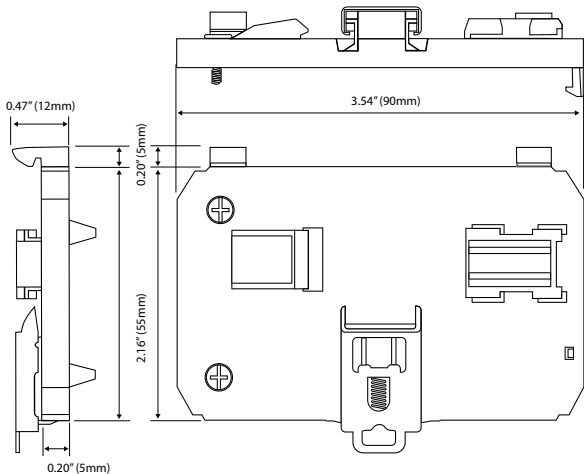
PXM1K-ETHMULTI



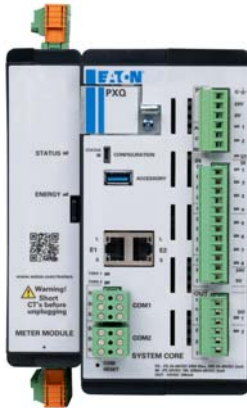
I/O Module



PXM1K DIN Rail Mounting Adapter



Power Xpert Quality (PXQ) Event Analysis System (Power Quality Meter)



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Description

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Panel Mounting Adapter Kit.	V3-T9-52



Power Xpert Quality (PXQ) Event Analysis System (Power Quality Meter)

Overview

Eaton's Power Xpert Quality (PXQ) event analysis system is a state-of-the-art power quality monitoring device designed for low- and medium-voltage switchgear and switchboards. It offers advanced analytics at the edge, simplifying the troubleshooting of power-quality events. The system is compatible with industry power quality standards such as IEC 61000-4-30 Class A and IEEE 1453, and features ANSI C12.20 Class 0.1 metering accuracy.

Applications

- **Protect critical systems:** Use the Power Quality Health Index to maintain the integrity of essential systems
- **Diagnose PQ problems:** Utilize high-precision time stamping and multichannel plotting for detailed analysis
- **Energy management:** Manage energy usage patterns and costs with detailed energy and demand readings
- **Configurable input expansion:** Up to 40 digital inputs configurable for status monitoring, sequence of events historian and/or pulse counting applications (WAGES)

Features

- **Power Quality Health Index:** Eaton's patented Power Quality Health Index provides an intelligent read-out of circuit health based on statistical analysis of power-quality events and disturbances
- **High-precision time stamping:** The system records events with a precision of ± 0.1 ms using precision time protocol (PTP), which is 10 times better than the industry benchmark
- **Multichannel dual plotting:** This feature allows high-resolution comparisons of current and voltage channels, making it easier to explore the effects of large loads on your system
- **Event analysis calendar:** 12-month view of triggered events, investigating power-quality disturbances and recurring problems by severity, time or occurrence with graphical ITIC/SEMI-F47 analysis and sequenced events, part of the unique web-based analysis suite available onboard PXQ; color-coded events offer a visual indicator of event types
- **Zero-config trending:** Hundreds of metering parameters logged, including 200 ms min./max. and 5-minute interval averages for each parameter, with no configuration required
- **Graphical trended data:** Interactive multichannel trends with dual plotting of current and voltage provide insights when comparing both trends simultaneously; pan, zoom and export options are available for reporting and analysis
- **Disturbance navigator timeline:** View power quality events with sufficient context for intuitive troubleshooting of the power distribution system; a single-page view for multi-channel waveforms, event sequence RMS, event parameters and graphical ITIC/SEMI-F47 analysis
- **Advanced harmonics analysis:** Calculation of individual harmonic magnitudes and phase angles for each phase voltage and current through the 85th harmonic; harmonic trending for up to 50 selected harmonics
- **Sag source analysis:** Capture voltage disturbances upstream and downstream of PXQ to easily determine the source of each voltage sag
- **Energy management:** Manage energy usage patterns and associated costs with energy and demand readings; graphical comparisons identify periods of heavy energy use, exportable as PDF or PNG for easy reporting
- **Event sequence RMS:** Up to 2 minutes of event sequence RMS shows the big picture and provides critical clues relating back-to-back events

Benefits

- **Automatic PQ analysis:** Captures harmonics, sags, swells and subcycle disturbance transients to protect mission-critical IT equipment and infrastructure, such as motors, capacitor fuse banks, transformers and conductors, from damage
- **Minimize business interruptions:** Automatically diagnose disruptions to sensitive, mission-critical processes with Setpoint Learning and pre-configured ITIC/SEMI-F47 triggers to resume operations quickly
- **Highest ANSI class accuracy:** Provides high-fidelity measurements on current, voltage, power factor and other comprehensive power metering parameters such as harmonic distortion, flicker, crest factor and K-Factor
- **Secure access:** Onboard webserver for advanced analytics and graphical views of real-time and historical data without requiring additional software

Technical Specifications

- **Accuracy:** ANSI C12.20 Class 0.1 metering device
- **Power quality:** 61000-4-30, Class A
- **Sampling rate:** 512 or 1024 samples per cycle
- **Memory:** Up to 32 GB onboard memory
- **Environmental:** Operates within -20°C to $+70^{\circ}\text{C}$ temperature range and 5–95% relative humidity

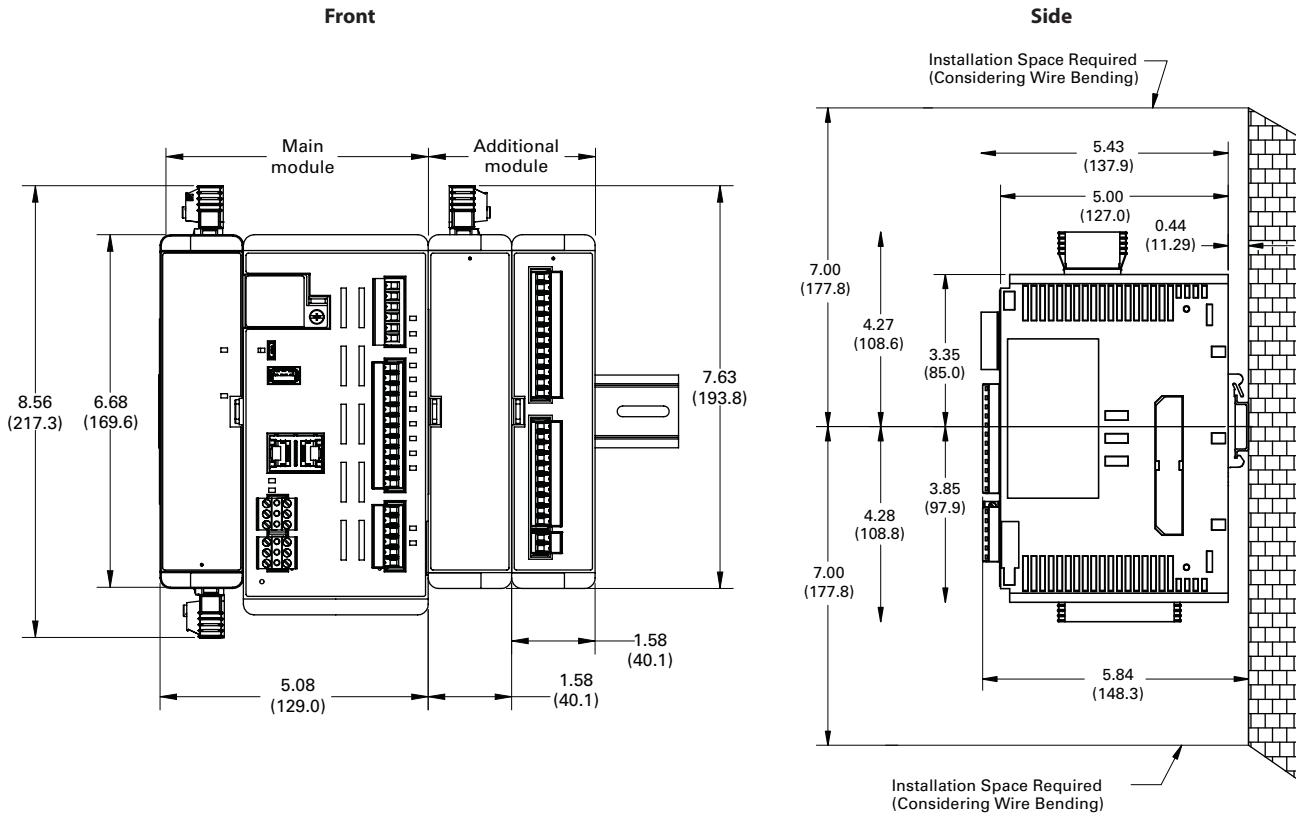
Technical Specifications

Category	Parameter	Specification
Dimensions	Height (chassis only)	7.200" (182.88 mm)
	Height (including connectors)	8.557" (217.34 mm)
	Width (includes meter module)	5.429" (137.90 mm)
	Depth	5.12" (130.0 mm)
Power quality/metering standards	Accuracy	IEC 62053-22 Class 0.1 S, ANSI C12.20 2015 Class 0.1
	Power quality	61000-4-30, Class A IEC 62586 IEC 62586-2
	Harmonics and spectral components	IEC 61000-4-7
	Flicker	IEC 61000-4-15 IEEE 1453
	Power monitoring devices (PMD)	IEC 61557-12/SD/K70.0.2 IEC 61557-12/SS/K70.0.2
Power quality recording and event detection	Standard sampling rate	True RMS PXQ Tier 1: 512 samples/cycle PXQ Tier 2: 1024 samples/cycle
	Transient detection and capture	17 μs subcycle transient (or 20 μs at 50 Hz) 100 ns impulsive or oscillatory transients with PXQ-ENH module
	Voltage tolerance curves	ITIC, SEMI-F47
	Modes to trigger	Trigger on user-defined value Trigger manually in web interface Trigger via a Modbus command Trigger on a learned setpoint
	Event types	Out of limits Demand overload ITIC sags/swells: L2, L4, L8 sags / L2, L4, L8 swells Subcycle disturbance transient: absolute voltage or dV/dt change threshold SEMI-F47 sags High-speed voltage transient (with PXQ-ENH)
	Waveform recording	PXQ Tier 1: 60 cycles COMTRADE at 512 sampling PXQ Tier 2: 120 cycles COMTRADE at 1024 sampling
	Event sequence RMS (extended RMS capture)	PXQ Tier 1: 1-minute COMTRADE at half-cycle sampling PXQ Tier 2: 2-minute COMTRADE at half-cycle sampling

Technical Specifications, continued

Category	Parameter	Specification
Environmental specifications	Ingress protection	IEC 60529 IP 20 minimum, IP 30 preferred, NEMA 1
	Operating temperature range	–20 °C to +70 °C (–4 °F to +158 °F)
	Storage temperature range	–40 °C to +85 °C (–40 °F to +158 °F)
	Humidity	5–95% relative humidity, noncondensing
	Pollution degree	II
	Elevation	0 to 9843 ft (0 to 3000 m)
	Housing	IP20
	Safety	IEC/EN 61010-1 UL 61010-1 File E530482
System core and metering module specifications	Onboard memory	Up to 32 GB (4 GB standard)
	Energy data retention	Up to 3 years at 15-minute intervals
Ports and connections	Device power supply input (PS)	Voltage: 24–48 Vdc Maximum draw: 50 VA Minimum ride-through: 200 ms Optional ride-through: Up to 15 seconds
	Digital inputs x8 (IN, D1-D8)	Event time stamp accuracy: +/- 0.1 ms (when connected to PTP source, +/- 1 ms otherwise) Maximum voltage: 60 Vdc
	Solid-state outputs (OUT)	Outputs: 2 Type: Form C NO and NC Bidirectional FET Maximum external source voltage: 48 Vdc (+/- 20%) Maximum load current: 170 mA
	Serial port (COM1)	RS-485, two-wire, half duplex Supported protocols: Modbus RTU
	Ethernet ports (E1, E2)	Dual RJ45 10/100/1000BASE-T Ethernet ports Supported protocols: IPv4, IPv6, HTTPS, Modbus TCP, BACnet I/P, PTP or NTP, SFTP, SNMP, SMTP with support for authentication
Meter module specifications	Current inputs (CT1-4) (ratings per channel)	Rating: 5 A secondary nominal, 20 A continuous max. Metering range: 0.05 A to 20 A Frequency range: 50–60 Hz +/-15% (42.5–69 Hz) Burden: <10 m ohm Accuracy: IEC 61557-12 Class 0.1
	Standard metering voltage inputs (VT, V1-VR)	Maximum rating: 700 Vac rms L–G, 1200 Vac rms L–L Metering range: 30–700 Vac rms L–G Accuracy: IEC 61557-12 Class 0.1
Communications protocols	Industrial communication	Modbus TCP/RTU, BACnet/IP
	Network communications	SNMP v1, SNMP v3, HTTP, HTTPS, SMTP
	Network addressing	IPv4, IPv6, DHCP
	Time synchronization	NTP/SNTP, PTP
	File transfer	sFTP (secure FTP)
	Authentication	LDAP for OpenLDAP systems
	Cryptography	TSL 1.2, SSL
	Industrial communication	Modbus TCP/RTU, BACnet/IP
Display specifications	Eaton 7-inch HMI (PXDB-HMI-07)	Physical characteristics: 7.56 W x 5.20 H x 1.42 D inches Cutout: 7.3 W x 4.9 H inches Weight: 1.1 lb Aluminum front, side PTFE coating Display size: 7 inches Display resolution: 1024 x 600 pixels TFT capacitive touch screen LED backlight with 50,000 hr expected life Brightness: 500 cd/m² Multitouch functionality (pinch, zoom, scroll and swipe) Power supply (external): 12–32 Vdc Maximum power consumption: 7 W Connectivity: 2 USB v2.0 ports, 1 Ethernet 1 Gb Port + 1 Ethernet 10/100 Mb
	Alternative: Bring Your Own Display (BYOD) for larger display options	PXQ is display agnostic and supports BYOD if you require a custom size for your installation. Minimum specifications— Display resolution: 1024 x 600 RAM: 2 GB Flash: 8 GB 1x Ethernet 10/100 Mb port, supports browser (Google Chrome recommended)

Dimensional Drawing



Expansion Modules

PXQ provides options for additional capability and customization to your specific needs.

Your power quality meter should grow and adapt to your changing business needs. PXQ modules are field installable, allowing future PXQ expansion

Enhanced Capture Module (PXQ-ENH)

Improve your PXQ's diagnostic capability with the Enhanced Capture Module. With the Enhanced Capture Module, PXQ can detect and record high-speed voltage transients.

High-speed voltage transients (sometimes called "fast transients") are short, high-intensity surges (for example, 5–7 kV on a system rated for 480 V) caused by device switching (transformers, capacitor banks, etc.), power system faults and nearby lightning strikes. Such high voltages can degrade and damage electronic equipment or motors (including HVAC systems), resulting in data corruption, equipment misoperation, disruptions to critical operations and shorter equipment life.

Regular meters are unable to accurately record the shape of these events because they do not have the sufficient resolution to capture the waveform clearly.

- Detect and record high-speed voltage transients:
 - As short as 100 ns duration
 - Up to 10 kV magnitude
- Forensic waveform data available:
 - 1 cycle (17 ms) COMTRADE at 167,000 samples per cycle

Expanded Input Module (PXQ-SER)

Complete the picture of your metering and power quality analysis with additional digital inputs. PXQ includes eight built-in digital inputs on the system core. Up to two input expansion modules can be added (16 additional digital inputs each) for a maximum of 40 total inputs (8 + 16 + 16).

Digital inputs are configurable for the following applications:

- Status monitoring and alerts—Simplify your switchgear design by using PXQ's integrated digital inputs to monitor the statuses of breakers, UPS, generators and more
- Sequence of events historian—PXQ's high-accuracy time stamps and historical recording capability help to recreate the timeline around a fault or power-quality disturbance, allowing more efficient root cause analysis; this is a cost-effective alternative to bulky, standalone sequence of events recorders
- Pulse counting (WAGES)—When configured for WAGES applications, PXQ provides a built-in WAGES dashboard, converting inputs from other utility meters and providing an integrated view of multiple utilities

Product Selection**PXQ Main Unit**

Description	Catalog Number
PXQ event analysis system kit (Tier 1) Includes system core and meter module 512 samples/cycle, 60 cycles COMTRADE, 1-minute RMS, 4 GB memory.	PXQ-ST1-1A1
PXQ event analysis system kit (Tier 2) Includes system core and meter module 1024 samples/cycle, 120 cycles COMTRADE, 2-minute RMS, 32 GB memory.	PXQ-ST2-1A1

Accessories and expansion modules

Description	Catalog Number
7-inch touchscreen display (web-based)	PXDB-HMI-07
Enhanced capture module Detect and record high-speed voltage transients up to 10 kV in magnitude.	PXQ-ENH
Input expansion module Configurable for device status monitoring, sequence of events historian and pulse-counting (WAGES) applications.	PXQ-SER

Retrofit kits

Description	Catalog Number
PXQ retrofit kit for PXM4000/6000 replacement Comes preinstalled in adapter and ready to swap. Includes PXQ System Core & Meter Module, built-in 24 V power supply and rewiring for quick installation. Includes space for one expansion module.	PXQ-ST1-1A1-A46K
PXQ retrofit kit for PXM8000 replacement Comes preinstalled in adapter and ready to swap. Includes PXQ System Core and Meter Module, Enhanced Capture Module, built-in 24 V power supply and rewiring for quick installation.	PXQ-ST1-1A1-A8K
PXQ retrofit kit for PXM4000/6000 replacement UPGRADE (doubles your sampling rate and accuracy over PXM4000/6000) Comes preinstalled in adapter and ready to swap. Includes PXQ System Core & Meter Module, built-in 24 V power supply and rewiring for quick installation. Includes space for one expansion module.	PXQ-ST2-1A1-A46K
PXQ retrofit kit for PXM8000 replacement UPGRADE (doubles your sampling rate and accuracy over PXM8000) Comes preinstalled in adapter and ready to swap. Includes PXQ System Core and Meter Module, Enhanced Capture Module, built-in 24 V power supply and rewiring for quick installation.	PXQ-ST2-1A1-A8K

Power Xpert Branch Circuit Monitor (PXBCM)



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Power Xpert Branch Circuit Monitor (PXBCM)

Product Description

Eaton's Power Xpert Branch Circuit Monitor (PXBCM) provides Ethernet access to current, voltage, power and energy readings. BACnet/IP and Modbus TCP protocols enable simple integration into facility building management and power monitoring systems.

The PXBCM provides ANSI C12.20 0.5% revenue accuracy for panelboard applications and satisfies energy code requirements to meter energy by branch circuit and report energy consumption by load group.

Overload alerts empower high-performance customers, such as data centers, optimize server capacity and avoid costly downtime due to unexpected circuit breaker overload trips.

Application Description

PXBCM is ideally suited to handle submetering in low-voltage power distribution equipment applications such as distribution boards in residential or multi-tenant buildings, PDUs in data center applications, and separately installed enclosures for retrofit metering needs.

Meter module strips support 1-inch pole spacing for branch circuits up to 100 A and are available with up to 21 current transformers (CTs). External meter modules support flexible design with 333 mV or 100 mA current sensors for up to 100 circuits. The modular form factor makes PXBCM easy to scale for 18-, 30-, 42- and 84-circuit panelboard applications.

Circuits can be grouped into virtual meters representing tenants or branch circuits as follows:

- 100, two-wire (single-pole)
- 48, three-wire (two-pole)
- 32, four-wire (three-pole)

Features and Benefits

- Intuitive, secure web interface provides the ability to access live energy readings remotely and facilitates data integration
- Downtime is minimized or prevented by overload alerts that indicate when the circuit is close to exceeding its threshold
- Energy usage can be confidently tracked with ANSI C12.20 (0.5%) system accuracy for cost allocation
- Modular form factor supports design flexibility and cost efficiency by only monitoring what is needed (from 25 to 100 circuits per system)
- Supports ASHRAE 90.1 compliance by providing end users the ability to monitor branch circuits and aggregate loads by type

Standards and Certifications

PXBCM is designed and tested to meet the stringent requirements for:

- UL 61010-1
- CAN/C22.2
- CE mark
- EMC EN61326
- IEC 61000-4-X level 3

Product Selection

Meter Base

Each PXBCM system requires one meter base. Each meter base can accept up to four meter module options. Meter bases are available in two versions:

- **BASIC (PXBCM-MB-BASIC)**

The economy high-density panelboard meter.

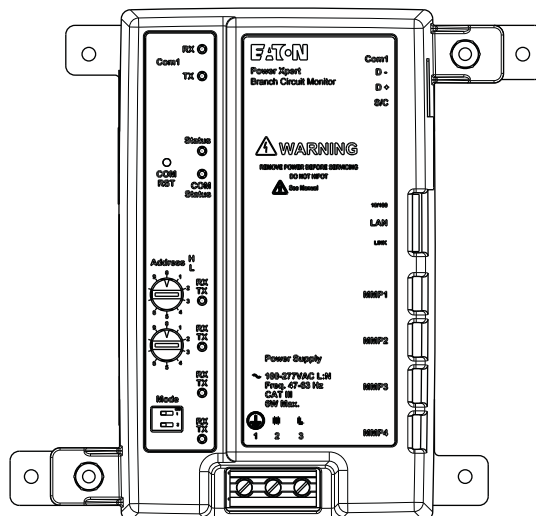
- Provides essential monitoring (volts, amps, watts, VA, power factor, demand)
- Scalable for up to 100 circuits
- Secure onboard web interface for monitoring

- **ENERGY CODE (PXBCM-MB-ENERGY)**

The panelboard meter designed for tenant metering applications.

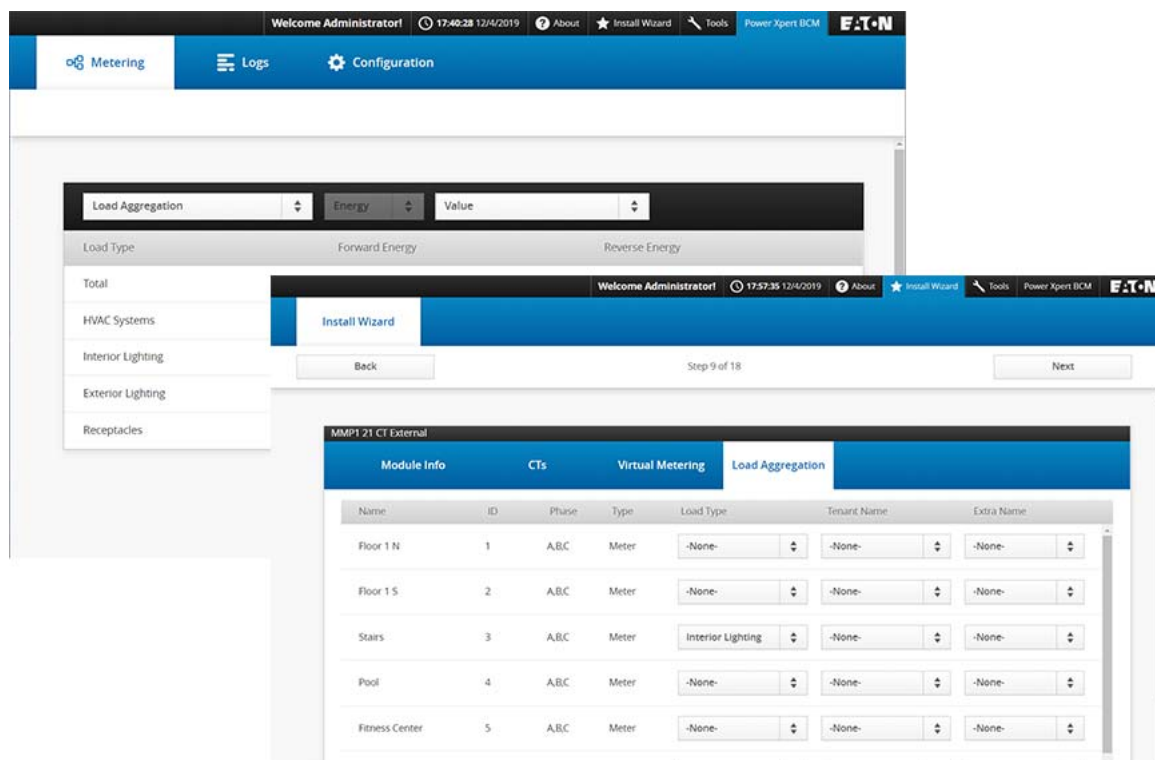
- Includes all the functionality of the PXBCM-MB-BASIC
- Log data and export as CSV
- 15-minute data logging retained for 3 years:
 - Virtual meter power demand
 - Virtual meter forward and reverse energy
- Aggregate virtual meters into ASHRAE 90.1 or California Title 24 load groups

Meter Base Mounting Drawing



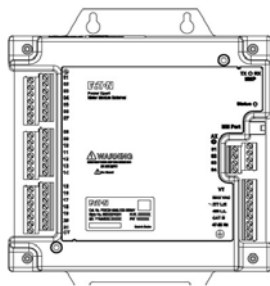
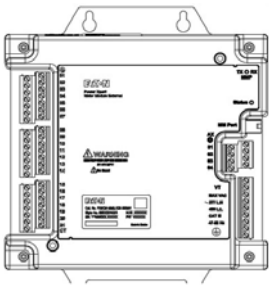
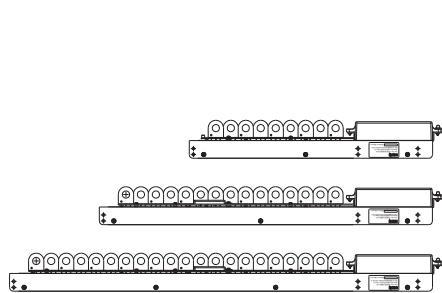
Energy Code Load Grouping Configuration and Reporting

Load aggregation support for energy code requirements in PXBCM-MB-ENERGY.



Meter Modules

Up to four metering options can be selected for each meter base. Each requires a meter module port cable to connect to the meter base. Meter module strips are available in left or right versions, designating the edge of the module the CT strip aligns.



Description	PXBCM-MMS-LXX-A PXBCM-MMS-RXX-A	PXBCM-MME-X25-333MV	PXBCM-MME-X21-100MA
100% breaker current rating	100 A	Up to 2000 A	100 A, 200 A
Breaker pole-to-pole spacing	1 inch	Flexible	Flexible
CT type	Solid	Split	Solid
Current sensor inputs	9, 15 or 21 pre-mounted current sensors 4 auxiliary (333 mV)	Up to 21 feeders (333 mV) 4 auxiliary (333 mV)	Up to 21 feeders (333 mV) 4 auxiliary (333 mV)
Accuracy	ANSI C12.20 0.5%	ANSI C12.20 0.5%	ANSI C12.20 0.5%
Best for	Lighting, plug loads, small motors (PRL 1a, 2a, 3e panelboards, Pow-R-Command) CTEP certified	Retrofit for branch circuit monitoring/ energy code compliance Large ampacity circuits (mains or large feeders)	Regulated tenant metering applications

Note: 333 mV metered channels: ANSI C12.20 0.5% class transformer rated meter accuracy. For PXBCM-MMS, substitute 09, 15 or 21 for XX to designate number of mounted CTs (e.g., PXBCM-MMS-L21-A; PXBCM-MMS-R09-A).

Meter Module Port Cable

Each meter module strip or meter module external requires a meter module port cable to connect to the meter base. No more than two packs are required for each meter base. All cables are sold in packs of two.

Catalog Number	Length
PXBCM-MMP-CBL6I	6 inches
PXBCM-MMP-CBL01	1 ft
PXBCM-MMP-CBL02	2 ft
PXBCM-MMP-CBL03	3 ft
PXBCM-MMP-CBL04	4 ft
PXBCM-MMP-CBL06	6 ft
PXBCM-MMP-CBL08	8 ft
PXBCM-MMP-CBL12	12 ft
PXBCM-MMP-CBL16	16 ft
PXBCM-MMP-CBL20	20 ft
PXBCM-MMP-CBL28	28 ft
PXBCM-MMP-CBLEX08	8 ft extension
PXBCM-MMP-CBLEX16	16 ft extension

Accessories

Display

A local display option is available for the PXBCM. This display includes one 4 ft data cable to connect between the PXBCM-MB and the display.

- 640 x 480 pixel backlit VGA touch screen display
- Power: 24 Vdc input
- Height: 5.24 in (133 mm)
- Width: 6.81 in (173 mm)
- Depth: 1.54 in (39 mm)
- Weight: 1.32 lb (600 g)
- Cutout dimensions: 4.61 x 6.18 inches (117.0 x 157.0 mm)

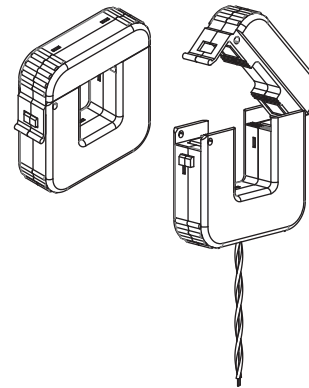
Description	Dimensions	Catalog Number
BCM local display	5.7-inch diameter display	PXBCM-DISP-6-XV
BCM replacement local display cable	4 ft length	PXBCM-DISP6XV-DAT

Cables

For replacement cables to connect between the local display and PXBCM, reference Display. For cables to connect between the PXBCM Meter Base and PXBCM Meter Modules (strips or external), reference Meter Module Port Cable.

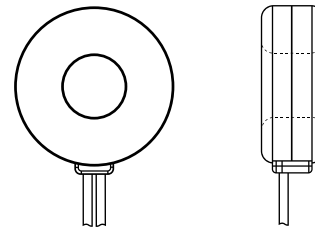
Current Sensors

333 mV Current Sensors



Split-core 333 mV sensors can be connected to the four auxiliary current inputs on the BCM-MMS or BCM-MME as well as any of the 21 current inputs on the PXBCM-MME-X25-333MV. A variety of window sizes and ratios are available.

100 mA Current Sensors



100 mA current sensors can be connected to any of the 21 current inputs on the PXBCM-MME-X21-100MA. A selection of solid core 100 mA sensors are available. Refer to the Current Sensors section of this catalog for ordering information.

Dimensions

Approximate dimensions in inches. Dimensional drawings and full specifications are available in TD150021EN.

Catalog Number	Dimensions (H x W in inches)
PXBCM-MB	Mounting footprint: 6.25 x 6.95 Chassis: 6.69 x 4.12
PXBCM-MME	Mounting Footprint: 8.53 x 7.66 Chassis: 6.93 x 7.70
PXBCM-MMS-X09-A	Overall: 16.93 x 2.96; includes 5.85 x 2.96 chassis Strip width: 1.37
PXBCM-MMS-X15-A	Overall: 22.93 x 2.96; includes 5.85 x 2.96 chassis Strip width: 1.37
PXBCM-MMS-X21-A	Overall: 28.93 x 2.96; includes 5.85 x 2.96 chassis Strip width: 1.37
PXBCM-DISP-6-XV	5.24 x 6.81 x 1.54

Power Xpert Multi-Point Meter



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Panel Mounting Adapter Kit	

Power Xpert Multi-Point Meter

Product Overview

Eaton's Power Xpert Multi-Point Meter is an ANSI C12.20 revenue class web-enabled electronic submetering device that can be mounted in panelboards switchboards or enclosures. When mounted in a panelboard or a switchboard, the Power Xpert Multi-Point Meter provides customers with an integrated power distribution and energy metering solution that saves space, reduces installation labor and lowers total cost.

The Eaton Power Xpert Multi-Point Meter (PXMP Meter) offers a highly modular approach to high-density metering applications in electrical power distribution systems. The PXMP Meter is compatible with most three-phase industrial, commercial and single-phase residential low voltage electrical power systems. The PXMP is equipped with two Modbus® RTU communication ports for local display and remote serial communications. The PXMP also has optional pulse input and digital output modules along with one standard digital output and three digital inputs. The PXMP Energy Portal Module is web enabled, making it suitable for use with Ethernet networks and modems.

Product Description

The Power Xpert Multi-Point Meter can measure up to any of the following number of circuits:

- Sixty single-phase, two-wire (single-pole)
- Thirty single-phase, three-wire (two-pole)
- Twenty three-phase, four-wire (three-pole)

The circuits listed above can be mixed provided that the total number of current sensors does not exceed 60. The meter provides current; voltage; power factor; demand and active, reactive, and real power (VA, var, kW); and active, reactive, and real energy (VA, var, kWh) measurements for each load. The unit also provides up to two years at 15-minute intervals or eight years at one-hour intervals of demand data logging storage in non-volatile memory for up to 60 submeters.

The Power Xpert Multi-Point Meter can be used with three different ratings of current sensors: 100 mA, 10 mA or 333 mV. Switchboard/ panelboard applications will use the 100 mA current sensors, which are highly accurate, self-protecting in the event of an open circuit condition under load and are supplied with an integral plug-in connector. The PXMP automatically detects the rating of the current sensor that is connected.

The PXMP can also use 10 mA current sensors that were previously installed for IQMESII retrofit applications. Additionally, the PXMP can use 333 mV split core current sensors for retrofit applications where metering has not previously existed. The 10 mA and 333 mV current sensors are also self-protecting in the event of an open circuit condition under load.

Application Description

The Power Xpert Multi-Point Meter is ideally suited to handle submetering in low voltage power distribution equipment applications such as distribution boards in multi-tenant buildings, comprehensive main and feeder metering in commercial/industrial switchboards or medium voltage distribution equipment with the use of voltage and current transformers.

The Power Xpert Multi-Point Meter provides a cost-effective solution for residential or commercial metering installations. Typical installations include:

- High-rise buildings
- Government institutions
- K–12, universities and campuses
- Office buildings
- Medical facilities
- Apartment and condominium complexes
- Airports
- Shopping malls
- Industrial sites
- Mixed-use facilities

Features

- Monitors power and energy for up to 60 current sensors; space-saving modular design allows measurement from 1 to 60 circuits
- Built-in communication interfaces
- Monitors single-phase and three-phase loads from 120 to 600 Vac
- Monitors current, voltage, power factor, frequency, power and energy
- Stores extensive energy profile data for each metering point; can be used to identify coincidental peak demand contribution
- LEDs provide status of unit communication activity and verify sensor connections
- Meets rigid ANSI C12.20 accuracy specifications for revenue meters
- Three standard digital inputs and eight pulse inputs per optional module to monitor WAGES (water, air, gas, electric, or steam)
- One standard digital output and eight digital outputs per optional module for alarm indication
- Three types of meter modules to support 10 mA, 100 mA or 333 mV sensors

- Can be directly mounted in a UL Listed panelboard, switchboard or enclosure
- 256 MB of memory in meter base for up to two years of 15-minute interval data (eight years of one-hour interval data) for eight demand values up to 60 submeters

Communication Capabilities

With the Power Xpert Multi-Point Meter's built-in communication capabilities, remote meter reading and monitoring functions can be integrated into both new and retrofit applications.

- Standard Modbus RTU
- Optional Modbus TCP / BACnet/IP / SNMP / HTTP / SMTP / NTP / SFTP communications

Software Compatibility

The Power Xpert Multi-Point Meter:

- Can be used as part of an electrical energy monitoring and cost allocation system
- Can be remotely monitored via onboard web pages with Eaton's optional Energy Portal Module
- Is compatible with third-party software platforms and interface devices

Configuration

- The Power Xpert Multi-Point Meter is fully configurable using Power Xpert Multi-Point configuration software that can be down-loaded free from the Eaton website at www.eaton.com/meters
- Each Power Xpert Multi-Point Meter module can be configured for up to six metering points in any combination of single-phase and three-phase metering points corresponding to the voltage wiring of the meter base
- Power Xpert Multi-Point configuration software simplifies system commissioning and startup; PXMP configuration software supports both online and offline configurations

Easy to Install

- UL Listed for mounting inside panelboards (e.g., PRL4), switchboards, and NEMA 12 enclosures
- Quick connect terminals for current sensors, Modbus communications, and bus voltages make wiring the unit quick and easy

Features

Description	Main/Aggregate	Channel Data	Tenant
Instrumentation			
Current, per phase	■ ①	■	—
Voltage, per phase (L-L, L-N)	■	■	—
Frequency	—	■	■
Minimum/maximum readings, V	Per phase	—	—
Minimum/maximum readings, W, var, VA	Total and per phase	—	—
Minimum/maximum readings, PF, F	Total	—	—
Power			
Real, reactive, and apparent power (W, var, VA)	Total and per phase	Total and per phase	Total
Power factor	—	Average	Average
Demand			
Block interval (fixed, sliding)	■	—	—
Real, reactive and apparent power demand	Total and per phase	—	—
Minimum/maximum readings, PF, W, var, VA	Total and per phase	Total	—
Energy			
Real, reactive and apparent energy (Wh, varh, VAh)	Total	—	Total
Real, forward and reverse, and total (Wh)	■	—	■

Note

① Main only.

Standards and Certifications

Environmental

The PXMP Meter and current sensors must be housed in a NEMA or UL enclosure that keeps the internal environment within the PXMP's environmental specification ranges and provides suitable fire and mechanical protection in the end product installation.

- Temperature range: –20 °C to +70 °C (–4 °F to +158 °F)
- Storage temperature range: –40 °C to +85 °C
- Humidity: 5–95% noncondensing environment
- Pollution degree: II
- Elevation: 0 to 9843 ft (0 to 3000 m)
- Housing: IP20
- CE Mark
- EMC EN61326

Emissions Conducted and Radiated

- FCC part 15 Class B
- CISPR 11 Class B

Electromagnetic Immunity

Standard	Description	Level
EN61000-4-2	ESD	3
EN61000-4-3	RF radiated	3
EN61000-4-4	Electrical fast transient	3
EN61000-4-5	Surge	3 ①
EN61000-4-6	RF conducted	3
EN61000-4-11	Volt sag/swell/variation	—

Product Safety

- IEC/EN61010-1
- UL 61010-1 File E185559
- CNL evaluation to CAN/C22.2 No 1010.1.92

Accuracy

- ANSI C12.20—Accuracy Class 0.5% with either CSXXX or PXMP-CSXXX sensors
 - Measurement Canada Approval Pending



Product Selection

The Power Xpert Multi-Point Meter, current sensors, and other accessories can be ordered from Eaton distributors. Refer to the following catalog numbers when ordering.

Power Xpert Multi-Point Meter Products

Product Description	Catalog Number
Meter Bases and Meter Modules with ABCN Voltage Inputs	
PXMP meter base—three-phase with ABCN voltage inputs	PXMP-MB
PXMP meter module with six 100 mA inputs for use with PXMP current sensors	PXMP-MM100MA
PXMP meter module with six 10 mA inputs for use with IQMESII current sensors	PXMP-MM10MA
PXMP meter module with six 333 mV inputs for use with 333 mV current sensors	PXMP-MM333MV
Meter Bases and Meter Modules with ABN Voltage Inputs	
PXMP meter base—single-phase, three-wire with ABN voltage inputs	PXMP-MB-AB
PXMP meter module with six 100 mA inputs for use with PXMP current sensors	PXMP-MM100MA-AB
PXMP meter module with six 10 mA inputs for use with IQMESII current sensors	PXMP-MM10MA-AB
PXMP meter module with six 333 mV inputs for use with 333 mV current sensors	PXMP-MM333MV-AB
IO Modules	
PXMP meter pulse input module with eight inputs	PXMP-PIM
PXMP meter digital output module with eight outputs	PXMP-DOM
Communication Module	
PXMP meter energy portal module	PXMP-EPM
Current Sensor Kits	
KIT, PXMP CS125 sensor, quantity of 3	PXMP-CS125-3
KIT, PXMP CS250 sensor, quantity of 3	PXMP-CS250-3
KIT, PXMP CS400 sensor, quantity of 3	PXMP-CS400-3
Current Sensor Cable Kits	
KIT, PXMP sensor cable, 4 ft (1.2 m), quantity of 3	PXMP-SC4-3
KIT, PXMP sensor cable, 6 ft (1.8 m), quantity of 3	PXMP-SC6-3
KIT, PXMP sensor cable, 8 ft (2.4 m), quantity of 3	PXMP-SC8-3
KIT, PXMP sensor cable, 12 ft (3.7 m), quantity of 3	PXMP-SC12-3
Current Sensor Extension Cable Kits	
KIT, PXMP sensor extension cable, 8 ft (2.4 m), quantity of 3	PXMP-SCE-8-3
KIT, PXMP sensor extension cable, 16 ft (4.9 m), quantity of 3	PXMP-SCE-16-3
Interface Modules	
PXMP current sensor interface module for 333 mV, kit X 3	PXMP-IM333MV-3

Note

Total sensor lead length must not exceed 28 ft (8.5 m).

The Pulse Input Module (PXMP-PIM) can be used to totalize pulse outputs from water meters, gas meters, steam meters or even old electrical meters with KZ pulse outputs. The PXMP-PIM can also be used for status monitoring in applications where status indication updates of 6 seconds over Modbus satisfies the application requirement.

Support products for the Power Xpert Multi-Point Meter include the HMI display, IMPCABLE and power supplies as described in the table below.

Power Xpert Multi-Point Meter Support Products

Product Description	Catalog Number
Communication cable, 1000 ft (305 m), 600 V insulation	IMPCABLE
PXMP meter display—6-inch color touchscreen (with cable)	PXMP-DISP-6
Power supply—single-phase 90–264 Vac, 24 Vdc at 2.5 A	PSG60E
Power supply—three-phase 360–575 Vac, 24 Vdc at 2.5 A	PSG60F
Power supply—three-phase 600 Vac, 24 Vdc	PSS55D

Meter Selection

Meter Module	Meter Base		Typical Applications			
	Three-Phase Application or Single-Phase with ABCN	Single-Phase Application with ABN	New Switchboards PXMP Current Sensors, Solid Core, PXMP-CSXXX, Ampere Ratings	Retrofit Existing IQMESII Sensors, Solid Core, CS-XXX, Ampere Ratings	Enclosed PXMP 333MV Sensors, Split Core, CS-SP-X-XXXX-333MV, Ampere Ratings	Enclosed PXMP Interface Modules
PXMP-MM100MA	PXMP-MB	—	125, 250, 400	—	—	—
PXMP-MM333MV	PXMP-MB	—	—	—	100, 200, 300, 400, 600, 800, 1000, 1200, 1600, 2000 ^①	PXMP-IM333MV
PXMP-MM10MA	PXMP-MB	—	—	5, 50, 70, 125, 200, 400	—	—
PXMP-MM100MA-AB	—	PXMP-MB-AB	125, 250, 400	—	—	—
PXMP-MM333MV-AB	—	PXMP-MB-AB	—	—	100, 200, 300, 400, 600, 800, 1000, 1200, 1600, 2000 ^①	PXMP-IM333MV
PXMP-MM10MA-AB	—	PXMP-MB-AB	—	5, 50, 70, 125, 200, 400	—	—

Note

^① For applications requiring more than 2000 A current sensors, use a CS005 with 5 A CT in conjunction with PXMP-MM10MA.

Technical data and Specifications

External Circuit Group Specifications

PXMP-MB (-AB) Meter base

Discrete Output

- Quantity 1—solid-state relay Form A NO Bidirectional FET
- Polarity of external source is not important
- Isolation circuit to ground 2 kV/1 min.
- Maximum external source voltage 28 Vdc
- Line-to-line TVS clamp across switching element at 32 Vdc
- Solid-state relay on resistance 35 ohms maximum
- Maximum load current 80 mA
- Minimum pulse width 20 milliseconds
- Fixed 25 milliseconds for pulse initiator function
- Maximum pulse rate 25 Hz
- Wiring to two-position removable terminal plug
 - 12–18 AWG (3.31–0.82 mm²), wire ferrules recommended
 - T1 (polarity not important)
 - T2 (polarity not important)

Discrete Inputs

- Quantity 3, common circuits inputs 1–3
- Group isolation 2 kV
 - No input-to-input circuit isolation
- All inputs per module share a common external 24 V ($\pm 10\%$) supply
 - 24 V externally sourced between common and inputs
 - Design to interface with external dry contact
 - Input impedance $\sim 2.2\text{K}$ ohms
 - Input current draw ~ 10 mA per input
- Minimum pulse width 10 milliseconds
- Maximum pulse rate 20 Hz
- Wiring to four-position removable terminal plug
 - 12–18 AWG (3.31–0.82 mm²), wire ferrules recommended
 - T3—Common (connect ext. 24 common here)
 - T4—Input 1 (dry contact to 24 V hot)
 - T5—Input 2 (dry contact to 24 V hot)
 - T6—Input 3 (dry contact to 24 V hot)

COM1 and COM2 RS-485 Serial Ports

- No D+/D– biasing reliance on fail-safe driver and biasing at Master
- Baud rate configurable between 9600–115K baud (default)
- Use cable designed for RS-485 communications
 - Low L:L capacitance
 - Impedance of ~ 100 – 120 ohms
 - Shield—Mylar for high frequency; Braid for low frequency
 - Separate common and shield for best noise immunity
 - Maximum cable length is 4000 ft (1219.2 m) with 32 nodes at 19.2K baud increased data rates will reduce maximum cable distance
 - 2000 ft (609.6 m) with 32 total nodes at 115.2K baud
- Isolation 300 V to ground due to TVS diode clamps
- Modbus RTU slave protocol, address defined by rotary switch
- Green Rx and Red Tx LEDs per channel
- Data + > Data—during idle marked, logic 1 state

- End of Line Termination resistance should match cable impedance (typ. 100–120 ohms)
- Four-position removable terminal plug 18–22 AWG (0.82–0.33 mm²) typical, wire ferrules recommended
 - COM1
 - T7—Shield
 - T8—RS-485 common
 - T9—Data –
 - T10—Data +
 - COM2
 - T11—Shield
 - T12—RS-485 common
 - T13—Data –
 - T14—Data +

PXMP-MB Power Supply Input

- 24 Vdc $\pm 20\%$
- 15W maximum load
- 1 kV isolation barrier internal to PXMP-MB
- Externally fuse circuit to protect wire
- Green power OK LED
- Three-position terminal block 16–12 AWG (1.31–3.31 mm²), wire ferrules recommended
 - T15—24 Vdc – (common)
 - T16—24 Vdc + (Hot)
 - T17—Shield (optional) capacitively referenced to chassis ground for enhanced EMC performance

Meter Voltage Inputs

- Overvoltage CAT III
- Maximum voltage rating
 - 480VL:G (corner grounded delta)
 - 347VL:N
 - 600VL:L
- Frequency rating 47–63 Hz
- Metering range (temporary transitions)
 - 30–700VL:N
 - 30–700VL:L
- Abuse withstand rating 1000 V sustained
- High pot withstand rating 2500 V/1 min
- Input impedance 4M ohms
- Fuse inputs rated to protect wiring to mains. External fuses
 - must be installed between the meter voltage terminal and the mains disconnect switch to the main lines to protect the lines. 600 V 1 A BUSS type KTK-R-1 Fast Acting or equivalent fuses
 - are recommended.
- Wiring to removable terminal plug 10–18 AWG (5.26–0.82 mm²), wire ferrules recommended
 - T18—N (VR)
 - T19—C (V3)
 - T20—B (V2)
 - T21—A (V1)

PXMP meter modules (PXMP-MMs)

Compatible with all PXMP Meter Base slots 1–10 LED indicators:

- Health and status green, blink to show activity
- Pulse energy output one red per group of three loads
- Load energy direction red/green pair per load

All variations support six load inputs.

Current sensor connection is one 2 x 2 connector per load.

Compatible with PXMP-SCXX sensor cables, total cable length to the sensor should not exceed 28 ft (8.5 m).

Note that -AB suffix only affects what voltage channels the loads are paired with for metering purposes.

PXMP-MM10MA supports the CSXXX series of 10 mA maximum secondary output current transformers.

PXMP-MM100MA supports the PXMP-CSXXX series of 100 mA maximum secondary output current transformers.

PXMP-MM333MV supports 333 mV maximum secondary output current transformers with the use of the PXMP-IM333MV interface module.

PXMP digital output module (PXMP-DOM)

- Compatible with all PXMP-MB slots 1–10
- LED indicators
 - Health and status green, blink to show activity
 - Output On/Off status one green per output
 - Eight individual solid-state relay outputs
- Each circuit rated for 24 Vdc ($\pm 20\%$) with an 80 mA load maximum
- 24 Vdc is externally sourced
- Group isolation to ground 2 kV
- Each circuit has its own separate common, circuit-to-circuit isolation 120 V
- 16-position removable terminal plug
- 12–18 AWG (3.31–0.82 mm²), wire ferrules recommended

PXMP pulse input modules (PXMP-PIMs)

- Compatible with all PXMP-MB slots 1–10
- LED indicators
 - Health and status green, blink to show activity
 - Input On/Off status one green per pulse input
- Eight pulse inputs to external dry contacts
- Maximum pulse rate is 20 Hz
- Minimum pulse width is 20 milliseconds
- External circuit groups rated for 24 Vdc ($\pm 20\%$)
 - All circuits share the same electrical common
- External supply connects to the module with a two-position removable terminal plug
- The supply is internally fanned out to all circuits
- Group isolation limited to 300 V to ground due to TVS diode clamp
- Input impedance $\sim 2.2\text{K}$ causing a 10 mA load per input when energized
- External circuit groups connect with a 16-position removable terminal plug
 - Terminals support 12–18 AWG (3.31–0.82 mm²), wire ferrules recommended

PXMP energy portal module (PXMP-EPM)

- Only functionally compatible with PXMP-MB slot 10
- LED indicators
 - Top health and status green, blink to show activity
 - Com. reset button—reset to defaults
 - Local IP 192/10
 - RJ45 front-facing Ethernet configuration port LEDs
 - Link (Tx/Rx blink)
 - 10/100 speed
- LED four-stack for bottom LAN/WAN Ethernet port
 - Link (Tx/Rx blink)
 - 10/100 speed
 - DHCP/Fixed
 - TX active
- Config. Ethernet RJ45 Cat5 STP/UTP
 - 10BASE-T/100BASE-TX
 - Auto crossover capability supported
 - Java web browser interface
- Bottom facing LAN/WAN Ethernet port
 - RJ45 Cat5 STP/UTP 10BASE-T/100BASE-TX
 - STP required for full electromagnetic immunity
 - Auto crossover capability supported
 - Supports Modbus TCP and Java web browser interface
- Bottom-facing telephone modem interface
 - Modem type V92/56K baud
 - RJ11 field interface

Power Xpert Multi-Point Meter System — Hardware Specifications

Components	Field Circuit	Power Source	Rated Voltage	Rated Current	Circuit Impedance	Isolation	Note 1	Note 2
PXMP-MB	Digital output	External	24 ±20% ①	0.080 A maximum	35 ohms maximum	2.0 kV	—	—
PXMP-MB-AB	Digital input	External	24 ±20% ①	0.01 A	2.22K	2.0 kV	Up to drops supply by 2 V	Group are electrically common
	COM1 RS-485	Internal	5 V ①	—	50–60 ohms	300 V	TVS diode clamped to PE	—
	COM2 RS-485	Internal	5 V ①	—	50–60 ohms	300 V	TVS diode clamped to PE	—
	Power supply input	External	24 ±20% ①	0.7 A maximum	N/A	1.0 kV	Installation Class II input	15W maximum
	Voltage inputs A (V1)/ B (V2)/ C (V3)/ N (VR)	External mains	480 V L:G ②	0.12 mA	4M ohms	N/A	Installation Class III	High pot 2500 V/1 minimum
			347 V L:N ②	0.09 mA	4M ohms	N/A	Installation Class III	High pot 2500 V/1 minimum
			600 V L:L ②	0.09 mA	4M ohms	N/A	Installation Class III	High pot 2500 V/1 minimum
PXMP-MM100MA	CT secondary	External	N/A	100 mA	14.6 ohms	N/A	20% over-range	See sensor for primary isolation
PXMP-MM10MA	CT secondary	External	N/A	10 mA	67 ohms	N/A	20% over-range	See sensor for primary isolation
PXMP-MM333MV	CT secondary	External	0.333 V ②	N/A	50,000 ohms	N/A	20% over-range	See sensor for primary isolation
PXMP-DOM	Digital output	External	24 ±20% ①	0.080 A maximum	10 ohms maximum	2 kV group	120 V isolation circuit-to-circuit	Isolation dependent on external source
PXMP-PIM	Pulse input	External	24 ±20% ①	0.01 A	2.22K ohms	300 V to ground	TVS diode clamped to PE; group isolated, all circuits common to 24 V external source	Note: Opto creates 2.2 V drop sourced by 2.2K ohms; isolation dependent on external source
PXMP-EPM	Ethernet 100 Bt	Internal	—	N/A	N/A	1 kV	—	—
	POT modem	Internal	—	N/A	N/A	—	—	—

Notes

① DC.

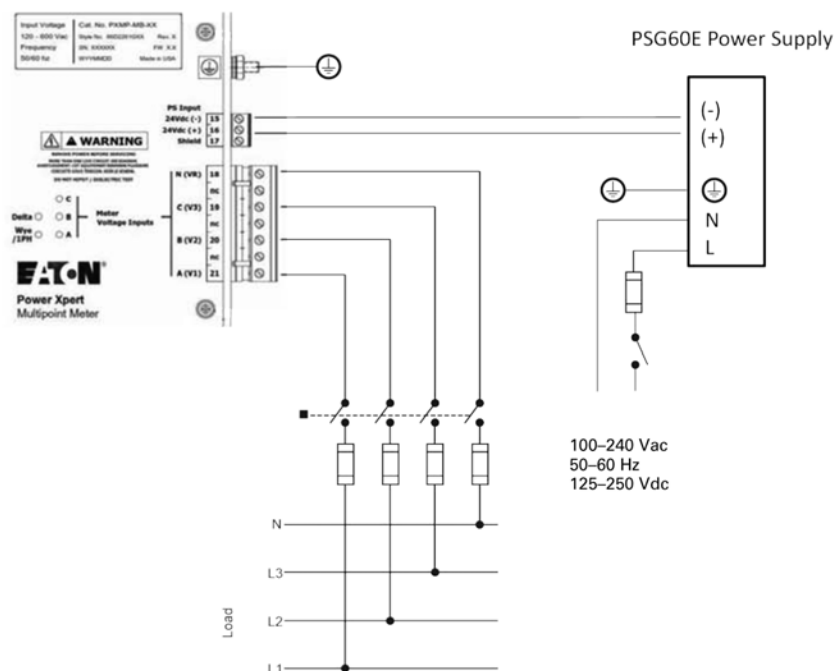
② AC rms.

Wiring Diagrams

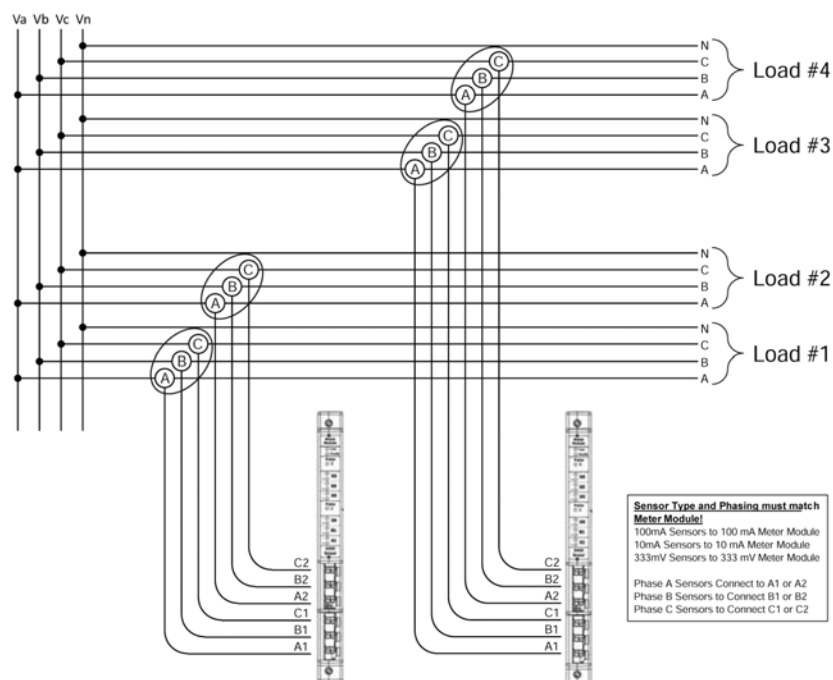
Wiring for PXMB-MB

Note: For all voltage connections—fuses should be sized in accordance with best practices to protect the instrumentation wire.

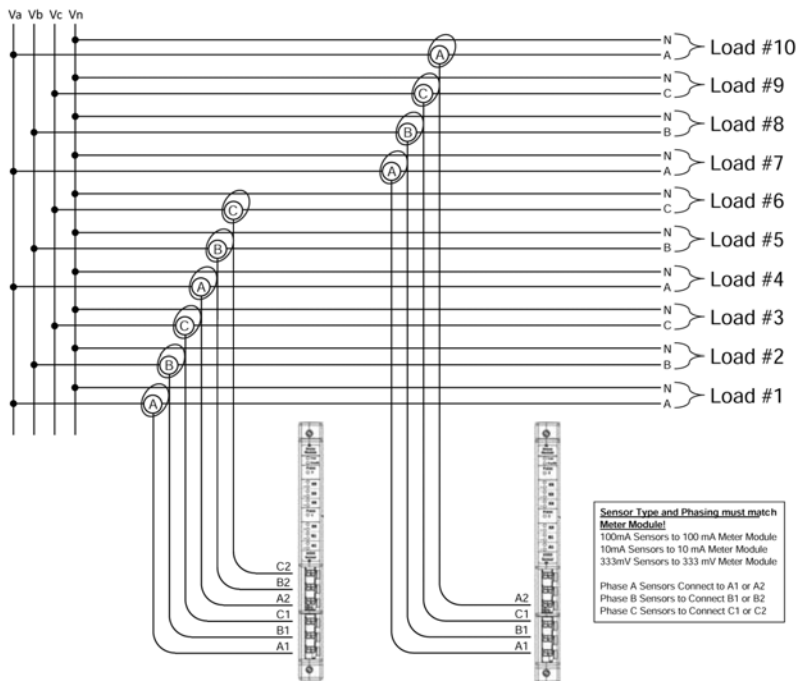
Four-Wire Wye Voltage Connection Inputs



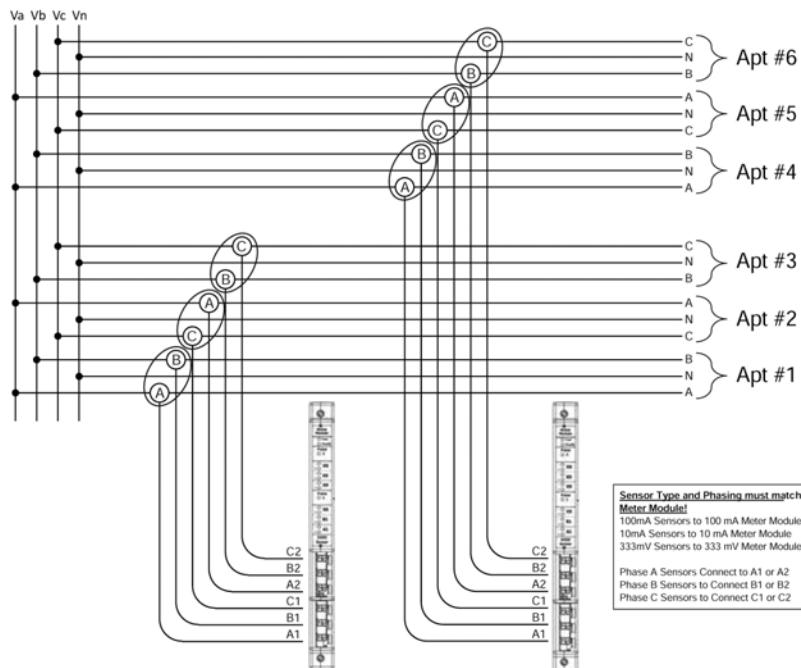
Three-Phase, Four-Wire Service Current Sensor Connections



Three-Phase, Four-Wire Service (Ten Single-Phase, Single-Pole) Current Sensor Connections

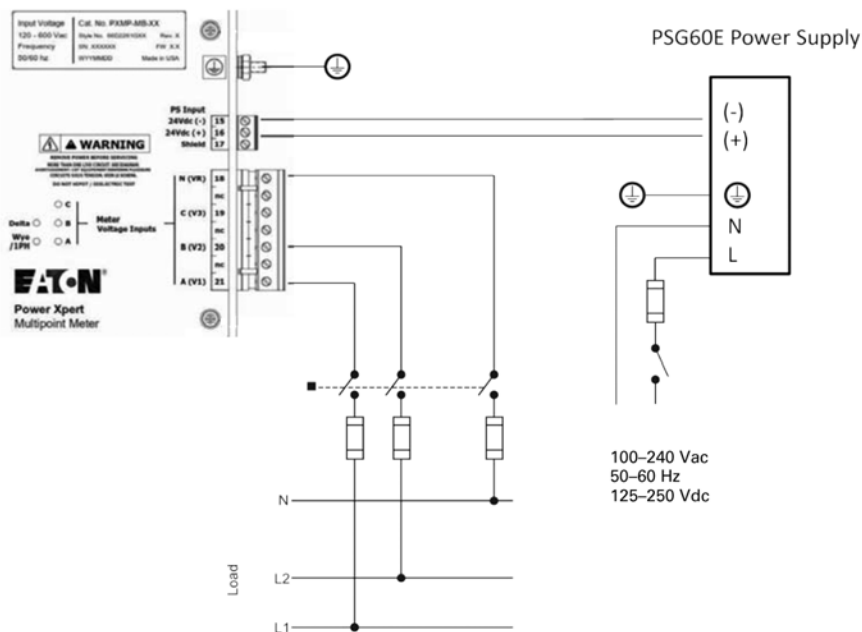
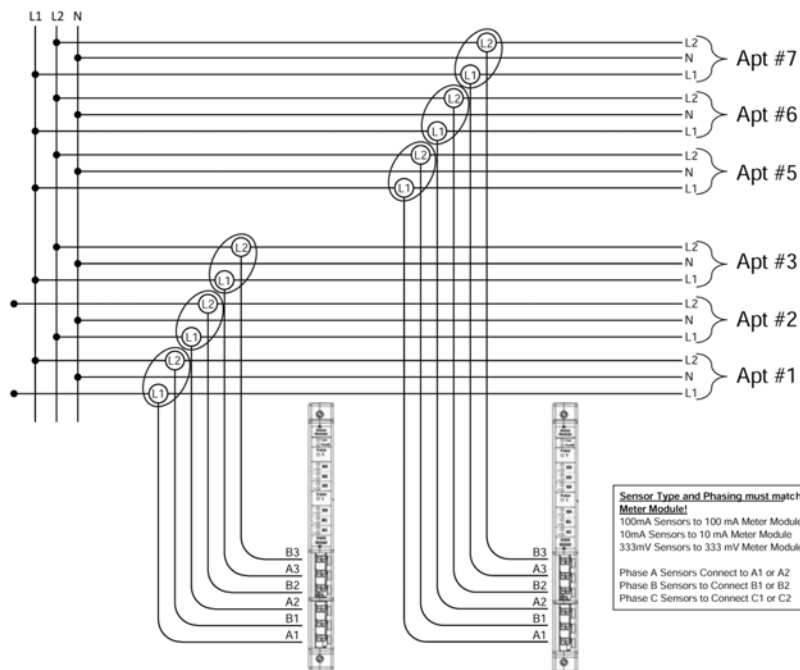


Network 120/208 Three-Wire Apartment Service Current Sensor Connections



Wiring for PXMB-MB-AB

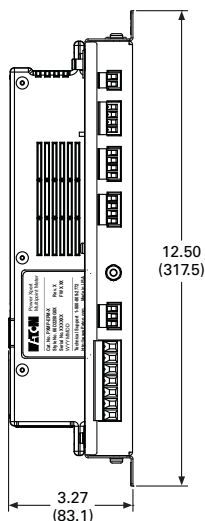
Note: For all voltage connections—fuses should be sized in accordance with best practices to protect the instrumentation wire.

Single-Phase, Three-Wire 120/240 Voltage Connection Inputs**120/240 Single-Phase, Three-Wire Service Current Sensor Connections**

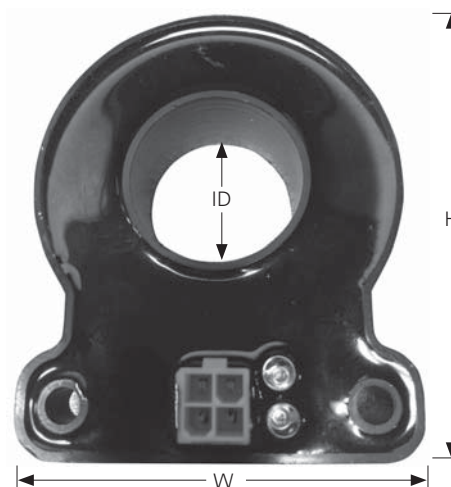
Approximate Dimensions in Inches (mm)

Figure 1: Front Panel of the PMP-MB-XX Meter Base. The diagram shows a 10-slot rack with slots 1-7 containing Meter Modules and slots 8-10 containing optional modules like RS-485, Modbus, and RS-485/Modbus. Dimensions are provided: 10.67 (271.0) for the rack width, 0.20 (5.1) for the slot width, 11.67 (296.4) for the rack height, and 12.00 (304.8) for the panel height. A warning label is present on the right side.

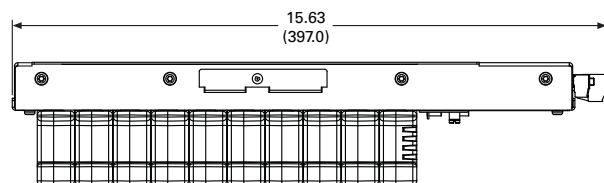
Single Unit—Side View



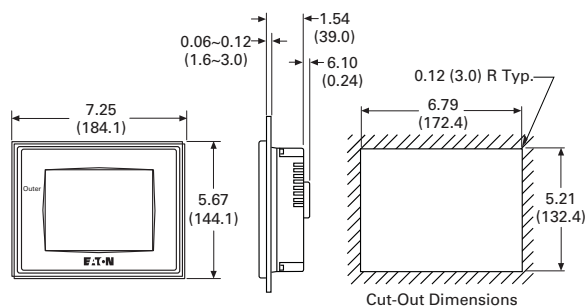
Current Sensor Dimensions



Single Unit—Top View



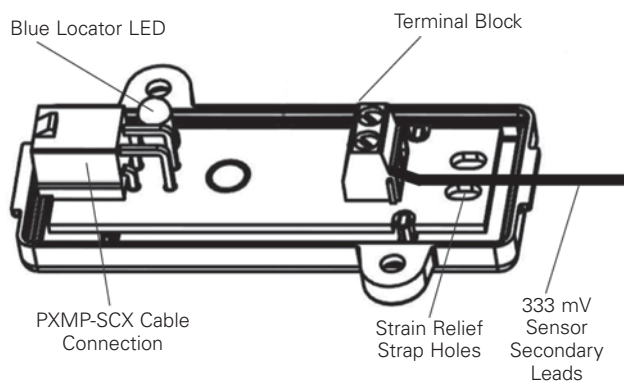
PXMP Color Touchscreen Display



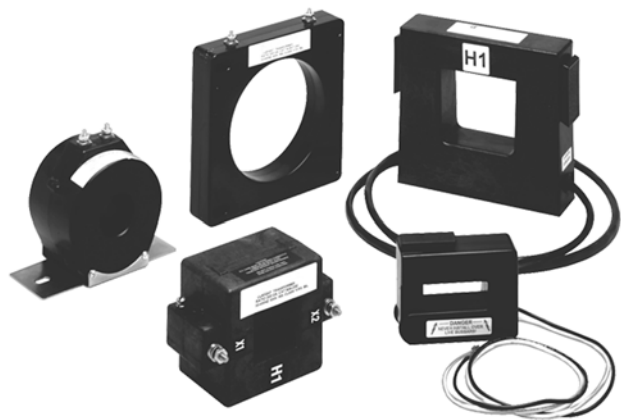
Current Sensor Dimensions

Sensor	H	W	D
PXMP-CS125	2.66 (67.6)	1.66 (42.1)	0.53 (13.5)
PXMP-CS250	2.96 (75.2)	2.42 (61.5)	1.12 (28.4)
PXMP-CS400	3.64 (92.5)	3.03 (77.2)	1.74 (44.2)

Open Interface Module (PXMP-IM333MV)



Current Transformers (CTs)



Current Transformers (CTs)

Product Description

Eaton’s low voltage current transformers are available in both solid core and split core designs. Engineered for electronic metering applications, all solid core designs and selected split core designs offer ANSI metering quality accuracy. The solid core designs also meet ANSI C57.13 relay accuracy requirements including over-ranging capabilities. The current transformer offering has a 5 ampere secondary at the rated primary current.

Split core CTs are specifically designed to be installed around primary conductors without disconnecting wires or breaking the circuit to be monitored. These current transformers are perfect solutions for energy management applications and are manufactured for installation ease.

Contents

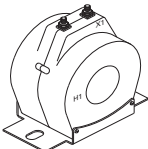
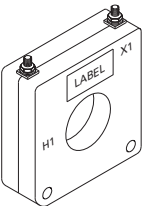
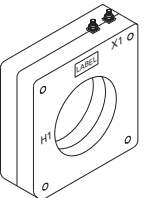
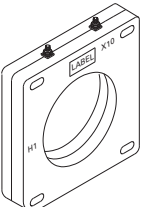
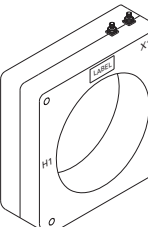
Description	Page
Metering Products Family	V3-T9-2
PXM350	V3-T9-7
Power Xpert Energy Meter	V3-T9-14
Power Xpert Quality (PXQ) Event Analysis System (Power Quality Meter)	V3-T9-22
Power Xpert Branch Circuit Monitor (PXBCM)	V3-T9-27
Power Xpert Multi-Point Meter	V3-T9-31
Current Transformers (CTs)	
Product Selection	V3-T9-44
Dimensions	V3-T9-47
Panel Mounting Adapter Kit	V3-T9-52

Application Description

For new construction and retrofit applications where no current transformer exists, Eaton offers a complete selection of low voltage (up to 600 V) current transformers. These current transformers can be used in commercial-grade applications, such as control panels and panelboards. Additionally, they can be used for most industrial metering and relaying applications in switchboards, switchgear and motor control centers. These CTs are intended for use with the Power Xpert Meter 2000/4000/6000/8000, IQ 250/260, IQ 130/140/150, IQ Analyzer 6400/6600, IQ DP-4000 and IQ 230 series.

Product Selection

Solid Core ANSI Metering Accuracy

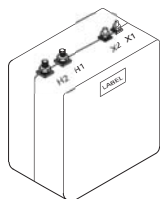
	Primary Current Rating	ANSI B0.1 Metering Class at 60 Hz (Accuracy in %)	Window Size in Inches (mm) Diameter	Catalog Number	Mounting Bracket Catalog Number
S060 	1.25 (31.8) Window				
	50	1.2	1.25 (31.8)	S060-500	①
	100	0.6	1.25 (31.8)	S060-101	①
	150	0.3	1.25 (31.8)	S060-151	①
	200	0.3	1.25 (31.8)	S060-201	①
S050 	1.56 (39.6) Window				
	300	0.3	1.56 (39.6)	S050-301	S050BRAC
	400	0.3	1.56 (39.6)	S050-401	S050BRAC
	500	0.3	1.56 (39.6)	S050-501	S050BRAC
	600	0.3	1.56 (39.6)	S050-601	S050BRAC
	750	0.3	1.56 (39.6)	S050-751	S050BRAC
	800	0.3	1.56 (39.6)	S050-801	S050BRAC
	1000	0.3	1.56 (39.6)	S050-102	S050BRAC
	1200	0.3	1.56 (39.6)	S050-122	S050BRAC
	3.25 (82.6) Window				
S080 	400	0.3	3.25 (82.6)	S080-401	S080BRAC
	500	0.3	3.25 (82.6)	S080-501	S080BRAC
	600	0.3	3.25 (82.6)	S080-601	S080BRAC
	750	0.3	3.25 (82.6)	S080-751	S080BRAC
	800	0.3	3.25 (82.6)	S080-801	S080BRAC
	1000	0.3	3.25 (82.6)	S080-102	S080BRAC
	1200	0.3	3.25 (82.6)	S080-122	S080BRAC
S090 	4.25 (108.0) Window				
	500	0.3	4.25 (108.0)	S090-501	S090BRAC
	600	0.3	4.25 (108.0)	S090-601	S090BRAC
	750	0.3	4.25 (108.0)	S090-751	S090BRAC
	800	0.3	4.25 (108.0)	S090-801	S090BRAC
	1000	0.3	4.25 (108.0)	S090-102	S090BRAC
	1200	0.3	4.25 (108.0)	S090-122	S090BRAC
	1500	0.3	4.25 (108.0)	S090-152	S090BRAC
	1600	0.3	4.25 (108.0)	S090-162	S090BRAC
	2000	0.3	4.25 (108.0)	S090-202	S090BRAC
	2500	0.3	4.25 (108.0)	S090-252	S090BRAC
	3000	0.3	4.25 (108.0)	S090-302	S090BRAC
	6.31 (160.3) Window				
S025 	600	0.3	6.31 (160.3)	S025-601	S025BRAC
	750	0.3	6.31 (160.3)	S025-751	S025BRAC
	800	0.3	6.31 (160.3)	S025-801	S025BRAC
	1000	0.3	6.31 (160.3)	S025-102	S025BRAC
	1200	0.3	6.31 (160.3)	S025-122	S025BRAC
	1500	0.3	6.31 (160.3)	S025-152	S025BRAC
	1600	0.3	6.31 (160.3)	S025-162	S025BRAC
	2000	0.3	6.31 (160.3)	S025-202	S025BRAC
	2500	0.3	6.31 (160.3)	S025-252	S025BRAC
	3000	0.3	6.31 (160.3)	S025-302	S025BRAC
	3500	0.3	6.31 (160.3)	S025-352	S025BRAC
	4000	0.3	6.31 (160.3)	S025-402	S025BRAC

Note

① Contact Eaton for further information.

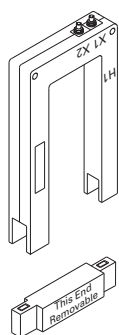
Split Core ANSI Metering Accuracy

W190



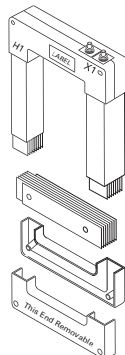
Primary Current Rating	ANSI B0.1 Metering Class at 60 Hz (Accuracy in %)	Window Size in Inches (mm)	Catalog Number
Wound and Primary CTs			
25	0.3	Wound	W190-025
50	0.3	Primary	W190-050

M000



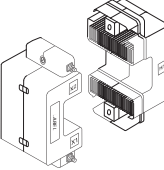
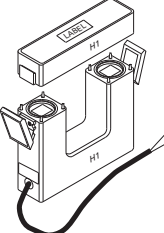
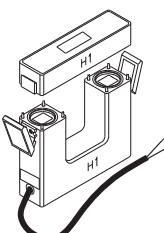
2.00 x 5.50 (50.8 x 139.7)			
400	2.4	2.00 x 5.50 (50.8 x 139.7)	M000-401
500	2.4	2.00 x 5.50 (50.8 x 139.7)	M000-501
600	2.4	2.00 x 5.50 (50.8 x 139.7)	M000-601
800	1.2	2.00 x 5.50 (50.8 x 139.7)	M000-801
1000	1.2	2.00 x 5.50 (50.8 x 139.7)	M000-102
1200	0.6	2.00 x 5.50 (50.8 x 139.7)	M000-122
1500	0.6	2.00 x 5.50 (50.8 x 139.7)	M000-152
1600	0.6	2.00 x 5.50 (50.8 x 139.7)	M000-162
2000	0.6	2.00 x 5.50 (50.8 x 139.7)	M000-202

M050



4.10 x 7.10 (104.1 x 180.3)			
600	4.8	4.10 x 7.10 (104.1 x 180.3)	M050-601
750	4.8	4.10 x 7.10 (104.1 x 180.3)	M050-751
800	2.4	4.10 x 7.10 (104.1 x 180.3)	M050-801
1000	2.4	4.10 x 7.10 (104.1 x 180.3)	M050-102
1200	1.2	4.10 x 7.10 (104.1 x 180.3)	M050-122
1500	1.2	4.10 x 7.10 (104.1 x 180.3)	M050-152
2000	0.6	4.10 x 7.10 (104.1 x 180.3)	M050-202
2500	0.6	4.10 x 7.10 (104.1 x 180.3)	M050-252
3000	0.6	4.10 x 7.10 (104.1 x 180.3)	M050-302
3500	0.6	4.10 x 7.10 (104.1 x 180.3)	M050-352
4000	0.3	4.10 x 7.10 (104.1 x 180.3)	M050-402

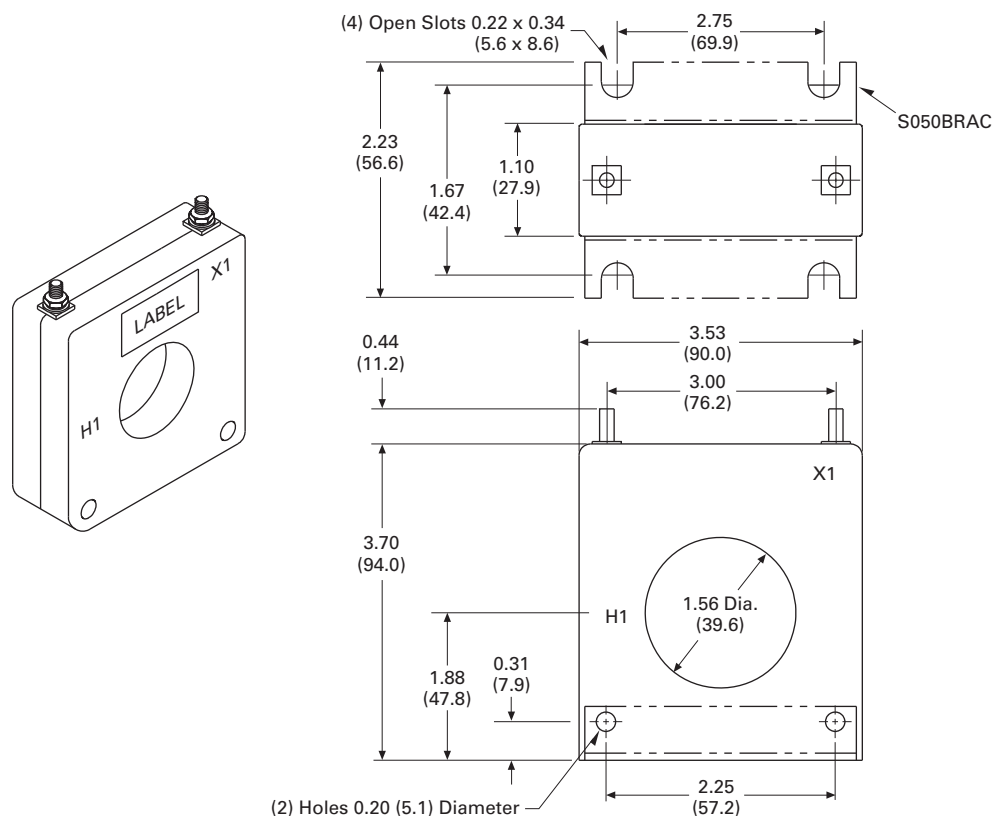
Split Core Current Transformers

	Primary Current Rating	Accuracy at 60 Hz (in %)	Window Size in Inches (mm)	Catalog Number
M030 	0.80 x 1.95 (20.3 x 49.5)			
	100	5.0	0.80 x 1.95 (20.3 x 49.5)	M030-101
	150	5.0	0.80 x 1.95 (20.3 x 49.5)	M030-151
	200	4.0	0.80 x 1.95 (20.3 x 49.5)	M030-201
	300	2.0	0.80 x 1.95 (20.3 x 49.5)	M030-301
	400	2.0	0.80 x 1.95 (20.3 x 49.5)	M030-401
M040 	1.42 x 1.53 (36.1 x 38.9)			
	100	5.0	1.42 x 1.53 (36.1 x 38.9)	M040-101
	150	4.0	1.42 x 1.53 (36.1 x 38.9)	M040-151
	200	1.5	1.42 x 1.53 (36.1 x 38.9)	M040-201
	300	1.5	1.42 x 1.53 (36.1 x 38.9)	M040-301
	400	1.5	1.42 x 1.53 (36.1 x 38.9)	M040-401
M060 	2.60 x 2.75 (66.0 x 69.9)			
	200	1.0	2.60 x 2.75 (66.0 x 69.9)	M060-201
	300	1.0	2.60 x 2.75 (66.0 x 69.9)	M060-301
	400	1.0	2.60 x 2.75 (66.0 x 69.9)	M060-401
	500	1.0	2.60 x 2.75 (66.0 x 69.9)	M060-501
	600	1.0	2.60 x 2.75 (66.0 x 69.9)	M060-601
	750	1.0	2.60 x 2.75 (66.0 x 69.9)	M060-751
	800	1.0	2.60 x 2.75 (66.0 x 69.9)	M060-801
	1000	1.0	2.60 x 2.75 (66.0 x 69.9)	M060-102
	1200	1.0	2.60 x 2.75 (66.0 x 69.9)	M060-122
M080 	2.60 x 6.25 (66.0 x 158.8)			
	500	1.0	2.60 x 6.25 (66.0 x 158.8)	M080-501
	600	1.0	2.60 x 6.25 (66.0 x 158.8)	M080-601
	800	1.0	2.60 x 6.25 (66.0 x 158.8)	M080-801
	1000	1.0	2.60 x 6.25 (66.0 x 158.8)	M080-102
	1200	1.0	2.60 x 6.25 (66.0 x 158.8)	M080-122
	1500	1.0	2.60 x 6.25 (66.0 x 158.8)	M080-152
	1600	1.0	2.60 x 6.25 (66.0 x 158.8)	M080-162
	2000	1.0	2.60 x 6.25 (66.0 x 158.8)	M080-202
	2500	1.0	2.60 x 6.25 (66.0 x 158.8)	M080-252
	3000	1.0	2.60 x 6.25 (66.0 x 158.8)	M080-302

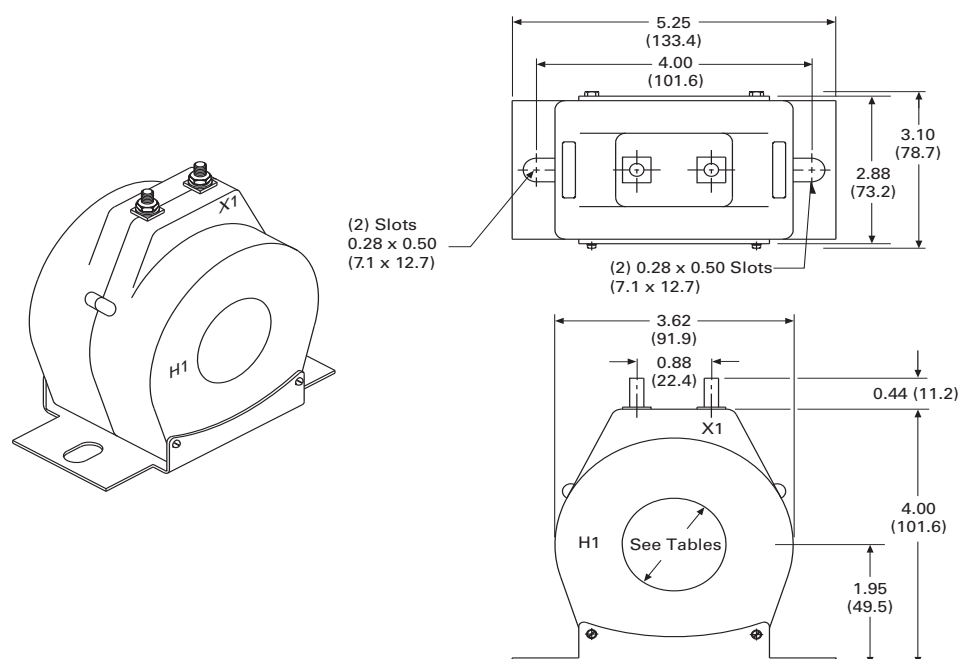
Dimensions

Approximate Dimensions in Inches (mm)

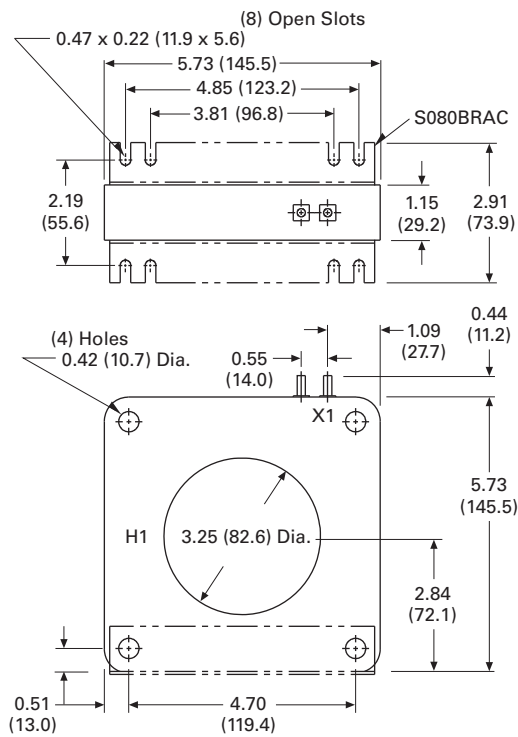
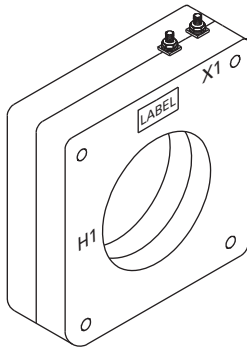
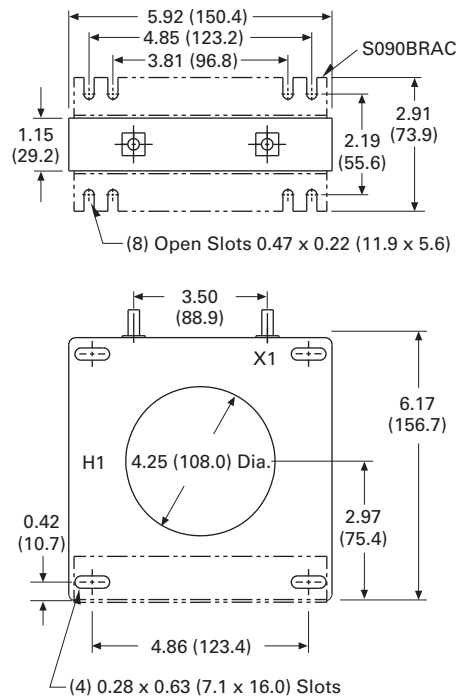
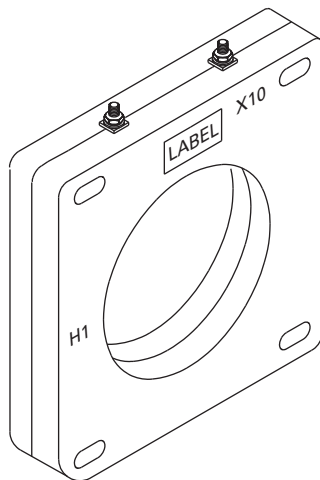
S050



S060

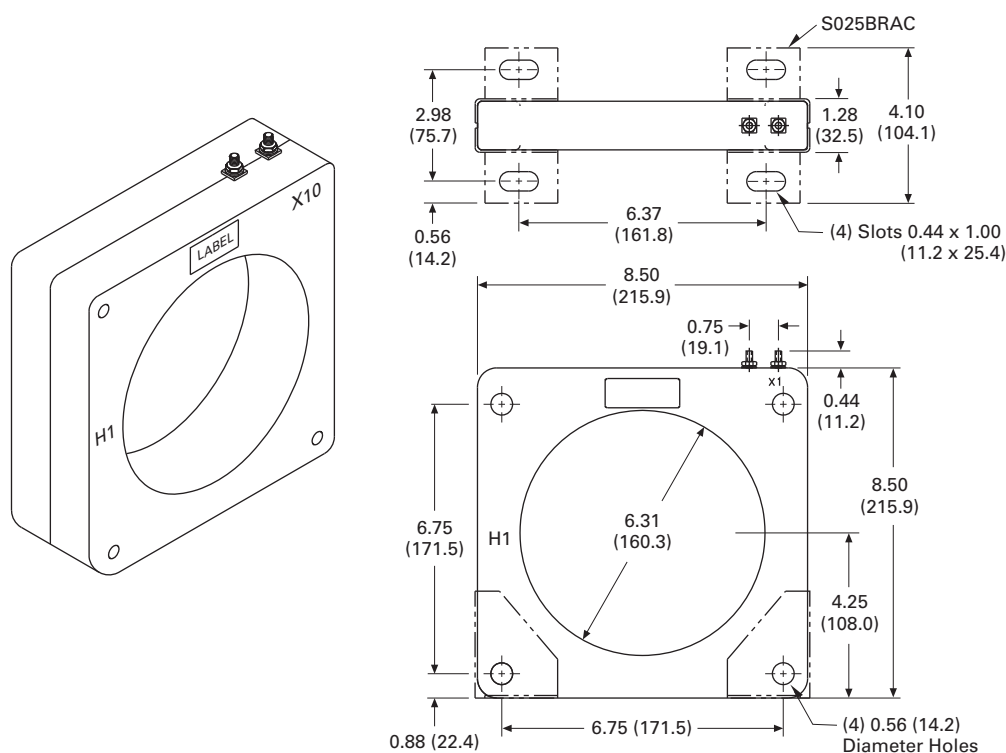


Approximate Dimensions in Inches (mm)

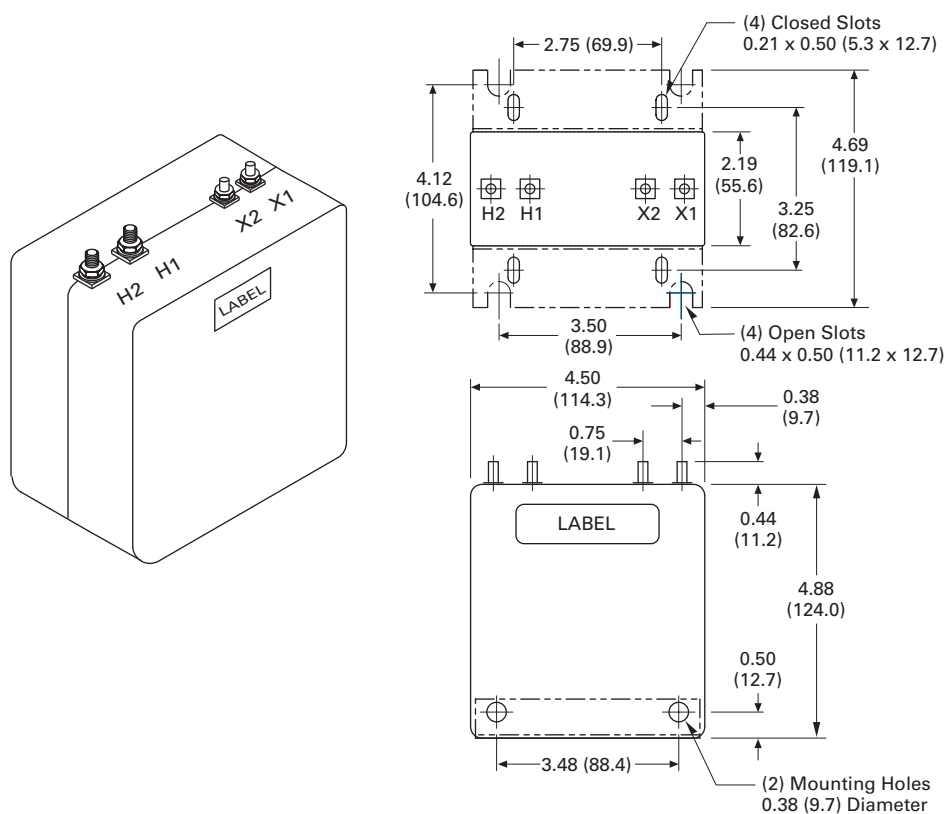
S080**S090**

Approximate Dimensions in Inches (mm)

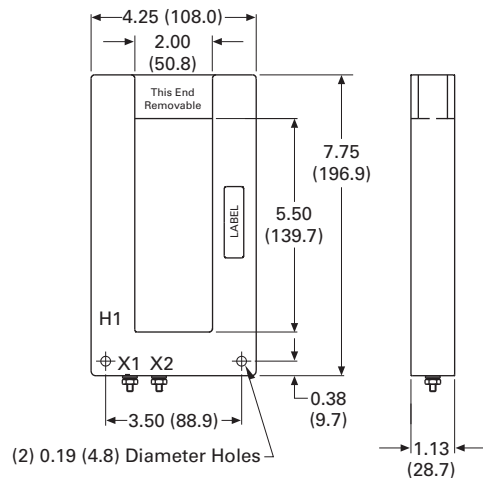
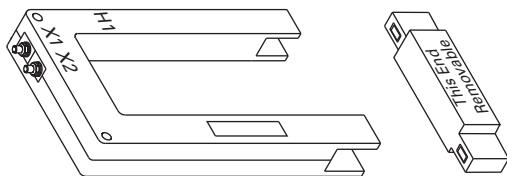
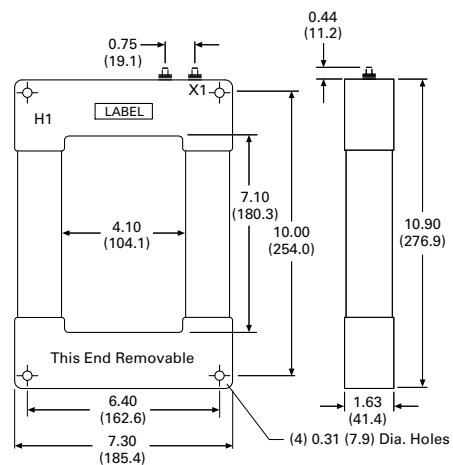
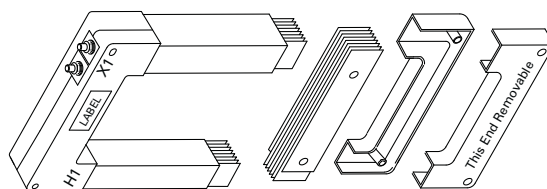
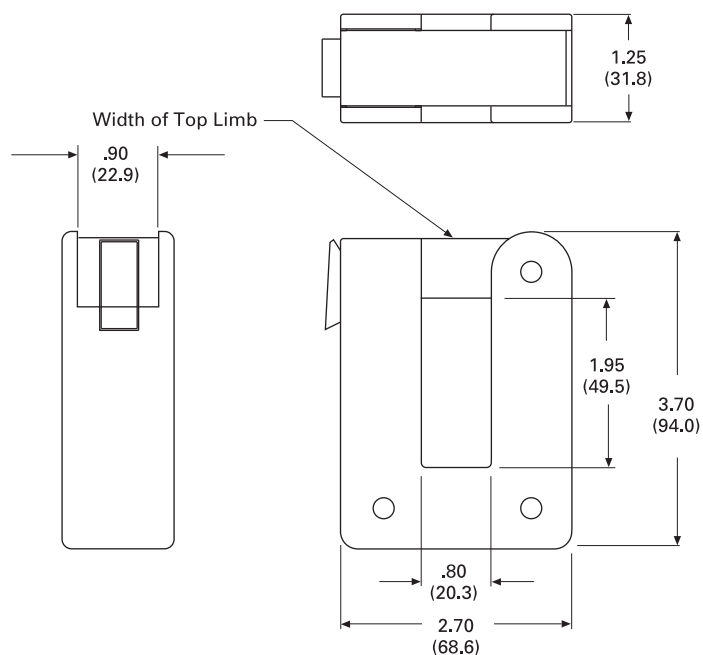
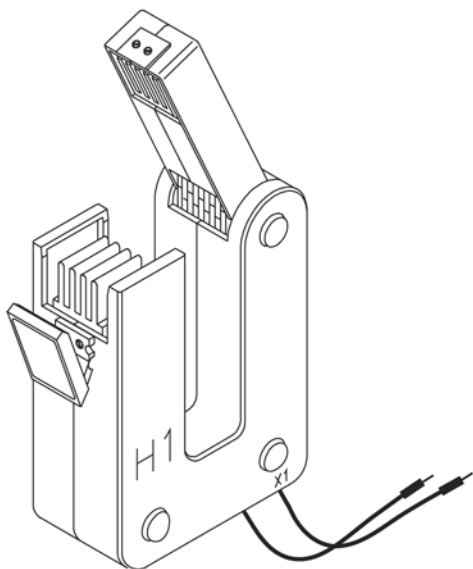
S025



W190

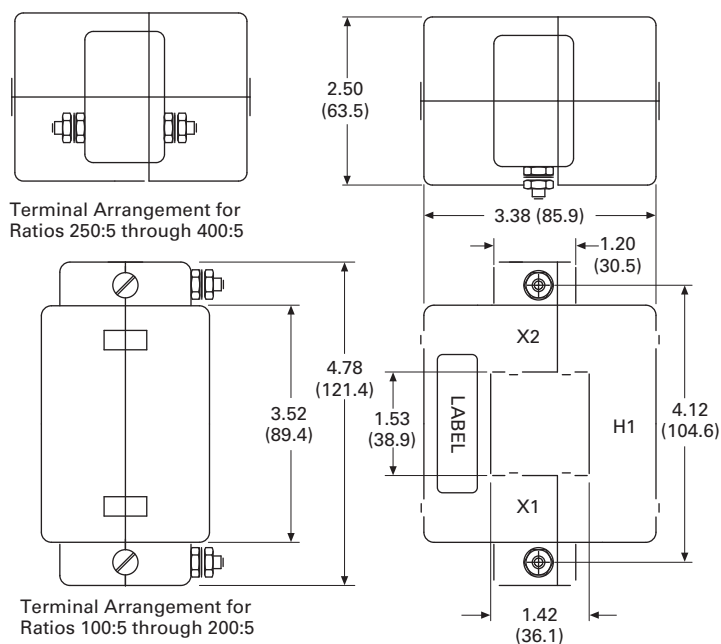
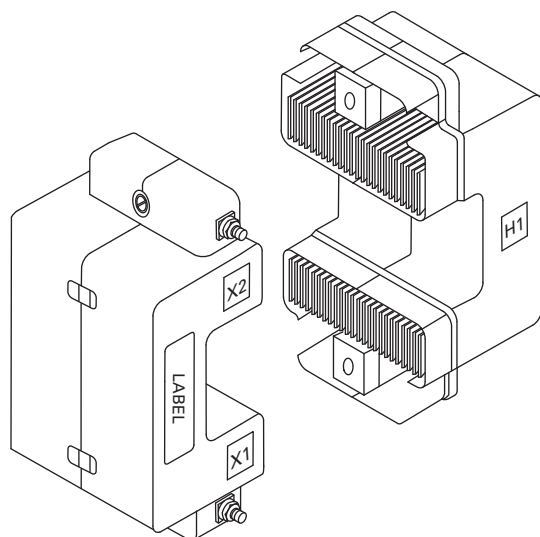


Approximate Dimensions in Inches (mm)

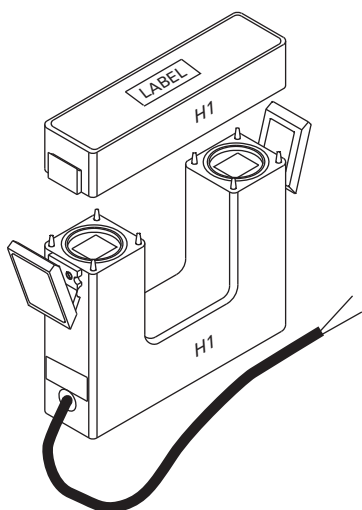
M000**M050****M030**

Approximate Dimensions in Inches (mm)

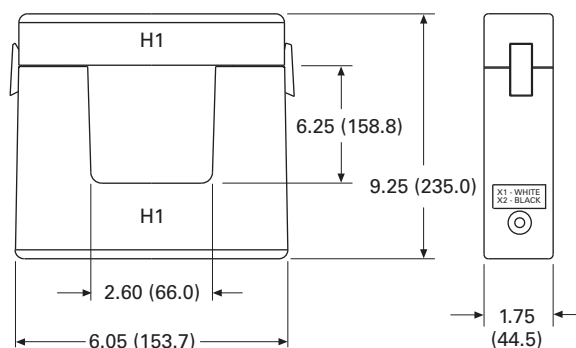
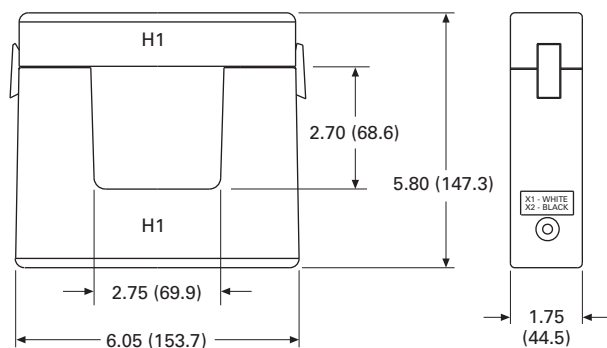
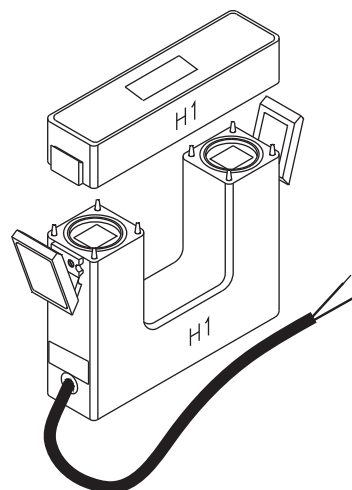
M040



M060



M080



Panel Mounting Adapter Kit for IQ 100/200 Series and PXM 2000 Meters



Panel Mounting Adapter Kit for IQ 100/200 Series and PXM 2000 Meters

Product Description

The flange adapter plate can be installed as follows:

1. Remove the old meter from the panel or door. Many IQ metering products use the typical IQ drilling pattern shown at right for mounting
2. Install the flange adapter plate. Mount it from the rear using the six screws provided in the kit. The flange adapter plate screw hole pattern shown at right should match the typical IQ drilling pattern. If not, perform the next step
3. Drill six holes in the panel or the door to mount the flange adapter plate. Follow the typical IQ drilling pattern. You need only the top, center and bottom sets of holes
4. Install the new IQ 100/200 Series or PXM 2000 meter in the flange adapter plate. Secure it from behind with four flat washers, lock washers and nuts provided with the meter

Contents

Description

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Power Xpert Quality (PXQ) Event Analysis System (Power Quality Meter)	V3-T9-22
Power Xpert Branch Circuit Monitor (PXBCM)	V3-T9-27
Power Xpert Multi-Point Meter	V3-T9-31
Current Transformers (CTs)	V3-T9-43
Panel Mounting Adapter Kit	

Product Selection

Panel Mounting Adapter Kit

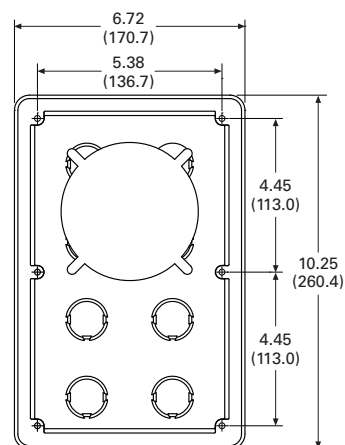


Panel Mounting Adapter Kit

Description	Catalog Number
Panel mounting adapter kit IQ 100/200 and PXM 2000 Series adapter kit to IQ Analyzer/IQ DP-4000/IQ Data	IQ250-PMK

Dimensions

Flange Adapter Plate Screw Hole Pattern



Contents**Description****Page**

Product Selection Guide	
Arc Flash Relay	V3-T9-59
EDR-3000 Feeder Protection	V3-T9-61
EDR-5000 Distribution Protection Relay	V3-T9-70
EBR—Line Differential Relay	V3-T9-83
EMR-3MP0 Motor Protection Relay	V3-T9-85
EMR-3000 Motor Protection Relay	V3-T9-87
EMR-4000 Motor Protection Relay	V3-T9-99
EMR-5000 Motor Protection Relay	V3-T9-112
ETR-4000 Transformer Protection Relay	V3-T9-124
ETR-5000 Transformer Protection Relay	V3-T9-136
EGR-5000 Generation Protection Relay	V3-T9-149
Universal RTD Module	V3-T9-162

Product Selection Guide**Protective Relay Selection Chart****Protection Functions**

Description	Feeder Protection			Motor Protection			Transformer Protection		Generator Protection
	IEEE Device Number	EDR-3000 V3-T9-61	EDR-5000 V3-T9-70	EMR-3000 V3-T9-87	EMR-4000 V3-T9-99	EMR-5000 V3-T9-112	ETR-4000 V3-T9-124	ETR-5000 V3-T9-112	EGR-5000 V3-T9-149
Phase inst. OC	50	■	■	■	■	■	■	■	■
Phase TOC	51	■	■	■	■	■	■	■	■
Ground inst. OC (measured)	50G	■	■	■	■	■	■	■	■
Ground TOC (measured)	51G	■	■	■	■	■	■	■	■
Ground inst. OC (calculated)	50R	■	■	■	■	■	■	■	■
Ground TOC (calculated)	51R	■	■	■	■	■	■	■	■
No. of curves (ANSI/IEC/thermal)		11	11	11	11	11	11	11	11
Zone selective interlocking		■	■	■	■	■	■	■	■
Phase directional control ①	67		■		■	■		■	■
Ground directional control ①	67N		■		■	■		■	■
Phase voltage restrained OC	51VR		■		■	■		■	■
Undervoltage	27		■		■	■		■	■
Current unbalance	46	■	■	■	■	■		■	■

Note

① Directional elements are controlled by reverse, forward, or both directions.

Protection Functions, continued

Description	IEEE Device Number	Feeder Protection		Motor Protection			Transformer Protection		Generator Protection	
		EDR-3000 V3-T9-61	EDR-5000 V3-T9-70	EMR-3000 V3-T9-87	EMR-4000 V3-T9-99	EMR-5000 V3-T9-112	ETR-4000 V3-T9-124	ETR-5000 V3-T9-149	EGR-5000 V3-T9-149	
Voltage unbalance	47		■		■	■		■	■	
Power factor	55		■		■	■			■	
Overvoltage	59		■		■	■		■	■	
Frequency (over/under)	81		■		■	■		■	■	
Rate of change of frequency	81R		■		■	■		■	■	
Vector surge	78V		■		■	■		■	■	
Forward/reverse power	32		■		■	■		■	■	
Forward/reverse vars	32V		■		■	■		■	■	
Sync check	25		■						■	
Reclosing	79		■					■	■	
Ground overvoltage	59N		■						■	
Thermal overload ①	49			■	■	■	■	■	■	
Underload	37			■	■	■				
Locked rotor	49S/51			■	■	■				
Jam/stall	51R			■	■	■				
Incomplete sequence	48			■	■	■				
Number of starts limit				■	■	■				
Starts per hour	66			■	■	■				
Time between starts				■	■	■				
Long acceleration time				■	■	■				
Emergency override				■	■	■				
Broken rotor bar detection					■	■				
Loss of potential	60LOP		■					■	■	
Current transformer supervision		■	■	■	■	■	■	■	■	
Cold load pickup		■	■		■	■	■	■	■	
Switch on to fault		■	■					■	■	
Breaker failure	50BF	■	■	■	■	■	■	■	■	
2nd harmonic restraint							■	■		
4th harmonic restraint							■	■		
5th harmonic restraint							■	■		
Differential	87					■	■	■	■	
Ground differential	87GD						■	■	■	
Trip lock out	86	■	■	■	■	■	■	■	■	
Negative sequence current	51Q						■	■	■	
External protection		■	■	■	■	■	■	■	■	
Overexcitation (Volts/Hz)	24							■	■	
Loss of field	40								■	
Low voltage ride-through	27T		■					■	■	
Reactive power and undervoltage	27Q		■					■	■	
Inadvertent energization	50/27								■	

Note

① When communicating to an external URTD device.

Control Functions

Description	Feeder Protection			Motor Protection			Transformer Protection		Generator Protection	
	IEEE Device Number	EDR-3000 V3-T9-61	EDR-5000 V3-T9-70	EMR-3000 V3-T9-87	EMR-4000 V3-T9-99	EMR-5000 V3-T9-112	ETR-4000 V3-T9-124	ETR-5000 V3-T9-149	EGR-5000 V3-T9-149	
Remote open/close		■	■	■	■	■	■	■	■	
Programmable I/O		■	■	■	■	■	■	■	■	
Digital inputs		4 or 8	8	4	8	8 or 16	8	8	8 or 16	
Relay outputs		3 or 5	10	3	4	8	8	8	8	
Supervisory/alarm output		1	1	1	1	1	1	1	1	
Programmable logic control		■	■	■	■	■	■	■	■	
Multiple settings groups		4	4	4	4	4	4	4	4	
Adaptive parameters		■	■	■	■	■	■	■	■	
Reduced voltage starting				■	■	■				
Analog outputs					4	Option for 2		Option for 2	Option for 2	
Analog inputs						Option for 2		Option for 2	Option for 2	

Metering Functions

Description	Feeder Protection		Motor Protection			Transformer Protection		Generator Protection	
	IEEE Device Number	EDR-3000 V3-T9-61	EDR-5000 V3-T9-70	EMR-3000 V3-T9-87	EMR-4000 V3-T9-99	EMR-5000 V3-T9-112	ETR-4000 V3-T9-124	ETR-5000 V3-T9-149	EGR-5000 V3-T9-149
Amperes		■	■	■	■	■	■	■	■
Ampere demand		■	■	■	■	■	■	■	■
Voltage (L-N and L-L)			■		■	■		■	■
Phase angle		■	■	■	■	■	■	■	■
Pos., neg. and zero sequence		■	■	■	■	■	■	■	■
Watts			■		■	■		■	■
Watt demand			■		■	■		■	■
Watt-hour			■		■	■		■	■
Vars			■		■	■		■	■
Var demand			■		■	■		■	■
Var-hour			■		■	■		■	■
VA			■		■	■		■	■
VA Demand			■		■	■		■	■
VA-hour			■		■	■		■	■
Frequency			■		■	■		■	■
Minimum/maximum recording		■	■	■	■	■	■	■	■
Current unbalance		■	■	■	■	■	■	■	■
Voltage unbalance			■		■	■		■	■
Power factor			■		■	■		■	■
Sync values			■						■
Differential currents						■	■	■	■
2nd, 4th, 5th harmonic currents							■	■	
3rd harmonic voltage									■
THD current		■	■	■	■	■	■	■	■
THD voltage			■		■	■		■	■
Volt/Hertz					■	■		■	■
Thermal capacity				■	■	■			■
Generator hours of operation									■

Monitoring Functions

Description	IEEE Device Number	Feeder Protection		Motor Protection	EMR-3000 V3-T9-87	EMR-4000 V3-T9-99	EMR-5000 V3-T9-112	Transformer Protection ETR-4000 V3-T9-124	ETR-5000 V3-T9-149	Generator Protection EGR-5000 V3-T9-149
		EDR-3000 V3-T9-61	EDR-5000 V3-T9-70							
Trip circuit monitor	74	■	■		■	■	■	■	■	■
Breaker wear		■	■		■	■	■	■	■	■
Fault recorder		■	■		■	■	■	■	■	■
Waveform recorder		■	■		■	■	■	■	■	■
Sequence of events recorder		■	■		■	■	■	■	■	■
Trend recorder (load profile)		■	■		■	■	■	■	■	■
Clock		■	■		■	■	■	■	■	■
Time synchronization		■	■		■	■	■	■	■	■
RTD temperature ①					■	■	■	■	■	■
Hottest RTD ①					■	■	■	■	■	■

Communications

Description	Feeder Protection		Motor Protection	Transformer Protection			Generator Protection		
	IEEE Device Number	EDR-3000 V3-T9-61		EDR-5000 V3-T9-70	EMR-3000 V3-T9-87	EMR-4000 V3-T9-99		EMR-5000 V3-T9-112	ETR-4000 V3-T9-124
Front access interface									
Local human machine interface		■	■	■	■	■	■	■	■
RS-232		■	■	■	■	■	■	■	■
USB		②	②	②	②	②	②	②	②
Rear communication port interface									
RS-485		Option	Option	Option	Option	Option	Option	Option	Option
Ethernet copper (RJ45)		Option	Option	Option	Option	Option	Option	Option	Option
Fiber optic ST (note)		②	②	②	②	②	②	②	②
Fiber optic LC (note)		②	②	②	②	②	②	②	②
Protocol									
INCOM									
Modbus-RTU		Option	Option	Option	Option	Option	Option	Option	Option
Modbus-TCP		Option	Option	Option	Option	Option	Option	Option	Option
IEC 61850		Option	Option	Option	Option	Option	Option	Option	Option
DNP3.0 (note)		②	②	②	②	②	②	②	②
PROFIBUS (note)		②	②	②	②	②	②	②	②
IRIG-B		Option	■	■	■	■	■	■	■
SNTP		Option	Option	Option	Option	Option	Option	Option	Option

Notes

- ① When communicating to an external URTD device.
 ② Option available beginning in late 2015.

Construction

Description	IEEE Device Number	Feeder Protection		Motor Protection			Transformer Protection		Generator Protection	
		EDR-3000 V3-T9-61	EDR-5000 V3-T9-70	EMR-3000 V3-T9-87	EMR-4000 V3-T9-99	EMR-5000 V3-T9-112	ETR-4000 V3-T9-124	ETR-5000 V3-T9-149	EGR-5000 V3-T9-149	
Panel mount case		Semi-flush or projected	Semi-flush or projected	Semi-flush or projected	Semi-flush or projected	Semi-flush or projected	Semi-flush or projected	Semi-flush or projected	Semi-flush or projected	
Drawout case		Removable terminals	Removable terminals	Removable terminals	Removable terminals	Removable terminals	Removable terminals	Removable terminals	Removable terminals	
Self-shorting CT terminals		■	■	■	■	■	■	■	■	
Operating temperature range		–40 °C to +60 °C	–40 °C to +60 °C	–40 °C to +60 °C	–40 °C to +60 °C	–40 °C to +60 °C	–40 °C to +60 °C	–40 °C to +60 °C	–40 °C to +60 °C	
Power supply range (Vac)		40–250 Vac	40–250 Vac	40–250 Vac	40–250 Vac	40–250 Vac	40–250 Vac	40–250 Vac	40–250 Vac	
Power supply range (Vdc)		19–300 Vdc	19–300 Vdc	19–300 Vdc	19–300 Vdc	19–300 Vdc	19–300 Vdc	19–300 Vdc	19–300 Vdc	
AC current inputs		■	■	■	■	■	■	■	■	
AC voltage inputs			■		■	■		■	■	
Wye VT configuration			■		■	■		■	■	
Open delta VT configuration			■		■	■		■	■	
Sensitive ground	50/51G	Option	Option	Option	Option	Option	Option	Option	Option	
Local display / HMI		Backlit LCD w/8 pushbuttons	Backlit LCD w/8 pushbuttons	Backlit LCD w/8 pushbuttons	Backlit LCD w/8 pushbuttons	Backlit LCD w/8 pushbuttons	Backlit LCD w/8 pushbuttons	Backlit LCD w/8 pushbuttons	Backlit LCD w/8 pushbuttons	
LEDs (local targets)		Programmable	Programmable	Programmable	Programmable	Programmable	Programmable	Programmable	Programmable	

Standards

Description	IEEE Device Number	Feeder Protection		Motor Protection			Transformer Protection		Generator Protection	
		EDR-3000 V3-T9-61	EDR-5000 V3-T9-70	EMR-3000 V3-T9-87	EMR-4000 V3-T9-99	EMR-5000 V3-T9-112	ETR-4000 V3-T9-124	ETR-5000 V3-T9-149	EGR-5000 V3-T9-149	
ANSI		■	■	■	■	■	■	■	■	
IEC		■	■	■	■	■	■	■	■	
UL		■	■	■	■	■	■	■	■	
CE		■	■	■	■	■	■	■	■	
CSA		■	■	■	■	■	■	■	■	

Arc Flash Relay

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EMR-3MP0 Motor Protection Relay	V3-T9-85
EMR-3000 Motor Protection Relay	V3-T9-87
EMR-4000 Motor Protection Relay	V3-T9-99
EMR-5000 Motor Protection Relay	V3-T9-112
ETR-4000 Transformer Protection Relay	V3-T9-124
ETR-5000 Transformer Protection Relay	V3-T9-136
EGR-5000 Generation Protection Relay	V3-T9-149
Universal RTD Module	V3-T9-162

Arc Flash Relay

Information not available at this time.

Information not available at this time.

EDR-3000



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EDR-3000 Feeder Protection

Product Description

The EDR-3000 Protective Relay is a multifunction, microprocessor-based overcurrent relay designed for both ANSI and IEC applications. It is a panel-mounted, self-contained unit that operates from either AC or DC control power. The EDR-3000 design provides true rms and fundamental sensing of each phase and ground current. Only one unit is required for each three-phase circuit.

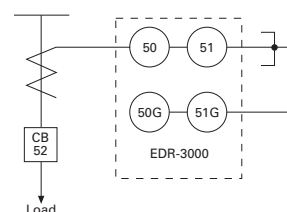
Current monitoring and operator selectable protective functions are integral to each relay. The EDR-3000 relay operates from the 5 A or 1 A secondary output of standard current transformers. Current transformer ratio information is quickly programmed into the unit via settings. This enables the relay to display metered current in primary amperes, secondary amperes or per unit values. The EDR-3000 features a user-friendly operations panel to monitor and program the relay. Operating parameters and troubleshooting information are displayed in the 128 x 64 LCD. In addition, all data and information can be communicated to a host computer equipped with PowerPort-E™.

A "Communication Trip" and "Communication Close" control command can also be initiated by a host computer with an authorized access code for remote breaker operation.

Application Description

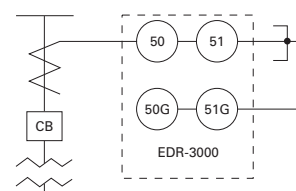
The EDR-3000 microprocessor-based relay provides reliable three-phase and ground overcurrent protection for all voltage levels. It can be used for any application where instantaneous and/or time overcurrent protection is required. It is most commonly used as primary feeder circuit protection, shown below.

Primary Feeder Circuit Protection



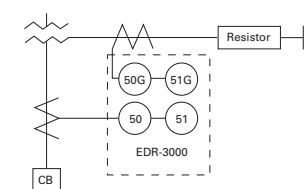
The EDR-3000 may be applied as the transformer primary protection or as backup to the differential protection, see below.

Transformer Overcurrent Protection



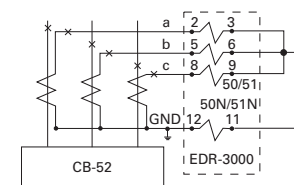
The EDR-3000 may be connected to the secondary side of a delta-wye grounded transformer with the ground element connected to a separate CT in the neutral connection of the transformer. With this connection, a lower CT ratio and a pickup setting can be used to provide more sensitive ground fault protection especially for resistance grounded systems, shown below.

Transformer Secondary Protection with Neutral CT Connection



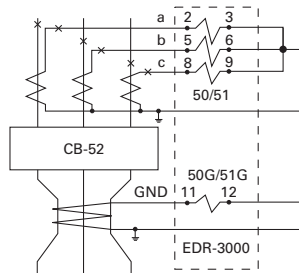
The EDR-3000 relay has special provisions for connection in a Zone Interlocking scheme that can be used for bus protection or to improve protection coordination in a tight or close system. Zone Interlocking is described in following sections. In addition the EDR-3000 has multiple setting groups that can be used to reduce arc flash hazard with instantaneous elements.

Residual Ground Connection



Overcurrent Protection

The EDR-3000 provides complete three-phase and ground protection with separate elements and settings. The relay can be used with CTs from 1 to 50,000 A of primary current and 1 or 5 A of secondary current. The CT ratio can be set independently for phase and ground, allowing the ground element to be connected in either the residual or the separate ground CT configuration, shown on below.

Separate Zero Sequence Ground CT Connection**Zone Selective Interlocking (Phase and Ground)**

Note: Refer to the Ordering Information and (Catalog Ordering Information) for optional features, see **Page V3-T9-64**.

Zone Selective interlocking is a protection function to minimize equipment damage resulting from a phase or a ground fault in an area where long time and/or short time delay is in use.

When the "Ground Zone Interlocking" feature is utilized, an immediate trip is initiated when the fault is in the breaker's zone of protection, regardless of its preset time delay. When the "Phase Zone Interlocking" feature is utilized, the time overcurrent elements work as follows. The instantaneous phase element will initiate an immediate trip when the fault is in the breaker's zone of protection, regardless of its preset time delay. For the time overcurrent phase element, the current sensed by the EDR-3000 must exceed 1.5 times the pickup setting for the zone selective interlocking to initiate an immediate trip signal when the fault is in the breaker's zone of protection.

Upstream EDR-3000 protected breakers are restrained from tripping immediately by an interlocking signal from the downstream EDR-3000 relay. This interlocking signal requires only a pair of wires from the downstream breaker to the upstream breaker.

It provides standard coordinated tripping when the fault is located outside the zone of protection.

In the sample zone interlocking system shown below, circuit breakers A, B and C are equipped with EDR-3000 overcurrent relays.

Fault Location Zone 3

Note: For the time overcurrent phase element, the current sensed by the EDR-3000 must exceed 1.5 times the pickup setting for the zone selective interlocking to initiate an immediate trip signal when the fault is in the breaker's zone of protection.

If a fault occurs at a point in Zone 3, the EDR-3000 of downstream breaker C senses the fault and sends a restraining signal to the upstream EDR-3000 of feeder breaker B. Having received this signal, the EDR-3000 of feeder breaker B withholds its trip command. As a result, only downstream breaker C is tripped.

Fault Location Zone 2

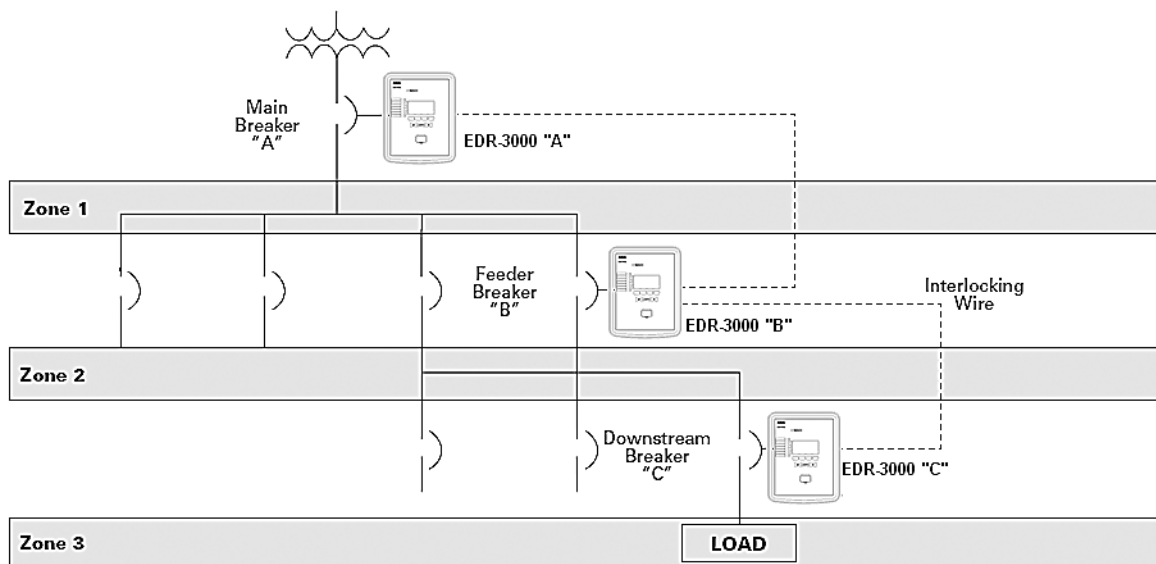
Note: For the time overcurrent phase element, the current sensed by the EDR-3000 must exceed 1.5 times the pickup setting for the zone selective interlocking to initiate an immediate trip signal when the fault is in the breaker's zone of protection.

If a fault occurs at a point in Zone 2, the EDR-3000 of feeder breaker B senses the fault and sends a restraining signal to the upstream EDR-3000 of main breaker A. The EDR-3000 of the downstream breaker C does not see this fault since it is situated on the downstream side of the fault. As a result, the EDR-3000 of downstream breaker C does not send a restraining signal to the EDR-3000 of feeder breaker B. Since it did not receive a restraining signal from the EDR-3000 of downstream breaker C, the EDR-3000 of feeder breaker B identifies that the fault is in Zone 2 and immediately trips feeder breaker B, regardless of its time setting.

Fault Location Zone 1

Note: For the time overcurrent phase element, the current sensed by the EDR-3000 must exceed 1.5 times the pickup setting for the zone selective interlocking to initiate an immediate trip signal when the fault is in the breaker's zone of protection.

If a fault occurs in Zone 1, no restraining signal is received by the Digitrip of main breaker A. As a result, main breaker A is immediately tripped by its EDR-3000 overcurrent relay, regardless of its time setting.

Sample Zone Selective Interlocking System

Features, Benefits and Functions

Applications

- Provides reliable three-phase and ground overcurrent protection for all voltage levels
- Primary feeder circuit protection
- Primary transformer protection
- Backup to differential protection
- May be used where instantaneous and/or time overcurrent protection is required
- Ground element capable of residual, zero sequence or external source connections

Protection Functions

- Breaker failure (50BF)
- Phase overcurrent protection per time-current curve (51-1, 51-2, 51-3)
- Calculated ground fault protection per time-current curve (51R-1, 51R-2)
- Independent measured ground or neutral fault protection per time-current curve (51X-1, 51X-2)
- Phase instantaneous overcurrent (50-1, 50-2, 50-3)
- Calculated ground or neutral instantaneous overcurrent (50R-1, 50R-2)
- Independent measured ground or neutral instantaneous overcurrent (50X-1, 50X-2)
- Curve shapes: ANSI, IEC, or thermal curves (11 thermal curves)
- Instantaneous or time delay reset
- True rms or fundamental sensing of each phase and ground current
- Zone selective interlocking (phase and ground) or reverse blocking for bus protection

Note: Refer to the Ordering Information and **Page V3-T9-64** (Catalog Ordering Information) for optional features.

Metered Values

- rms and fundamental phase currents
- rms and fundamental ground currents
- Maximum, minimum and average rms and fundamental phase currents
- Maximum, minimum and average rms and fundamental ground currents

Monitored and Data Recording Values

- Trip circuit monitoring

Note: Refer to the Ordering Information and **Page V3-T9-64** (Catalog Ordering Information) for optional features.

- Breaker wear (accumulated interrupted current)
- Fault data logs (up to 20 events)
- Sequence of event recorder (1 ms time stamp, last 300 events)
- Waveform capture (7200 cycles total)
- Trip Cause displays fault recorder data on HMI after fault event
- CT supervision

Control Functions

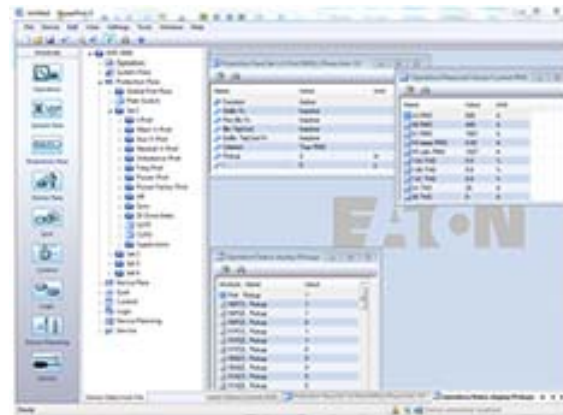
- Remote open/close
- Programmable I/O
- Programmable LEDs
- Multiple setting groups (up to four)

Communication Software

- Local HMI
- Front RS-232 port
- Rear RS-485 port
- Protocols
 - Modbus RTU
 - Modbus TCP (option)
 - IEC 61850 (option)
 - IRIG-B (option)
 - SNTP (option)

PowerPort-E

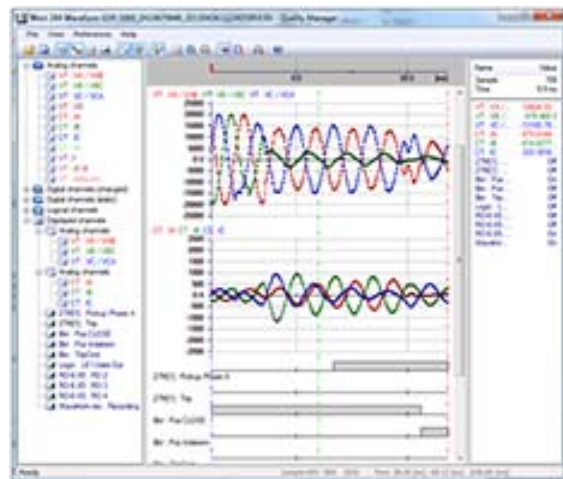
PowerPort-E is the software program used to configure off-line protection setting files for all E-Series relay models. PowerPort-E is also used for viewing measured values of the relays in real-time, uploading/downloading setting files, and retrieving event log and waveform records.



Waveform Capture (Quality Manager)

The EDR-3000 relay provides oscillographic recording capabilities. The relay will record all measured signals along with the binary signals of pickup, trip, internal logic, and contact inputs. The EDR-3000 can record up to 7200 cycles of data. The number of records is proportional to the programmed size of each record; the maximum size per

record is 600 cycles. The waveform capture is initiated by up to 8 different triggers (i.e., trip/alarm events) or manually via communications or the HMI. PowerPort-E setting software is used to retrieve the records. Quality Manager is a separate software program downloaded with PowerPort-E used for analyzing the waveform and trending files retrieved from the relay.



Standards and Certifications

- Generic standard:
 - EN 61000-6-2
 - EN 61000-6-3
- Product standard:
 - IEC 60255-6
 - EN 50178
- UL 508 (Industrial Control Equipment)
- CSA® C22.2 No. 14-95 (Industrial Control Equipment)
- ANSI C37.90
- UL, CSA, CE

**Catalog Number Selection**

The catalog number identification chart defines the electrical characteristics and operation features included in the EDR-3000. For example, if the catalog number is EDR-3000-2A0BA1, the device would have the following:

EDR-3000

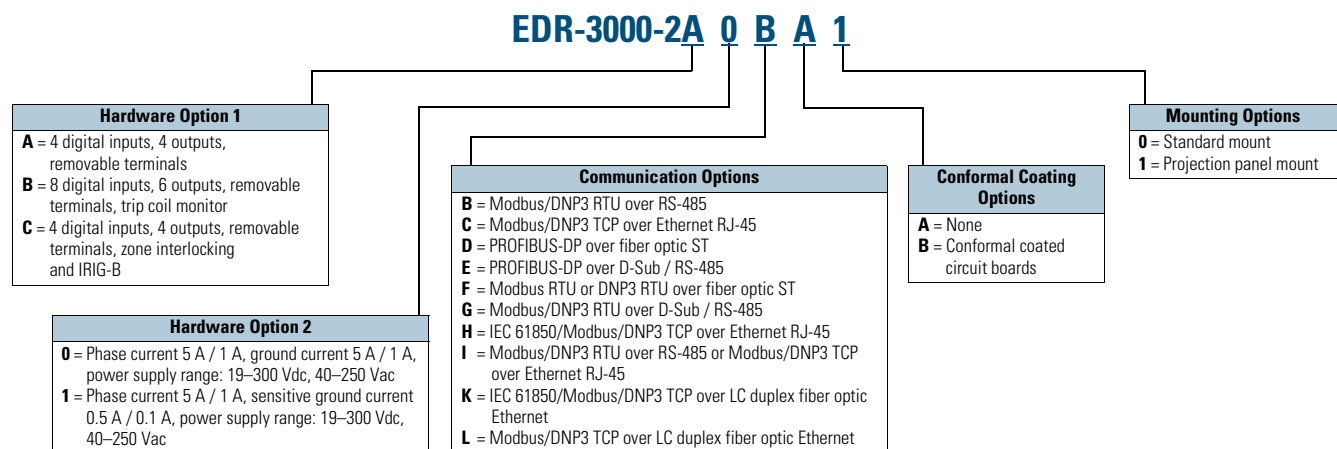
(A)—Four digital inputs, four output relays

(0)—Phase current 5 A / 1 A, Ground Current 5 A / 1 A, Power supply: 19–300 Vdc, 40–250 Vac

(B)—Modbus-RTU (RS-485)

(A)—Without conformal coating

(1)—Projection panel mount

Relay Removable Terminals

Technical Data and Specifications

Climatic Environmental Conditions

- Storage temperature: -13 °F to 158 °F (-25 °C to +70 °C)
- Operating temperature: -4 °F to 140 °F (-20 °C to +60 °C)
- Permissible humidity at ann. average: <75% rel. (on 56d up to 95% rel.)
- Permissible Installation altitude:
 - <2000 m (6561.67 ft) above sea level
 - If 4000 m (13,123.35 ft) altitude apply, a changed classification of the operating and test voltages may be necessary

Degree of Protection EN 60529

- HMI front panel with seal: IP54
- Rear side terminals: IP30

Routine Test

- Insulation test according to IEC 60255-5: All tests to be carried out against ground and other input and output circuits
- Aux. voltage supply, digital inputs, current measuring inputs, signal relay outputs: 2.5 kV (eff)/50 Hz
- Voltage measuring inputs: 3.0 kV (eff)/50 Hz
- All wire-bound communication interfaces: 1.5 kV DC

Housing

- Material, housing: aluminum extruded section
- Material, front panel: aluminum/foil front
- Mounting position: horizontal ($\pm 45^\circ$ around the X-axis must be permitted)

Plug-in Connector with Integrated Short-Circuiter (Conventional Current Inputs)

- Nominal current: 1 A and 5 A
- Continuous loading capacity: $4 \times I_N$ /continuously
- Overcurrent withstand: $30 \times I_N/10$ s
- $100 \times I_N/1$ s
- $250 \times I_N/10$ ms (1 half-wave)
- Screws: M4, captive type according to VDEW
- Connection cross-sections:
 - $2 \times 2.5 \text{ mm}^2$ (2 x AWG 14) with wire end ferrule
 - $1 \times$ or $2 \times 4.0 \text{ mm}^2$ (2 x AWG 12) with ring cable sleeve or cable sleeve
 - $1 \times$ or $2 \times 6 \text{ mm}^2$ (2 x AWG 10) with ring cable sleeve or cable sleeve

Voltage Supply

- Aux. voltage: 19–300 Vdc/40–250 Vac
- Buffer time in case of supply failure: ≥ 50 ms at minimal aux. voltage communication is permitted to be interrupted
- Max. permissible making current:
 - 18 A peak value for <0.25 ms
 - 12 A peak value for <1 ms
- The voltage supply must be protected by a fuse of:
 - 2.5 A time-lag miniature fuse 5×20 mm (approx. $1/5$ in x 0.8 in) according to IEC 60127
 - 3.5 A time-lag miniature fuse 6.3×32 mm (approx. $1/4$ in x $1 1/4$ in) according to UL 248-14

Power Consumption

- Power supply range: Power consumption in idle mode
- Max. power consumption
- 19–300 Vdc: 6 W 8.5 W
- 40–250 Vac
- For frequencies of 40–70 Hz: 6 W 8.5 W

Real-Time Clock

- Running reserve of the real-time clock: 1 year min.

Display

- Display type: LCD with LED background illumination
- Resolution graphics display: 128×64 pixel
- LED-type: two colored, red/green
- Number of LEDs, housing B1: 8

Digital Inputs

- Max. input voltage: 300 Vdc/270 Vac
- Input current: <4 mA
- Reaction time: <20 ms
- Fallback time: <30 ms (safe state of the digital inputs)
- Four switching thresholds: $U_N = 24 \text{ Vdc}$, 48 Vdc , 60 Vdc , 110 Vac/Vdc , 230 Vac/Vdc $U_N = 24 \text{ Vdc}$
 - Switching threshold 1 ON
 - Switching threshold 1 OFF
 - Min. 19.2 Vdc
 - Max. 9.6 Vdc
 - $U_N = 48 \text{ V}/60 \text{ Vdc}$
 - Switching threshold 2 ON
 - Switching threshold 2 OFF
 - Min. 42.6 Vdc
 - Max. 21.3 Vdc
 - $U_N = 110/120 \text{ Vac/Vdc}$
 - Switching threshold 3 ON
 - Switching threshold 3 OFF
 - Min. 88.0 Vdc/88.0 Vac
 - Max. 44.0 Vdc/44.0 Vac
 - $U_N = 230/240 \text{ Vac/Vdc}$
 - Switching threshold 4 ON
 - Switching threshold 4 OFF
 - Min. 184 Vdc/184 Vac
 - Max. 92 Vdc/92 Vac
- Terminals: screw-type terminal

Current and Ground Current Measurement

- Nominal currents: 1 A / 5 A
- Max. measuring range:
 - up to $40 \times I_n$ (phase currents)
 - up to $25 \times I_n$ (ground current standard)
 - up to $2.5 \times I_n$ (ground current sensitive)
- Continuous loading capacity: $4 \times I_n$ /continuously
- Overcurrent proof:
 - $30 \times I_n/10$ s
 - $100 \times I_n/1$ s
 - $250 \times I_n/10$ ms (1 half-wave)
- Power consumption: Phase current inputs
 - at $I_n = 1$ A S = 0.15 MVA
 - at $I_n = 5$ A S = 0.15 MVA
- Ground current input
 - at $I_n = 1$ A S = 0.35 MVA
 - at $I_n = 5$ A S = 0.35 MVA
- Frequency range: 50 Hz/60 Hz $\pm 10\%$
- Terminals: Screw-type terminals with integrated short-circuiters (contacts)

Binary Output Relays

- Continuous current: 5 A AC/DC
- Switch-on current: 25 A AC/DC for 4 s
- Max. breaking current: 5 A AC up to 125 Vac
- 5 A DC up to 50 V (resistive)
- 0.2 A DC at 300 V
- Max. switching voltage: 250 Vac/300 Vdc
- Switching capacity: 2000 VA
- Contact type: 1 changeover contact
- Terminals: Screw-type terminals

Front Interface RS-232

- Baud rates: 115,200 baud
- Handshake: RTS and CT
- Connection: 9-pole D-Sub plug

RS-485

- Master/slave: slave
- Connection: 6 screw-clamping terminals RM 3.5 mm (138 MIL) (terminating resistors internal)

Tolerances of the Real-Time Clock

- Resolution: 1 ms
- Tolerance: <1 minute/month (+20 °C)

Measuring Accuracy

- Max. measuring range: up to $40 \times I_n$ (phase currents) up to $25 \times I_n$ (ground current standard)
- Frequency range: 50 Hz/60 Hz $\pm 10\%$
- Accuracy: Class 0.5
- Amplitude error if $I < I_n$: $\pm 0.5\%$ of the rated value
- Amplitude error if $I > I_n$: $\pm 0.5\%$ of the measured value
- Amplitude error if $I > 2 I_n$: $\pm 1.0\%$ of the measured value
- Resolution: 0.01 A
- Harmonics up to 20% 3rd harmonic $\pm 2\%$ up to 20% 5th harmonic $\pm 2\%$
- Frequency influence $< \pm 2\%/Hz$ in the range of ± 5 Hz of the parameterized nominal frequency
- Temperature influence $< \pm 1\%$ within the range of 0 °C up to +60 °C

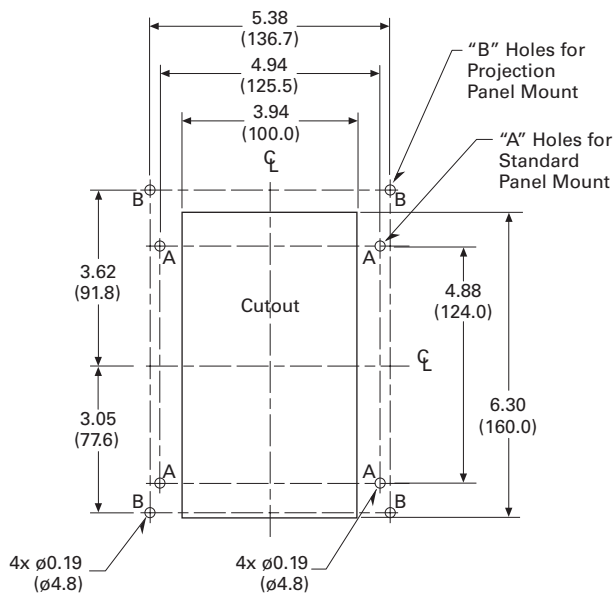
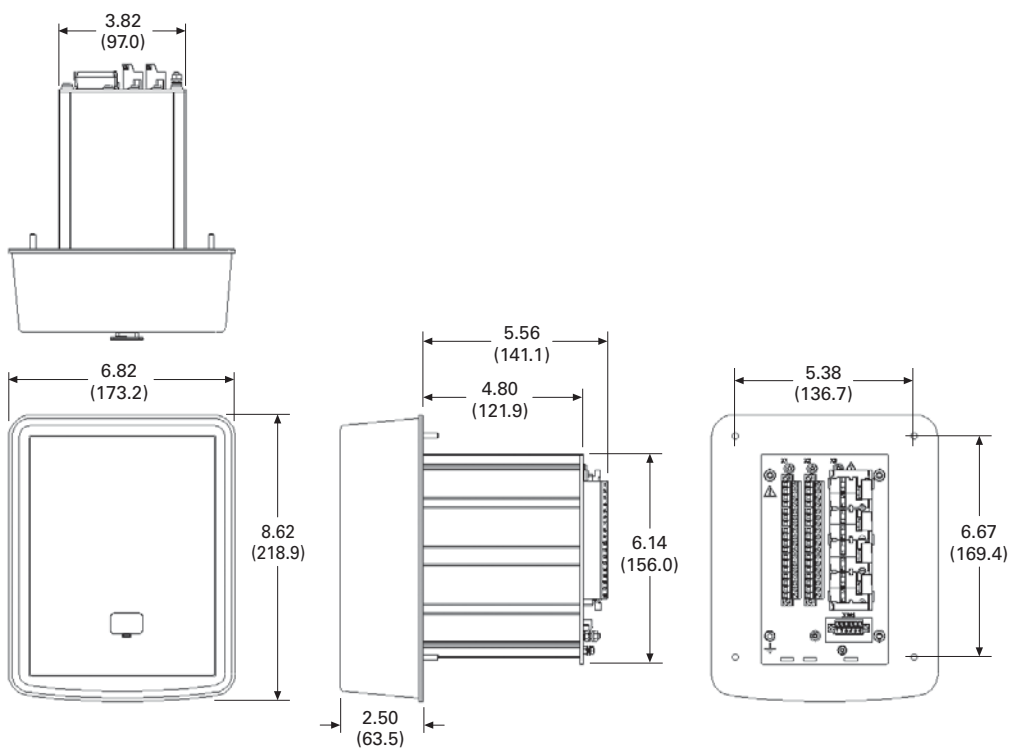
EDR-3000

Figure 1 is a block diagram of a multi-channel system. A central block labeled "X3." is connected to 12 numbered blocks (1-12). Each numbered block is connected to a corresponding coil (1A, 5A, N) of a transformer. The transformers are grouped into four sets: (1A, 5A, N) for 1A, (1A, 5A, N) for 1B, (1A, 5A, N) for 1C, and (1A, 5A, N) for 1X.

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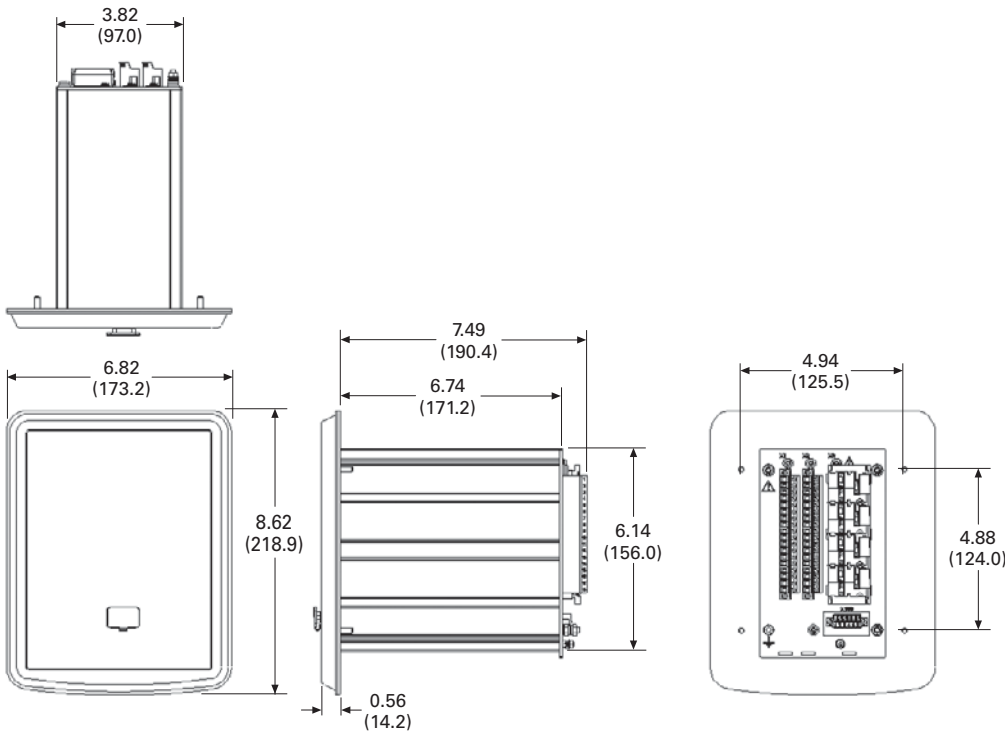
Dimensions

Approximate Dimensions in Inches (mm)

Drilling Pattern**Projection Mounting**

Approximate Dimensions in Inches (mm)

Standard Mounting



EDR-3000

Width	Height	Depth
6.82 (173.2)	8.62 (218.9)	7.49 (190.2) ①

EDR-3000 Housing B1

Width	Height	Depth	Shipping Weight Lb (kg)
5.57 (141.5)	7.21 (183.0)	8.19 (208.0) ②	5.3 (2.4)

Notes

- ① Depth behind panel with projection mounted enclosure.
- ② Includes terminals.

EDR-5000 Distribution Protection Relay



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EGR-5000 Generation Protection Relay	V3-T9-149
Universal RTD Module	V3-T9-162

EDR-5000 Distribution Protection Relay

Product Description

Eaton's EDR-5000 distribution protection relay is a multi-functional, microprocessor-based relay for feeder circuits of all voltage levels. It may be used as a primary protection on feeders, mains and tie circuit breaker applications; or as backup protection for transformers, high voltage lines and differential protection. The relay is most commonly used on medium voltage switchgear applications.

The EDR-5000 distribution protection relay provides complete current, voltage, and frequency protection and metering in a single, compact case. The relay has four current inputs rated for either 5 amperes or 1 ampere and four voltage inputs. Three of the voltage inputs are to be connected to the three-phase power voltage for voltage protection and for metering. They can be connected in wye-ground or open delta configuration. The fourth voltage is for independent single-phase undervoltage/overvoltage protection, sync-check or ground protection for an ungrounded system.

The maintenance mode password protected soft key can be used for arc flash mitigation to change to an alternate settings group, set to have instantaneous elements only. The multiple setting groups can also be changed, via communications or a digital input.

An integral keypad and display is provided for direct user programming and retrieval of data without the need of a computer. 14 programmable LEDs provide quick indication of relay status.

A front port is provided for direct computer connection. An RS-485 communication port on the back is standard for local area networking using Modbus-RTU. An optional Ethernet port and protocols are available.

The EDR-5000 distribution protection relay includes programmable logic functions. Logic gates and timers may be defined and arranged for customized applications. Programmable logic control functions make the EDR-5000 relay ideally suited for main-tie-main and main 1/main 2 transfer schemes. Flash memory is used for the programming and all settings are stored in nonvolatile memory.

The relay allows for four preprogrammed setting groups which can be activated through software or contact input.

Flash memory is used for the programming and all settings are stored in nonvolatile memory. The relay allows for four preprogrammed setting groups which can be activated through software, the display or a contact input.

The EDR-5000 distribution protection relay has mass memory for data storage and a real-time clock with 1 ms time resolution. The relay will log 300 sequence of event records, 20 detailed trip logs, minimum/maximum values, load profiles, breaker wear information and oscillography data.

The EDR-5000 has eight programmable binary inputs, 2 normally opened and 8 Form C heavy-duty outputs and one form C signal alarm relay. It can be powered from 19 Vdc to 300 Vdc or 40 Vac to 250 Vac auxiliary power.

Application Description

The Eaton's EDR-5000 distribution protection relay has been designed for maximum user flexibility and simplicity. The base relay includes all the standard current and voltage protection and metering functions.

Applications include distribution feeder protection, primary or backup protection for transformers and generators, utility interconnections and transfer schemes.

Features, Benefits and Functions

Directional Overcurrent Protection

The EDR-5000 distribution protection relay provides complete three-phase and ground directional overcurrent protection. There are 8 independent ground overcurrent elements. The ground elements "X" use the independently measured ground (or neutral) current from a separate current-sensing input. The ground elements "R" uses a calculated 3I₀ residual current obtained from the sum of the three-phase currents. This calculated current could be used for either the neutral or ground current in a three-phase, four-wire system. Each of the phase and ground overcurrent elements can be selected to operate based on fundamental or rms current.

Phase direction is a function used to supervise all phase current elements (50, 51). A quadrature voltage is compared to a corresponding phase current to establish the direction of the fault. This function is selectable to operate in the forward, reverse or both directions. Ground direction is used to supervise ground current elements and is accomplished by using ground, negative sequence or residual currents supervised by zero, negative or positive sequence voltages or ground current. This function is selectable to operate in forward, reverse or both directions.

Voltage Restrained Overcurrent

Voltage restraint reduces the overcurrent pickup level (51P[3]). This modification of the pickup overcurrent level is compared to the corresponding phase input voltage. The EDR-5000 uses the simple linear model below to determine the effective pickup value.

Sync Check

The sync check function is provided for double-ended power source applications. The sync check monitors voltage magnitude, phase angle and slip frequency between the bus and line. It also incorporates breaker close time, dead bus dead line, dead bus live line and live bus live line features.

Reverse Power

Reverse power provides control for power flowing through a feeder. There are three elements to be configured: Operate in forward or reverse; or, under or over power conditions. Reverse power is typically applied to generator or motor applications while under power is generally applied to load or generation loss.

Reverse Vars

Reverse vars can be used to detect loss of excitation in synchronous machines. There are three elements to be configured: operate in forward or reverse; or, under or over vars conditions.

Inverse-Time Characteristics

There are 11 user-selectable inverse-time overcurrent curve characteristics. The user can select from the ANSI, IEC or thermal curve families and can select instantaneous or time delay reset characteristics.

Breaker Failure

The EDR-5000 distribution protection relay includes a breaker failure (50BF, 62BF) function that can be initiated from either an internal or external trip signal. This is an independent element that can be used to operate a lockout relay or trip an upstream breaker. The timer must be longer than the breaker operating time and the protective function reset times.

Voltage Protection

The EDR-5000 distribution protection relay has four voltage-input circuits. There is a three-phase set designated as Main Voltage (M) and a single-phase voltage circuit designated as Auxiliary Voltage (A). Both include undervoltage (27) and overvoltage (59) protection. The three-phase voltage protection can be set to operate on a single-phase, two out of three phases, or all three-phase logic. The Main VTs also provide phase voltage unbalance/reversal (47 negative sequence) protection. Each element has an independent threshold set point and adjustable time delay.

Ground Voltage Protection

In high impedance grounded systems, ground fault protection is provided by the detection of zero sequence voltage (3V₀) voltage in the neutral of the transformer by an overvoltage element (59N) connected to the secondary of the distribution grounding transformer, or in the secondary of a Wye-Broken Delta transformer used when the neutral is not accessible or in Delta system. In the EDR-5000 we can measure this zero sequence voltage through the 4th voltage input; the 59N element has to be desensitized for 3rd harmonic voltages that can be present in the system under normal operation.

Flexible Phase Rotation

The EDR-5000 distribution protection relay can be applied on either an A-B-C or A-C-B phase rotation. A user setting permits correct operation and indication of the actual system configuration.

Frequency Protection

The EDR-5000 relay provides 6 frequency elements than can be used to detect under/over frequency, rate of change, and a vector surge (decoupling of two systems) protection on the Main VT inputs. Each element has an independent threshold set point and adjustable time delay.

Autoreclosing Logic

The EDR-5000 provides a 6 shot-recloser scheme. Autoreclosing is normally used by the utilities in their distribution and transmission lines, but it can be used in commercial and industrial applications with long overhead lines. Nearly 85% of the faults that occur on overhead lines are transient in nature. Tripping of a circuit breaker normally clears a transient fault and reclosing of the circuit breaker restores power back to the circuit.

Maintenance Mode

The Maintenance Mode can improve safety by providing a simple and reliable method to reduce fault clearing time and lower incident energy levels at energized panels. The Maintenance Mode allows the user to switch to more sensitive settings via a password protected soft key, communication or via a digital Input while maintenance work is being performed at an energized panel or device. The more sensitive settings provide greater security for maintenance personnel and helps reduce the possibility of injury.

Protection Features

- Phase overcurrent elements:
 - Three instantaneous elements with timers (50P[1], 50P[2] and 50P[3])
 - Three inverse time overcurrent elements (51P[1], 51P[2] and 51P[3])
- 11 standard curves
- Instantaneous or time delay reset
- Voltage Restraint (51P[2] and 51P[3])
- Directional Control (All Elements)

- Ground overcurrent elements:
 - Two instantaneous measured elements with timers (50X[1] and 50X[2])
 - Two instantaneous calculated elements with timers (50R[1] and 50R[2])
 - Two inverse time overcurrent measured elements (51X[1] and 51X[2])
 - Two inverse time overcurrent calculated elements (51R[1] and 51R[2])
- 11 standard curves
- Instantaneous or time delay reset
- Directional control (all elements)
- Breaker failure (50BF)
- Phase unbalance negative sequence overcurrent (46[1], 46[2])
- Phase voltage unbalance and sequence protection (47[1], 47[2])
- Main three-phase under/overvoltage (27M[1], 27M[2], 59M[1], 59M[2])
- Auxiliary single-phase under/overvoltage (27A[1], 27A[2], 59A[1], 59A[2])
- Ground fault overvoltage relay (59N[1], 59N[2])
- 6 frequency elements that can be assigned to: over frequency, under frequency, rate of change, or vector surge (81[1], 81[2], 81[3], 81[4], 81[5], 81[6])
- Apparent and displacement power factor (55A[1], 55A[2], 55D[1], 55D[2])
- Forward and reverse watts (32[1], 32[2], 32[3])
- Forward and reverse vars (32V[1], 32V[2], 32V[3])
- Sync check (25)
- Autoreclosing (79)
- Zone interlocking for bus protection (87B)
- Switch onto fault protection
- Cold load pickup

Metering Features

- Amperes: Positive, negative and zero sequence
- Ampere demand
- Volts: Positive, negative and zero sequence
- Phase angles
- Volt-amperes and VA demand
- Watts and kW demand
- kWh (forward, reverse, net)
- Vars and kvar demand
- kvarh (lead, lag and net)
- Power factor
- Frequency
- % THD V and I
- Magnitude THD V and I
- Minimum/maximum recording.
- Sync Values
- Trending (load profile over time)

Monitoring Features

- Trip coil monitor
- Breaker wear primary and secondary (accumulated interrupted current)
- Oscillography (7200 cycles total)
- Fault data logs (up to 20 events)
- Sequence of events report (up to 300 events)
- Clock (1 ms time stamping)
- Trip cause displays fault reorder data on HMI after fault event

Control Functions

- Breaker open/close
- Remote open/close
- Programmable I/O
- Programmable Logic
- Programmable LEDs
- Multiple setting groups
- Cold load pickup
- CT supervision

Communication Features

- Local HMI
- Password protected
- Addressable
- IRIG-B
- Local communication port:
 - RS-232
- Remote communication port:
 - RS-485
 - Ethernet RJ-45
- Protocols:
 - Modbus-RTU
 - Modbus-TCP (optional)
 - IEC-61850 (optional)
- Configuration software

Monitoring and Metering

Sequence of Events Records

The EDR-5000 protection relay records a maximum of 300 events associated with the relay. An event is classified as a change of state as detected by the relay. These include relay pickups, dropouts, trips, contact closure, alarms, setting changes and self-diagnostic failures. Each event is date and time stamped to a 1 ms resolution. The events are stored in a FIFO in chronological order.

Trip Log

The EDR-5000 protection relay will store a maximum of 20 trip records in a FIFO trip log. Each trip record will be date and time stamped to a 1 ms resolution. The trip log record will include information on the type of fault, protection elements that operated, fault location and currents and voltages at the time of the fault.

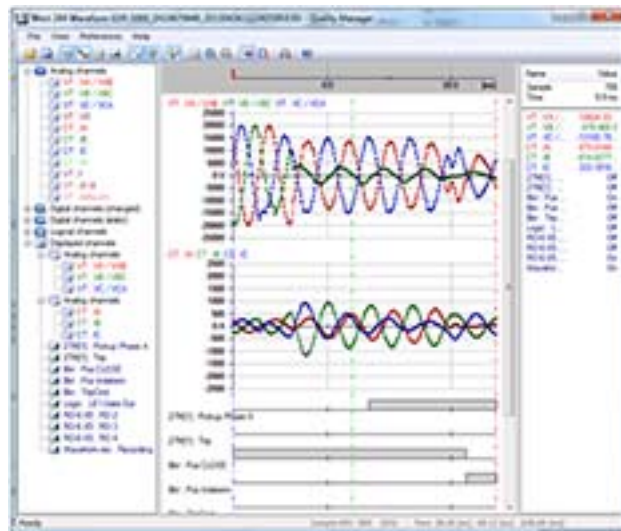
PowerPort-E

PowerPort-E is the software program used to configure off-line protection setting files for all E-Series relay models. PowerPort-E is also used for viewing measured values of the relays in real-time, uploading/downloading setting files, and retrieving event log and waveform records.

Waveform Capture (Quality Manager)

The EDR-5000 relay provides oscillographic recording capabilities. The relay will record all measured signals along with the binary signals of pickup, trip, internal logic and contact inputs. The EDR-5000 can record up to 7200 cycles of data. The number of records is proportional to the programmed size of each record; the maximum size per record is 600 cycles.

The waveform capture is initiated by up to 8 different triggers (i.e., trip/alarm events) or manually via communications or the HMI. PowerPort-E setting software is used to retrieve the records. Quality Manager is a separate software program downloaded with PowerPort-E used for analyzing the waveform and trending files retrieved from the relay.



Waveform Capture (Quality Manager)

Integral User Interface

The front panel user interface has a 128 x 64 pixel LCD display with background illumination for wide angle viewing in all light conditions. 17 programmable LEDs provide quick and easy visual display of power on, mode of operation, alarm and trip indication. Soft keys are provided for operation mode selection, scrolling through data and settings. In addition, the relay settings and test functions are password protected.

Load Profiling/Trending

The EDR-5000 relay automatically records selected quantities into non-volatile memory every 5, 10, 15, 30 or 60 minutes, depending on the trending report setting.

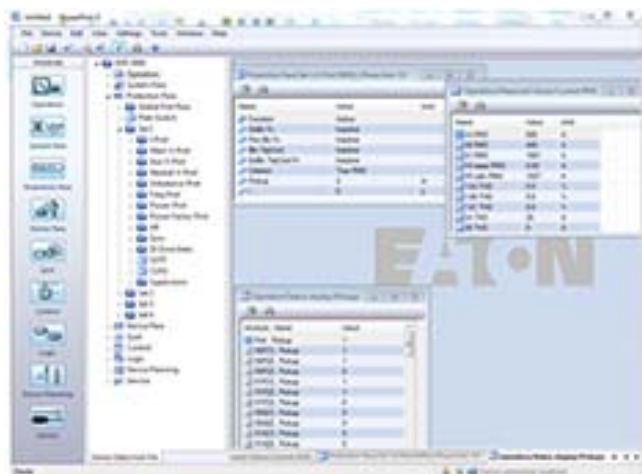
Programmable I/O

The EDR-5000 distribution protection relay provides heavy-duty, trip-rated, 2 normally open and 8 Form C contacts. Two isolated inputs can be used for monitoring the trip circuit. One Form C contact is dedicated to the relay failure alarm function and is operated in a normally energized (failsafe) mode.

There are eight user-configurable discrete inputs that accept a wet contact and can operate through a wide range of power. Each input and output is user-programmable for maximum application flexibility.

Programmable Logic

The EDR-5000 distribution protection relay provides logic gates and timers that the user can customize for special or unique applications. Each gate can be assigned a logic function of either AND, OR, NAND or NOR. Each gate can have a maximum of four input signals and each input signal can be required to be a NOT. Input signals can be external inputs received via the binary inputs or internal values associated with the protection, alarm or metering set points. Each gate has a unique output assignment and designation that can be used as the input to another gate. There are 24 independent timers that have adjustable pickup and dropout delay settings.



PowerPort-E

Standards and Certifications

Design Standards

- Generic Standard:
 - EN 61000-6-2
 - EN 61000-6-3
- Product Standard:
 - IEC 60255-6
 - EN 50178
 - UL 508 (Industrial Control Equipment)
 - CSA C22.2 No. 14-95 (Industrial Control Equipment)
 - ANSI C37.90
- UL-listed file: e217753



Standards

High Voltage Tests (IEC 60255-6)

- High frequency interference test:
 - IEC 60255-22-1 Class 3
 - Within one circuit—1 kV/2 s
 - Circuit to ground—2.5 kV/2 s
 - Circuit to circuit—2.5 kV/2 s
- Insulation voltage test:
 - IEC 60255-5, EN 50178
 - All circuits to other circuits and exposed conductive parts: 2.5 kV (eff.)/50 Hz, 1 min.
 - Except interfaces: 1.5 kV DC, 1 min.
 - Voltage measuring input: 3 kV (eff.)/50 Hz, 1 min.
- Impulse voltage test:
 - IEC 60255-5: 5 kV/0.5J, 1.2/50 μ s

EMC Immunity Tests

- Fast transient disturbance immunity test (burst):
 - IEC 60255-22-4: Power supply, mains inputs— ± 4 kV, 2.5 kHz
 - IEC 61000-4-4 Class 4: Other inputs and outputs— ± 2 kV, 5 kHz (coupling network)
 - ANSI C37.90.1: ± 4 kV, 2.5 kHz (coupling clamp)
- Surge Immunity Test:
 - IEC 61000-4-5 Class 4
 - Within one circuit—2 kV
 - Circuit to ground—4 kV
- Electrical discharge immunity test:
 - IEC 60255-22-2: Air discharge—8 kV
 - IEC 61000-4-2 Class 3: Contact discharge—6 kV
- Radiated radio frequency electromagnetic field immunity test
 - IEC 61000-4-3: 26 MHz–80 MHz—10 V/m
 - Class X: 80 MHz–1 GHz—35 V/m
 - ANSI C37.90.2: 1 GHz–3 GHz—10 V/m
- Immunity to conducted disturbances induced by radio frequency fields:
 - IEC 61000-4-6 Class 3: 10 V
- Power frequency magnetic field immunity test:
 - IEC 61000-4-8: Continuous—30 A/m
 - Class 4: 3 sec—300 A/m

EMC Emission Tests

- Radio interference suppression test:
 - IEC/CISPR11—Limit value class B
- Radio interference radiation test:
 - IEC/CISPR11—Limit value class B

Environmental Tests

Classification

- IEC 60068-1: Climatic—0/055/56
- IEC 60721-3-1:
 - Classification of ambient conditions (storage)—1K5/1B1/1C1L/1S1/1M2 but min. -13°F (-25°C)
- IEC 60721-3-2: Classification of ambient conditions (transportation)—2K3/2B1/2C1/2S1/2M2
- IEC 60721-3-3: Classification of ambient conditions (Stationary use at weather protected locations)—3K6/3B1/3C1/3S1/3M2 but min. 32°F (0°C) and 3K8H for 2 h

Test ad: Cold

- IEC 60068-2-1:
 - Temperature— -4°F (-20°C)
 - Test duration—16 h

Test Bd: Dry heat

- IEC 60068-2-2:
 - Temperature— 131°F (55°C)
 - Relative humidity— $<50\%$
 - Test duration—72 h

Test cab: Damp heat (steady state)

- IEC 60068-2-78:
 - Temperature— 104°F (40°C)
 - Relative humidity—93%
 - Test duration—56 d

Test Db: Damp heat (cyclic)

- IEC 60068-2-30:
 - Temperature— 131°F (55°C)
 - Relative humidity—95%
 - Cycles (12 + 12-hour)—2

Mechanical Tests

Test Fc: Vibration Response Test

- IEC 60068-2-6, IEC 60255-21-1, Class 1:
 - Displacement: (10 Hz–59 Hz)—0.0014 in (0.035 mm)
 - Acceleration: (59 Hz–150 Hz)—0.5 gn
 - Number of cycles in each axis: 1

Test Fc: Vibration Endurance Test

- IEC 60068-2-6, IEC 60255-21-1, Class 1:
 - Acceleration: (10 Hz–150 Hz)—1.0 gn
 - Number of cycles in each axis: 20

Test Ea: Shock Test

- IEC 60068-2-27, IEC 60255-21-2, Class 1
 - Shock response test: 5 gn, 11 ms, 3 impulses in each direction
 - Shock resistance test: 15 gn, 11 ms, 3 impulses in each direction

Test Eb: Shock Endurance Test

- IEC 60068-2-29, IEC 60255-21-2, Class 1
 - Shock endurance test: 10 gn, 16 ms, 1000 impulses in each direction

Test Fe: Earthquake Test

- IEC 60068-3-3, KTA 3503, IEC 60255-21-3, Class 2
 - Single axis earthquake vibration test:
 - 3–7 Hz: Horizontal 0.394 in (10 mm), 1 cycle each axis
 - 7–35 Hz Horizontal: 2 gn, 1 cycle each axis

Catalog Number Selection

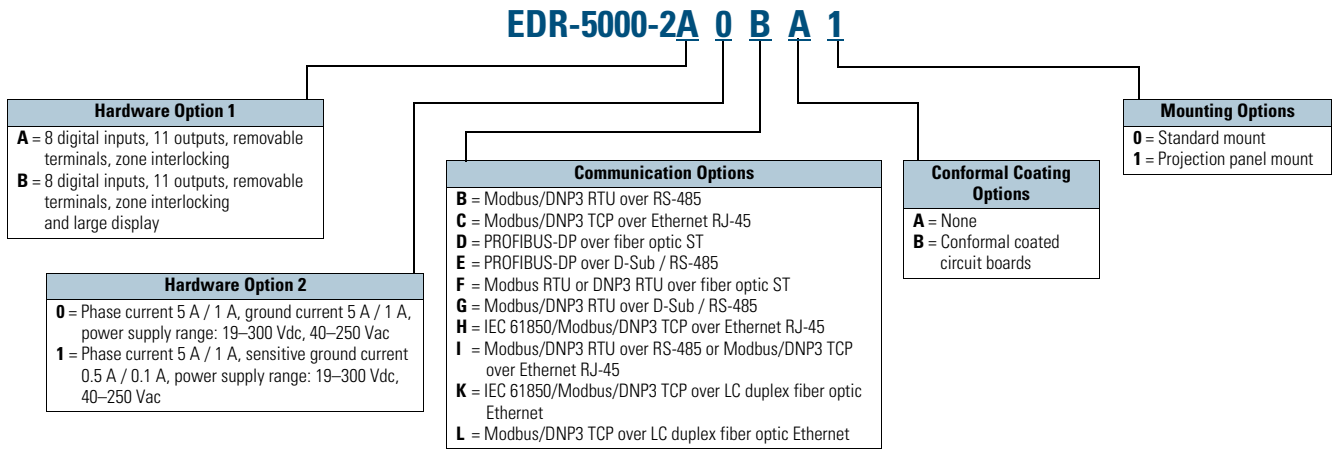
The catalog number identification chart defines the electrical characteristics and operation features included in the EDR-5000. For example, if the catalog number is EDR-5000-2A0BA1, the device would have the following:

- EDR-5000
- (A)–8 digital inputs, 11 output relays

(B)–Modbus-RTU (RS-485)
- (0)–5 A / 1 A phase and ground CTs, power supply range: 19–300 Vdc, 40–250 Vac

(A)–Without conformal coating
- (1)–Projection panel mount

Relay Removable Terminals



Technical Data and Specifications

Climatic Environmental Conditions

- Storage temperature: –22 °F to 158 °F (–30 °C to +70 °C)
- Operating temperature: –4 °F to 140 °F (–20 °C to +60 °C)
- Permissible humidity at ann. average: <75% rel. (on 56d up to 95% rel.)
- Permissible installation altitude:
 - 6,561.67 ft (<2000 m) above sea level
 - If 13,123.35 ft (4000 m) altitude applies, a changed classification of the operating and test voltages may be necessary

Degree of Protection EN 60529

- HMI front panel with seal: IP54
- Rear side terminals: IP20

Routine Test

- Insulation test according to IEC 60255-5: All tests to be carried out against ground and other input and output circuits
- Aux. voltage supply, digital inputs: 2.5 kV (eff.)/50 Hz
- Current measuring inputs, signal relay outputs: 2.5 kV (eff.)/50 Hz
- Voltage measuring inputs: 3.0 kV (eff.)/50 Hz
- All wire-bound communication interfaces: 1.5 kV DC

Housing

- Housing B2: Height / Width 7.205 in (183 mm)/ 8.374 in (212.7 mm)
- Housing Depth (Incl. Terminals): 8.189 in (208 mm)
- Material, housing: Aluminum extruded section
- Material, front panel: Aluminum/foil front
- Mounting position: Horizontal ($\pm 45^\circ$ around the X-axis must be permitted)
- Weight: Approx. 9.259 lb (4.2 kg)

Current and Ground Current Measurement

- Nominal currents: 1 A / 5 A
- Max. measuring range:
 - Up to $40 \times I_n$ (phase currents)
 - Up to $25 \times I_n$ (ground current standard)
 - Up to $2.5 \times I_n$ (ground current sensitive)
- Continuous loading capacity: $4 \times I_n$ /continuously
- Overcurrent proof:
 - $30 \times I_n/10$ s
 - $100 \times I_n/1$ s
 - $250 \times I_n/10$ ms (1 half-wave)
- Power consumption:
 - Phase current inputs
 - At $I_n = 1$ A
S = 0.15 MVA
 - At $I_n = 5$ A
S = 0.15 MVA
 - Ground current input
 - At $I_n = 1$ A
S = 0.35 MVA
 - At $I_n = 5$ A
S = 0.35 MVA
- Frequency range: 50 Hz/ 60 Hz $\pm 10\%$
- Terminals: Screw-type terminals with integrated short-circuiters (contacts)
- Connection cross sections:
 - $1 \times$ or 2×2.5 mm² (2 x AWG 14) with wire end ferrule
 - $1 \times$ or 2×4.0 mm² (2 x AWG 12) with ring cable sleeve or cable sleeve
 - $1 \times$ or 2×6 mm² (2 x AWG 10) with ring cable sleeve or cable sleeve
 - The current measuring board's terminal blocks may be used as with 2 (double) conductors AWG 10, 12, 14 otherwise with single conductors only

Plug-in Connector with Integrated Short-Circuiter (Conventional Current Inputs)

- Nominal current: 1 A and 5 A
- Continuous loading capacity: $4 \times I_n$ /continuously
- Overcurrent withstand:
 - $30 \times I_n/10$ s
 - $100 \times I_n/1$ s
 - $250 \times I_n/10$ ms (1 half-wave)
- Screws: M4, captive type acc. to VDEW
- Connection cross sections:
 - $1 \times$ or 2×2.5 mm² (2 x AWG 14) with wire end ferrule
 - $1 \times$ or 2×4.0 mm² (2 x AWG 12) with ring cable sleeve or cable sleeve
 - $1 \times$ or 2×6 mm² (2 x AWG 10) with ring cable sleeve or cable sleeve
 - The current measuring board's terminal blocks may be used as with 2 (double) conductors AWG 10, 12, 14 otherwise with single conductors only

Control Power Supply

- Aux. voltage: 24–270 Vdc/ 48–230 Vac (–20/+10%)
- Buffer time in case of supply failure: ≥ 50 ms at minimal aux. voltage interrupted communication is permitted
- Maximum permissible making current:
 - 18 A peak value for < 0.25 ms
 - 12 A peak value for < 1 ms
- The voltage supply must be protected by a fuse of:
 - 2.5 A time-lag miniature fuse approx. 0.2 x 0.8 in (5 x 20 mm) according to IEC 60127
 - 3.5 A time-lag miniature fuse approx. 0.25 x 1.25 in (6.3 x 32 mm) according to UL 248-14

Voltage and Residual Voltage Measurement

- Nominal voltages: 100 V/ 110 V/ 230 V/ 400 V (can be configured)
- Max. measuring range: 2 x nominal voltage
- Continuous loading capacity: 2 x nominal voltage (800 Vac)
- Power consumption:
 - at $V_n = 100$ V
S = 0.1 MVA
 - at $V_n = 110$ V
S = 0.1 MVA
 - at $V_n = 230$ V
S = 0.4 MVA
 - at $V_n = 400$ V
S = 1.0 MVA
- Frequency range: 50 Hz or 60 Hz $\pm 10\%$
- Terminals: screw-type terminals

Frequency Measurement

- Nominal frequencies: 50 Hz / 60 Hz

Voltage Supply

- Aux. voltage: 24–270 Vdc/ 48–230 Vac (–20/+10%)
- Buffer time in case of supply failure: ≥ 50 ms at minimal aux. voltage communication is permitted to be interrupted
- Max. permissible making current:
 - 18 A peak value for < 0.25 ms
 - 12 A peak value for < 1 ms
- The voltage supply must be protected by a fuse of:
 - 2.5 A time-lag miniature fuse 5 x 20 mm (approx. 0.2 in x 0.8 in) according to IEC 60127
 - 3.5 A time-lag miniature fuse 6.3 x 32 mm (approx. 0.25 in x 1.25 in) according to UL 248-14

Power Consumption

- Power supply range: 24–270 Vdc
 - Power consumption in idle mode—7 W
 - Maximum power consumption—13 W
- Power supply range: 48–230 Vac (for frequencies of 40–70 Hz)
 - Power consumption in idle mode—7 VA
 - Maximum power consumption—13 VA

Display

- Display type: LCD with LED background illumination
- Resolution graphics display: 128 x 64 pixel
- LED-type: two colored, red/green
- Number of LEDs, housing B2: 15

Front Interface

- Baud rates: 115,200 Baud
- Handshake: RTS and CTS
- Connection: 9-pole D-sub plug

Real-Time Clock

- Running reserve of the real-time clock: 1 year min.

Digital Inputs

- Maximum input voltage: 300 Vdc/259 Vac
 - Input current: <4 mA
 - Reaction time: <20 ms
 - Fallback time: <30 ms
- (Safe state of the digital inputs)
- Four switching thresholds: Un = 24 Vdc, 48 Vdc, 60 Vdc, 110 Vac/Vdc, 230 Vac/Vdc
 - Un = 24 Vdc
 - Switching threshold 1 ON: Min. 19.2 Vdc
 - Switching threshold 1 OFF: Max. 9.6 Vdc
 - Un = 48 V / 60 Vdc
 - Switching threshold 2 ON: Min. 42.6 Vdc
 - Switching threshold 2 OFF: Max. 21.3 Vdc
 - Un = 110 / 120 Vac/Vdc
 - Switching threshold 3 ON: Min. 88.0 Vdc / 88.0 Vac
 - Switching threshold 3 OFF: Max. 44.0 Vdc / 44.0 Vac
 - Un = 48–60 Vdc
 - Switching threshold 4 ON: Min. 184 Vdc / 184 Vac
 - Switching threshold 4 OFF: Max. 92 Vdc / 92 Vac
 - Terminals: screw-type terminal

Relay Outputs

- Continuous current: 5 A AC/DC
- Maximum make current:
 - 25 A AC / 25 A DC up to 30 V for 4s
 - 30 A/230 Vac according to ANSI IEEE Std. C37.90-2005
 - 30 A/250 Vdc according to ANSI IEEE Std. C37.90-2005
- Maximum breaking current:
 - 5 A AC up to 250 Vac
 - 5 A DC up to 30 V (resistive)
 - 0.3 A DC at 300 V
- Maximum switching voltage: 250 Vac/250 Vdc
- Switching capacity: 1250 VA
- Contact type: Form C or normally open contact
- Terminals: screw-type terminals

Supervision Contact (SC)

- Continuous current: 5 A AC/DC
- Maximum switch-on current: 15 A AC / 15 A DC up to 30 V for 4 s
- Maximum breaking current:
 - 5 A Vac up to 250 Vac
 - 5 A Vdc up to 30 Vdc
 - 0.4 A at 125 Vdc
- Contact type: 1 Form C contact
- Terminals: screw-type

Time Synchronization IRIG-B00X

- Nominal input voltage: 5 V
- Connection: Screw-type terminals (twisted pair)

Zone Interlocking

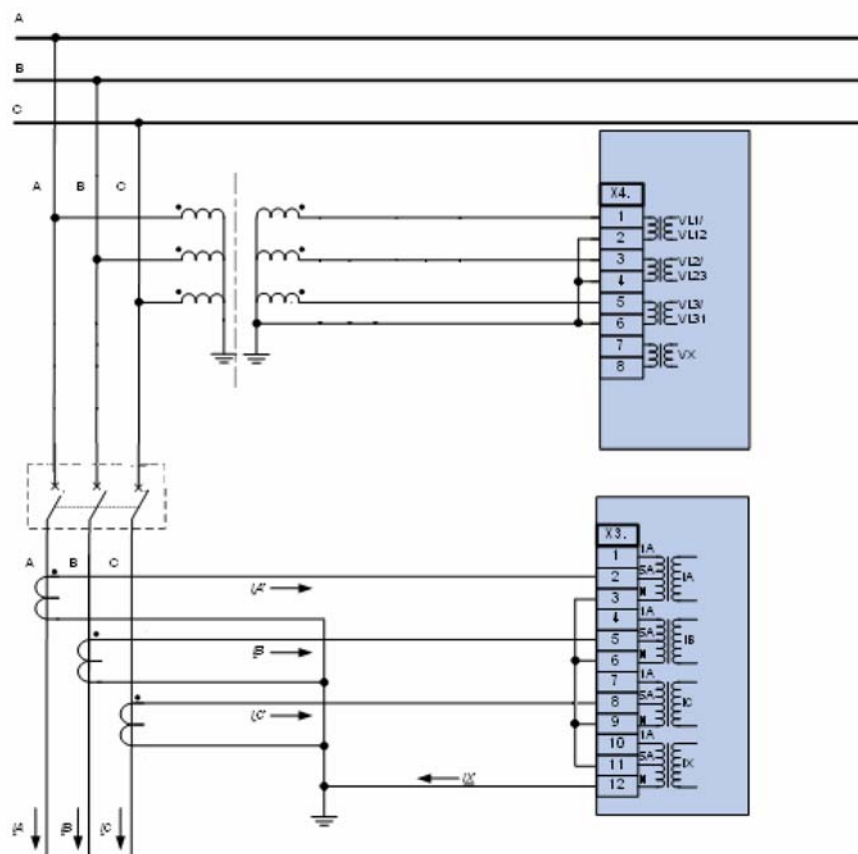
- Zone Out:
 - Output voltage (High) 4.75 to 5.25 Vdc
 - Output voltage (Low) 0.0 to +0.5 Vdc
- Zone In:
 - Nominal input voltage +5 Vdc
 - Max. input voltage +5.5 Vdc
 - Switching threshold ON min. 4.0 Vdc
 - Switching threshold OFF max. 1.5 Vdc
- Galvanic isolation 2.5 kV AC (to ground and other IO)
- Connection: Screw-type terminals (twisted pair)

RS-485

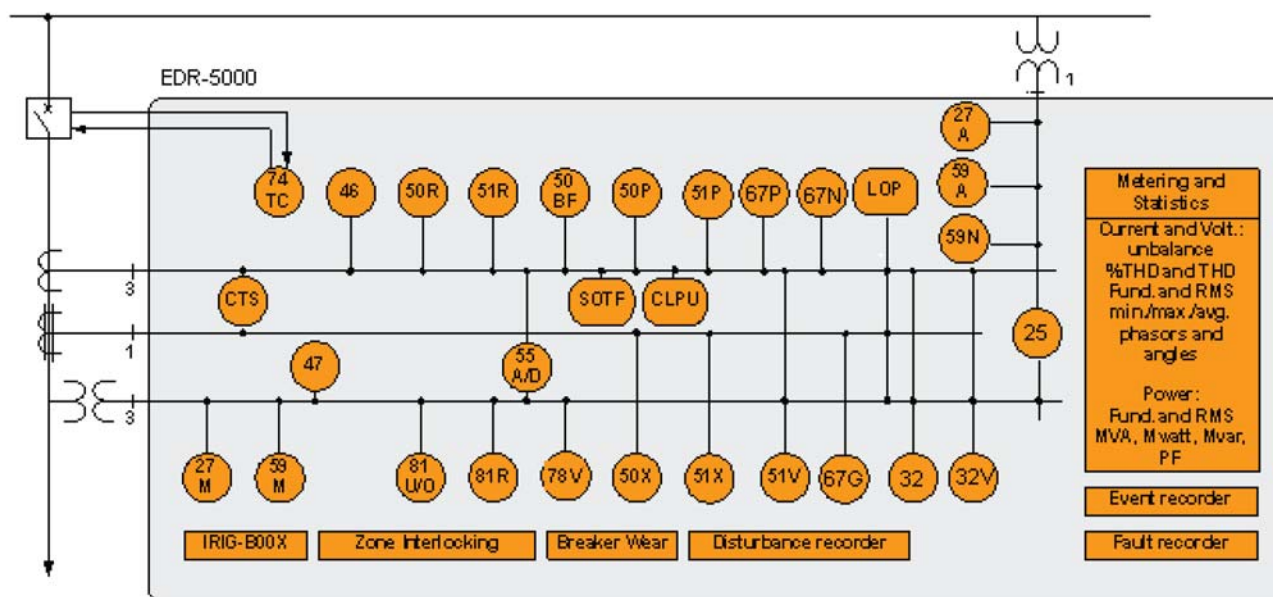
- Master/slave: slave
- Connection: 6 screw-clamping terminals RM 138 MIL (3.5 mm) (terminating resistors internal)

Wiring Diagrams

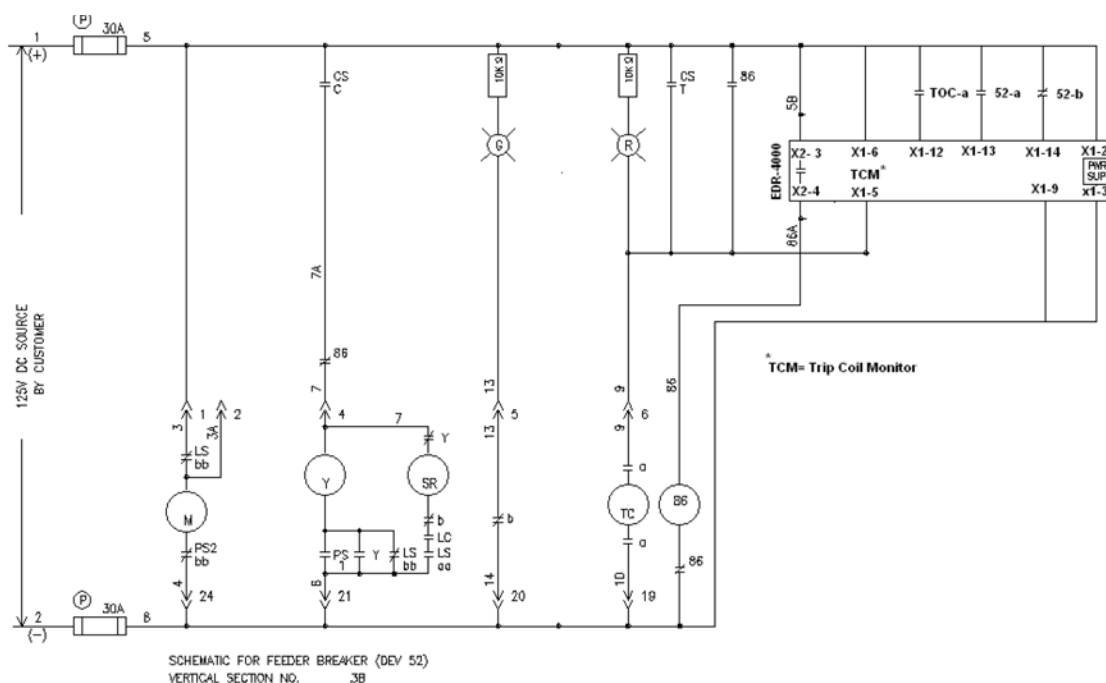
Typical AC Connections—Wye VTs, 5 A CTs and Ground Current Measured by Residual Connection



Typical One-Line Diagram



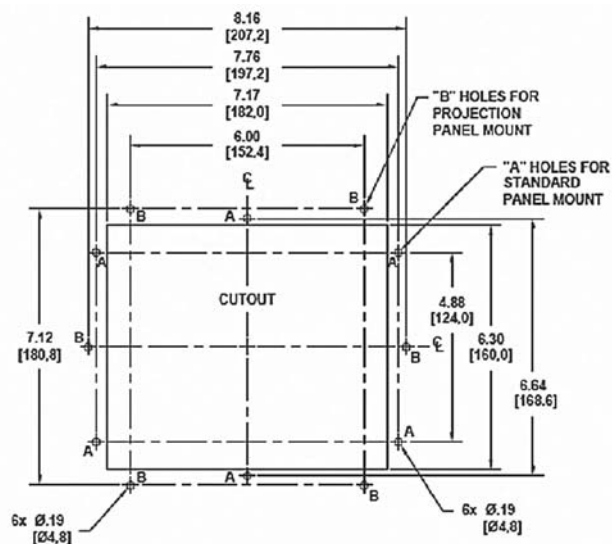
Typical Control Diagram



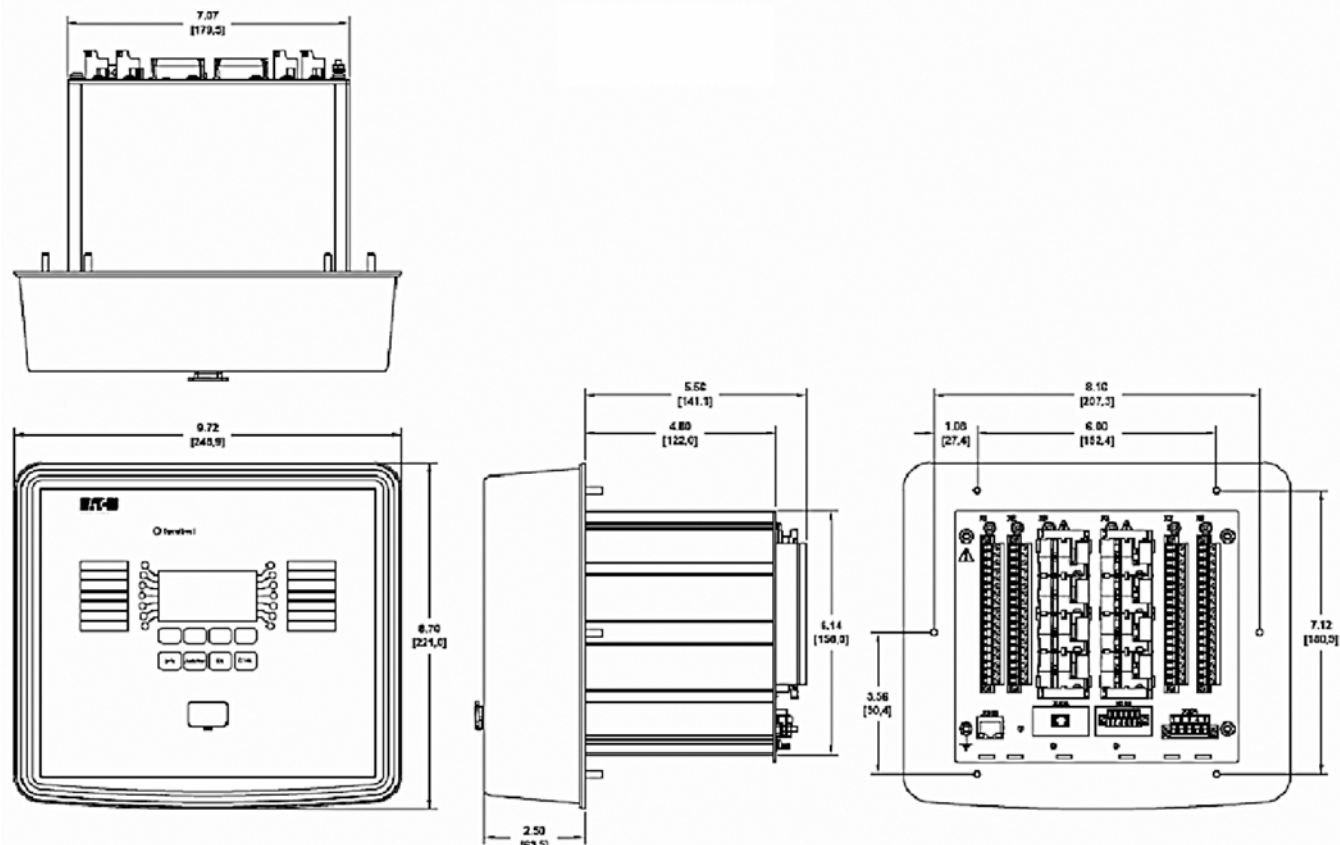
Dimensions

Approximate Dimensions in Inches (mm)

Drilling Plan



Projection Mount Front and Side Views



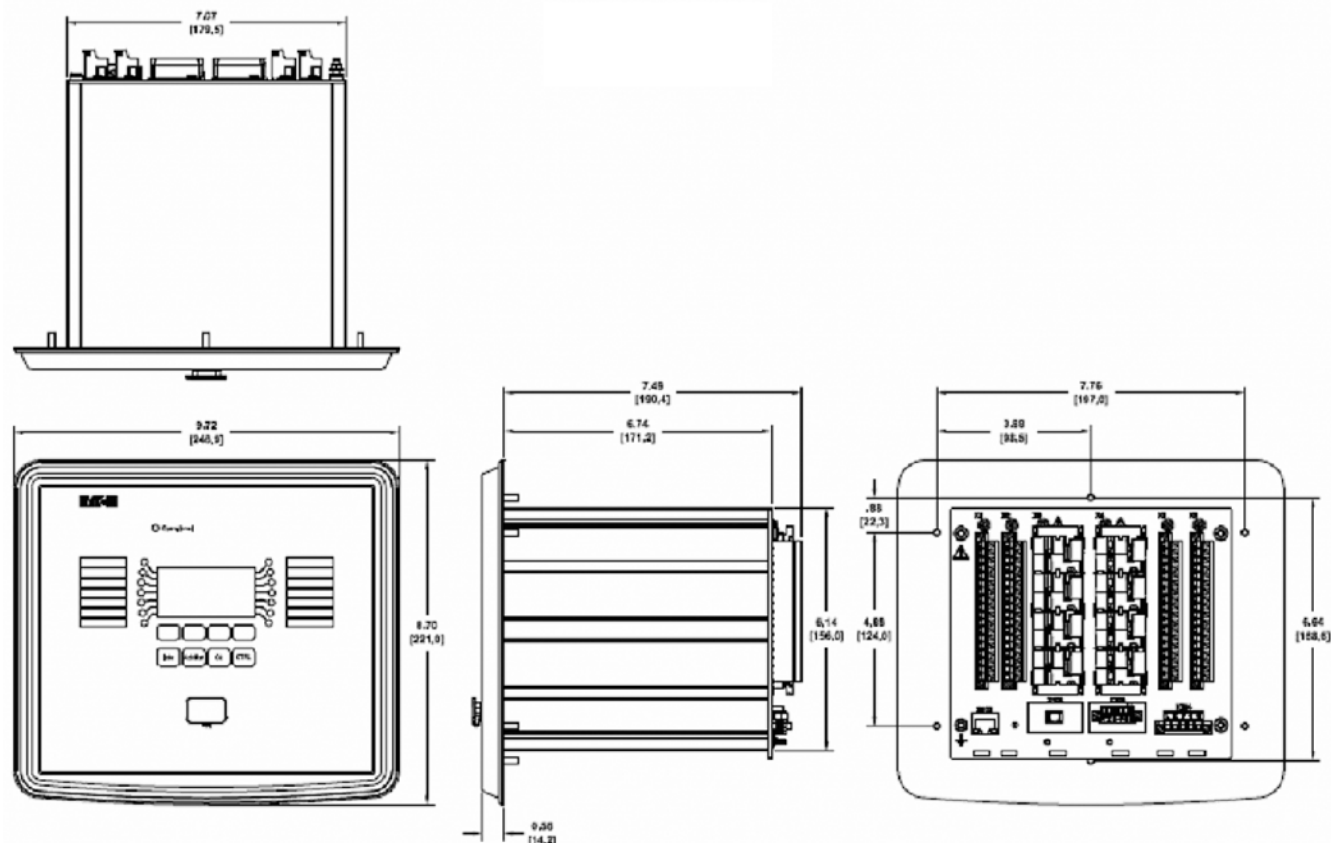
9.2

Metering Devices, Protective Relays, Software and Connectivity

Protective Relays

Approximate Dimensions in Inches (mm)

Standard Mount Front and Side Views



EBR—Line Differential Relay

Contents

<i>Description</i>	<i>Page</i>
Product Selection Guide	V3-T9-53
Arc Flash Relay	V3-T9-59
EDR-3000 Feeder Protection	V3-T9-61
EDR-5000 Distribution Protection Relay	V3-T9-70
EBR—Line Differential Relay	
EMR-3MP0 Motor Protection Relay	V3-T9-85
EMR-3000 Motor Protection Relay	V3-T9-87
EMR-4000 Motor Protection Relay	V3-T9-99
EMR-5000 Motor Protection Relay	V3-T9-112
ETR-4000 Transformer Protection Relay	V3-T9-124
ETR-5000 Transformer Protection Relay	V3-T9-136
EGR-5000 Generation Protection Relay	V3-T9-149
Universal RTD Module	V3-T9-162

EBR—Line Differential Relay

Information not available at this time.

Information not available at this time.

EMR-3MP0 Motor Protection Relay

Contents

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EDR-3000 Feeder Protection	V3-T9-61
EDR-5000 Distribution Protection Relay	V3-T9-70
EBR—Line Differential Relay	V3-T9-83
EMR-3MP0 Motor Protection Relay	V3-T9-87
EMR-3000 Motor Protection Relay	V3-T9-99
EMR-4000 Motor Protection Relay	V3-T9-112
EMR-5000 Motor Protection Relay	V3-T9-124
ETR-4000 Transformer Protection Relay	V3-T9-136
ETR-5000 Transformer Protection Relay	V3-T9-149
EGR-5000 Generation Protection Relay	V3-T9-162
Universal RTD Module	

EMR-3MP0 Motor Protection Relay

Information not available at this time.

Information not available at this time.

EMR-3000 Motor Protection Relay



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EGR-5000 Generation Protection Relay	V3-T9-149
Universal RTD Module	V3-T9-162

EMR-3000 Motor Protection Relay

Product Description

Eaton's EMR-3000 motor protection relay is a multifunctional microprocessor-based protective relay for the protection of any size motor at all voltage levels. It is most commonly applied on medium voltage or larger motors. The EMR-3000 relay is a current only device that provides complete and reliable motor protection, monitoring, and starting control functions.

The EMR-3000 motor protection relay has removable terminal blocks, and it has Modbus-RTU communications as standard; and an optional Ethernet port for Modbus-TCP communications. The EMR-3000 motor protection relay has three-phase and one ground current inputs. It can be used with either a 5 A or 1 A CTs. The ground protection can be used with either a zero sequence ground CT or from the residual connection of the phase CTs.

The zero sequence ground CT provides greater ground fault sensitivity than the residual connection. The unit is capable of 60 Hz or 50 Hz operation.

The maintenance mode password protected soft key, can be used for arc flash mitigation to change to an alternate settings group, set to have instantaneous elements only. The multiple setting groups can also be changed, via communications or a digital input. Flash memory is used for the programming and all settings are stored in nonvolatile memory.

An integral keypad and display is provided for direct user programming and retrieval of data without the need of a computer. 14 programmable LEDs provide quick indication of relay status.

A front port is provided for direct computer connection. An RS-485 communication port on the back is standard for local area networking using Modbus-RTU. An optional Ethernet port and protocols are available.

The EMR-3000 motor protection relay has mass memory for data storage and a real-time clock with 1 ms time resolution. The relay will log 300 sequence of event records, 20 detailed trip logs, minimum/maximum values, load profiles, the 5 latest start profiles, motor trending, breaker wear information and oscillography data.

The EMR-3000 motor protection relay has four discrete inputs and 1 fiber optic input, 1 Form C, and 2 NO programmable contacts, 1 Form C healthy contact. It also has an optional 4–20 mA analog output or zone interlocking card. The relay provides maximum user flexibility to configure the I/O. All inputs and outputs (except the healthy output) are user-programmable. The unit also counts with a test mode to force outputs and simulate currents, to facilitate the commissioning of the unit. It can be powered from 19 Vdc to 300 Vdc or 40 Vac to 250 Vac auxiliary power.

Application Description

Eaton's EMR-3000 motor protection relay has been designed for maximum motor operation and protection. It permits running the motor close to its design limits while protecting it against excessive heating and damaging overload conditions. The EMR-3000 field-proven protection algorithms were developed based on motor designs and operating parameters for optimum operation and protection while minimizing nuisance tripping. The EMR-3000 motor protection relay utilizes a patented protection algorithm and measurement technique based on proven positive and negative (unbalance) sequence current sampling and true rms calculations.

Features, Benefits and Functions

Protection Features

- Thermal protection (49/51)
 - Locked rotor protection (49S/51)
- Phase overcurrent elements:
 - Two instantaneous elements with timers (50P[1], 50P[2] and 50P[3])
 - Three inverse time overcurrent elements (51P[1], 51P[2] and 51P[3])
 - 11 standard curves
 - Instantaneous or time delay reset
- Ground overcurrent elements:
 - Two instantaneous measured elements with timers (50X[1] and 50X[2])
 - Two instantaneous calculated elements with timers (50R[1] and 50R[2])
 - Two inverse time overcurrent measured elements (51X[1] and 51X[2])
 - Two inverse time overcurrent calculated elements (51R[1] and 51R[2])
 - 11 standard curves
 - Instantaneous or time delay reset
- Jam or Stall protection (50J[1], 50J[2])
- Phase unbalance negative sequence overcurrent (46[1], 46[2])
- Underload protection (37[1], 37[2], 37[3])
- Temperature protection with optional URTD (49/38)
- Stars per hour (66)
- Lockout protection (86)
- Breaker failure (50BF)
- Zone interlocking for bus protection (87B)

Metering Features

- Amperes: Positive, negative and zero sequence
- Ampere demand
- % THD I
- Magnitude THD I
- Minimum/maximum recording
- Temperature with remote URTD module

Monitoring Features

- Trip coil monitor
- Breaker wear primary and secondary (accumulated interrupted current)
- Oscillography (7200 cycles total)
- Trip Cause displays fault recorder data on HMI after fault event
- Fault data logs (up to 20 events)
- Sequence of events report (up to 300 events)
- Trending (load profile over time)
- Motor history
- Records the last 5 motor start profiles
- Motor start trending
- CT supervision
- Clock (1 ms time stamping)

Control Functions

- Transition for reduced voltage starts
- Incomplete sequence delay
- Permits numbers of cold starts
- Limits numbers of starts per hour
- Anti-backspin time delay
- Mechanical load shedding
- Zero speed switch for long acceleration motors
- Motor stop inputs
- Remote trip input
- Differential trip input
- Emergency override
- Breaker/Contactor open-close/stop-start
- Remote open-close (stop-start)
- Programmable I/O
- Programmable LEDs
- Multiple setting groups

Communication Features

- Local HMI
- Password protected
- Addressable
- IRIG-B
- Local communication port:
 - RS-232
- Remote communication port:
 - RS-485
 - Ethernet port
- Protocols:
 - Modbus-RTU
 - Modbus-TCP (optional)
 - IEC 61850 (optional)
- Configuration software
 - PowerPort-E

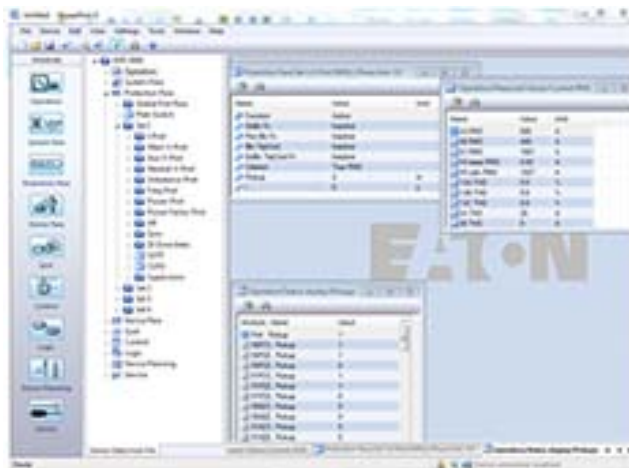
Trip Log

The EMR-3000 protection relay will store a maximum of 20 trip records in a FIFO trip log. Each trip record will be date and time stamped to a 1 ms resolution. The trip log record will include information on the type of fault, protection elements that operated, fault location and currents and voltages at the time of the fault.

Monitoring and Metering

Sequence of Events Records

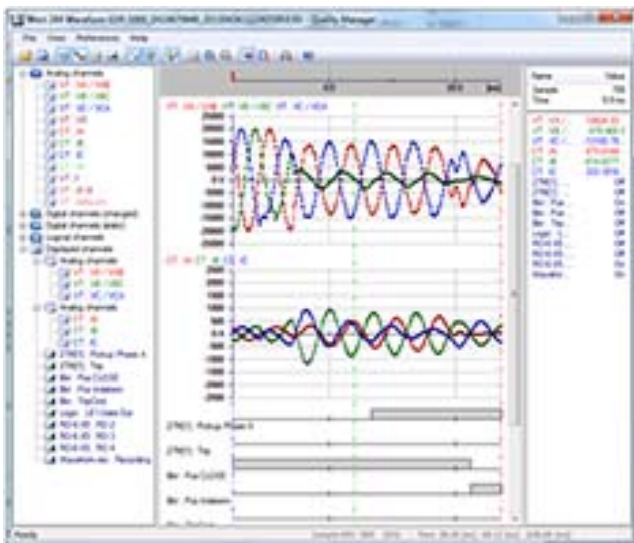
The EMR-3000 protection relay records a maximum of 300 events associated with the relay. An event is classified as a change of state as detected by the relay. These include relay pickups, dropouts, trips, contact closure, alarms, setting changes and self-diagnostic failures. Each event is date and time stamped to a 1 ms resolution. The events are stored in a FIFO in chronological order.



Waveform Capture (Quality Manager)

The EMR-3000 relay provides oscillographic recording capabilities. The relay will record all measured signals along with the binary signals of pickup, trip, internal logic, and contact inputs. The EMR-3000 can record up to 7200 cycles of data. The number of records is proportional to the programmed size of each record; the maximum size per record is 600 cycles.

The waveform capture is initiated by up to 8 different triggers (i.e., trip/alarm events) or manually via communications or the HMI. PowerPort-E setting software is used to retrieve the records. Quality Manager is a separate software program downloaded with PowerPort-E used for analyzing the waveform and trending files retrieved from the relay.



Integral User Interface

The front panel user interface has a 128 x 64 pixel LCD display with background illumination for wide angle viewing in all light conditions. Seven programmable LEDs provide quick and easy visual display of power on, mode of operation, alarm and trip indication. Soft keys are provided for operation mode selection, scrolling through data and settings. In addition, the relay settings and test functions are password protected.

Starting Profiles

The EMR-3000 records the average current versus time for the last five starting cycles. This information is available via the communications port through PowerPort-E.

Motor Statistics

For each motor start, the EMR-3000 stores a motor start report and add this data to the motor statistics buffer. With the motor statistics you can track motor start data for the past eighteen 30-day periods. For each 30-day interval, the relay records the following information:

- The date the interval began
- The total number of starts in the interval
- The averages of the following quantities:
 - Motor Start Time
 - Start % Rotor Thermal Capacity Used
 - Maximum Start Current

Load Profiling/Trending

The EMR-3000 relay automatically records selected quantities into non-volatile memory every 5, 10, 15, 30 or 60 minutes, depending on the trending report setting.

Programmable I/O

The EMR-3000 motor protection relay provides heavy-duty, triparted, 2 normally open and 1 Form C contacts. One isolated inputs can be used for monitoring the trip circuit. One Form C contact is dedicated to the relay failure alarm function and is operated in a normally energized (failsafe) mode. There are 4 eight user-configurable discrete inputs that accept a wet contact and can operate through a wide range of power. Each input and output is user-programmable for maximum application flexibility.

Intel-I-Trip (P_t) Overload Protection

The EMR-3000 motor relay features the exclusive Eaton Intel-I-Trip intelligent overload protection system. Intel-I-Trip develops custom overload curves simply from motor nameplate data. Intel-I-Trip protects motors from potentially damaging overload and abnormal operating conditions. The Intel-I-Trip intelligent overload protection feature utilizes field proven measurement techniques and a patented motor thermal protection model. The EMR-3000 motor relay's unique measurement technique samples the current waveforms 36 times per cycle, providing accurate measurements of the positive and negative sequence currents. The negative sequence current causes a greater heating effect on the rotor and has a greater impact on the thermal model in the relay. Intel-I-Trip utilizes these measurements in its motor model to safely protect the motor against the heating effects of these currents.

The motor thermal model is analogous to a bucket that is being filled and drained at the same time. The fill rate is dependent on the motor currents and the drain is based on motor design principles. The size of the bucket is equivalent to the thermal capacity associated with the mass of the motor. Intel-I-Trip integrates these rates and will issue a trip when the thermal capacity is filled.

Intel-I-Trip features adaptive trip characteristics that adjust the trip times based on measured motor temperature when RTDs are used.

Instantaneous Overcurrent

The EMR-3000 motor protection relay provides an instantaneous phase overcurrent function to trip the motor for high fault current levels and save the fuses. This function can be disabled and has an adjustable time delay on starting to avoid nuisance tripping on inrush.

Phase Unbalance Protection

Motor supply circuits are often fed through fuses and can be run with a single-phase fuse blown, referred to as single phasing the motor. The EMR-3000 motor protection relay measures the current unbalance and can be used to alarm or trip the motor before damage occurs. Pickup, start and run timers, and a second element for alarm purposes are provided.

Ground Fault Protection

A separate measuring circuit is used to measure ground current. A ground CT is recommended for more sensitive protection against winding insulation breakdown to ground. The relay ground circuit can be connected residually from the three-phase CTs. The ground fault protection has pickup and time delay set points or can be disabled.

Jam Protection

The user-selectable Jam function protects motors that are running against a sudden mechanical jam or stall condition. The common application is on motors used on crushers, chippers, or conveyors. It detects an increase of motor current to a level above full load. Pickup, start, and run timers and a second element for alarm purposes are provided.

Underload Protection

The user-selectable underload function is used to detect the loss of load on the motor. Coupling failure is a common cause for loss of load. Pickup, start, and run timers and a second element for alarm purposes are provided.

Reduced Voltage Starting

The EMR-3000 motor protection relay provides a transition and incomplete sequence function for reduced voltage starting. The user can select to transition based on the current level and/or on time.

Antibackspin

The stop function is programmable from 2–20%. For certain applications, such as pumping a fluid up a pipe, the motor may be driven backward for a period of time after it stops. The EMR-3000 relay provides an antibackspin timer to prevent starting the motor while it is spinning in the reverse direction. The timer begins counting from the moment a stop is declared by the relay.

Start Control Timers

Motors typically have limits to the number of cold starts, starts per hour period, or time between starts that are permitted without damage. The EMR-3000 motor protection relay incorporates these timers to prevent starting the motor beyond its capabilities.

Load Shedding

The EMR-3000 motor protection relay provides a mechanical load shedding feature that can be used to control an upstream process. The load-shedding function closes a contact on an overload condition to control an upstream process from adding more load until the overload condition is gone.

Emergency Override

The EMR-3000 motor protection relay has a user-programmable feature that will let the operator reset the start inhibitor timers and thermal overload bucket. This function is intended for use in emergency conditions only, and it may result in motor damage or failure.

Long Acceleration Motors

Large motors with a high inertia may experience starting currents that exceed the locked rotor current and time. The EMR-3000 motor protection relay has logic and provisions for a zero speed switch input to differentiate between a stall and start condition. If the motor is spinning, then the relay will not trip on the normal locked rotor time allowing the motor to start.

Remote/Differential Trip

The digital inputs can be programmed to accept a contact input from a separate differential relay or other device to trip the motor. This provides local and remote target information and utilizes the trip contacts of the EMR-3000 motor protection relay. It will also record and log the motor information at the time of the trip.

Breaker Failure or Stuck Contactor

The EMR-3000 motor protection relay includes a breaker failure (50BF, 62BF) function that can be initiated from either an internal or external trip signal. This is an independent element that can be used to operate a lockout relay or trip an upstream breaker. The timer must be longer than the breaker operating time and the protective function reset times.

Flexible Phase Rotation

The EMR-3000 motor protection relay can be applied on either an A-B-C or A-C-B phase rotation. A user setting permits correct operation and indication of the actual system configuration.

Maintenance Mode

The Maintenance Mode can improve safety by providing a simple and reliable method to reduce fault clearing time and lower incident energy levels at energized panels. The Maintenance Mode allows the user to switch to more sensitive settings via a password protected soft key, communication or via a digital Input while maintenance work is being performed at an energized panel or device. The more sensitive settings provide greater security for maintenance personnel and helps reduce the possibility of injury.

Standards and Certifications

Design Standards

- Generic Standard:
 - EN 61000-6-2
 - EN 61000-6-3
- Product Standard:
 - IEC 60255-6
 - EN 50178
 - UL 508 (Industrial Control Equipment)
 - CSA C22.2 No. 14-95 (Industrial Control Equipment)
 - ANSI C37.90



Catalog Number Selection

The catalog number identification chart defines the electrical characteristics and operation features included in the EMR-3000. For example, if the catalog number is EMR-3000-2A0BA1, the device would have the following:

EMR-3000

(A)—Four digital inputs, four output relays, 1 4–20 mA analog output, URDT interface

(0)—5 A / 1 A phase and ground CTs, power supply range: 19–300 Vdc, 40–250 Vac

(B)—Modbus-RTU (RS-485)

(A)—Without conformal coating

(1)—Projection panel mount

Motor Relay Removable Terminals

EMR-3000-2A 0 B A 1

Hardware Option 1
A = 4 DI, 4 outputs, removable terminals, 1 4–20 mA analog output, URDT interface, IRIG-B small display
B = 4 DI, 4 outputs, removable terminals, zone interlocking, URDT interface, IRIG-B, small display

Hardware Option 2
0 = Phase current 5 A / 1 A, ground current 5 A / 1 A, power supply range: 19–300 Vdc, 40–250 Vac
1 = Phase current 5 A / 1 A, sensitive ground current 0.5 A / 0.1 A, power supply range: 19–300 Vdc, 40–250 Vac

Communication Options
B = Modbus/DNP3 RTU over RS-485
C = Modbus/DNP3 TCP over Ethernet RJ-45
D = PROFIBUS-DP over fiber optic ST
E = PROFIBUS-DP over D-Sub / RS-485
F = Modbus RTU or DNP3 RTU over fiber optic ST
G = Modbus/DNP3 RTU over D-Sub / RS-485
H = IEC 61850/Modbus/DNP3 TCP over Ethernet RJ-45
I = Modbus/DNP3 RTU over RS-485 or Modbus/DNP3 TCP over Ethernet RJ-45
K = IEC 61850/Modbus/DNP3 TCP over LC duplex fiber optic Ethernet
L = Modbus/DNP3 TCP over LC duplex fiber optic Ethernet

Conformal Coating Options
A = None
B = Conformal coated circuit boards

Mounting Options
0 = Standard mount
1 = Projection panel mount

Accessories

Standard Accessories EMR-3000

Description	Catalog Number
UNVL RTD Mod with Modbus-RTU 48–240 Vac/48–250 Vdc	URTDII-01 ①
UNVL RTD Mod with Modbus-RTU 24–48 Vdc	URTDII-02 ①
E-SERIES 3000 IQ adapter kit projection mounted ②	ER-IQRETROKIT

Notes

① See URTD section for fiber optic cables required to communicate to the EMR-3000.

② Retrofitting mounting plate MP-3000 relay, projection panel mount necessary.

Technical Data and Specifications

Climatic Environmental Conditions

- Storage Temperature: –25 °C up to +70 °C (–13 °F to +158 °F)
- Operating temperature: –20 °C up to +60 °C (–4 °F to +140 °F)
- Permissible humidity at Ann. Average: <75% rel. (on 56d up to 95% rel.)
- Permissible Installation Altitude: <2,000 m (6,561.67 ft) above sea level.
- If 4,000 m (13,123.35 ft) altitude applies, a changed classification of the operating and test voltages may be necessary.

Degree of Protection EN 60529

- HMI front panel with seal: IP54
- Rear side terminals: IP30

Routine Test

- Insulation test acc. to IEC 60255-5: All tests to be carried out against ground and other input and output circuits.
- Aux. voltage supply, digital inputs, current measuring inputs, signal relay outputs: 2.5 kV (eff.) / 50 Hz
- Voltage measuring inputs: 3.0 kV (eff.) / 50 Hz
- All wire-bound communication interfaces: 1.5 kV DC

Housing

- Housing B1: height / width 183 mm (7.205 in) / 141.5 mm (5.571 in)
- Housing depth (incl. terminals): 208 mm (8.189 in)
- Material, housing: aluminum extruded section
- Material, front panel: aluminum/foil front
- Mounting position: Horizontal (±45° around the X-axis must be permitted)
- Weight EMR-3000 housing B1: Approx. 2.4 kg (5.291 lb)

Plug-in Connector with Integrated Short-Circuiter (Conventional Current Inputs)

- Nominal current: 1 A and 5 A
- Continuous loading capacity: $4 \times I_N$ / continuously
- Overcurrent withstand:
 - $30 \times I_N / 10$ s
 - $100 \times I_N / 1$ s
 - $250 \times I_N / 10$ ms (1 half-wave)
- Screws: M4, captive type acc. to VDEW
- Connection cross sections:
 - 1 x or 2 x 2.5 mm² (2 x AWG 14) with wire end ferrule
 - 1 x or 2 x 4.0 mm² (2 x AWG 12) with ring cable sleeve or cable sleeve
 - 1 x or 2 x 6 mm² (2 x AWG 10) with ring cable sleeve or cable sleeve

Voltage Supply

- Aux. voltage: 24–270 Vdc / 48–230 Vac (–20/+10%)
- Buffer time in case of supply failure: ≥50 ms at minimal aux. voltage communication is permitted to be interrupted
- Max. permissible making current:
 - 18 A peak value for <0.25 ms
 - 12 A peak value for <1 ms
- The voltage supply must be protected by a fuse of:
 - 2.5 A time-lag miniature fuse 5 x 20 mm (approx. 1/5 in x 0.8 in) according to IEC 60127
 - 3.5 A time-lag miniature fuse 6.3 x 32 mm (approx. 1/4 in x 1 1/4 in) according to UL 248-14

Power Consumption

- Power supply range:
 - 19–300 Vdc: 6 W idle mode / 8 W max. power
 - 40–250 Vac: 6 W idle mode / 8 W max. power (For frequencies of 40–70 Hz)

Real Time Clock

- Running reserve of the real time clock: 1 year min.

Display

- Display type: LCD with LED background illumination
- Resolution—graphics display: 128 x 64 pixel
- LED Type: two colored: red / green
- Number of LEDs, housing B1: 8

Digital Inputs

- Max. input voltage: 300 Vdc / 270 Vac
- Input current: <4 mA
- Reaction time: <20 ms
- Fallback time: <30 ms
- (Safe state of the digital inputs)
- Switching thresholds:
Un = 24 Vdc, 48 Vdc, 60 Vdc, 110 Vac / Vdc, 230 Vac / Vdc
 - Un = 24 Vdc
 - Switching threshold 1 ON:
 - Switching threshold 1 OFF:
 - Min. 19.2 Vdc
 - Max. 9.6 Vdc
 - Un = 48 V / 60 Vdc
 - Switching threshold 2 ON:
 - Switching threshold 2 OFF:
 - Min. 42.6 Vdc
 - Max. 21.3 Vdc
 - Un = 110 / 120 Vac/Vdc
 - Switching threshold 3 ON:
 - Switching threshold 3 OFF:
 - Min. 88.0 Vdc / 88.0 Vac
 - Max. 44.0 Vdc / 44.0 Vac
 - Un = 230 / 240 Vac/Vdc
 - Switching threshold 4 ON:
 - Switching threshold 4 OFF:
 - Min. 184 Vdc / 184 Vac
 - Max. 92 Vdc / 92 Vac
- Terminals: screw-type terminal

Current and Ground Current Measurement

- Nominal currents: 1 A / 5 A
- Max. measuring range:
 - Up to 40 x In (phase currents)
 - Up to 25 x In (ground current standard)
 - Up to 2.5 x In (ground current sensitive)
- Continuous loading capacity: 4 x In / continuously
- Overcurrent proof:
 - 30 x In / 10 s
 - 100 x In / 1 s
 - 250 x In / 10 ms (1 half-wave)
- Power consumption: phase current inputs
 - At In = 1 A burden = 0.15 MVA
 - At In = 5 A burden = 0.15 MVA
- Ground current input
 - At In = 1 A burden = 0.35 MVA
 - At In = 5 A burden = 0.35 MVA
- Frequency range: 50 Hz / 60 Hz $\pm 10\%$
- Terminals: screw-type terminals with integrated short-circuiters (contacts)

Binary Output Relays

- Continuous current: 5 A AC/DC
- Switch-on current: 25 A AC/DC for 4 s
- Max. breaking current:
 - 5 A AC up to 125 Vac
 - 5 A DC up to 50 V (resistive)
 - 0.2 A DC at 300 V
- Max. Switching Voltage: 250 Vac/300 Vdc
- Switching capacity: 2000 VA
- Contact type: 1 changeover contact
- Terminals: screw-type terminals

Front Interface RS-232

- Baud rates: 115200 baud
- Handshake: RTS and CTS
- Connection: 9-pole D-Sub plug

RS-485

- Master/slave: slave
- Connection: 6 screw-clamping terminals RM 3.5 mm (138 MIL) (terminating resistors internal)

Tolerances of the Real Time Clock

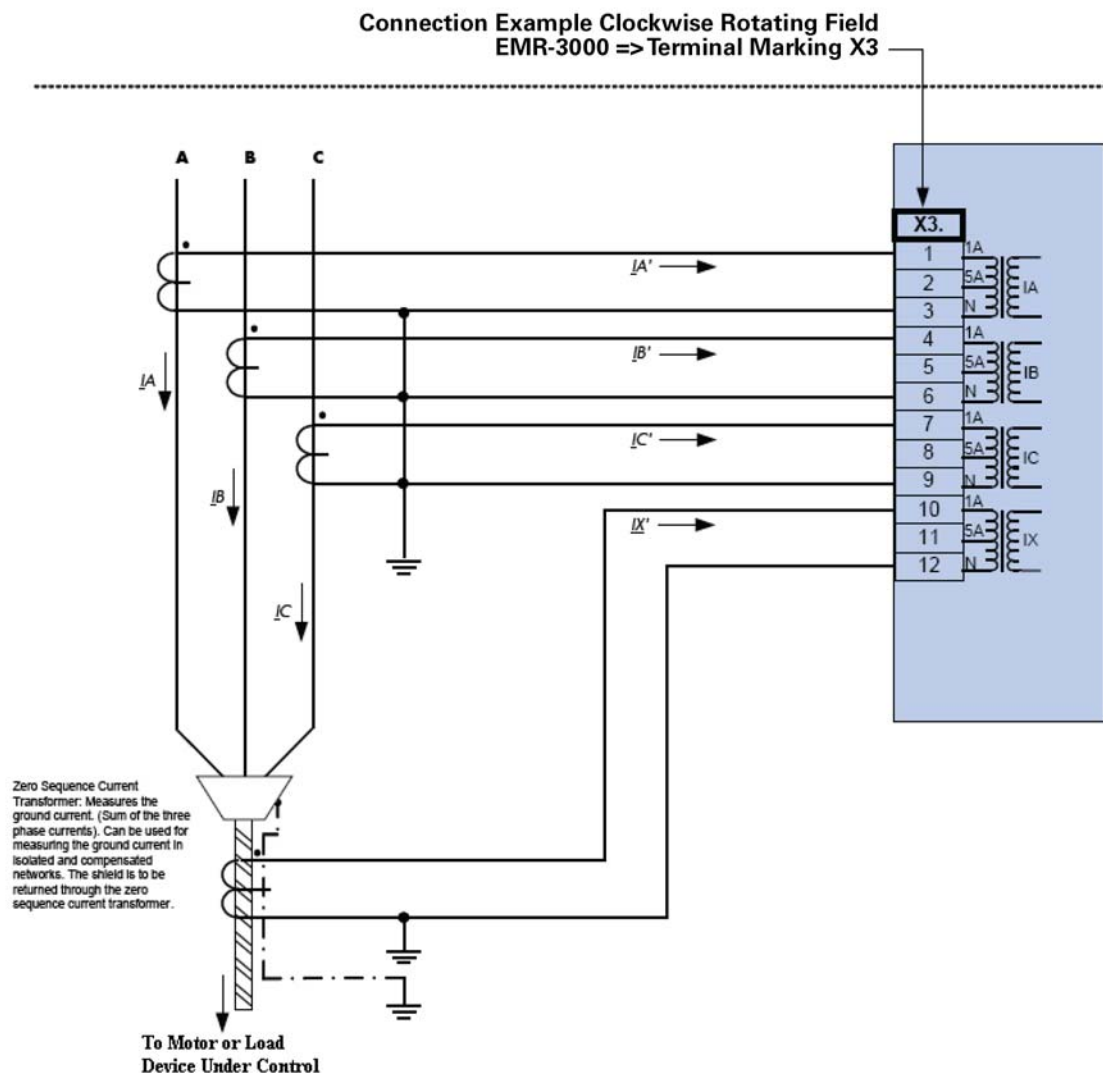
- Resolution: 1 ms
- Tolerance: <1 minute / month (+20 °C)

Measuring Accuracy

- Max. measuring range: Up to 40 x In (phase currents)
- Up to 25 x In (ground current standard)
- Frequency range: 50 Hz / 60 Hz $\pm 10\%$
- Accuracy: Class 0.5
- Amplitude error if $I < 1$ In: $\pm 0.5\%$ of the rated value
- Amplitude error if $I > 1$ In: $\pm 0.5\%$ of the measured value
- Amplitude error if $I > 2$ In: $\pm 1.0\%$ of the measured value
- Resolution: 0.01 A
- Harmonics: Up to 20% 3rd harmonic $\pm 2\%$ Up to 20% 5th harmonic $\pm 2\%$
- Frequency influence: $< \pm 2\%$ / Hz in the range of ± 5 Hz of the parametrized nominal frequency
- Temperature influence: $< \pm 1\%$ within the range of 0 °C up to +60 °C

Wiring Diagrams

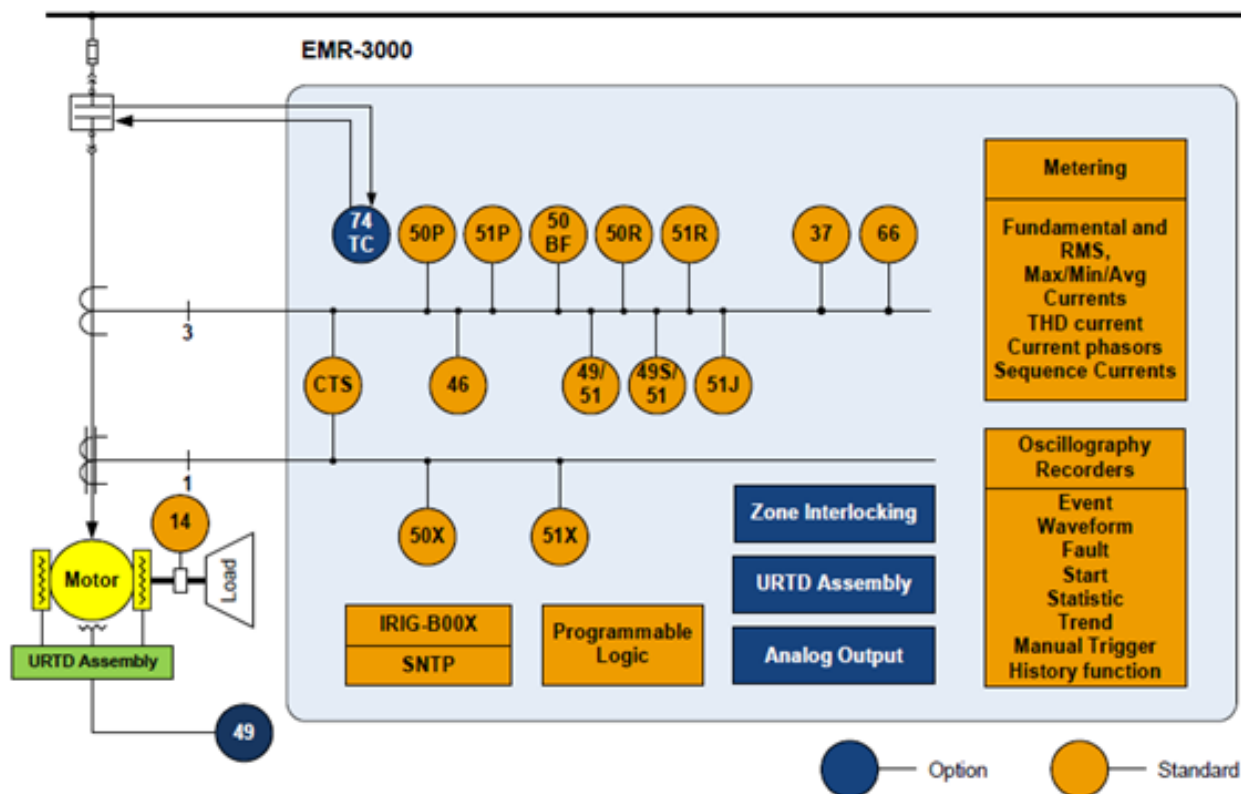
Typical AC Connections—1 A CTs and Ground Current Measured by Zero Sequence CT



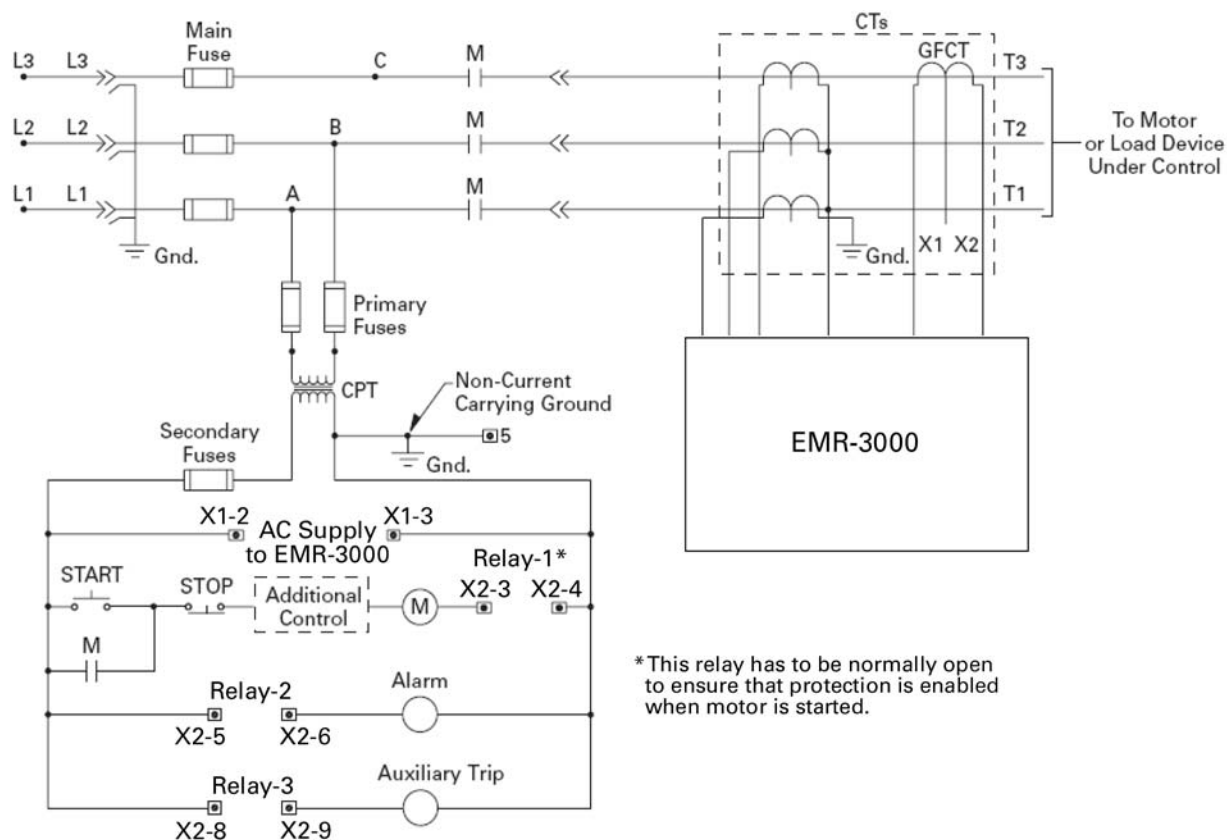
Three Phase Current Measurement; I_{nom} Secondary = 1 A.

Ground Current Measuring via Zero Sequence CT ; I_{Gnom} Secondary = 1 A.

Typical One-Line Diagram



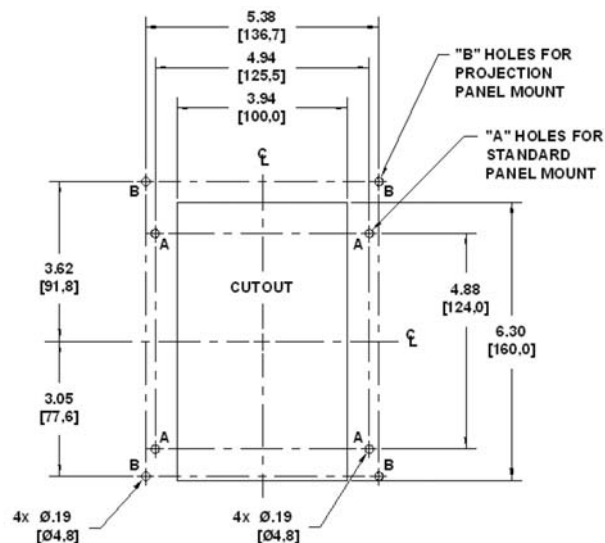
Typical Control Diagram



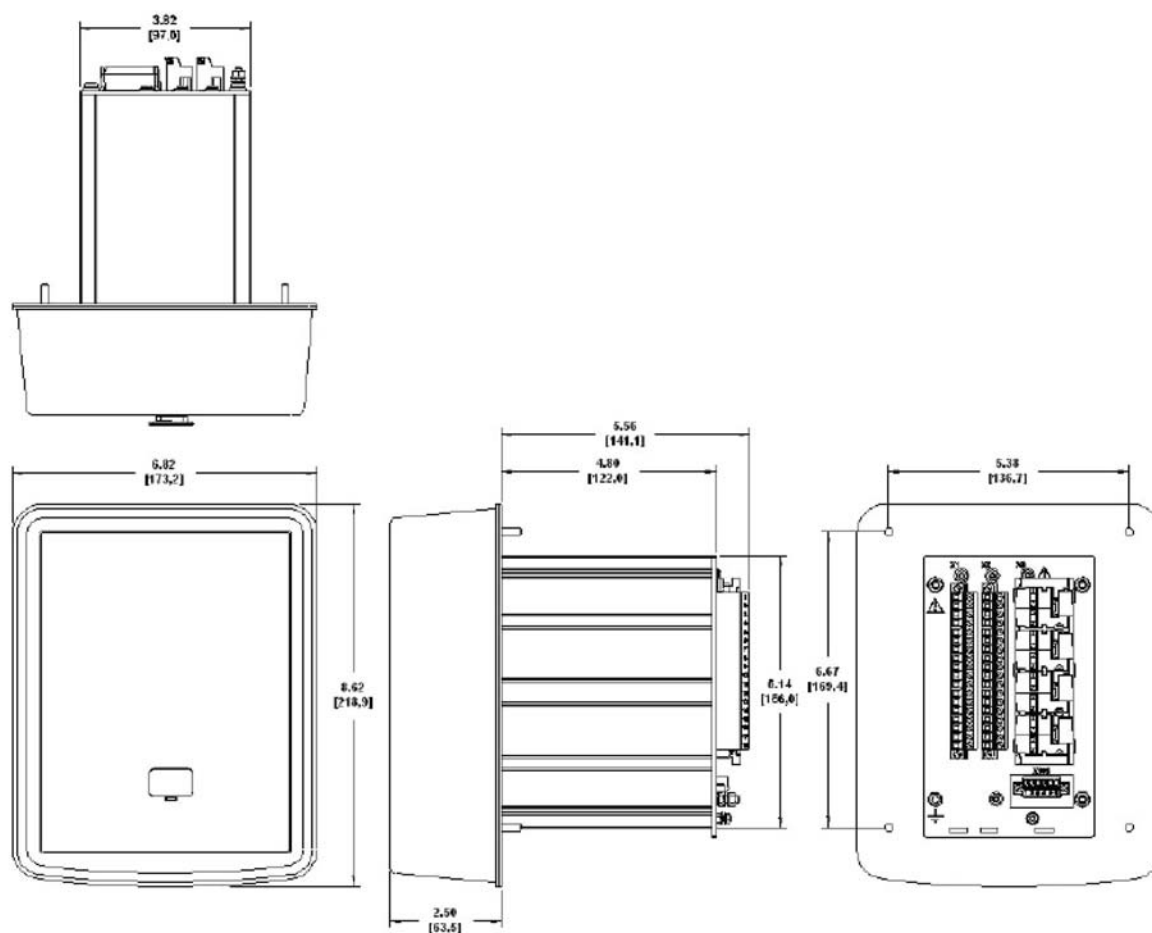
Dimensions

Approximate Dimensions in Inches (mm)

Drilling Plan



Projection Mount Front and Side Views



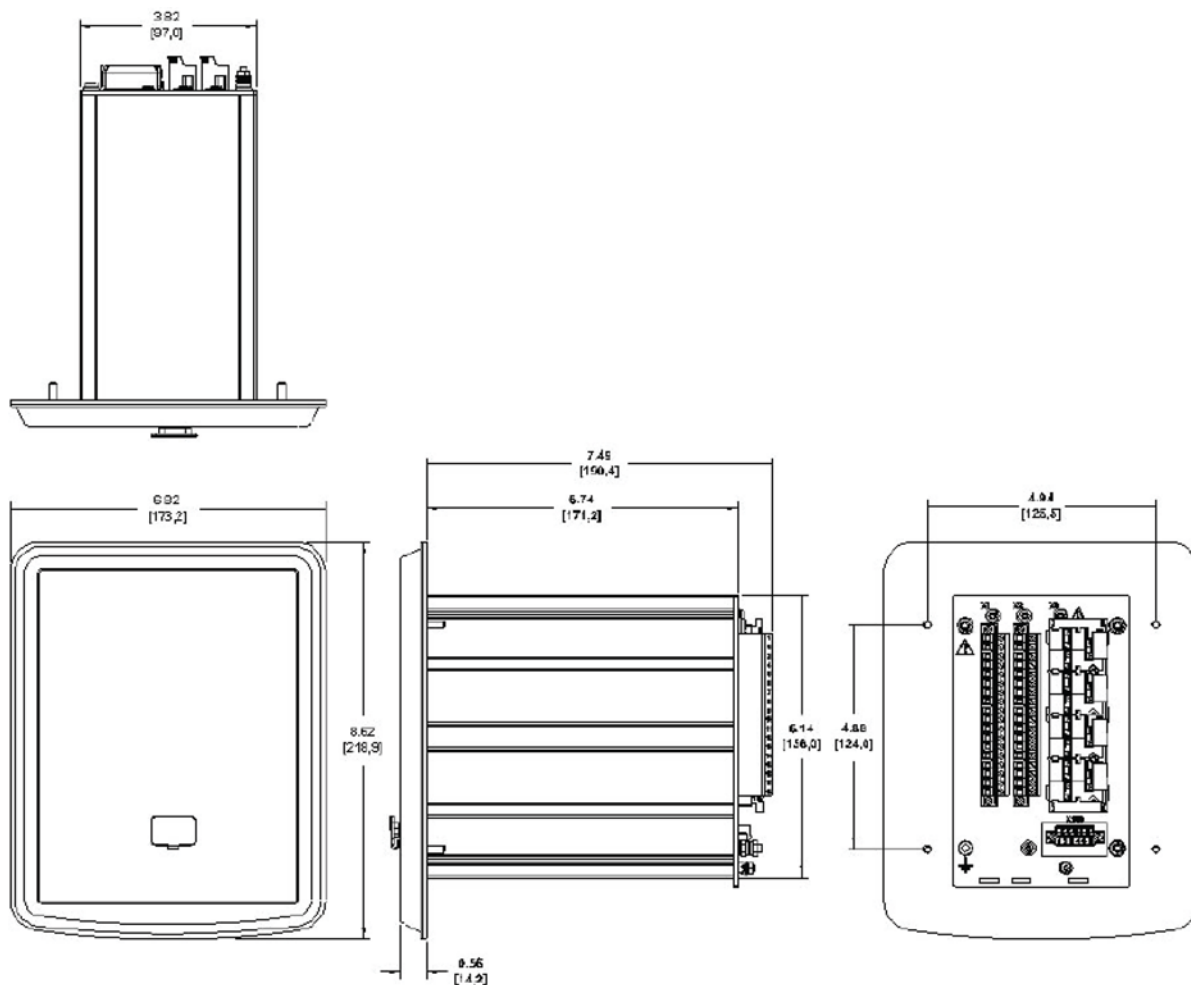
9.2

Metering Devices, Protective Relays, Software and Connectivity

Protective Relays

Approximate Dimensions in Inches (mm)

Standard Mount Front and Side Views



EMR-4000 Motor Protection Relay



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EMR-4000 Motor Protection Relay

Product Description

Eaton's EMR-4000 motor protection relay is a multifunctional microprocessor-based protective relay for the protection of any size motor at all voltage levels. It is most commonly applied on medium voltage or larger motors. The EMR-4000 relay is a current and voltage device that provides complete and reliable motor protection, monitoring, diagnostics, metering and starting control functions.

The EMR-4000 motor protection relay has removable terminal blocks, and it has Modbus-RTU communications as standard; and an optional Ethernet port for Modbus-TCP communications or IEC-61850.

The EMR-4000 motor protection relay provides complete current, voltage, and frequency protection in a single compact case. The relay has four current inputs rated for either 5 amperes or 1 ampere and four voltage inputs. Three of the voltage inputs are to be connected to the three-phase power voltage for voltage protection and for metering.

They can be connected in wye-ground or open delta configuration. The fourth voltage is for independent single-phase undervoltage/overvoltage protection. The unit is capable of 60 Hz or 50 Hz operation.

The maintenance mode password protected soft key, can be used for arc flash mitigation to change to an alternate settings group, set to have instantaneous elements only. The multiple setting groups can also be changed, via communications or a digital input. Flash memory is used for the programming and all settings are stored in nonvolatile memory.

An integral keypad and display is provided for direct user programming and retrieval of data without the need of a computer. 14 programmable LEDs provide quick indication of relay status.

A front port is provided for direct computer connection. An RS-485 communication port on the back is standard for local area networking using Modbus-RTU. An optional Ethernet port and protocols are available.

The EMR-4000 motor protection relay includes programmable logic functions. Logic gates and timers may be defined and arranged for customized applications. With the programmable logic control functions you can simplify the complexity of your starting schemes by eliminating timers and auxiliary relays. Flash memory is used for the programming and all settings are stored in nonvolatile memory. The relay allows for four preprogrammed setting groups which can be activated through software or contact input.

The EMR-4000 motor protection relay has mass memory for data storage and a real-time clock with 1 ms time resolution.

The relay will log 300 sequence of event records, 20 detailed trip logs, minimum/maximum values, load profiles, the 5 latest start profiles, motor trending, breaker/contact wear information and oscillography data.

The EMR-4000 motor protection relay has eight discrete inputs, 1 fiber optic input, 2 Form C, and 2 NO output programmable contacts, and 1 Form C healthy contact. It also has four 4-20 mA analog outputs and one zone interlocking card. The relay provides maximum user flexibility to configure the I/O. All inputs and outputs (except the healthy output) are user-programmable. The unit also counts with a test mode to force outputs and simulate currents, to facilitate the commissioning of the unit. It can be powered from 19 Vdc to 300 Vdc or 40 Vac to 250 Vac auxiliary power.

Application Description

Eaton's EMR-4000 motor protection relay has been designed for maximum motor operation and protection. It permits running the motor close to its design limits while protecting it against excessive heating and damaging overload conditions. The EMR-4000 field proven protection algorithms were developed based on motor designs and operating parameters for optimum operation and protection while minimizing nuisance tripping. The EMR-4000 motor protection relay utilizes a patented protection algorithm and measurement technique based on proven positive and negative (unbalance) sequence current sampling and true rms calculations.

Features, Benefits and Functions***Intel-I-Trip (I²t) Overload Protection***

The EMR-4000 motor relay features the exclusive Eaton Intel-I-Trip intelligent overload protection system. Intel-I-Trip develops custom overload curves simply from motor nameplate data. Intel-I-Trip protects motors from potentially damaging overload and abnormal operating conditions. The Intel-I-Trip intelligent overload protection feature utilizes field proven measurement techniques and a patented motor thermal protection model. The EMR-4000 motor relay's unique measurement technique samples the current waveforms 36 times per cycle, providing accurate measurements of the positive and negative sequence currents. The negative sequence current causes a greater heating effect on the rotor and has a greater impact on the thermal model in the relay. Intel-I-Trip utilizes these measurements in its motor model to safely protect the motor against the heating effects of these currents.

The motor thermal model is analogous to a bucket that is being filled and drained at the same time. The fill rate is dependent on the motor currents and the drain is based on motor design principles. The size of the bucket is equivalent to the thermal capacity associated with the mass of the motor. Intel-I-Trip integrates these rates and will issue a trip when the thermal capacity is filled.

Intel-I-Trip features adaptive trip characteristics that adjust the trip times based on measured motor temperature when RTDs are used.

Instantaneous Overcurrent

The EMR-4000 motor protection relay provides an instantaneous phase overcurrent function to trip the motor for high fault current levels and save the fuses. This function can be disabled and has an adjustable time delay on starting to avoid nuisance tripping on inrush.

Phase Unbalance Protection

Motor supply circuits are often fed through fuses and can be run with a single-phase fuse blown, referred to as single phasing the motor. The EMR-4000 motor protection relay measures the current and voltage unbalance and either can be used to alarm or trip the motor before damage occurs. The EMR-4000 has 2 voltage and 2 current unbalance elements. Pickup, start and run timers are provided for each element.

Ground Fault Protection

A separate measuring circuit is used to measure ground current. A ground CT is recommended for more sensitive protection against winding insulation breakdown to ground. The relay ground circuit can be connected residually from the three-phase CTs. The ground fault protection has pickup and time delay set points or can be disabled.

Jam Protection

The user-selectable Jam function protects motors that are running against a sudden mechanical jam or stall condition. The common application is on motors used on crushers, chippers, or conveyors. It detects an increase of motor current to a level above full load. Pickup, start, and run timers and a second element for alarm purposes are provided.

Underload/Underpower Protection

The user selectable underload/underpower function is used to detect the loss of load on the motor. Coupling failure is a common cause for loss of load. Whenever is possible, it is better to use underpower to detect loss of load. Three power elements and two underload elements are provided in the relay for tripping and alarm purposes. Pickup, start, and run timers are provided for each element.

Frequency Protection

The frequency elements provide the ability to detect when the motor is operating at off-nominal frequencies that can do damage to the process or, to signal to upstream protections or controls to implement load shedding actions.

Power Factor Protection

This protection is used in synchronous motors applications to detect out-of-synchronism conditions.

Undervoltage/Overvoltage Protection

Use the voltage protective functions to detect abnormal system voltage conditions potentially hazardous to the motor.

Reduced Voltage Starting

The EMR-4000 motor protection relay provides a transition and incomplete sequence function for reduced voltage starting. The user can select to transition based on the current level and/or on time.

Antibackspin

The stop function is programmable from 2 to 20%. For certain applications, such as pumping a fluid up a pipe, the motor may be driven backward for a period of time after it stops. The EMR-4000 relay provides an antibackspin timer to prevent starting the motor while it is spinning in the reverse direction. The timer begins counting from the moment a stop is declared by the relay.

Start Control Timers

Motors typically have limits to the number of cold starts, starts per hour period, or time between starts that are permitted without damage. The EMR-4000 motor protection relay incorporates these timers to prevent starting the motor beyond its capabilities.

Load Shedding

The EMR-4000 motor protection relay provides a mechanical load shedding feature that can be used to control an upstream process. The load-shedding function closes a contact on an overload condition to control an upstream process from adding more load until the overload condition is gone.

Emergency Override

The EMR-4000 motor protection relay has a user-programmable feature that will let the operator reset the start inhibitor timers and thermal overload bucket. This function is intended for use in emergency conditions only, and it may result in motor damage or failure.

Long Acceleration Motors

Large motors with a high inertia may experience starting currents that exceed the locked rotor current and time. The EMR-4000 motor protection relay has logic and provisions for a zero speed switch input to differentiate between a stall and start condition. If the motor is spinning, then the relay will not trip on the normal locked rotor time allowing the motor to start.

Remote/differential Trip

The digital inputs can be programmed to accept a contact input from a separate differential relay or other device to trip the motor. This provides local and remote target information and utilizes the trip contacts of the EMR-4000 motor protection relay. It will also record and log the motor information at the time of the trip.

Breaker Failure or Stuck Contactor

The EMR-4000 motor protection relay includes a breaker failure (50BF, 62BF) function that can be initiated from either an internal or external trip signal. This is an independent element that can be used to operate a lockout relay or trip an upstream breaker. The timer must be longer than the breaker operating time and the protective function reset times.

Flexible Phase Rotation

The EMR-4000 motor protection relay can be applied on either an A-B-C or A-C-B phase rotation. A user setting permits correct operation and indication of the actual system configuration.

Maintenance Mode

The Maintenance Mode can improve safety by providing a simple and reliable method to reduce fault clearing time and lower incident energy levels at energized panels. The Maintenance Mode allows the user to switch to more sensitive settings via a password protected soft key, communication or via a digital Input while maintenance work is being performed at an energized panel or device. The more sensitive settings provide greater security for maintenance personnel and helps reduce the possibility of injury.

Diagnostic Features**Broken Rotor Bar**

The EMR-4000 provides advanced motor diagnostics including a broken rotor bar detection function. The broken rotor bar detection is a condition maintenance function that continuously monitors the motor's health while in operation. The advanced Motor Current Signature Analysis (MCSA) continuously analyzes the motor current signature and based on preset algorithms will determine when a broken rotor bar is present in the motor.

The broken rotor bar function will provide early detection of any rotor problems and advise maintenance personnel of the impending issue allowing for predictive maintenance of the motor and prevention of catastrophic motor failures.

By providing early indication of potential rotor problems, serious system issues such as: reduced starting torque, overloads, torque and speed oscillation and bearing wear can be avoided. With the advanced broken rotor bar detection system, advanced warning of impending problems reduces catastrophic failures, maximizing motor life and system uptime.

Protection Features

- Thermal protection (49/51)
 - Locked rotor protection (49S/51)
- Phase overcurrent elements:
 - Two instantaneous elements with timers (50P[1], 50P[2] and 50P[3])
 - Three inverse time overcurrent elements (51P[1], 51P[2] and 51P[3])
 - 11 standard curves
 - Instantaneous or time delay reset
- Ground overcurrent elements:
 - Two instantaneous measured elements with timers (50X[1] and 50X[2])
 - Two instantaneous calculated elements with timers (50R[1] and 50R[2])
 - Two inverse time overcurrent measured elements (51X[1] and 51X[2])
 - Two inverse time overcurrent calculated elements (51R[1] and 51R[2])
 - 11 standard curves
 - Instantaneous or time delay reset
- Jam or Stall protection (50J[1], 50J[2])
- Phase unbalance negative sequence overcurrent (46[1], 46[2])
- Underload protection (37[1], 37[2])
- Temperature protection with optional URTD (49/38)
- Stars per hour (66)
- Switch onto fault protection
- Phase voltage unbalance and sequence protection (47[1], 47[2])
- Main three-phase under/overvoltage (27M[1], 27M[2], 59M[1], 59M[2])

- Auxiliary single-phase under/overvoltage (27A[1], 27A[2], 59A[1], 59A[2])
- Six frequency elements that can be assigned to: over frequency, under frequency, rate of change, or vector surge (81[1], 81[2], 81[3], 81[4], 81[5], 81[6])
- Apparent and displacement power factor (55A[1], 55A[2], 55D[1], 55D[2])
- Forward and reverse watts (32[1], 32[2], 32[3])
- Forward and reverse vars (32V[1], 32V[2], 32V[3])
- Lockout protection (86)
- Breaker failure (50BF)
- Zone interlocking for bus protection (87B)

Metering Features

- Amperes: Positive, negative and zero sequence
- Volts: Positive, negative and zero sequence
- Phase angles
- Volt-amperes and VA demand
- Watts and kW demand
- kWh (forward, reverse, net)
- Vars and kvar demand
- kvarh (lead, lag and net)
- Power factor
- Frequency
- % THD V and I
- Magnitude THD V and I
- Minimum/maximum recording
- Trending (load profile over time)
- Minimum/maximum recording
- Temperature with remote URTD module

Monitoring Features

- Trip coil monitor
- Breaker wear primary and secondary (accumulated interrupted current)
- Oscillography (7200 cycles total)
- Trip Cause displays fault recorder data on HMI after fault event
- Fault data logs (up to 20 events)
- Sequence of events report (up to 300 events)
- Trending (load profile over time)
- Motor history
- Records the last 5 motor start profiles
- Motor start trending
- CT supervision
- VT supervision
- Clock (1 ms time stamping)

Diagnostic Features

- Broken rotor bar

Control Functions

- Transition for reduced voltage starts
- Incomplete sequence delay
- Permits numbers of cold starts
- Limits numbers of starts per hour
- Anti-backspin time delay
- Mechanical load shedding
- Zero speed switch for long acceleration motors
- Motor stop inputs
- Remote trip input
- Differential trip input
- Emergency override
- Breaker/contactors open-close/stop-start
- Remote open-close (stop-start)
- Programmable I/O
- Programmable LEDs
- Programmable logic
- Multiple setting groups

Communication Features

- Local HMI
- Password protected
- Addressable.
- IRIG-B
- Local communication port.
 - RS-232
- Remote communication port:
 - RS-485
 - Ethernet port
- Protocols:
 - Modbus-RTU (optional)
 - Modbus-TCP (optional)
 - IEC-61850 (optional)
- Configuration software

Monitoring and Metering

Sequence of Events Records

The EMR-4000 protection relay records a maximum of 300 events associated with the relay. An event is classified as a change of state as detected by the relay. These include relay pickups, dropouts, trips, contact closure, alarms, setting changes and self-diagnostic failures. Each event is date and time stamped to a 1 ms resolution. The events are stored in a FIFO in chronological order.

Trip Log

The EMR-4000 protection relay will store a maximum of 20 trip records in a FIFO trip log. Each trip record will be date and time stamped to a 1 ms resolution. The trip log record will include information on the type of fault, protection elements that operated, fault location and currents and voltages at the time of the fault.

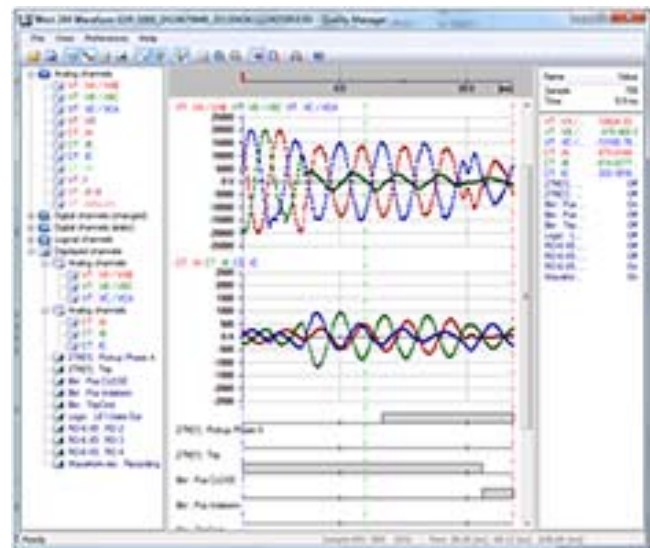
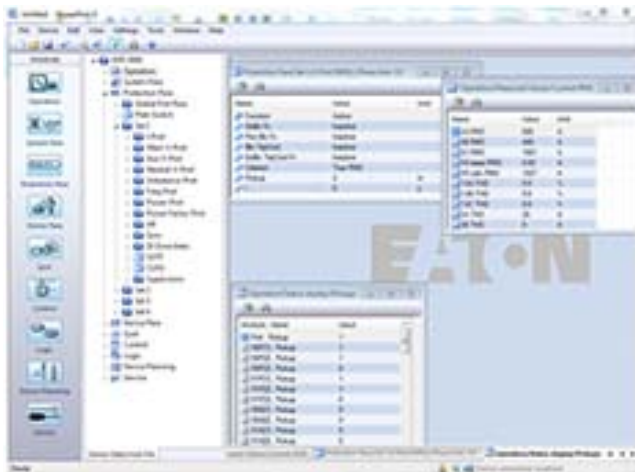
PowerPort-E

PowerPort-E is the software program used to configure off-line protection setting files for all E-Series relay models. PowerPort-E is also used for viewing measured values of the relays in real-time, uploading/downloading setting files, and retrieving event log and waveform records.

Waveform Capture (Quality Manager)

The EMR-4000 relay provides oscillographic recording capabilities. The relay will record all measured signals along with the binary signals of pickup, trip, internal logic, and contact inputs. The EMR-4000 can record up to 7200 cycles of data. The number of records is proportional to the programmed size of each record; the maximum size per record is 600 cycles. The

waveform capture is initiated by up to 8 different triggers (i.e., trip/alarm events) or manually via communications or the HMI. PowerPort-E setting software is used to retrieve the records. Quality Manager is a separate software program downloaded with PowerPort-E used for analyzing the waveform and trending files retrieved from the relay.



Integral User Interface

The front panel user interface has a 128 x 64 pixel LCD display with background illumination for wide angle viewing in all light conditions. Seven programmable LEDs provide quick and easy visual display of power on, mode of operation, alarm and trip indication. Soft keys are provided for operation mode selection, scrolling through data and settings. In addition, the relay settings and test functions are password protected.

Starting Profiles

The EMR-4000 records the average current versus time for the last five starting cycles. This information is available via the communications port through PowerPort-E

Motor Statistics

For each motor start, the EMR-4000 stores a motor start report and add this data to the motor statistics buffer. With the motor statistics you can track motor start data for the past eighteen 30-day periods. For each 30-day interval, the relay records the following information:

- The date the interval began
- The total number of starts in the interval
- The averages of the following quantities:
 - Motor start time
 - Start % rotor thermal capacity used
 - Maximum start current

Load Profiling/Trending

The EMR-4000 relay automatically records selected quantities into non-volatile memory every 5, 10, 15, 30, or 60 minutes, depending on the trending report setting.

Programmable I/O

The EMR-4000 motor protection relay provides heavy-duty, trip-rated, 2 normally open and 1 Form C contacts. One isolated inputs can be used for monitoring the trip circuit. One Form C contact is dedicated to the relay failure alarm function and is operated in a normally energized (failsafe) mode. There are 4 eight user-configurable discrete inputs that accept a wet contact and can operate through a wide range of power. Each input and output is user-programmable for maximum application flexibility.

Programmable Logic

The EMR-4000 motor protection relay provides logic gates and timers that the user can customize for special or unique applications. Each gate can be assigned a logic function of either AND, OR, NAND or NOR. Each gate can have a maximum of four input signals and each input signal can be required to be a NOT. Input signals can be external inputs received via the binary inputs or internal values associated with the protection, alarm or metering set points. Each gate has a unique output assignment and designation that can be used as the input to another gate. There are 80 independent timers that have adjustable pickup and dropout delay settings.

Standards and Certifications**Design Standards**

- Generic Standard:
 - EN 61000-6-2
 - EN 61000-6-3
- Product Standard:
 - IEC 60255-6
 - EN 50178
 - UL 508 (Industrial Control Equipment)
 - CSA C22.2 No. 14-95 (Industrial Control Equipment)
 - ANSI C37.90

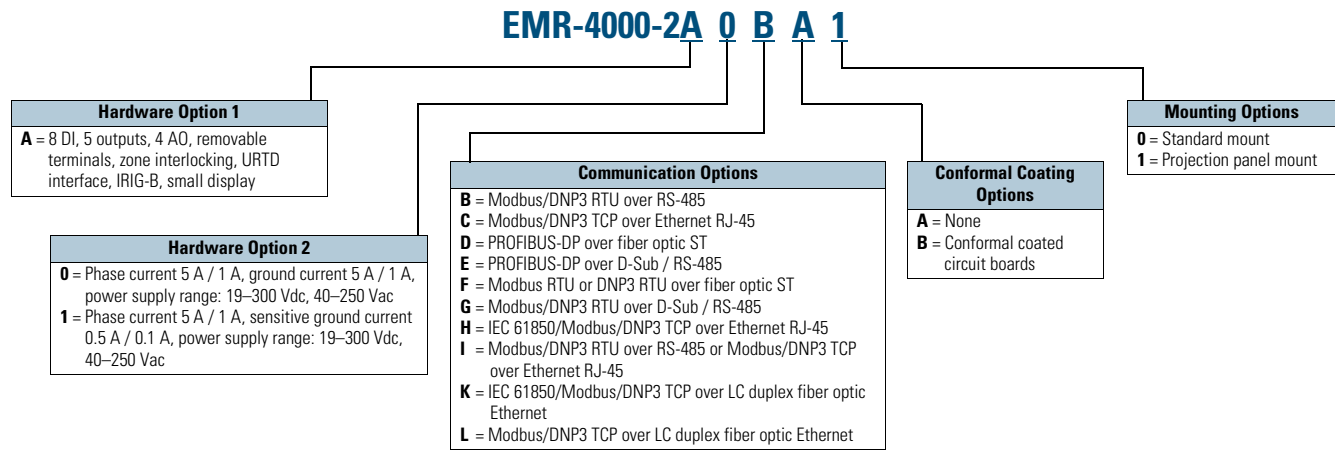


Catalog Number Selection

The catalog number identification chart defines the electrical characteristics and operation features included in the EMR-4000. For example, if the catalog number were EMR-4000-2A0BA1, the device would have the following:

- EMR-4000
- (A)–Four digital inputs, four output relays, 1 4-20 mA analog output, URTD interface
- (0)–5 A / 1 A phase and ground CTs, power supply range: 19–300 Vdc, 40–250 Vac
- (B)–Modbus-RTU (RS-485)
- (A)–Without conformal coating
- (1)–Projection panel mount

Motor Relay Removable Terminals



Accessories

Standard Accessories EMR-4000

Description	Catalog Number
UNVL RTD Mod with Modbus-RTU 48–240 Vac/48–250 Vdc	URTDII-01 ①
UNVL RTD Mod with Modbus-RTU 24–48 Vdc	URTDII-02 ①

Note

① See URTD section for fiber optic cables required to communicate to the EMR-3000.

Technical Data and Specifications

Climatic Environmental Conditions

- Storage temperature:
–30 °C to +70 °C
(–22 °F to +158 °F)
- Operating temperature:
–20 °C to +60 °C
(–4°F to +140 °F)
- Permissible humidity at ann. average: <75% rel.
(on 56d up to 95% rel.)
 - Permissible Installation
Altitude: <2,000 m
(6,561.67 ft) above sea level
- If 4,000 m (13,123.35 ft) altitude applies, a changed classification of the operating and test voltages may be necessary

Degree of Protection EN 60529

- HMI front panel with seal: IP54
- Rear side terminals: IP20

Routine Test

- Insulation test acc. to IEC 60255-5: All tests to be carried out against ground and other input and output circuits
- Aux. voltage supply, digital inputs, current measuring inputs, signal relay outputs: 2.5 kV (eff.) / 50 Hz
- Voltage measuring Inputs: 3.0 kV (eff.) / 50 Hz
- All wire-bound communication interfaces: 1.5 kV DC

Housing

- Housing B2: height / width 183 mm (7.205 in) / 212.7 mm (8.374 in)
- Housing depth (Incl. Terminals): 208 mm (8.189 in)
- Material, housing: aluminum extruded section
- Material, front panel: aluminum/foil front
- Mounting position: horizontal (±45° around the X-axis must be permitted)
- Weight: approx. 4.2 kg (9.259 lb)

Current and Ground Current Measurement

- Nominal currents: 1 A / 5 A
- Max. measuring range:
 - Up to 40 x In (phase currents)
 - Up to 25 x In (ground current standard)
 - Up to 2.5 x In (ground current sensitive)
- Continuous loading capacity: 4 x In / continuously
- Overcurrent proof:
 - 30 x In / 10 s
 - 100 x In / 1 s
 - 250 x In / 10 ms (1 half-wave)
- Power consumption:
 - Phase current inputs
At In= 1 A S=0.15 MVA
At In= 5 A S=0.15 MVA
 - Ground Current Input
At In= 1 A S=0.35 MVA
At In= 5 A S=0.35 MVA
- Frequency range: 50 Hz / 60 Hz ±10%
- Terminals: screw-type terminals with integrated short-circuiters (contacts)
- Connection cross sections:
 - 1 x or 2 x 2.5 mm² (2 x AWG 14) with wire end ferrule
 - 1 x or 2 x 4.0 mm² (2 x AWG 12) with ring cable sleeve or cable sleeve
 - 1 x or 2 x 6 mm² (2 x AWG 10) with ring cable sleeve or cable sleeve
 - The current measuring board's terminal blocks may be used as with 2 (double) conductors AWG 10,12,14 otherwise with single conductors only

Plug-in Connector with Integrated Short-Circuiter (Conventional Current Inputs)

- Nominal currents: 1 A / 5 A
- Continuous loading Capacity: 4 x In / continuously
- Overcurrent withstand:
 - 30 x In / 10 s
 - 100 x In / 1 s
 - 250 x In / 10 ms (1 half-wave)
- Screws: M4, captive type acc. to VDEW
- Connection cross sections:
 - 1 x or 2 x 2.5 mm² (2 x AWG 14) with wire end ferrule
 - 1 x or 2 x 4.0 mm² (2 x AWG 12) with ring cable sleeve or cable sleeve
 - 1 x or 2 x 6 mm² (2 x AWG 10) with ring cable sleeve or cable sleeve
 - The current measuring board's terminal blocks may be used as with 2 (double) conductors AWG 10,12,14 otherwise with single conductors only

Control Power Supply

- Aux. voltage: 240–270 Vdc / 48–230 Vac (–20/+10%)
- Buffer time in case of supply failure: ≥50 ms at minimal aux. voltage Interrupted communication is permitted
- Max. permissible making current:
 - 18 A peak value for <0.25 ms
 - 12 A peak value for <1 ms
- The voltage supply must be protected by a fuse of:
 - 2.5 A time-lag miniature fuse approx. 1/5 x 0.8 in (5 x 20 mm) according to IEC 60127
 - 3.5 A time-lag miniature fuse approx. 1/4 x 1 1/4 in (6.3 x 32 mm) according to UL 248-14

Voltage and Residual Voltage Measurement

- Nominal voltages: 100 V / 110 V / 230 V / 400 V (can be configured)
- Max. measuring range: 2 x nominal voltage
- Continuous loading capacity: 2 x nominal voltage (800 Vac)
- Power Consumption:
 - at Vn = 100 V S = 0.1 MVA
 - at Vn = 110 V S = 0.1 MVA
 - at Vn = 230 V S = 0.4 MVA
 - at Vn = 400 V S = 1.0 MVA
- Frequency range: 50 Hz or 60 Hz ±10%
- Terminals: screw-type terminals

Frequency Measurement

- Nominal Frequencies: 50 Hz / 60 Hz

Voltage Supply

- Aux. Voltage: 24–270 Vdc / 48–230 Vac (–20/+10%)
- Buffer time in case of supply failure:
 - ≥50 ms at minimal aux. voltage
 - Interrupted communication is permitted.
- Max. permissible making current:
 - 18 A peak value for 0.25 ms
 - 12 A peak value for 1 ms
- The voltage supply must be protected by a fuse of:
 - 2.5 A time-lag miniature fuse approx. 5 x 20 mm (0.2 x 0.8 in) according to IEC 60127
 - 3.5 A time-lag miniature fuse approx. 6.3 x 32 mm (0.25 x 1.25 in) according to UL 248-14

Power Consumption

- Power supply range: 24–270 Vdc
 - Power consumption in idle mode—7 W
 - Maximum power consumption—13 W
- Power supply range: 48–230 Vac (for frequencies of 40–70 Hz)
 - Power consumption in idle mode—7 W
 - Maximum power consumption—13 W

Display

- Display Type: LCD with LED background illumination
- Resolution—graphics display: 128 x 64 pixel
- LED type: two colored: red/green
- Number of LEDs, housing B2: 15

Front Interface

- Baud Rates: 115,200 baud
- Handshake: RTS and CTS
- Connection: 9-pole D-Sub plug

Real Time Clock

- Running reserve of the real time clock: 1 year min.

Digital Inputs

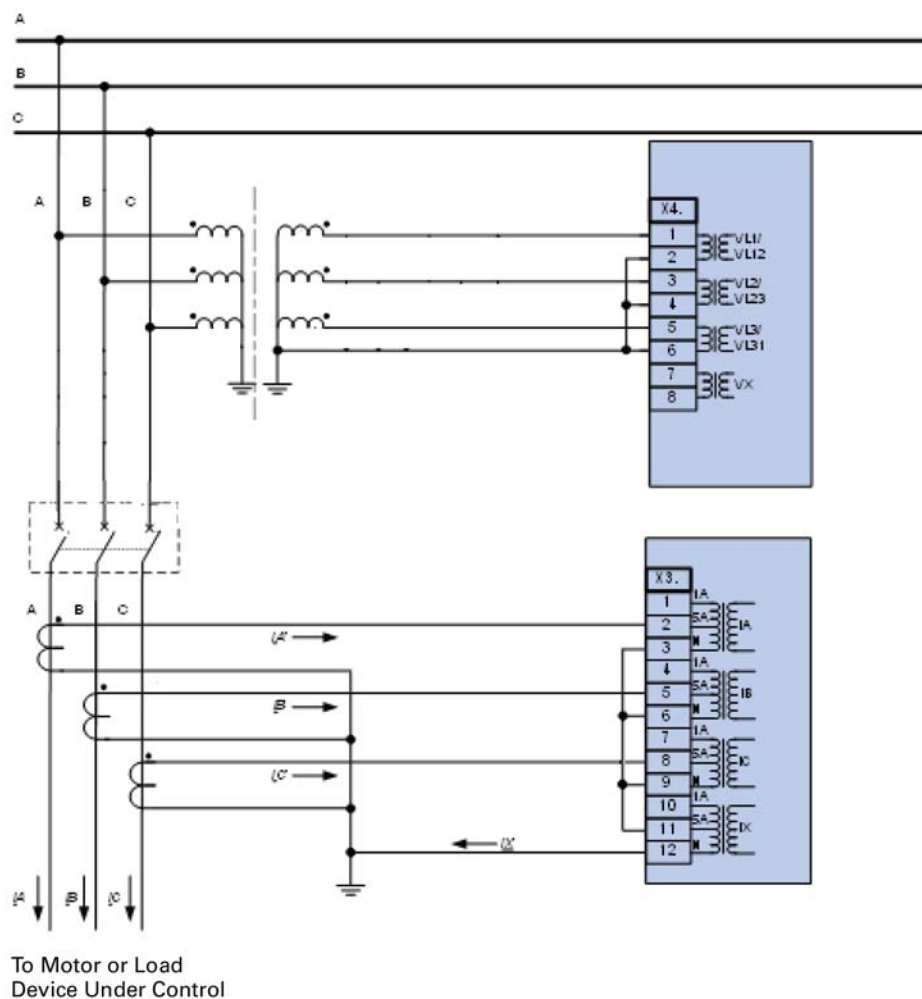
- Max. input voltage: 300 Vdc / 259 Vac
- Input current: <4 mA
- Reaction time: <20 ms
- Fallback time: <30 ms
- (Safe State of the Digital Inputs)
- Four switching thresholds:
 - Un = 24 Vdc, 48 Vdc, 60 Vdc, 110 Vac / Vdc, 230 Vac / Vdc
 - Un = 24 Vdc
 - Switching threshold 1 ON: Min. 19.2 Vdc
 - Switching threshold 1 OFF: Max. 9.6 Vdc
 - Un = 48 V / 60 Vdc
 - Switching threshold 2 ON: Min. 42.6 Vdc
 - Switching threshold 2 OFF: Max. 21.3 Vdc
 - Un = 110 / 120 Vac / Vdc
 - Switching threshold 3 ON: Min. 88.0 Vdc / 88.0 Vac
 - Switching threshold 3 OFF: Max. 44.0 Vdc / 44.0 Vac
 - Un = 230 / 240 Vac / Vdc
 - Switching threshold 4 ON: Min. 184 Vdc / 184 Vac
 - Switching threshold 4 OFF: Max. 92 Vdc / 92 Vac
- Terminals: screw-type terminal

Relay Outputs

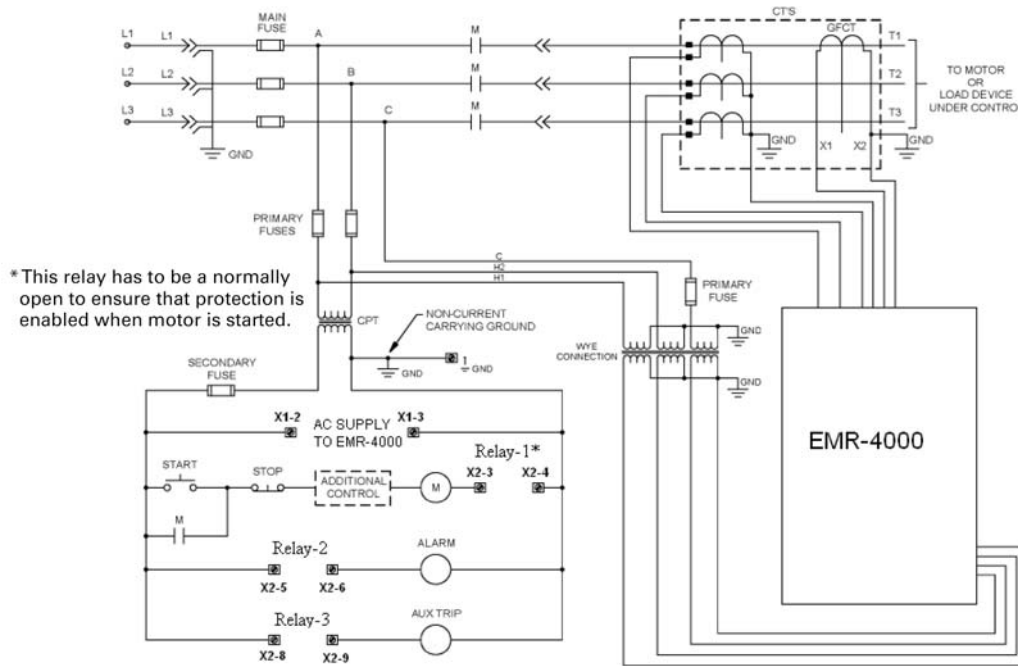
- Continuous current: 5 A AC/DC
- Max. make current:
 - 25 A AC / 25 A DC up to 30 V for 4 s
 - 30 A / 230 Vac according to ANSI IEEE Std C37.90-2005
 - 30 A / 250 Vdc according to ANSI IEEE Std C37.90-2005
- Max. breaking current:
 - 5 A AC up to 250 Vac
 - 5 A DC up to 30 V (resistive)
 - 0.3 A DC at 300 V
- Max. switching voltage: 250 Vac / 250 Vdc
- Switching capacity: 1250 VA
- Contact Type: Form C or normally open contact
- Terminals: screw-type terminals

Wiring Diagrams

Typical AC Connections, Wye VTs 5 A CTs and Ground Current Measured by Residual Connection

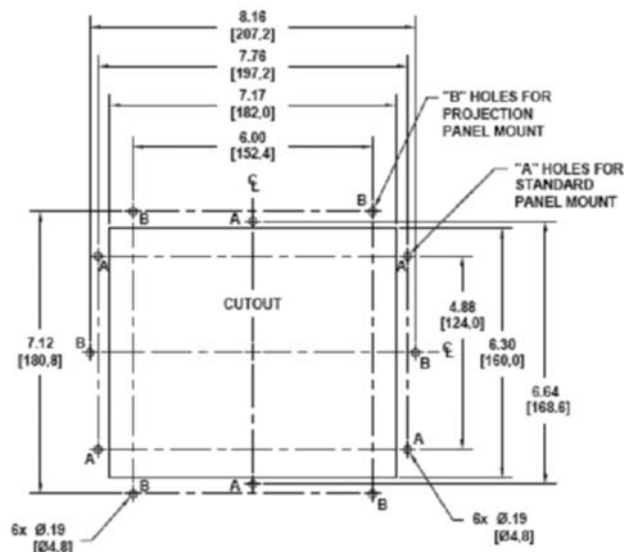
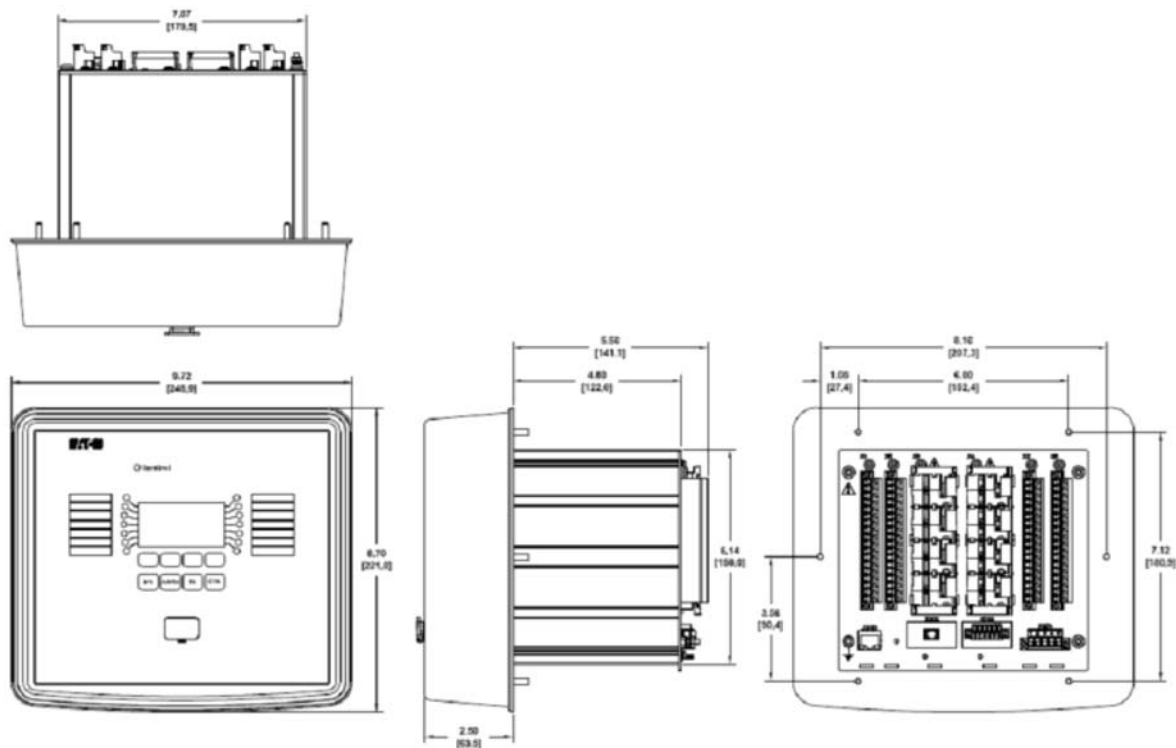


Typical Control Diagram



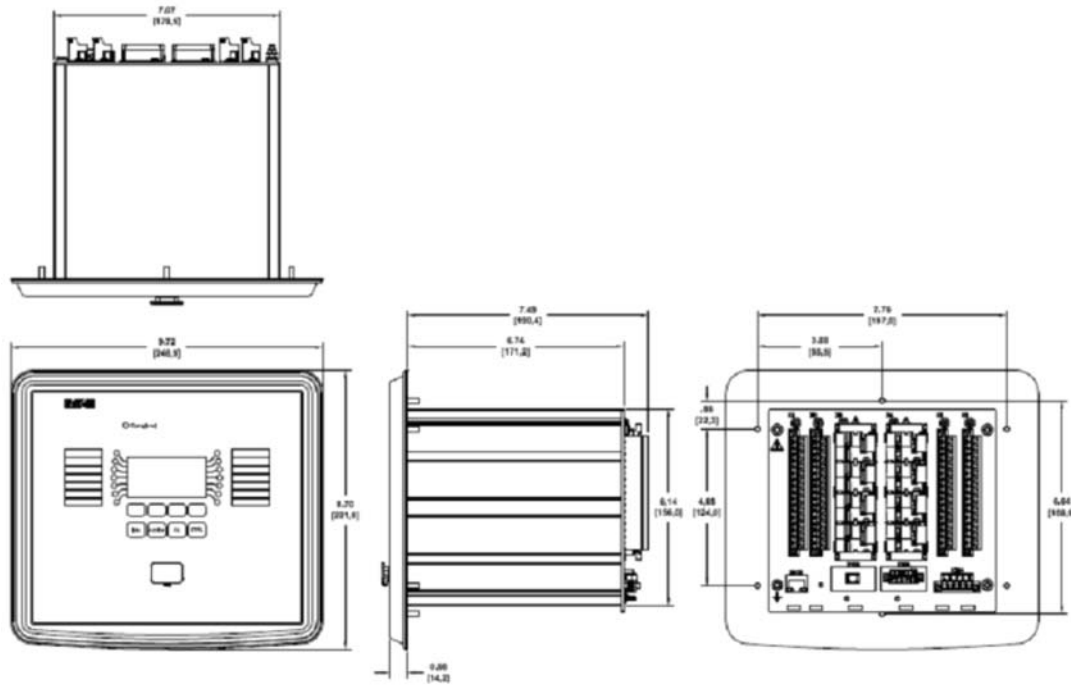
Dimensions

Approximate Dimensions in Inches (mm)

Drilling Plan**Projection Mount Front and Side Views**

Approximate Dimensions in Inches (mm)

Standard Mount Front and Side Views



EMR-5000 Motor Protection Relay**Contents****Description**

	Page
Product Selection Guide	V3-T9-53
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EDR-5000 Distribution Protection Relay	V3-T9-70
EBR—Line Differential Relay	V3-T9-83
EMR-3MP0 Motor Protection Relay	V3-T9-85
EMR-3000 Motor Protection Relay	V3-T9-87
EMR-4000 Motor Protection Relay	V3-T9-99
EMR-5000 Motor Protection Relay	V3-T9-124
ETR-4000 Transformer Protection Relay	V3-T9-136
ETR-5000 Transformer Protection Relay	V3-T9-149
EGR-5000 Generation Protection Relay	V3-T9-162
Universal RTD Module	

EMR-5000 Motor Protection Relay**Product Description**

Eaton's EMR-5000 motor protection relay is a multifunctional microprocessor-based protective relay for the protection of any size motor at all voltage levels. It is most commonly applied on medium voltage or larger motors. The EMR-5000 relay is a current and voltage device with built-in differential protection that provides complete and reliable motor protection, monitoring, diagnostics, metering and starting control functions.

The EMR-5000 motor protection relay provides complete current, voltage, and frequency protection in a single compact case. The relay has eight current inputs rated for either 5 amperes or 1 ampere and four voltage inputs. Three of the voltage inputs are to be connected to the three-phase power voltage for voltage protection and for metering. They can be connected in wye-ground or open delta configuration.

The fourth voltage is for independent single-phase undervoltage/overvoltage protection. The unit is capable of 60 Hz or 50 Hz operation.

The maintenance mode password protected soft key, can be used for arc flash mitigation to change to an alternate settings group, set to have instantaneous elements only. The multiple setting groups can also be changed, via communications or a digital input. Flash memory is used for the programming and all settings are stored in nonvolatile memory.

An integral keypad and display is provided for direct user programming and retrieval of data without the need of a computer. Fourteen programmable LEDs provide quick indication of relay status.

A front port is provided for direct computer connection. An RS-485 and an Ethernet ports in the back are optional for local area networking using. Optional Modbus-RTU, Modbus-TCP or IEC-61850 protocols are supported.

The EMR-5000 motor protection relay includes programmable logic functions. Logic gates and timers may be defined and arranged for customized applications. With the programmable logic control functions you can simplify the complexity of your starting schemes by eliminating timers and auxiliary relays. Flash memory is used for the programming and all settings are stored in nonvolatile memory. The relay allows for four preprogrammed setting groups that can be activated through software, manually, or contact input.

The EMR-5000 motor protection relay has mass memory for data storage and a real-time clock with 1 ms time resolution. The relay will log 300 sequence of event records, 20 detailed trip logs, minimum/maximum values, load profiles, the 5 latest start profiles, motor trending, breaker/contact wear information and waveform data.

The EMR-5000 has either eight programmable binary inputs, two analog inputs, two analog outputs, or 16 programmable binary inputs. It has 2NO and six Form C heavy-duty outputs and one form C signal alarm relay. The relay provides maximum user flexibility to configure the I/O. All inputs and outputs (except the healthy output) are user-programmable. The unit also counts with a test mode to force outputs and simulate currents, to facilitate the commissioning of the unit. It can be powered from 19 Vdc to 300 Vdc or 40 Vac to 250 Vac auxiliary power.

Application Description

Eaton's EMR-5000 motor protection relay has been designed for maximum motor operation and protection. It permits running the motor close to its design limits while protecting it against excessive heating and damaging overload conditions. The EMR-5000 field proven protection algorithms were developed based on motor designs and operating parameters for optimum operation and protection while minimizing nuisance tripping. The EMR-5000 motor protection relay utilizes a patented protection algorithm and measurement technique based on proven positive and negative (unbalance) sequence current sampling and true rms calculations.

Intel-I-Trip (I^2t) Overload Protection

The EMR-5000 motor relay features the exclusive Eaton Intel-I-Trip intelligent overload protection system. Intel-I-Trip develops custom overload curves simply from motor nameplate data. Intel-I-Trip protects motors from potentially damaging overload and abnormal operating conditions. The Intel-I-Trip intelligent overload protection feature utilizes field proven measurement techniques and a patented motor thermal protection model. The EMR-5000 motor relay's unique measurement technique samples the current waveforms 36 times per cycle, providing accurate measurements of the positive and negative sequence currents. The negative sequence current causes a greater heating effect on the rotor and has a greater impact on the thermal model in the relay. Intel-I-Trip utilizes these measurements in its motor model to safely protect the motor against the heating effects of these currents.

The motor thermal model is analogous to a bucket that is being filled and drained at the same time. The fill rate is dependent on the motor currents and the drain is based on motor design principles. The size of the bucket is equivalent to the thermal capacity associated with the mass of the motor. Intel-I-Trip integrates these rates and will issue a trip when the thermal capacity is filled.

Intel-I-Trip features adaptive trip characteristics that adjust the trip times based on measured motor temperature when RTDs are used.

Instantaneous Overcurrent

The EMR-5000 motor protection relay provides an instantaneous phase overcurrent function to trip the motor for high fault current levels and save the fuses. This function can be disabled and has an adjustable time delay on starting to avoid nuisance tripping on inrush.

Differential Protection

This protection function is mostly used to protect induction and synchronous motors against phase-to-phase faults. Differential protection may be considered the first line of protection for internal phase to phase or phase to ground faults. In the event of such faults, the quick response of the differential element may limit the damage that may have otherwise occurred to the motor. While this protection is recommended in all motors above 1500 hp, it can be used in smaller motors depending primarily in the importance and the cost of the motor.

Phase Unbalance Protection

Motor supply circuits are often fed through fuses and can be run with a single-phase fuse blown, referred to as single phasing the motor. The EMR-5000 motor protection relay measures the current and voltage unbalance and either can be used to alarm or trip the motor before damage occurs. The EMR-5000 has two voltage and two current unbalance elements. Pickup, start and run timers are provided for each element.

Ground Fault Protection

A separate measuring circuit is used to measure ground current. A ground CT is recommended for more sensitive protection against winding insulation breakdown to ground. The relay ground circuit can be connected residually from the three-phase CTs. The ground fault protection has pickup and time delay set points or can be disabled.

Jam Protection

The user-selectable Jam function protects motors that are running against a sudden mechanical jam or stall condition. The common application is on motors used on crushers, chippers, or conveyors. It detects an increase of motor current to a level above full load. Pickup, start, and run timers and a second element for alarm purposes are provided.

Underload/Underpower Protection

The user selectable underload/underpower function is used to detect the loss of load on the motor. Coupling failure is a common cause for loss of load. Whenever is possible, it is better to use underpower to detect loss of load. Three power elements and two underload elements are provided in the relay for tripping and alarm purposes. Pickup, start and run timers are provided for each element.

Frequency Protection

The frequency elements provide the ability to detect when the motor is operating at off-nominal frequencies that can do damage to the process or, to signal to upstream protections or controls to implement load shedding actions.

Power Factor Protection

This protection is used in synchronous motors applications to detect out-of-synchronism conditions.

Undervoltage/Overvoltage Protection

Use the voltage protective functions to detect abnormal system voltage conditions potentially hazardous to the motor.

Reduced Voltage Starting

The EMR-5000 motor protection relay provides a transition and incomplete sequence function for reduced voltage starting. The user can select to transition based on the current level and/or on time.

Antibackspin

The stop function is programmable from 2–20%. For certain applications, such as pumping a fluid up a pipe, the motor may be driven backward for a period of time after it stops. The EMR-5000 relay provides an antibackspin timer to prevent starting the motor while it is spinning in the reverse direction. The timer begins counting from the moment a stop is declared by the relay.

Start Control Timers

Motors typically have limits to the number of cold starts, starts per hour period, or time between starts that are permitted without damage. The EMR-5000 motor protection relay incorporates these timers to prevent starting the motor beyond its capabilities.

Load Shedding

The EMR-5000 motor protection relay provides a mechanical load shedding feature that can be used to control an upstream process. The load-shedding function closes a contact on an overload condition to control an upstream process from adding more load until the overload condition is gone.

Emergency Override

The EMR-5000 motor protection relay has a user-programmable feature that will let the operator reset the start inhibitor timers and thermal overload bucket. This function is intended for use in emergency conditions only, and it may result in motor damage or failure.

Long Acceleration Motors

Large motors with a high inertia may experience starting currents that exceed the locked rotor current and time. The EMR-5000 motor protection relay has logic and provisions for a zero speed switch input to differentiate between a stall and start condition. If the motor is spinning, then the relay will not trip on the normal locked rotor time allowing the motor to start.

Remote/Differential Trip

The digital inputs can be programmed to accept a contact input from a separate differential relay or other device to trip the motor. This provides local and remote target information and utilizes the trip contacts of the EMR-5000 motor protection relay. It will also record and log the motor information at the time of the trip.

Breaker Failure or Stuck Contactor

The EMR-5000 motor protection relay includes a breaker failure (50BF, 62BF) function that can be initiated from either an internal or external trip signal. This is an independent element that can be used to operate a lockout relay or trip an upstream breaker. The timer must be longer than the breaker operating time and the protective function reset times.

Flexible Phase Rotation

The EMR-5000 motor protection relay can be applied on either an A-B-C or A-C-B phase rotation. A user setting permits correct operation and indication of the actual system configuration.

Maintenance Mode

The Maintenance Mode can improve safety by providing a simple and reliable method to reduce fault clearing time and lower incident energy levels at energized panels. The Maintenance Mode allows the user to switch to more sensitive settings via a password protected soft key, communication or via a digital Input while maintenance work is being performed at an energized panel or device. The more sensitive settings provide greater security for maintenance personnel and helps reduce the possibility of injury.

Features, Benefits and Functions

Protection Features

- Motor differential protection (87M)
- Thermal protection (49/51)
 - Locked rotor protection (49S/51)
- Phase overcurrent elements:
 - Two instantaneous elements with timers (50P[1], 50P[2] and 50P[3])
 - Three inverse time overcurrent elements (51P[1], 51P[2] and 51P[3])
 - 11 standard curves
 - Instantaneous or time delay reset
- Ground overcurrent elements:
 - Two instantaneous measured elements with timers (50X[1] and 50X[2])
 - Two instantaneous calculated elements with timers (50R[1] and 50R[2])
 - Two inverse time overcurrent measured elements (51X[1] and 51X[2])
 - Two inverse time overcurrent calculated elements (51R[1] and 51R[2])
 - 11 standard curves
 - Instantaneous or time delay reset
- Jam or Stall protection (50J[1], 50J[2])
- Phase unbalance negative sequence overcurrent (46[1], 46[2])
- Underload protection (37[1], 37[2])
- Temperature protection with optional URTD (49/38)
- Stars per hour (66)
- Switch onto fault protection
- Phase voltage unbalance and sequence protection (47[1], 47[2])
- Main three-phase under/overvoltage (27M[1], 27M[2], 59M[1], 59M[2])
- Auxiliary single-phase under/overvoltage (27A[1], 27A[2], 59A[1], 59A[2])

- Six frequency elements that can be assigned to: over frequency, under frequency, rate of change, or vector surge (81[1], 81[2], 81[3], 81[4], 81[5], 81[6])
 - Apparent and displacement power factor (55A[1], 55A[2], 55D[1], 55D[2])
- Forward and reverse watts (32[1], 32[2], 32[3])
- Forward and reverse vars (32V[1], 32V[2], 32V[3])
- Lockout protection (86)
- Breaker failure (50BF)
- Zone interlocking for bus protection (87B)

Metering Features

- Amperes: Positive, negative and zero sequence
- Volts: Positive, negative and zero sequence
- Differential current
- Volt-amperes and VA demand
- Watts and kW demand
- kWh (forward, reverse, net)
- Vars and kvar demand
- kvarh (lead, lag and net)
- Power factor
- Frequency
- % THD V and I
- Magnitude THD V and I
- Minimum/maximum recording
- Trending (load profile over time)
- Minimum/maximum recording
- Temperature with remote URTD module

Monitoring Features

- Trip coil monitor
- Breaker wear primary and secondary (accumulated interrupted current)
- Oscillography (7200 cycles total)
- Trip Cause displays fault recorder data on HMI after fault event
- Fault data logs (up to 20 events)

- Sequence of events report (up to 300 events)
- Trending (load profile over time)
- Motor history
- Records the last 5 motor start profiles
- Motor start trending
- CT supervision
- VT supervision
- Clock (1 ms time stamping)

Diagnostic Features

- Broken rotor bar

Control Functions

- Transition for reduced voltage starts
- Incomplete sequence delay
- Permits numbers of cold starts
- Limits numbers of starts per hour
- Anti-backspin time delay
- Mechanical load shedding
- Zero speed switch for long acceleration motors
- Motor stop inputs
- Remote trip input
- Emergency override
- Breaker/Contactor open-close/stop-start
- Remote open-close (stop-start)
- Programmable I/O
- Programmable LEDs
- Programmable Logic
- Multiple setting groups

Communication Features

- Local HMI
- Password protected
- Addressable
- IRIG-B
- Local communication port:
 - RS-232
- Remote communication port:
 - RS-485
 - Ethernet port
- Protocols:
 - Modbus-RTU (Optional)
 - Modbus-TCP (Optional)
 - IEC-61850 (Optional)
- Configuration software

Diagnostic Features

Broken Rotor Bar

The EMR-5000 provides advanced motor diagnostics including a broken rotor bar detection function. The broken rotor bar detection is a condition maintenance function that continuously monitors the motor's health while in operation. The advanced Motor Current Signature Analysis (MCSA) continuously analyzes the motor current signature and based on preset algorithms will determine when a broken rotor bar is present in the motor.

The broken rotor bar function will provide early detection of any rotor problems and advise maintenance personnel of the impending issue allowing for predictive maintenance of the motor and prevention of catastrophic motor failures.

By providing early indication of potential rotor problems, serious system issues such as: reduced starting torque, overloads, torque and speed oscillation and bearing wear can be avoided. With the advanced broken rotor bar detection system, advanced warning of impending problems reduces catastrophic failures, maximizing motor life and system uptime.

Monitoring and Metering

Sequence of Events Records

The EMR-5000 protection relay records a maximum of 300 events associated with the relay. An event is classified as a change of state as detected by the relay. These include relay pickups, dropouts, trips, contact closure, alarms, setting changes and self-diagnostic failures. Each event is date and time stamped to a 1 ms resolution. The events are stored in a FIFO in chronological order.

Trip Log

The EMR-5000 protection relay will store a maximum of 20 trip records in a FIFO trip log. Each trip record will be date and time stamped to a 1 ms resolution. The trip log record will include information on the type of fault, protection elements that operated, fault location and currents and voltages at the time of the fault.

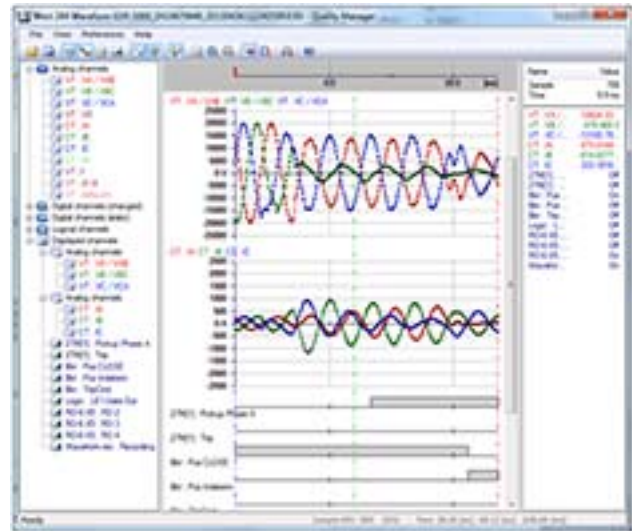
PowerPort-E

PowerPort-E is the software program used to configure off-line protection setting files for all E-Series relay models. PowerPort-E is also used for viewing measured values of the relays in real-time, uploading/downloading setting files, and retrieving event log and waveform records.

Waveform Capture (Quality Manager)

The EMR-5000 relay provides oscillographic recording capabilities. The relay will record all measured signals along with the binary signals of pickup, trip, internal logic, and contact inputs. The EMR-5000 can record up to 7200 cycles of data. The number of records is proportional to the programmed size of each record; the maximum size per record is 600 cycles.

The waveform capture is initiated by up to 8 different triggers (i.e., trip/alarm events) or manually via communications or the HMI. PowerPort-E setting software is used to retrieve the records. Quality Manager is a separate software program downloaded with PowerPort-E used for analyzing the waveform and trending files retrieved from the relay.



Waveform Capture (Quality Manager)

Integral User Interface

The front panel user interface has a 128 x 64 pixel LCD display with background illumination for wide angle viewing in all light conditions. Seven programmable LEDs provide quick and easy visual display of power on, mode of operation, alarm and trip indication. Soft keys are provided for operation mode selection, scrolling through data and settings. In addition, the relay settings and test functions are password protected.

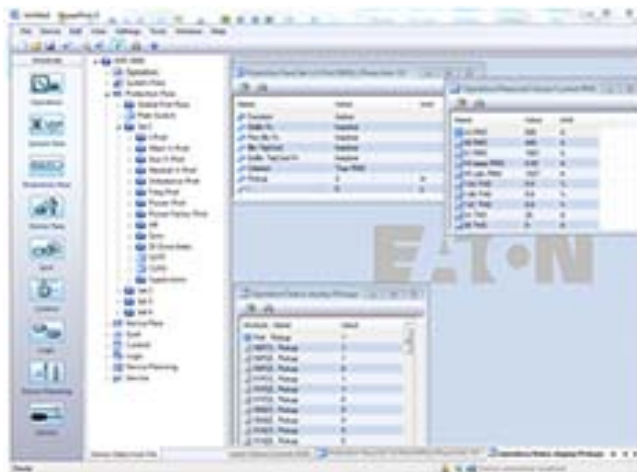
Starting Profiles

The EMR-5000 records the average current versus time for the last five starting cycles. This information is available via the communications port through PowerPort-E.

Motor Statistics

For each motor start, the EMR-5000 stores a motor start report and add this data to the motor statistics buffer. With the motor statistics you can track motor start data for the past eighteen 30-day periods. For each 30-day interval, the relay records the following information:

- The date the interval began
- The total number of starts in the interval
- The averages of the following quantities:
 - Motor start time
 - Start % rotor thermal capacity used
 - Maximum start current



PowerPort-E

Load Profiling/Trending

The EMR-5000 relay automatically records selected quantities into non-volatile memory every 5, 10, 15, 30, or 60 minutes, depending on the trending report setting.

Programmable I/O

The EMR-5000 motor protection relay provides heavy-duty, trip-rated, 2 normally open and 1 Form C contacts. One isolated inputs can be used for monitoring the trip circuit. One Form C contact is dedicated to the relay failure alarm function and is operated in a normally energized (failsafe) mode. There are 4 eight user-configurable discrete inputs that accept a wet contact and can operate through a wide range of power. Each input and output is user-programmable for maximum application flexibility.

Programmable Logic

The EMR-5000 motor protection relay provides logic gates and timers that the user can customize for special or unique applications. Each gate can be assigned a logic function of either AND, OR, NAND or NOR. Each gate can have a maximum of four input signals and each input signal can be required to be a NOT. Input signals can be external inputs received via the binary inputs or internal values associated with the protection, alarm or metering set points. Each gate has a unique output assignment and designation that can be used as the input to another gate.

Standards and Certifications

Approvals

- UL listed file: E217753

Design Standards

- Generic Standard:
 - EN 61000-6-2
 - EN 61000-6-3
- Product Standard:
 - IEC 60255-6
 - EN 50178
 - UL 508 (Industrial Control Equipment)
 - CSA C22.2 No. 14-95 (Industrial Control Equipment)
 - ANSI C37.90



Catalog Number Selection

The catalog number identification chart defines the electrical characteristics and operation features included in the EMR-5000. For example, if the catalog number is EMR-5000-2A0BA, the device would have the following:

EMR-5000

(A)—Four digital inputs, four output relays, 1 4–20 mA analog output, URTD interface

(0)—5 A / 1 A phase and ground CTs, power supply range: 19–300 Vdc, 40–250 Vac

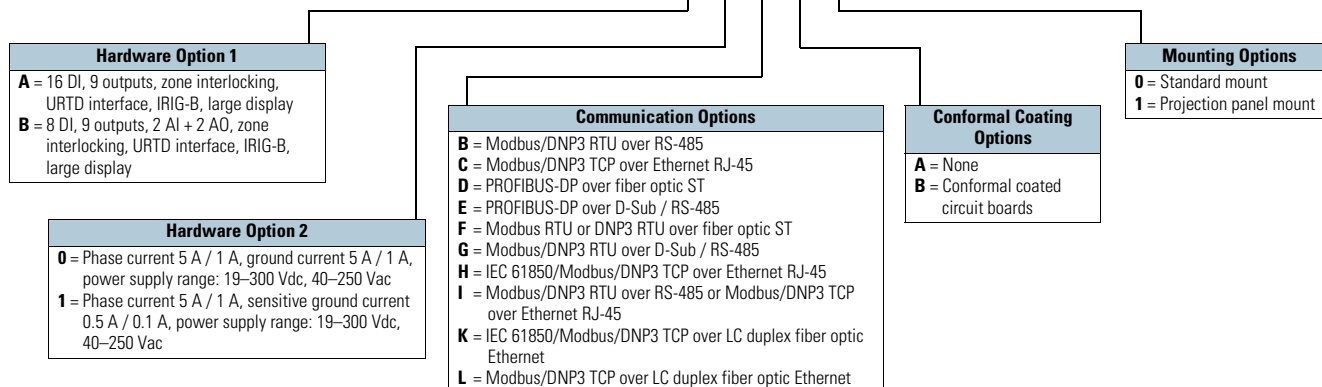
(B)—Modbus-RTU (RS-485)

(A)—Without conformal coating

(1)—Projection panel mount

EMR-5000 Eaton Motor Relay

EMR-5000-2A 0 B A 1



Technical Data and Specifications

Climatic Environmental Conditions

- Storage temperature: –30 °C to +70 °C (–22 °F to 158 °F)
- Operating temperature: –20 °C to +60 °C (–4 °F to 140 °F)
- Permissible humidity at ann. average: <75% rel. (on 56d up to 95% rel.)
- Permissible installation altitude:
 - <2,000 m (6,561.67 ft) above sea level
 - If 4,000 m (13,123.35 ft) altitude applies, a changed classification of the operating and test voltages may be necessary

Degree of Protection EN 60529

- HMI front panel with seal: IP54
- Rear side terminals: IP20

Routine Test

- Insulation test acc. to IEC60255-5: All tests to be carried out against ground and other input and output circuits
- Aux. voltage supply, digital inputs, current measuring inputs, signal relay outputs: 2.5 kV (eff.) / 50 Hz
- Voltage measuring inputs: 3.0 kV (eff.) / 50 Hz
- All wire-bound communication interfaces: 1.5 kV DC

Housing

- Housing B2: height / width 183 mm (7.205 in) / 212.7 mm (8.374 in)
- Housing depth (incl. terminals): 208 mm (8.189 in)
- Material, housing: aluminum extruded section
- Material, front panel: aluminum/foil front
- Mounting position: horizontal (±45° around the X-axis must be permitted)
- Weight: approx. 4.2 kg (9.259 lb)

Current and Ground Current Measurement

Plug-in connector with integrated short-circuiter (Conventional current inputs)

Phase and ground current inputs:

- Nominal currents: 1 A / 5 A
- Max. measuring range:
 - Up to 40 x In (phase currents)
 - Up to 25 x In (ground current standard)
- Capacity: 4 x In / continuously
- Overcurrent proof:
 - 30 x In / 10 s
 - 100 x In / 1 s
 - 250 x In / 10 ms (1 half-wave)
- Power consumption:
 - Phase current inputs
 - At In = 1 A S = 0.15 MVA
 - At In = 5 A S = 0.15 MVA
 - Ground current inputs
 - At In = 1 A S = 0.35 MVA
 - At In = 5 A S = 0.35 MVA

Sensitive ground current inputs:

- Nominal currents: 1 A / 5 A with 50:0:025 core balance CT
- Max. measuring range: up to 2.5 x In
- Capacity: 2 x In / continuously
- Overcurrent proof:
 - 10 x In / 10 s
 - 25 x In / 1 s
 - 100 x In / 10 ms (1 half-wave)
- Power consumption:
 - At In = 1 A S = 0.35 MVA
 - At In = 5 A S = 0.35 MVA
- Frequency range: 50 Hz / 60 Hz ± 10%
- Terminals: screw-type terminals with integrated short-circuiters (contacts)
- Screws: M4, captive type acc. to VDEW

- Connection cross sections:

- 1 x or 2 x 2.5 mm² (2 x AWG 14) with wire end ferrule
- 1 x or 2 x 4.0 mm² (2 x AWG 12) with ring cable sleeve or cable sleeve
- 1 x or 2 x 6 mm² (2 x AWG 10) with ring cable sleeve or cable sleeve
- The current measuring board's terminal blocks may be used as with 2 (double) conductors AWG 10,12,14 otherwise with single conductors only

Voltage and Residual Voltage Measurement

- Nominal voltages: 60–520 V (can be configured)
- Max. measuring range: 2 x nominal voltage or 800 V
- Continuous loading capacity: 800 Vac
- Power consumption:
 - at Vn = 100 V S = 0.1 MVA
 - at Vn = 110 V S = 0.1 MVA
 - at Vn = 230 V S = 0.4 MVA
 - at Vn = 400 V S = 1.0 MVA
- Nominal voltages: 60–520 V (can be configured)
- Frequency range: 50 Hz or 60 Hz ± 10%
- Terminals: screw-type terminals

Frequency Measurement

- Nominal Frequencies: 50 Hz / 60 Hz

Voltage Supply

- Aux. voltage: 24–270 Vdc / 48–230 Vac (–20/+10%)
- Buffer time in case of supply failure: ≥50 ms at minimal aux. voltage communication is permitted to be interrupted
- Max. permissible making current:
 - 18 A peak value for <0.25 ms
 - 12 A peak value for <1 ms

- The voltage supply must be protected by a fuse of:
 - 2.5 A time-lag miniature fuse 5 x 20 mm (approx. 1/5 in x 0.8 in) according to IEC 60127
 - 3.5 A time-lag miniature fuse 6.3 x 32 mm (approx. 1/4 in x 1 1/4 in) according to UL 248-14

Power Consumption

- Power supply range: 24–270 Vdc
 - Power consumption in idle mode—7 W
 - Maximum power consumption—13 W
- Power supply range: 48–230 Vac (for frequencies of 50–60 Hz)
 - Power consumption in idle mode—7 VA
 - Maximum power consumption—13 VA

Display

- Display type: LCD with LED background illumination
- Resolution graphics display: 128 x 128 pixel
- LED type: two colored, red/green
- Number of LEDs, housing B2: 15

Front Interface RS-232

- Baud rates: 115,200 baud
- Handshake: RTS and CTS
- Connection: 9-pole D-Sub plug

Real-Time Clock

- Running reserve of the real-time clock: 1 year min

Digital Inputs

- Max. Input voltage: 300 Vdc / 259 Vac
- Input current: <4 mA
- Reaction time: <20 ms
- Drop-out time:
 - Shorted inputs: <30 ms
 - Open inputs: <90 ms

Relay Output Contacts

- Continuous current: 5 A AC/DC
- Max. make current:
 - 25 A AC / 25 A DC for 4 s
 - 30 A / 230 Vac according to ANSI IEEE Std C37.90-2005
 - 30 A / 250 Vdc according to ANSI IEEE Std C37.90-2005
- Max. breaking current:
 - 5 A AC up to 240 Vac
 - 5 A DC up to 30 V (resistive)
- Continuous current: 5 A AC/DC
- Contact Type: Form C or normally open contact
- Terminals: screw-type terminals

Supervision Contact (SC)

- Continuous current: 5 A AC/DC
- Max. switch-on current: 15 A AC / 15 A DC for 4 s
- Max. breaking current:
 - 5 A AC up to 250 Vac
 - 5 A DC up to 30 Vdc (resistive)
 - 0.25 A at 250 Vdc (resistive)
- Max. switching voltage: 250 Vac / 250 Vdc
- Switching capacity: 1250 VA
- Contact type: Form C
- Terminals: screw-type terminals

Analog Outputs

The following technical data only apply to devices, which are equipped with analog outputs. Please refer to the order code of your device.

The mode of each output can be individually selected between current or voltage output. Shielded cable for the analog outputs is recommended. The terminals of the HF shield should be used, when connecting the shield to the ground on both sides of the cable is not possible. On one side of the cable the shield has to be directly connected to ground. In case of the use of unshielded twisted pair cables, the length must not exceed 10 m. All analog outputs have a common potential. Each output has an own common terminal.

- Current mode
 - Range: 0–20 mA
 - Max. load resistance: 1 k ohm
- Voltage mode range: 0–10 V maximum output current 20 mA
- Accuracy 0.5% of the nominal value 20 mA resp. 10 V
- Influence of temperature to accuracy: <1% (within the range of 0 °C to +60 °C (+32 °F to +140 °F))
- Test voltage of outputs (one group) against other electrical groups: 2.5 kV
- Test voltage of outputs (one group) against ground: 1.0 kV

Time Synchronization IRIG-B00X

- Nominal Input Voltage: 5 V
- Connection: screw-type terminals (twisted pair)

Zone Interlocking

- Zone Out:
 - Output voltage (High): 4.75 to 5.25 Vdc
 - Output voltage (Low): 0.0 to +0.5 Vdc
- Zone In:
 - Nominal input voltage: +5 Vdc
 - Max. input voltage: +5.5 Vdc
 - Switching threshold ON: min. 4.0 Vdc
 - Switching threshold OFF: max. 1.5 Vdc
- Galvanic isolation: 2.5 kV AC (to ground and other IO)
- Connection: screw-type terminals (twisted pair)

RS-485

- Master/slave: slave
- Connection: 6 screw-clamping terminals RM 3.5 mm (138 MIL) (terminating resistors internal)

Fiber Optic

- Master/slave: slave
- Connection: ST-Plug

URTD-Interface

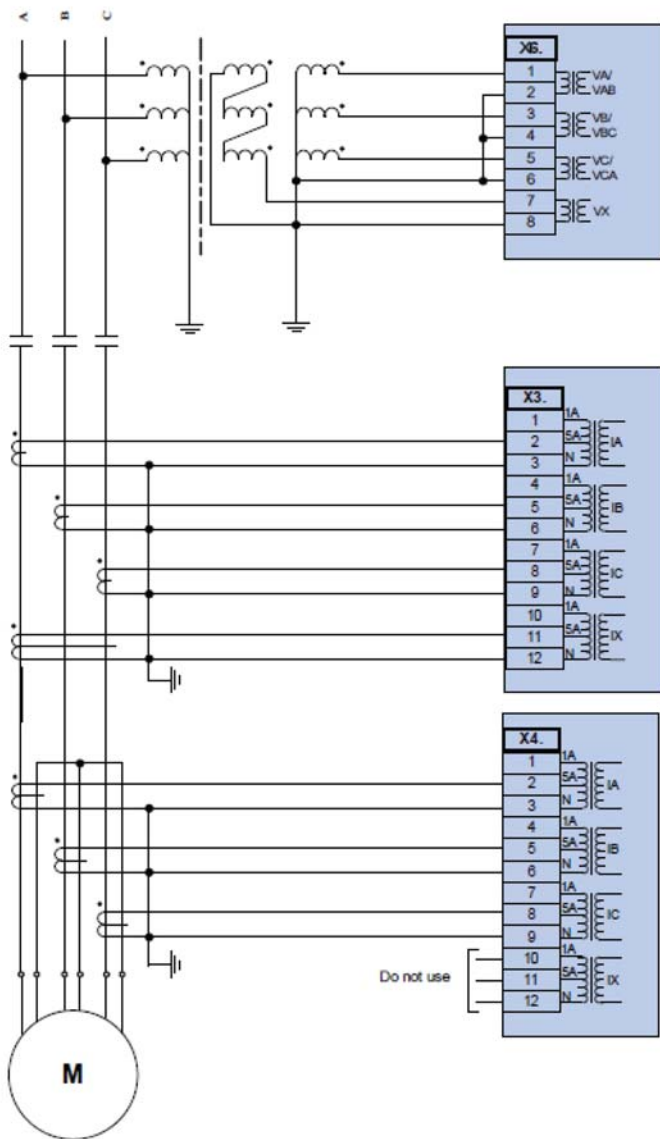
- Connection: versatile link

Boot Phase

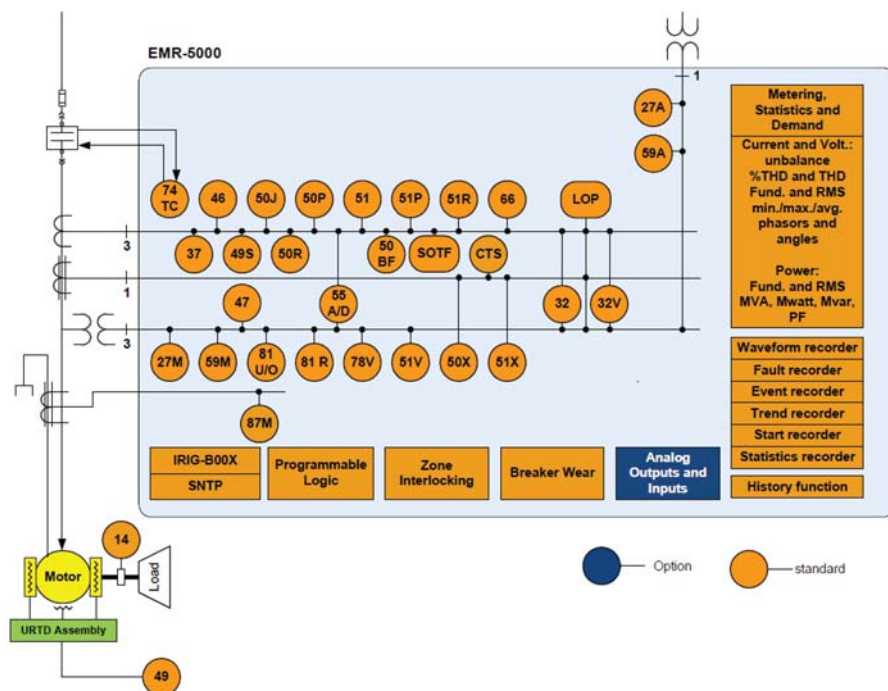
After switching on the power supply, the protection will be available in approximately 19 seconds. After approximately 165 seconds, the boot phase is completed (HMI and communication initialized).

Wiring Diagrams

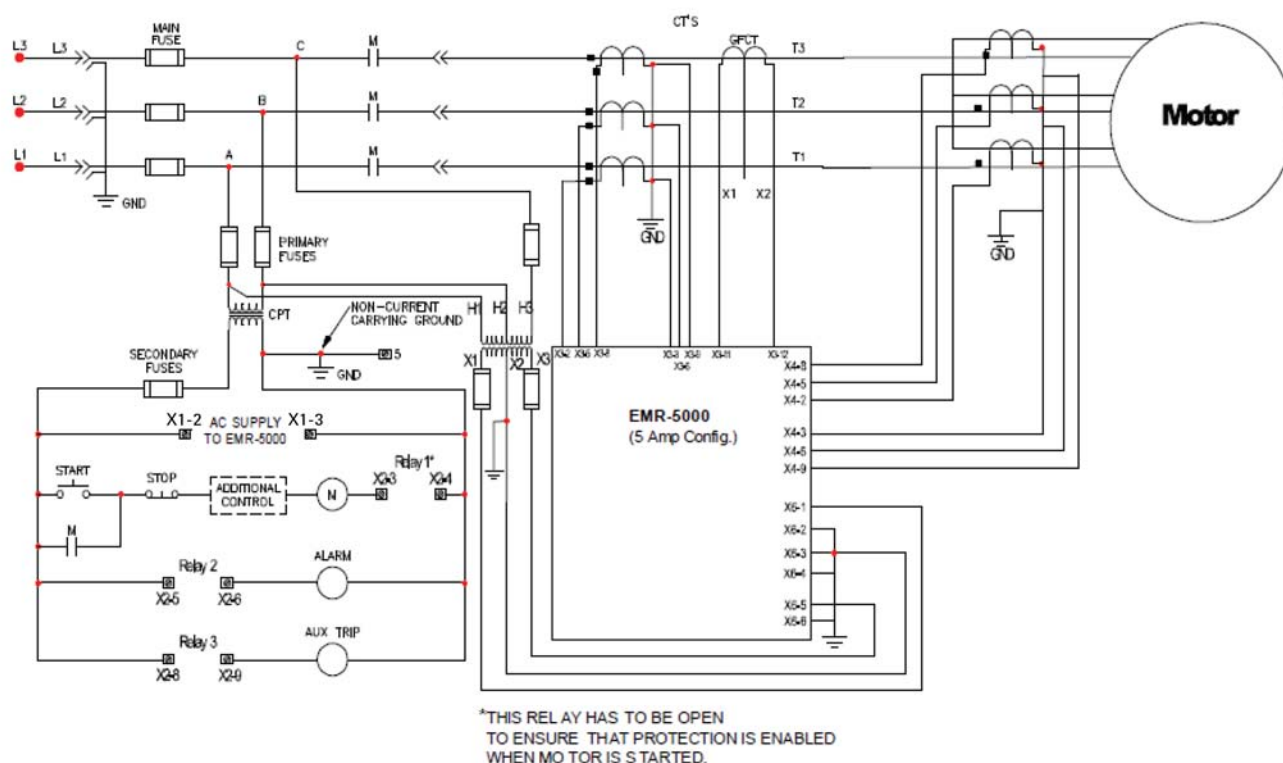
Typical AC Connections—Wye (or Delta) VTs, 5 A CTs, Ground Current Measured by 4th Zero Sequence CT, and 87 Motor Differential



Typical One-Line Diagram



Typical Control Diagram



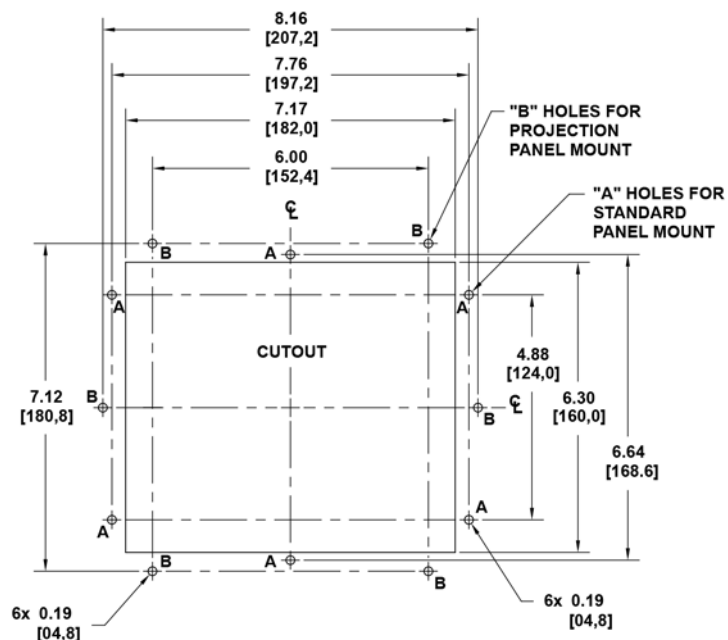
Metering Devices, Protective Relays, Software and Connectivity

Protective Relays

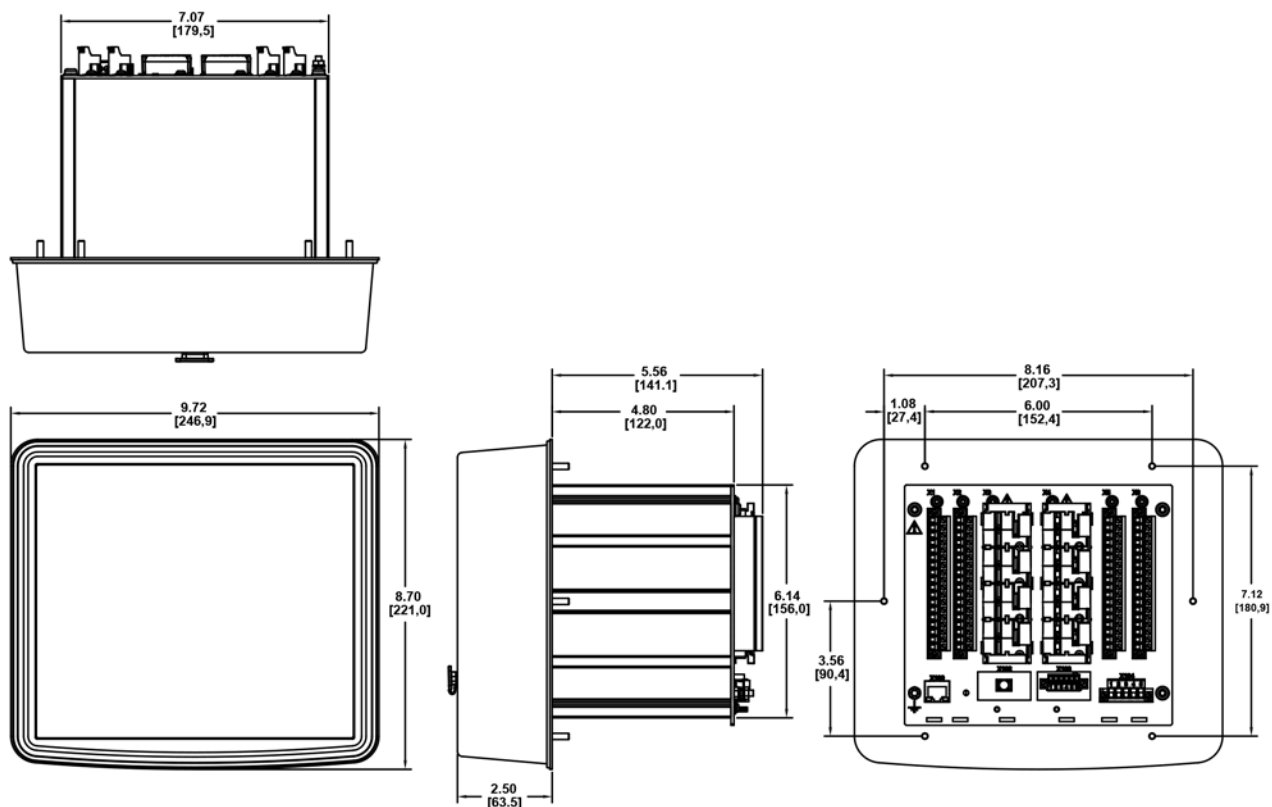
Dimensions

Approximate Dimensions in Inches (mm)

Drilling Plan

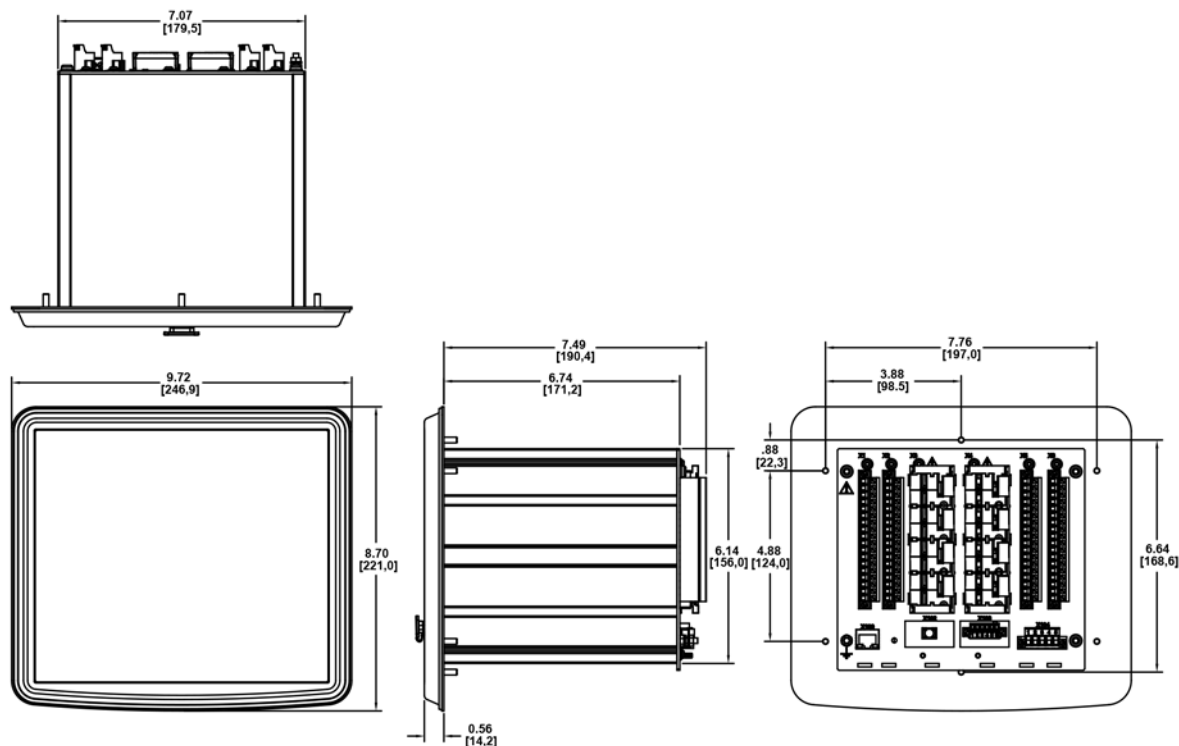


Projection Mount Front and Side Views



Approximate Dimensions in Inches (mm)

Standard Mount Front and Side Views



ETR-4000



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Description

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EBR—Line Differential Relay	V3-T9-83
EMR-3MP0 Motor Protection Relay	V3-T9-85
EMR-3000 Motor Protection Relay	V3-T9-87
EMR-4000 Motor Protection Relay	V3-T9-99
EMR-5000 Motor Protection Relay	V3-T9-112
ETR-4000 Transformer Protection Relay	V3-T9-136
ETR-5000 Transformer Protection Relay	V3-T9-149
EGR-5000 Generation Protection Relay	V3-T9-162
Universal RTD Module	

ETR-4000 Transformer Protection Relay

Product Description

Eaton's ETR-4000 transformer protection relay is a multi-functional, microprocessor-based relay for two winding transformers of all voltage levels. The ETR-4000 provides phase and ground percentage restrained differential protection using a variable dual slope characteristic with phase, negative, residual and neutral overcurrent elements for backup protection. It can also be used to provide restrained differential protection to large motors and generators.

The ETR-4000 has eight current inputs rated for either 5 amperes or 1 ampere to monitor both sides of the transformers. The CTs can be connected in wye in both sides of the transformer; the relay automatically compensates for the connection of the transformer and CT mismatch errors.

The maintenance mode password protected soft key, can be used for arc flash mitigation to change to an alternate settings group, set to have instantaneous elements only.

An integral keypad and display is provided for direct user programming and retrieval of data without the need of a computer. Fourteen programmable LEDs provide quick indication of relay status.

A front port is provided for direct computer connection. An RS-485 communication port on the back is standard for local area networking using Modbus-RTU. An optional Ethernet port and protocols are available.

Flash memory is used for the programming and all settings are stored in nonvolatile memory. The relay allows for four preprogrammed setting groups that can be activated through software, the display or a contact input.

The ETR-4000 transformer protection relay has mass memory for data storage and a real-time clock with 1 ms time resolution. The relay will log 300 sequence of event records, 20 detailed trip logs, minimum/maximum values, load profiles, breaker wear information and oscillography data.

The ETR-4000 has eight programmable binary inputs, 4 normally opened and 4 Form C heavy-duty outputs and one Form C signal alarm relay. It can be powered from 19 Vdc to 300 Vdc or 40 Vac to 250 Vac auxiliary power.

Features, Benefits and Functions

- Flexible phase and ground differential protection for two winding transformers, large motors and generators
- Complete protection and control in a single compact case to reduce panel space, wiring and costs
- Integral test function reduces maintenance time and expense
- Zone selective interlocking improves coordination and tripping time, and saves money compared to a traditional bus differential scheme
- Reduce troubleshooting time and maintenance costs. Trip and event recording in non-volatile memory provides detailed information for analysis and system restoration. 6000 cycles of waveform capture aids in post fault analysis (viewable using PowerPort-E software)
- Minimum replacement time. Removable terminal blocks ideal for industrial environments
- Front RS-232 port and PowerPort-E software provides local computer access and user-friendly Windows-based interface for relay settings, configuration and data retrieval
- Breaker open/close from relay faceplate or remotely via communications
- Fast an easy troubleshooting, improved maintenance procedures and increased device security. Provides detailed traceability for system configuration changes
- Relays self-diagnostics and reporting improves uptime and troubleshooting
- Breaker trip circuit monitoring improves the reliability of the breaker operation

Features

Protection Features

- Dual-slope percentage restrained current differential with magnetizing inrush and overexcitation blocking (87R)
- Unrestrained current differential (87H)
- Restricted ground fault/ Ground Differential (87GD)
- Phase overcurrent (elements can be assigned to either side of the transformer):
 - Four instantaneous elements with timers (50P[1], 50P[2], 50P[3] and 50P[4])
 - Four inverse time overcurrent elements (51P[1], 51P[2], 51P[3] and 51P[4])
 - 11 standard curves
 - Inrush Blocking
 - Instantaneous or time delay reset
- Negative sequence phase overcurrent (elements can be assigned to either side of the transformer):
 - Two inverse time overcurrent elements (51Q[1] and 51Q[2])
 - 11 standard curves
 - Instantaneous or time delay reset
- Ground overcurrent (elements can be assigned to either side of the transformer):
 - Two instantaneous measured elements with timers (50X[1] and 50X[2])
 - Two instantaneous calculated elements with timers (50R[1] and 50R[2])
 - Two inverse time overcurrent measured elements (51X[1] and 51X[2])
 - Two inverse time overcurrent calculated elements (51R[1] and 51R[2])
 - 11 standard curves
 - Instantaneous or time delay reset

- Two breaker failure elements (50BF[1] and 50BF[2])
- Phase transformer overload protection (49)
- Switch onto fault protection
- Cold load pickup
- Zone interlocking for bus protection (87B)

Metering Features

- Amperes: positive, negative and zero sequence
- Ampere demand
- Current phase angles
- % THD I
- Magnitude THD I
- Minimum/maximum recording
- Trending
- RTD Temperatures with remote URTD

Monitoring Features

- Trip coil monitor for both primary and secondary breakers
- Breaker wear primary and secondary (accumulated interrupted current)
- Oscillography (7200 cycles total)
- Fault data logs (up to 20 events)
- Sequence of events report (up to 300 events)
- Clock (1 ms time stamping)
- Trip Cause displays fault recorder data on HMI after fault event

Control Functions

- Breaker open/close both breakers
- Remote open/close
- Programmable I/O
- Programmable LEDs
- Multiple setting groups
- Cold load pickup
- CT supervision

Communication Features

- Local HMI
- Password protected
- Addressable
- IRIG-B
- Local communication port

- Remote communication port:
 - RS-232
 - RS-485
- Protocols:
 - Modbus-RTU
 - Modbus-TCP (Optional)
- Configuration software

Protection and Control Functions

Eaton's ETR-4000 transformer protection relay has been designed for maximum user flexibility and simplicity. The ETR-4000 is suitable for application on small, medium and large two winding power transformers.

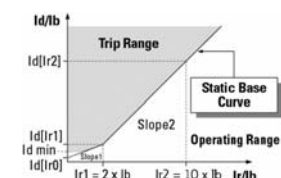
Multiple current inputs are used to provide primary protection, control and back-up protection of transformers, including current differential, restricted ground differential and overcurrent protection.

Dual-Slope Percent Differential Protection

The primary protective element for transformer protection is the percent differential element, which compares the current entering the primary and leaving the secondary of the transformer. The ETR-4000 has built in compensation for the turns-ratio and the phase shift of the transformer, so it's not necessary to compensate for the transformer connection by the connection of the CTs.

The current differential element looks at the vector difference between the current entering and leaving the zone of protection. If the difference exceeds a pre-determined amount, the element will operate.

The operating characteristic of the percent differential element is a dual-slope characteristic to accommodate for CT saturation and CT errors.

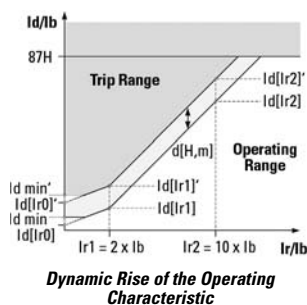


Dual-Slope Operating Characteristic

Harmonic Restraints

There are certain conditions like energizing one side of the transformer with the other side de-energized (inrush currents) or the paralleling of two transformers (sympathetic currents) that can create false differential currents. These differential currents if not recognized can cause a false trip; in the case of inrush conditions or sympathetic currents the differential current is characterized by a heavy content of 2nd and 4th harmonic currents. The percentage differential element is desensitize either permanently (stationary conditions) or temporarily (transient conditions), whenever the 2nd or 4th harmonic exceed the value programmed into the relay.

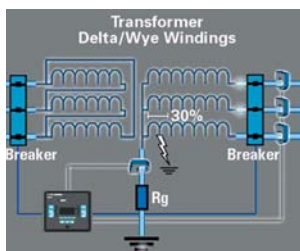
Another condition that can create a false differential current is a sudden change of voltage or frequency, that can put the transformer in an overexcitation state. In this case there is high content of 5th harmonic currents. The percentage differential element is also desensitized when the 5th harmonic content exceeds a predefined value.

**Unrestrained Differential**

An unrestrained differential element is provided for fast tripping on heavy internal faults to limit catastrophic damage to the transformer and minimize risks to the remainder of the power system.

Restricted Ground Fault

Ground differential protection is applied to transformers having impedance grounded wye windings. It is intended to provide sensitive ground fault detection for low magnitude fault currents, which would not be detected by the main percent differential element.

**Restricted Ground Fault****Overcurrent Elements**

The ETR-4000 can be used to provide backup for transformer and adjacent power system equipment. Instantaneous overcurrent elements can be used for fast clearing of severe internal or external (through) faults. Time overcurrent protection elements per winding allow coordinating with the adjacent protection zones and acting as a backup protection. There are 11 user-selectable inverse-time overcurrent curve characteristics. The user can select from the ANSI, IEC or thermal curve families and can select instantaneous or time delay reset characteristics.

Negative Sequence Overcurrent

Since this element does not respond to balanced load or three-phase faults, the negative-sequence overcurrent element may provide the desired overcurrent protection. This is particularly applicable to delta-wye grounded transformers where only 58% of the secondary p.u. phase-to-ground fault current appears in any one primary phase conductor. Backup protection can be particularly difficult when the wye is impedance grounded. A negative-sequence element can be used in the primary supply to the transformer and set as sensitively as required to protect for secondary phase-to-ground or phase-to-phase faults. This element should be set to coordinate with the low-side phase and ground relays for phase-to-ground and phase-to-phase faults. The negative sequence element must also be set higher than the negative-sequence current due to unbalanced loads.

Breaker Failure

The ETR-4000 transformer protection relay includes two breaker failure (50BF, 62BF) elements that can be initiated from either an internal or external trip signal. These are independent elements that can be used to operate a lockout relay or trip an upstream breaker. The timer must be longer than the breaker operating time and the protective function reset times.

Maintenance Mode

The Maintenance Mode can improve safety by providing a simple and reliable method to reduce fault clearing time and lower incident energy levels at energized panels. The Maintenance Mode allows the user to switch to more sensitive settings via a password protected soft key, communications or via a digital input while maintenance work is being performed at an energized panel or device. The more sensitive settings provide greater security for maintenance personnel and helps reduce the possibility of injury.

Monitoring and Metering**Sequence of Events Records**

The ETR-4000 protection relay records a maximum of 300 events associated with the relay. An event is classified as a change of state as detected by the relay. These include relay pickups, dropouts, trips, contact closure, alarms, setting changes and self-diagnostic failures. Each event is date and time stamped to a 1 ms resolution. The events are stored in a FIFO in chronological order.

Trip Log

The ETR-4000 protection relay will store a maximum of 20 trip records in a FIFO trip log. Each trip record will be date and time stamped to a 1 ms resolution. The trip log record will include information on the type of fault, protection elements that operated, fault location and currents at the time of the fault.

Waveform Capture

The ETR-4000 transformer protection relay provides oscillography-recording capabilities. The relay will record all measured signals along with the binary signals of pickup, trip, logic and contact closures. The ETR-4000 relay can record up to 6000 cycles of data. The number of records is proportional to the size of each record; the maximum size per record is 600 cycles. The waveform capture is initiated by up to 8 different triggers; it can also be generated manually through the display or via communications.

Integral User Interface

The front panel user interface has a 128 x 64 pixel LCD display with background illumination for wide angle viewing in all light conditions. Fourteen programmable LEDs provide quick and easy visual display of power on, mode of operation, alarm and trip indication. Soft keys are provided for operation mode selection, scrolling through data and settings. In addition, the relay settings and test functions are password protected.

Programmable I/O

The ETR-4000 transformer protection relay provides heavy-duty, trip-rated, 4 normally open and 4 Form C contacts. Two isolated inputs can be used for monitoring the trip circuits. One Form C contact is dedicated to the relay failure alarm function and is operated in a normally energized (fail-safe) mode. There are eight user-configurable discrete inputs that accept a wet contact and can operate through a wide range of power. Each input and output is user-programmable for maximum application flexibility.

Communication Software

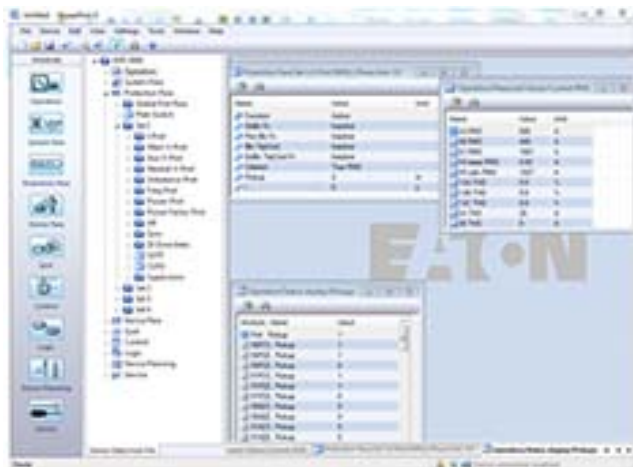
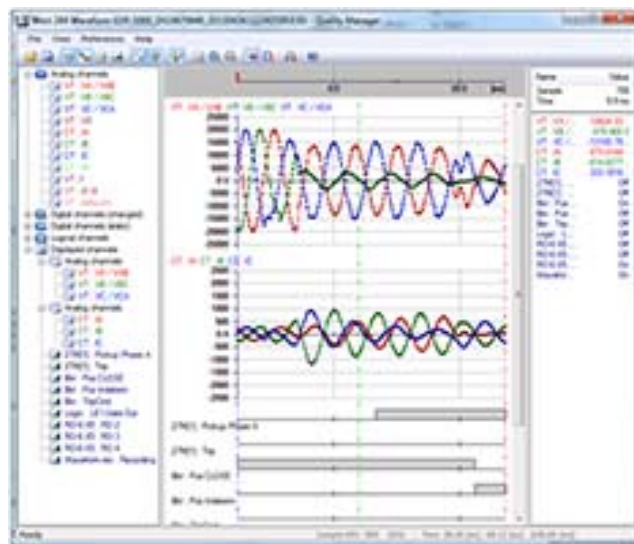
PowerPort-E

PowerPort-E is the software program used to configure off-line protection setting files for all E-Series relay models. PowerPort-E is also used for viewing measured values of the relays in real-time, uploading/downloading setting files, and retrieving event log and waveform records.

Waveform Capture (Quality Manager)

The ETR-4000 relay provides oscillographic recording capabilities. The relay will record all measured signals along with the binary signals of pickup, trip, internal logic, and contact inputs. The ETR-4000 can record up to 7200 cycles of data. The number of records is proportional to the programmed size of each record; the maximum size per

record is 600 cycles. The waveform capture is initiated by up to 8 different triggers (i.e., trip/alarm events) or manually via communications or the HMI. PowerPort-E setting software is used to retrieve the records. Quality Manager is a separate software program downloaded with PowerPort-E used for analyzing the waveform and trending files retrieved from the relay.



Standards and Certifications

Design Standards

- Generic Standard:
 - EN 61000-6-2
 - EN 61000-6-3
- Product Standard:
 - IEC 60255-6
 - EN 50178
 - UL 508 (Industrial Control Equipment)
 - CSA C22.2 No. 14-95 (Industrial Control Equipment)
 - ANSI C37.90
- UL listed file: E217753



Catalog Number Selection

The catalog number identification chart defines the electrical characteristics and operation features included in the ETR-4000. For example, if the catalog number is ETR-4000-2A0BA1, the device would have the following:

ETR-4000

(A)—8 Digital Inputs, 9 Output Relays

(0)—5 A / 1 A phase and ground CTs, Power Supply Range: 19–300 Vdc, 40–250 Vac

(B)—Modbus-RTU (RS-485)

(A)—Without Conformal Coating

(1)—Projection Panel Mount

ETR-4000 Eaton Transformer Protection Relay**ETR-4000-2A 0 B A 1****Hardware Option 1**

A = 8 DI, 9 outputs, removable terminals, 2 zone interlocking, URTD interface, IRIG-B, small display
B = 4 DI, 5 outputs, removable terminals, IRIG-B, small display
C = 8 DI, 5 outputs, removable terminals, 1 zone interlocking, IRIG-B, small display

Hardware Option 2

0 = Phase current 5 A / 1 A, ground current 5 A / 1 A, power supply range: 19–300 Vdc, 40–250 Vac
1 = Phase current 5 A / 1 A, sensitive ground current 0.5 A / 0.1 A, power supply range: 19–300 Vdc, 40–250 Vac

Communication Options

B = Modbus/DNP3 RTU over RS-485
C = Modbus/DNP3 TCP over Ethernet RJ-45
D = PROFIBUS-DP over fiber optic ST
E = PROFIBUS-DP over D-Sub / RS-485
F = Modbus RTU or DNP3 RTU over fiber optic ST
G = Modbus/DNP3 RTU over D-Sub / RS-485
H = IEC 61850/Modbus/DNP3 TCP over Ethernet RJ-45
I = Modbus/DNP3 RTU over RS-485 or Modbus/DNP3 TCP over Ethernet RJ-45
K = IEC 61850/Modbus/DNP3 TCP over LC duplex fiber optic Ethernet
L = Modbus/DNP3 TCP over LC duplex fiber optic Ethernet

Conformal Coating Options

A = None
B = Conformal coated circuit boards

Mounting Options

0 = Standard mount
1 = Projection panel mount

Technical Data and Specifications**Climatic Environmental Conditions**

- Storage temperature: –22 °F to +158 °F (–30 °C to +70 °C)
- Operating temperature: –40 °F to +140 °F (–40 °C to +60 °C)
- Permissible humidity at ann. average: <75% rel. (on 56d up to 95% rel.)
- Permissible installation altitude:
 - 6,561.67 ft (<2000 m) above sea level
 - If 13,123.35 ft (4000 m) altitude applies, a changed classification of the operating and test voltages may be necessary

Degree of Protection EN 60529

- HMI front panel with seal: IP54
- Rear side terminals: IP30

Note

① Display will stop working at –20 °C.

Routine Test

- Insulation test according to IEC 60255-5: All tests to be carried out against ground and other input and output circuits
- Aux. voltage supply, digital inputs: 2.5 kV (eff.)/50 Hz
- Current measuring inputs, signal relay outputs: 2.5 kV (eff.)/50 Hz
- Voltage measuring inputs: 3.0 kV (eff.)/50 Hz
- All wire-bound communication interfaces: 1.5 kV DC

Housing

- Material, housing: Aluminum extruded section
- Material, front panel: Aluminum/foil front
- Mounting position: Horizontal (±45° around the X-axis must be permitted)

Plug-in Connector with Integrated Short-Circuiter (Conventional Current Inputs)

- Nominal current: 1 A and 5 A
- Continuous loading capacity: 4 x I_n/continuously
- Overcurrent withstand:
 - 30 x I_n/10 s
 - 100 x I_n/1 s
 - 250 x I_n/10 ms (1 half-wave)
- Screws: M4, captive type acc. to VDEW
- Connection cross sections:
 - 2 x AWG 14 (1 x or 2 x 2.5 mm²) with wire end ferrule
 - 2 x AWG 12 (1 x or 2 x 4.0 mm²) with ring cable sleeve or cable sleeve
 - 2 x AWG 10 (1 x or 2 x 6 mm²) with ring cable sleeve or cable sleeve

Control Power Supply

- Aux. voltage: 24–270 Vdc/48–230 Vac (–20/+10%)
- Buffer time in case of supply failure: ≥50 ms at minimal aux. voltage interrupted communication is permitted
- Maximum permissible making current:
 - 18 A peak value for <0.25 ms
 - 12 A peak value for <1 ms
- The voltage supply must be protected by a fuse of:
 - 2.5 A time-lag miniature fuse approx. 0.2 x 0.8 in (5 x 20 mm) according to IEC 60127
 - 3.5 A time-lag miniature fuse approx. 0.25 x 1.25 in (6.3 x 32 mm) according to UL 248-14

Power Consumption

- Power supply range: 19–300 Vdc
 - Power consumption in idle mode—7 W
 - Maximum power consumption—13 W
- Power supply range: 40–250 Vac (for frequencies of 40–70 Hz)
 - Power consumption in idle mode—7 W
 - Maximum power consumption—13 W

Real-Time Clock

- Running reserve of the real-time clock: 1 year minimum

Display

- Display type: LCD with LED background illumination
- Resolution graphics display: 128 x 64 pixel
- LED type: Two colored—red/green
- Number of LEDs, housing B2: 15

Digital Inputs

- Maximum input voltage: 300 Vdc/270 Vac
- Input current: <4 mA
- Reaction time: <20 ms
- Fallback time: <30 ms

(Safe state of the digital inputs)

- 4 switching thresholds: $U_n = 24 \text{ Vdc}, 48 \text{ Vdc}, 60 \text{ Vdc}, 110 \text{ Vac/Vdc}, 230 \text{ Vac/Vdc}$
 - $U_n = 24 \text{ Vdc}$
 - Switching threshold 1 ON: Min. 19.2 Vdc
 - Switching threshold 1 OFF: Max. 9.6 Vdc
 - $U_n = 48\text{--}60 \text{ Vdc}$
 - Switching threshold 2 ON: Min. 42.6 Vdc
 - Switching threshold 2 OFF: Max. 21.3 Vdc

- $U_n = 110/120 \text{ Vac/Vdc}$
 - Switching threshold 3 ON: Min. 88.0 Vdc/88.0 Vac
 - Switching threshold 3 OFF: Max. 44.0 Vdc/44.0 Vac
- $U_n = 230/240 \text{ Vac/Vdc}$
 - Switching threshold 4 ON: Min. 184 Vdc/184 Vac
 - Switching threshold 4 OFF: Max. 92 Vdc/92 Vac
- Terminals: screw-type terminal

Current and Ground Current Measurement

- Nominal currents: 1 A / 5 A
- Max. measuring range:
 - Up to $40 \times I_n$ (phase currents)
 - Up to $25 \times I_n$ (ground current standard)
 - Up to $2.5 \times I_n$ (ground current sensitive)
- Continuous loading capacity: $4 \times I_n$ / continuously
- Overcurrent proof:
 - $30 \times I_n/10 \text{ s}$
 - $100 \times I_n/1 \text{ s}$
 - $250 \times I_n/10 \text{ ms}$ (1 half-wave)
- Power consumption:
 - Phase current inputs
 - At $I_n = 1 \text{ A}$ $S = 0.15 \text{ MVA}$
 - At $I_n = 5 \text{ A}$ $S = 0.15 \text{ MVA}$
 - Ground current input
 - At $I_n = 1 \text{ A}$ $S = 0.35 \text{ MVA}$
 - At $I_n = 5 \text{ A}$ $S = 0.35 \text{ MVA}$
- Frequency range: 50 Hz/60 Hz $\pm 10\%$
- Terminals: Screw-type terminals with integrated short-circuiters (contacts)

Relay Outputs

- Continuous current: 5 A AC/DC
- Maximum make current:
 - 25 A AC/25 A DC up to 30 V for 4s
 - 30 A/230 Vac according to ANSI IEEE Std. C37.90-2005
 - 30 A/250 Vdc according to ANSI IEEE Std. C37.90-2005
- Maximum breaking current:
 - 5 A AC up to 125 Vac
 - 5 A DC up to 30 V (resistive)
 - 0.3 A DC at 300 V
- Maximum switching voltage: 250 Vac/250 Vdc
- Switching capacity: 1250 VA
- Contact type: changeover contact or normally open contact
- Terminals: screw-type terminals

Supervision Contact (SC)

- Continuous current: 5 A at 120/240 Vac or 30 Vdc
- Maximum switch-on current: 15 A at 120/240 Vac or 30 Vdc (max. 4 s)
- Maximum breaking current:
 - 5 A at 120/240 Vac or 30 Vdc
 - 0.4 A at 125 Vdc
- Contact type: 1 changeover contact
- Terminals: screw-type terminals

Time Synchronization IIRIG

- Nominal input voltage: 5 V
- Connection: Screw-type terminals (twisted pair)

Front Interface RS-232

- Baud rates: 115,200 baud
- Handshake: RTS and CTS
- Connection: 9-pole D-Sub plug

RS-485

- Master/slave: slave
- Connection: 6 screw-clamping terminals RM 138 MIL (3.5 mm) (terminating resistors internal)

Zone Interlocking

- Nominal input level: 5 V
- Nominal output level: 5 V
- Connection: Screw-type terminals (twisted pair)

Standards

High Voltage Tests (IEC 60255-6)

- High frequency interference test:
 - IEC 60255-22-1 Class 3
 - Within one circuit—1 kV/2 s
 - Circuit to ground—2.5 kV/2 s
 - Circuit to circuit—2.5 kV/2 s
- Insulation voltage test:
 - IEC 60255-5, EN 50178
 - All circuits to other circuits and exposed conductive parts: 2.5 kV (eff.)/50 Hz, 1 min.
 - Except interfaces: 1.5 kV DC, 1 min.
 - Voltage measuring input: 3 kV (eff.)/50 Hz, 1 min.
- Impulse voltage test:
 - IEC 60255-5: 5 kV/0.5J, 1.2/50 μs

EMC Immunity Tests

- Fast transient disturbance immunity test (burst):
 - IEC 60255-22-4: Power supply, mains inputs— ± 4 kV, 2.5 kHz
 - IEC 61000-4-4 Class 4: Other inputs and outputs— ± 2 kV, 5 kHz (coupling network)
 - ANSI C37.90.1: ± 4 kV, 2.5 kHz (coupling clamp)
- Surge Immunity Test:
 - IEC 61000-4-5 Class 4
 - Within one circuit—2 kV
 - Circuit to ground—4 kV
- Electrical discharge immunity test:
 - IEC 60255-22-2: Air discharge—8 kV
 - IEC 61000-4-2 Class 3: Contact discharge—6 kV
- Radiated radio frequency electromagnetic field immunity test
 - IEC 61000-4-3: 26 MHz – 80 MHz—10 V/m
 - Class X: 80 MHz–1 GHz—35 V/m
 - ANSI C37.90.2: 1 GHz–3 GHz—10 V/m
- Immunity to conducted disturbances induced by radio frequency fields:
 - IEC 61000-4-6 Class 3: 10 V
- Power frequency magnetic field immunity test:
 - IEC 61000-4-8: Continues—30 A/m
 - Class 4: 3 sec—300 A/m

EMC Emission Tests

- Radio interference suppression test:
 - IEC/CISPR11—Limit value class B
- Radio interference radiation test:
 - IEC/CISPR11—Limit value class B

Environmental Tests**Classification**

- IEC 60068-1: Climatic—0/055/56
- IEC 60721-3-1:
 - Classification of ambient conditions (storage)—1K5/1B1/1C1L/1S1/1M2 but min. -13 °F (-25 °C)
- IEC 60721-3-2: Classification of ambient conditions (transportation)—2K3/2B1/2C1/2S1/2M2
- IEC 60721-3-3: Classification of ambient conditions (Stationary use at weather protected locations)—3K6/3B1/3C1/3S1/3M2 but min. 32 °F (0 °C) and 3K8H for 2 h

Test ad: Cold

- IEC 60068-2-1:
 - Temperature— -4 °F (-20 °C)
 - Test duration—16 h

Test Bd: Dry heat

- IEC 60068-2-2:
 - Temperature— 131 °F (55 °C)
 - Relative humidity— $<50\%$
 - Test duration—72 h

Test cab: Damp heat (steady state)

- IEC 60068-2-78:
 - Temperature— 104 °F (40 °C)
 - Relative humidity—93%
 - Test duration—56d

Test Db: Damp heat (cyclic)

- IEC 60068-2-30:
 - Temperature— 131 °F (55 °C)
 - Relative humidity—95%
 - Cycles (12 + 12-hour)—2

Mechanical Tests**Test Fc: Vibration response test**

- IEC 60068-2-6, IEC 60255-21-1, Class 1:
 - Displacement: (10 Hz–59 Hz)—0.0014 in (0.035 mm)
 - Acceleration: (59 Hz–150 Hz)—0.5 gn
 - Number of cycles in each axis: 1

Test Fc: Vibration endurance test

- IEC 60068-2-6, IEC 60255-21-1, Class:
 - Acceleration: (10 Hz–150 Hz)—1.0 gn
 - Number of cycles in each axis: 20

Test Ea: Shock test

- IEC 60068-2-27, IEC 60255-21-2, Class 1
 - Shock response test: 5 gn, 11 ms, 3 impulses in each direction
 - Shock resistance test: 15 gn, 11 ms, 3 impulses in each direction

Test Eb: Shock endurance test

- IEC 60068-2-29, IEC 60255-21-2, Class 1
 - Shock endurance test: 10 gn, 16 ms, 1000 impulses in each direction

Test Fe: Earthquake test

- IEC 60068-3-3, KTA 3503, IEC 60255-21-3, Class 2
 - Single axis earthquake vibration test:
 - 3–7 Hz: horizontal 0.394 in (10 mm), 1 cycle each axis
 - 7–35 Hz: horizontal: 2 gn, 1 cycle each axis

Tolerances**Tolerances of the Real-Time Clock**

- Resolution: 1 ms
- Tolerance:
 - <1 minute/month (68 °F [$+20$ °C])
 - $<\pm 1$ ms if synchronized via IRIG-B

Tolerances of the Measured Value Acquisition

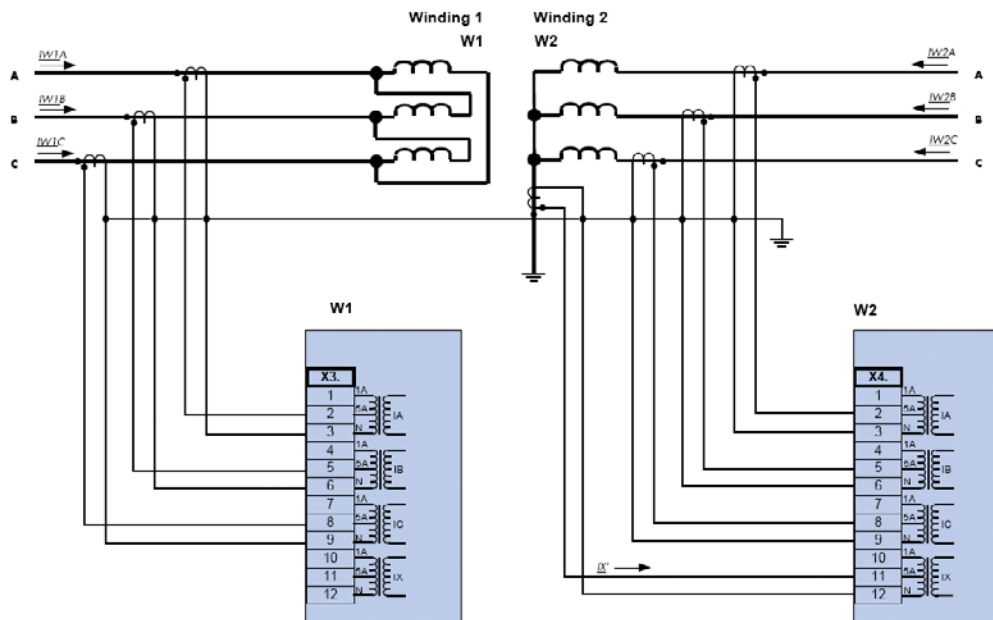
Phase and ground current measuring

- Maximum measuring range:
 - Up to $40 \times I_n$ (phase currents)
 - Up to $25 \times I_n$ (ground current standard)
 - Up to $2.5 \times I_n$ (earth current sensitive)

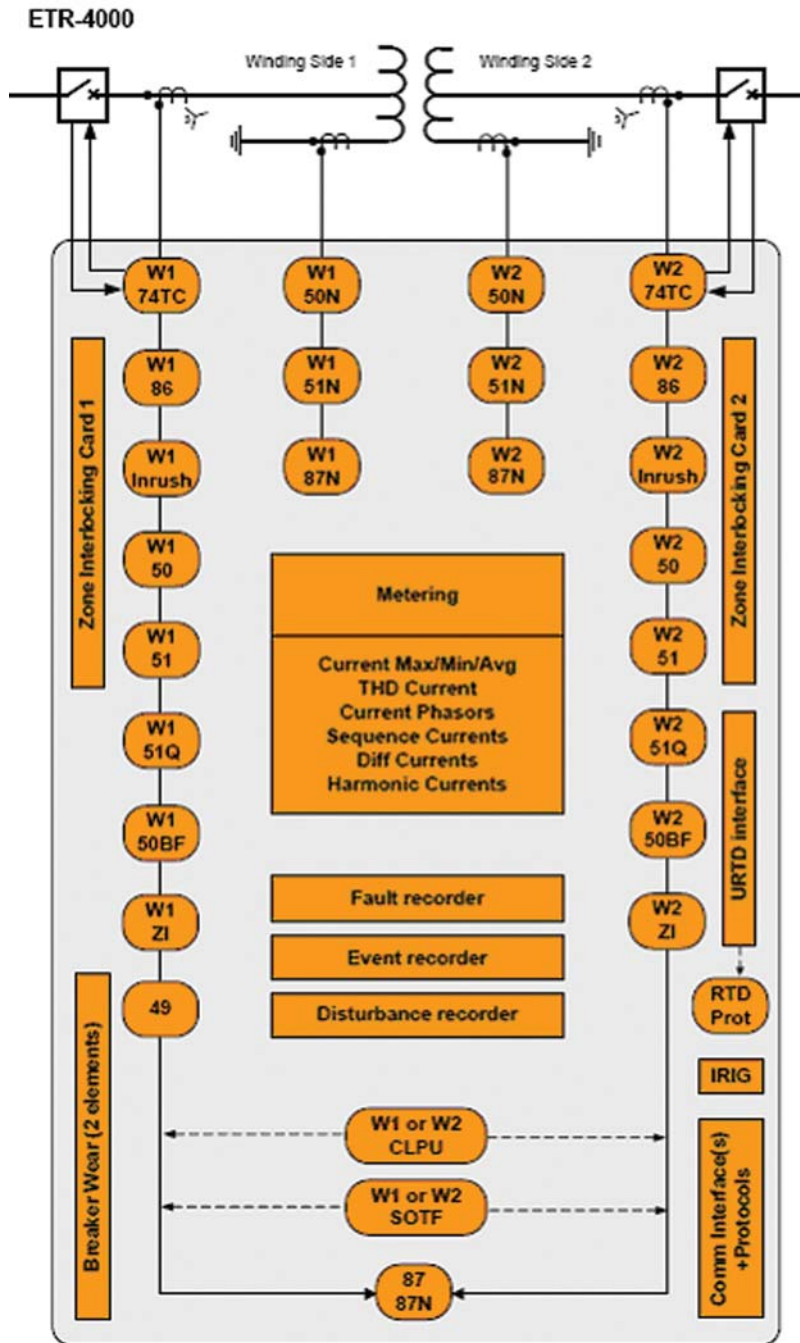
Note: The precision does not depend on the nominal value but is referenced to 100 mA (with $I_n = 1$ A) respectively, 500 mA (with $I_n = 5$ A)

- Frequency range: 50 Hz / 60 Hz $\pm 10\%$
- Accuracy: Class 0.5
- Amplitude Error if $I < 1 I_n$: $\pm 0.5\%$ of the rated value
- Amplitude Error if $I > 1 I_n$: $\pm 0.5\%$ of the measured value
- Amplitude Error if $I > 2 I_n$: $\pm 1.0\%$ of the measured value
- Resolution: 0.01 A
 - Harmonics: Up to 20% 3rd harmonic $\pm 1\%$
 - Up to 20% 5th harmonic $\pm 1\%$
- Frequency influence: $< \pm 2\%$ / Hz in the range of ± 5 Hz of the parametrized nominal frequency
- Temperature influence: $< \pm 1\%$ within the range of $+32$ °F to $+140$ °F (0 °C to $+60$ °C)

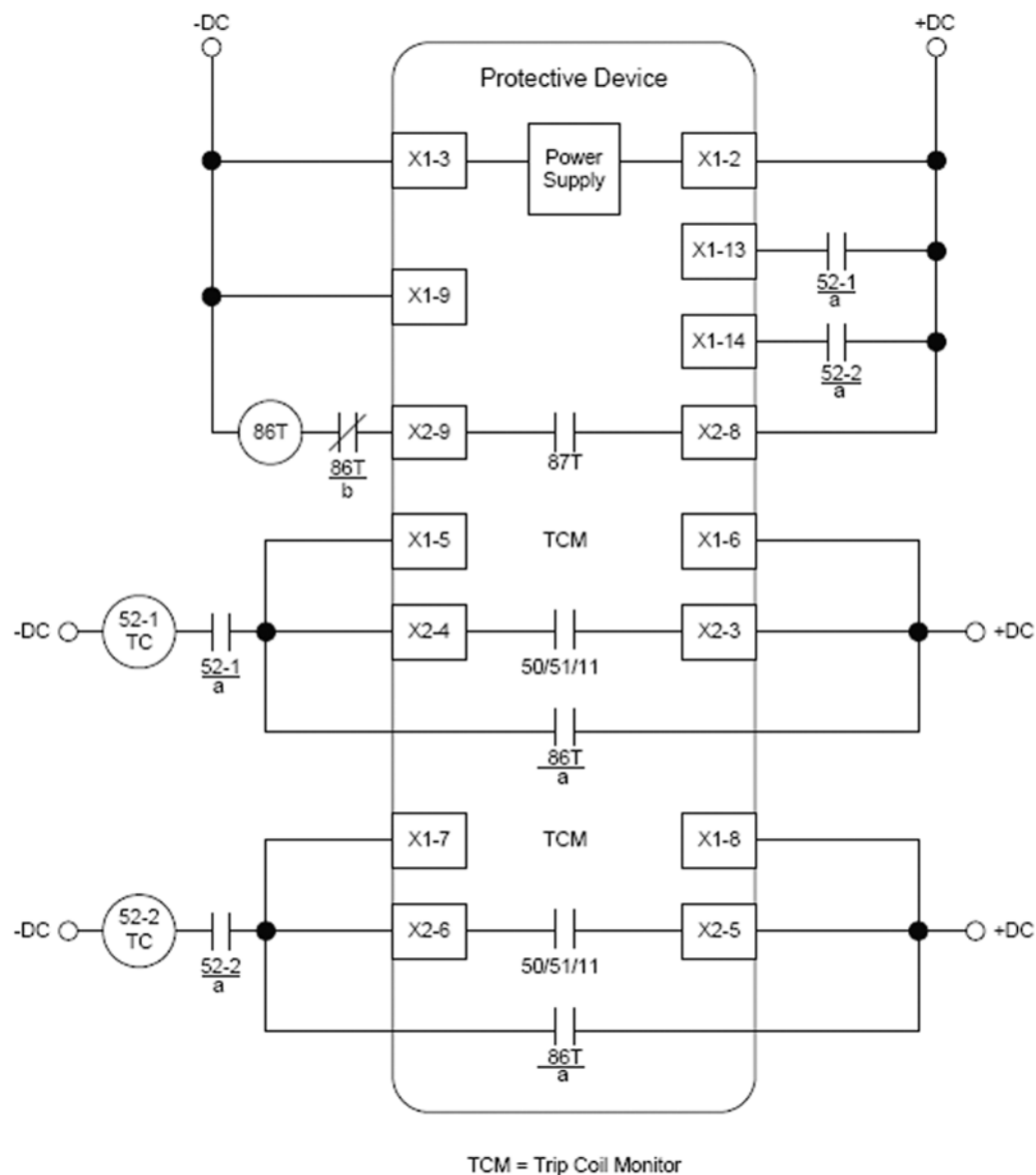
Typical AC Connections Delta-Wye Transformer with Wye CTs and Neutral CT



Typical One-Line Diagram

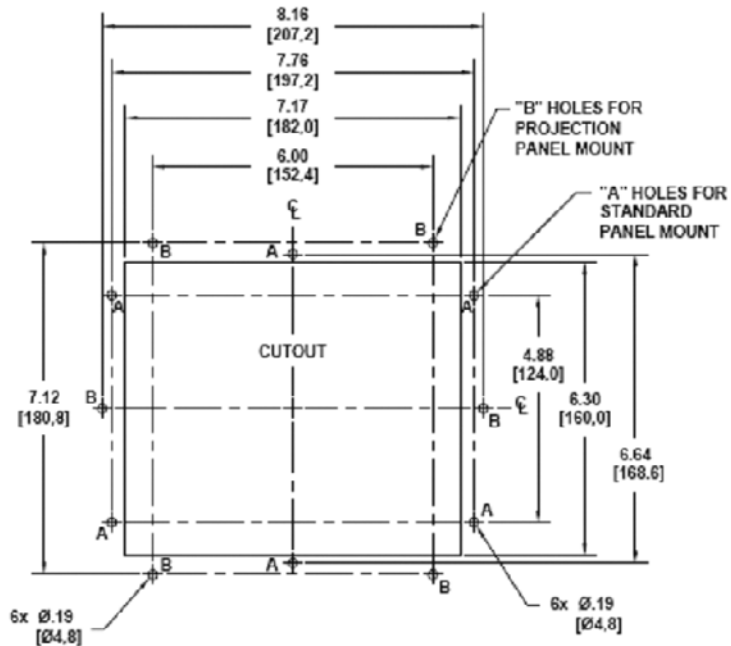
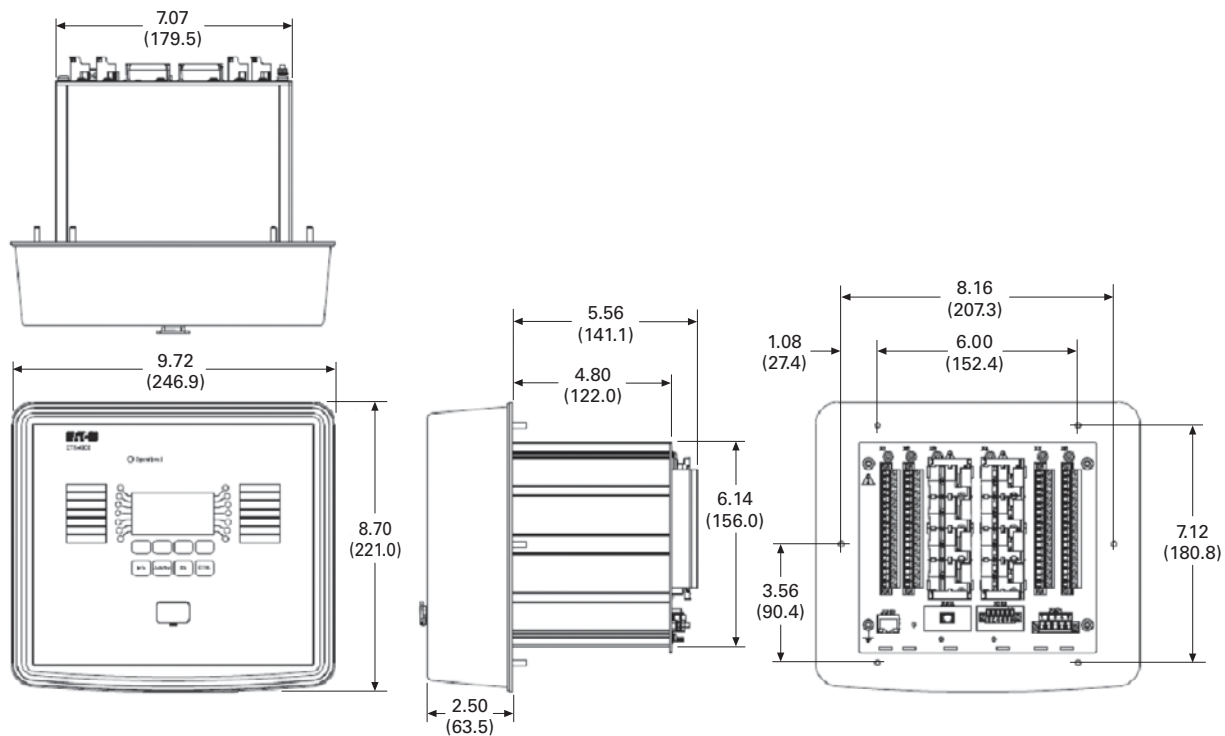


Typical Control Diagram



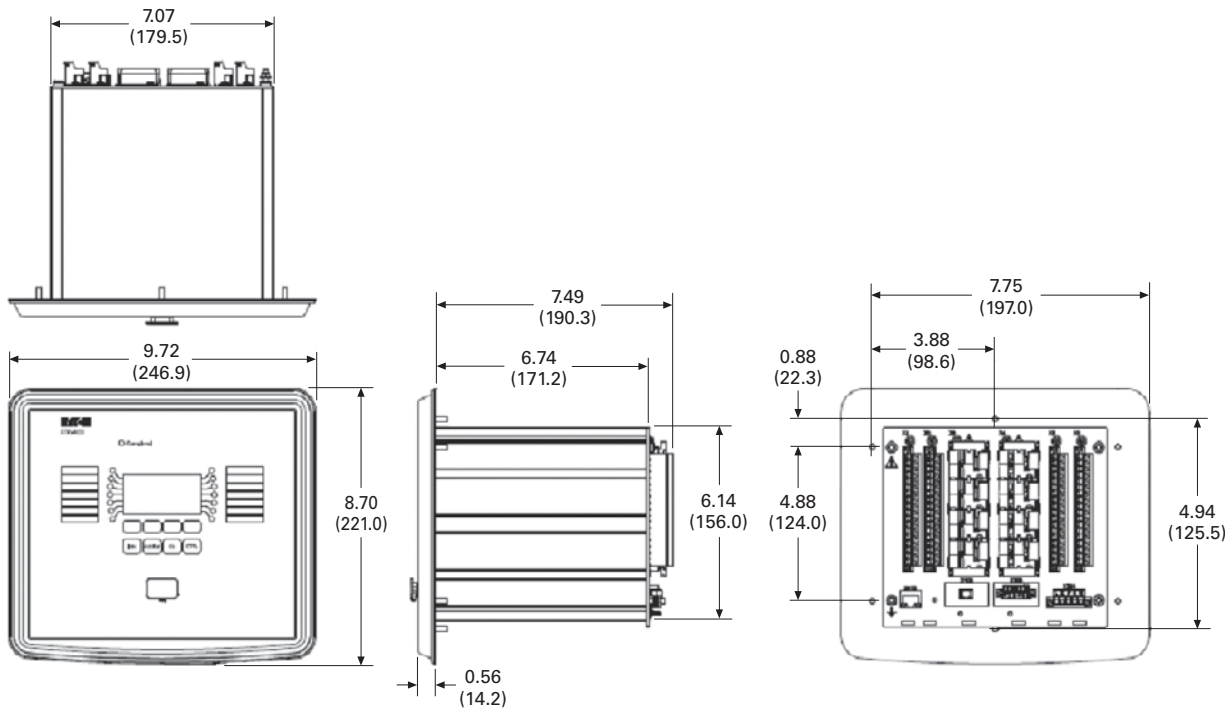
Dimensions

Approximate Dimensions in Inches (mm)

Drilling Plan**Projection Mount Front and Side Views**

Approximate Dimensions in Inches (mm)

Standard Mount Front and Side Views



ETR-4000 Housing B2

Width	Height	Depth ①	Shipping Weight Lb (kg)
6.81 (173.0)	8.37 (212.7)	8.19 (208.0)	9.3 (4.2)

Note

① Includes terminals.

ETR-5000 Transformer Protection Relay



Contents

Description

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ETR-5000 Transformer Protection Relay

Product Description

Eaton's ETR-5000 transformer protection relay is a multi-functional, microprocessor-based relay for two winding transformers of all voltage levels. The ETR-5000 provides phase and ground percentage restrained differential protection using a variable dual slope characteristic with phase, residual, and neutral directional overcurrent elements for backup protection. Negative sequence overcurrent elements, three-phase overvoltage/undervoltage, voltage unbalance, current unbalance, over/under and rate-of-change frequency, vector surge, directional vars, directional power, and overexcitation are standard functions.

The ETR-5000 transformer relay provides all required protection, control, monitoring and metering for any size two winding transformer in a single, compact case. The relay has eight current inputs rated for either 5 A or 1 A and four voltage inputs. The CTs can be connected in wye in both sides of the transformer; the relay automatically compensates for the connection of the transformer, and CT mismatch errors.

Three of the voltage inputs are to be connected to the three-phase power voltage for voltage protection and for metering. They can be connected in wye-ground or open delta configuration. The fourth voltage is for independent single-phase undervoltage/overvoltage protection.

The maintenance mode password protected soft key, can be used for arc flash mitigation to change to an alternate settings group, set to have instantaneous elements only.

An integral keypad and display is provided for direct user programming and retrieval of data without the need of a computer. Fourteen programmable LEDs provide quick indication of relay status.

A front port is provided for direct computer connection. An RS-485 and an Ethernet ports in the back are optional for local area networking using. Optional Modbus-RTU, Modbus-TCP, or IEC-61850 protocols are supported.

The ETR-5000 transformer protection relay includes programmable logic functions. Logic gates and timers may be defined and arranged for customized applications. Programmable logic control functions make the ETR-5000 very flexible.

Flash memory is used for the programming and all settings are stored in nonvolatile memory.

The ETR-5000 generator protection relay has mass memory for data storage and a real-time clock with 1 ms time resolution. The relay will log 300 sequence of event records, 20 detailed trip logs, minimum/maximum values, load profiles, breaker wear information and waveform data.

The ETR-5000 has eight programmable binary inputs, 2 analog inputs, 2 analog outputs, 1 zone interlocking card or eight programmable binary inputs, and 2 zone interlocking cards. It has 2 normally opened and 6 Form C heavy-duty outputs and one Form C signal alarm relay. The ETR-5000 can be powered from 19 Vdc to 300 Vdc or 40 Vac to 250 Vac auxiliary power.

Application Description

Eaton's ETR-5000 transformer protection relay has been designed for maximum user flexibility and simplicity. The ETR-5000 is suitable for application on small, medium, and large two winding power transformers. Multiple current inputs are used to provide primary protection, control and back-up protection of transformers, including current differential, restricted ground differential, and overcurrent protection.

Dual-Slope Percent Differential Protection

The primary protective element for transformer protection is the percent differential element, which compares the current entering the primary and leaving the secondary of the transformer. The ETR-5000 has built in compensation for the turns-ratio and the phase shift of the transformer, so it's not necessary to compensate for the transformer connection by the connection of the CTs.

The current differential element looks at the vector difference between the current entering and leaving the zone of protection. If the difference exceeds a pre-determined amount, the element will operate.

The operating characteristic of the percent differential element is a dual-slope characteristic to accommodate for CT saturation and CT errors.

Harmonic Restraints

There are certain conditions like energizing one side of the transformer with the other side de-energized (inrush currents) or the paralleling of two transformers (sympathetic currents) that can create false differential currents. These differential currents if not recognized can cause a false trip; in the case of inrush conditions or sympathetic currents the differential current is characterized by a heavy content of 2nd and 4th harmonic currents. The percentage differential element is desensitize either permanently (stationary conditions) or temporarily (transient conditions), whenever the 2nd or 4th harmonic exceed the value programmed into the relay.

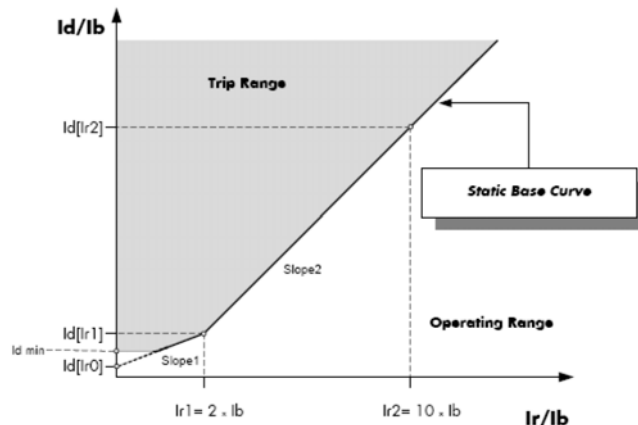
Another condition that can create a false differential current is a sudden change of voltage or frequency, that can put the transformer in an overexcitation state. In this case there is high content of 5th harmonic currents. The percentage differential element is also desensitized when the 5th harmonic content exceeds a predefined value.

Unrestrained Differential

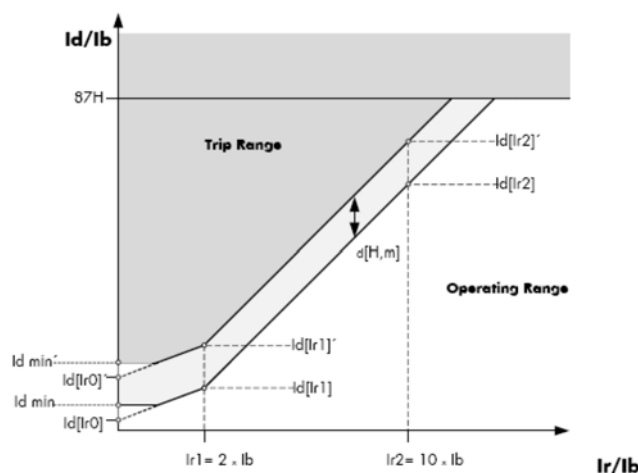
An unrestrained differential element is provided for fast tripping on heavy internal faults to limit catastrophic damage to the transformer and minimize risks to the remainder of the power system.

Restricted Ground Fault

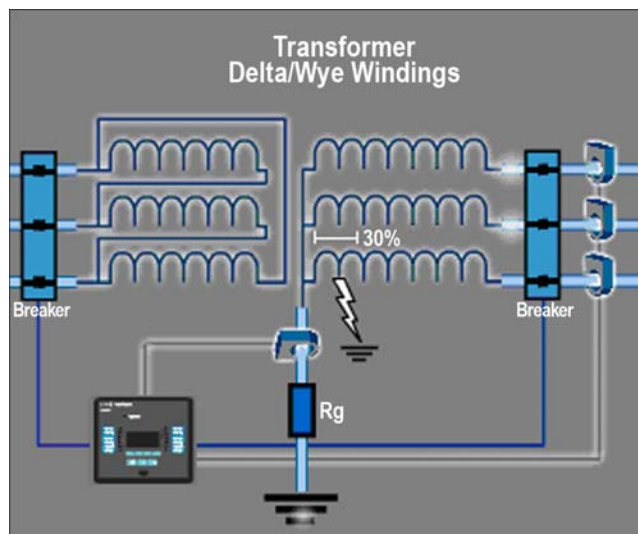
Ground differential protection is applied to transformers having impedance grounded wye windings. It is intended to provide sensitive ground fault detection for low magnitude fault currents, which would not be detected by the main percent differential element.



Dual-Slope Operating Characteristic



Dynamic Rise of the Operating Characteristic.



Restricted Ground Fault

Directional Overcurrent Elements

The ETR-5000 can be used to provide backup for transformer and adjacent power system equipment. Instantaneous overcurrent elements can be used for fast clearing of severe internal or external (through) faults.

Time overcurrent protection elements per winding allow coordinating with the adjacent protection zones and acting as a backup protection. There are 11 user-selectable inverse-time overcurrent curve characteristics. The user can select from the ANSI, IEC or thermal curve families and can select instantaneous or time delay reset characteristics.

Phase direction is a function used to supervise all phase current elements (50, 51). A quadrature voltage is compared to a corresponding phase current to establish the direction of the fault. This function is selectable to operate in the forward, reverse or both directions.

Ground direction is used to supervise ground current elements and is accomplished by using ground, negative sequence or residual currents supervised by zero, negative or positive sequence voltages or ground current. This function is selectable to operate in forward, reverse or both directions.

Directional elements are dependant on the location of the VTs (primary or secondary winding) when voltage is used as the polarizing quantity.

Negative Sequence Overcurrent

Since this element does not respond to balanced load or three-phase faults, the negative-sequence overcurrent element may provide the desired overcurrent protection. This is particularly applicable to delta-wye grounded transformers where only 58% of the secondary p.u. phase-to-ground fault current appears in any one primary phase conductor. Backup protection can be particularly difficult when the wye is impedance grounded. A negative-sequence element can be used in the primary supply to the transformer and set as sensitively as required to protect for secondary phase-to-ground or phase-to-phase faults. This element should be set to coordinate with the low-side phase and ground relays for phase-to-ground and phase-to-phase faults. The negative sequence element must also be set higher than the negative-sequence current due to unbalanced loads.

Overexcitation Protection

Transformer overexcitation occurs when the ratio of voltage versus frequency is too high, and the transformer iron saturates due to high flux density. High flux density results in stray flux in components not designed to carry it, which in turn causes overheating and can potentially damage the transformer. This protection is provided through a Volts/Hertz function with a programmable inverse time characteristic.

Voltage Protection

The ETR-5000 transformer protection relay has four voltage-input circuits. There is a three-phase set designated as Main Voltage (M) and a single-phase voltage circuit designated as Auxiliary Voltage (A). Both include undervoltage (27) and overvoltage (59) protection. The three-phase voltage protection can be set to operate on a single-phase, 2 out of 3 phases, or all three-phase logic. The Main VTs also provide phase voltage unbalance/reversal (47 negative sequence) protection. Each element has an independent threshold set point and adjustable time delay.

Flexible Phase Rotation

The ETR-5000 distribution protection relay can be applied on either an A-B-C or A-C-B phase rotation. A user setting permits correct operation and indication of the actual system configuration.

Frequency Protection

The ETR-5000 relay provides six frequency elements than can be used to detect underfrequency/overfrequency, rate of change, and a vector surge (decoupling of two systems) protection on the Main VT inputs. Each element has an independent threshold set point and adjustable time delay.

Reverse Power

Reverse power provides control for power flowing through a feeder. There are three elements to be configured: operate in forward or reverse; or, under or over power conditions. Reverse power is typically applied to generator or motor applications while under power is generally applied to load or generation loss.

Reverse Vars

Reverse vars can be used to detect loss of excitation in synchronous machines. There are three elements to be configured: operate in forward or reverse; or, under or over vars conditions.

Breaker Failure

The ETR-5000 transformer protection relay includes two breaker failure (50BF, 62BF) elements that can be initiated from either an internal or external trip signal. These are independent elements that can be used to operate a lockout relay or trip an upstream breaker. The timer must be longer than the breaker operating time and the protective function reset times.

Maintenance Mode

The Maintenance Mode can improve safety by providing a simple and reliable method to reduce fault clearing time and lower incident energy levels at energized panels. The Maintenance Mode allows the user to switch to more sensitive settings via a password protected soft key, communications or via a digital input while maintenance work is being performed at an energized panel or device. The more sensitive settings provide greater security for maintenance personnel and helps reduce the possibility of injury.

Features, Benefits and Functions

Protection Features

- Dual-slope percentage restrained current differential with magnetizing inrush and overexcitation blocking (87R)
- Unrestrained current differential (87H)
- Restricted ground fault/ Ground Differential (87GD)
- Phase overcurrent (elements can be assigned to either side of the transformer):
 - Four instantaneous elements with timers (50P[1], 50P[2], 50P[3] and 50P[4])
 - Four inverse time overcurrent elements (51P[1], 51P[2], 51P[3] and 51P[4])
 - 11 standard curves;
 - Inrush blocking
 - Instantaneous or time delay reset
 - Voltage restraint (all elements)
 - Directional control (all elements)
- Negative sequence phase overcurrent (elements can be assigned to either side of the transformer):
 - 2 inverse time overcurrent elements (51Q[1] and 51Q[2])
 - 11 standard curves
 - Instantaneous or time delay reset
- Ground overcurrent (elements can be assigned to either side of the transformer):
 - Two instantaneous measured elements with timers (50X[1] and 50X[2])
 - Two instantaneous calculated elements with timers (50R[1] and 50R[2])
 - Two inverse time overcurrent measured elements (51X[1] and 51X[2])
 - Two inverse time overcurrent calculated elements (51R[1] and 51R[2])
- 11 standard curves
- Instantaneous or time delay reset
- Directional control (all elements)
- Two breaker failure elements (50BF[1] and 50BF[2])
- Phase transformer overload protection (49)
- Phase unbalance negative sequence overcurrent (46[1], 46[2])
- Phase voltage unbalance and sequence protection (47[1], 47[2])
- Main three-phase undervoltage/overvoltage (27M[1], 27M[2], 59M[1], 59M[2])
- Auxiliary single-phase under/overvoltage (27A[1], 27A[2], 59A[1], 59A[2])
- Six frequency elements that can be assigned to: overfrequency, underfrequency, rate of change, or vector surge (81[1], 81[2], 81[3], 81[4], 81[5], 81[6])
- Forward and reverse watts (32[1], 32[2], 32[3])
- Forward and reverse vars (32V[1], 32V[2], 32V[3])
- Overexcitation, volts-per-Hertz (24[1], 24[2])
- Lockout (86)
- Loss of potential-LOP
- Zone interlocking for bus protection (87B)
- Switch onto fault protection
- Cold load pickup

Metering Features

- Phase differential current
- Ground differential current
- Amperes: positive, negative and zero sequence
- Ampere demand
- Volts: positive, negative and zero sequence
- Phase angles
- Volt-amperes and VA demand
- Watts and kW demand
- kWh (forward, reverse, net)
- Vars and kvar demand
- kvarh (lead, lag and net)
- Power factor
- Volts/Hertz
- % THD V and I
- Magnitude THD V and I
- Minimum/maximum recording
- Trending (load profile over time)
- Temperature with remote URTD module

Monitoring Features

- Trip coil monitor for both primary and secondary breakers
- Breaker wear primary and secondary (accumulated interrupted current)
- Oscillography (7200 cycles total)
- Trip Cause displays fault recorder data on HMI after fault event
- Fault data logs (up to 20 events)
- Sequence of events report (up to 300 events)
- Clock (1 ms time stamping)

Control Functions

- Breaker open/close both breakers
- Remote open/close
- Programmable I/O
- Programmable Logic
- Programmable LEDs
- Multiple setting groups
- Cold load pickup
- CT supervision

Communication Features

- Local HMI
- Password protected
- Addressable
- IRIG-B
- Local communication port: RS-232
- Remote communication port:
 - RS-485
 - Ethernet port
- Protocols:
 - Modbus-RTU
 - Modbus-TCP (optional)
 - IEC-61850 (optional)
- Configuration software

Monitoring and Metering

Sequence of Events Records

The ETR-5000 protection relay records a maximum of 300 events associated with the relay. An event is classified as a change of state as detected by the relay. These include relay pickups, dropouts, trips, contact closure, alarms, setting changes and self-diagnostic failures. Each event is date and time stamped to a 1 ms resolution. The events are stored in a FIFO in chronological order.

Trip Log

The ETR-5000 protection relay will store a maximum of 20 trip records in a FIFO trip log. Each trip record will be date and time stamped to a 1 ms resolution. The trip log record will include information on the type of fault, protection elements that operated, fault location and currents and voltages at the time of the fault.

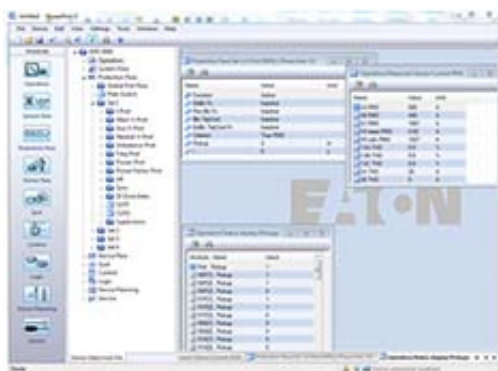
PowerPort-E

PowerPort-E is the software program used to configure off-line protection setting files for all E-Series relay models. PowerPort-E is also used for viewing measured values of the relays in real-time, uploading/downloading setting files, and retrieving event log and waveform records.

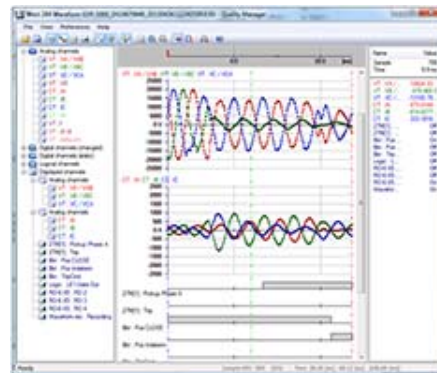
Waveform Capture (Quality Manager)

The ETR-5000 relay provides oscillographic recording capabilities. The relay will record all measured signals along with the binary signals of pickup, trip, internal logic, and contact inputs. The ETR-5000 can record up to 7200 cycles of data. The number of records is proportional to the programmed size of each record; the maximum size per record is 600 cycles.

The waveform capture is initiated by up to 8 different triggers (i.e., trip/alarm events) or manually via communications or the HMI. PowerPort-E setting software is used to retrieve the records. Quality Manager is a separate software program downloaded with PowerPort-E used for analyzing the waveform and trending files retrieved from the relay.



PowerPort-E



Waveform Capture (Quality Manager)

Integral User Interface

The front panel user interface has a 128 x 64 pixel LCD display with background illumination for wide angle viewing in all light conditions. 14 programmable LEDs provide quick and easy visual display of power on, mode of operation, alarm and trip indication. Soft keys are provided for operation mode selection, scrolling through data and settings. In addition, the relay settings and test functions are password protected.

Load Profiling/Trending

The ETR-5000 relay automatically records selected quantities into non-volatile memory every 5, 10, 15, 30 or 60 minutes, depending on the trending report setting.

Programmable I/O

The ETR-5000 transformer protection relay provides heavy-duty, trip-rated, 2NO and 6 Form C contacts. Two isolated inputs can be used for monitoring the trip circuit. One Form C contact is dedicated to the relay failure alarm function and is operated in a normally energized (failsafe) mode. There are up to 8 user-configurable discrete inputs that accept a wet contact and can operate through a wide range of power. Each input and output is user-programmable for maximum application flexibility.

The ETR-5000 also offers two optional analog inputs and two optional analog outputs. The analog inputs are available for providing protection. The analog inputs are field programmable to measure transducer signals that operate over a range of 0 to 20 mA, 4 to 20 mA, or 1 to 10V. The two optional analog outputs can be used for signaling the value of measured analog quantities to external process control devices such as PLCs. They can be programmed to operate over a 0 to 20 mA, 4–20 mA, or 1 to 10 V range. The analog outputs can be configured to signal a representation of most analog quantities measured by the ETR-5000 including, current, voltages and RTD temperature.

Programmable Logic

The ETR-5000 transformer protection relay provides logic gates and timers that the user can customize for special or unique applications. Each gate can be assigned a logic function of either AND, OR, NAND or NOR. Each gate can have a maximum of four input signals and each input signal can be required to be a NOT. Input signals can be external inputs received via the binary inputs or internal values associated with the protection, alarm or metering set points. Each gate has a unique output assignment and designation that can be used as the input to another gate.

Standards and Certifications

Approvals

- UL listed file: E217753

Design Standards

- Generic Standard:
 - EN 61000-6-2
 - EN 61000-6-3
- Product Standard:
 - IEC 60255-6
 - EN 50178
 - UL 508 (Industrial Control Equipment)
 - CSA C22.2 No. 14-95 (Industrial Control Equipment)
 - ANSI C37.90



Catalog Number Selection

The catalog number identification chart defines the electrical characteristics and operation features included in the ETR-5000. For example, if the catalog number is ETR-5000-2A0BA1, the device would have the following:

ETR-5000

(A)—8 Digital Inputs, 9 Output Relays

(0)—5 A / 1 A phase and ground CTs, Power Supply Range: 19–300 Vdc, 40–250 Vac

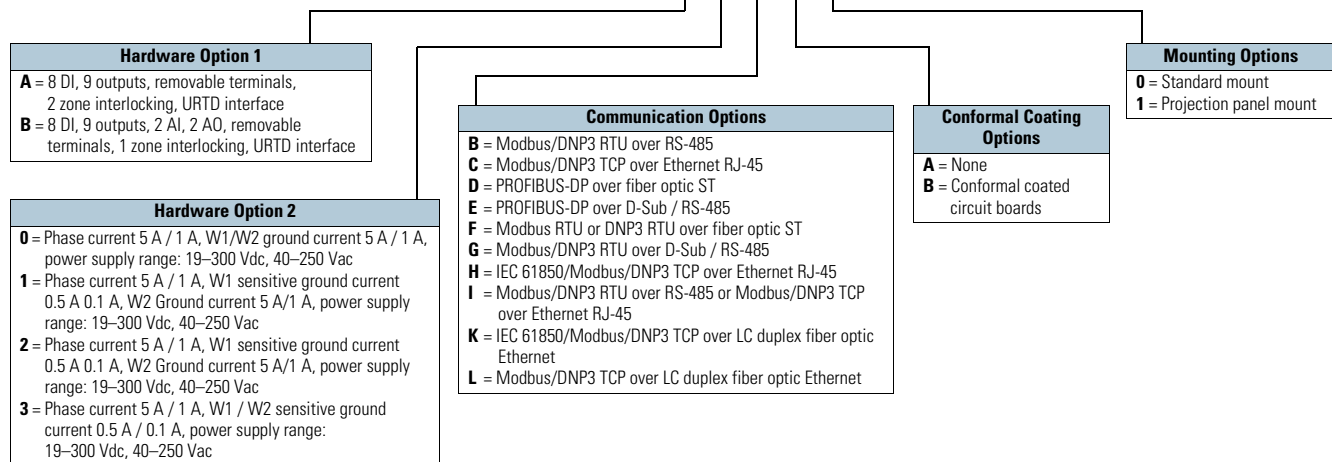
(B)—Modbus-RTU (RS-485)

(A)—Without Conformal Coating

(1)—Projection Panel Mount

ETR-5000 Eaton Transformer Protection Relay

ETR-5000-2A 0 B A 1



Technical Data and Specifications**Climatic Environmental Conditions**

- Storage temperature: -30 °C to +70 °C (-22 °F to +158 °F)
- Operating temperature: -20 °C to +60 °C (-4 °F to +140 °F)
- Permissible humidity at ann. average: <75% rel. (on 56d up to 95% rel.)
- Permissible installation altitude:
 - <2000 m (6,561.67 ft) above sea level
 - If 4000 m (13,123.35 ft) altitude applies, a changed classification of the operating and test voltages may be necessary

Degree of Protection EN 60529

- HMI front panel with seal: IP54
- Rear side terminals: IP30

Routine Test

- Insulation test acc. to IEC 60255-5: All tests to be carried out against ground and other input and output circuits.
- Aux. voltage supply, digital inputs: 2.5 kV (eff.) / 50 Hz
- Current measuring inputs, signal relay outputs: 2.5 kV (eff.) / 50 Hz
- Voltage measuring inputs: 3.0 kV (eff.) / 50 Hz
- All wire-bound communication interfaces: 1.5 kV DC

Housing

- Housing B2: height/width: 173 mm (6.811 in / 4 U) / 212.7 mm (8.374 in / 42 hp)
- Housing depth (incl. terminals): 208 mm (8.189 in)
- Material, housing: aluminum extruded section
- Material, front panel: aluminum/foil front
- Mounting position: horizontal (±45° around the X-axis must be permitted)
- Weight: ETR-5000 housing B2: approx. 9.259 lb (4.2 kg)

Plug-in Connector with Integrated Short-Circuiter

(Conventional current inputs)

- Nominal current: 1 A and 5 A
- Continuous loading capacity: 4 x In / continuously
- Overcurrent withstand:
 - 30 x In / 10 s
 - 100 x In / 1 s
 - 250 x In / 10 ms (1 half-wave)
- Screws: M4, captive type acc. to VDEW
- Connection cross sections:
 - 1 x or 2 x 2.5 mm² (2 x AWG 14) with wire end ferrule
 - 1 x or 2 x 4.0 mm² (2 x AWG 12) with ring cable sleeve or cable sleeve
 - 1 x or 2 x 6 mm² (2 x AWG 10) with ring cable sleeve or cable sleeve

Control power supply

- Aux. voltage: 24–270 Vdc / 48–230 Vac (-20/+10%)
- Buffer time in case of supply failure:
 - ≥50 ms at minimal aux. voltage
 - Interrupted communication is permitted
- Max. permissible making current:
 - 18 A peak value for <0.25 ms
 - 12 A peak value for <1 ms
- The voltage supply must be protected by a fuse of:
 - 2.5 A time-lag miniature fuse 5 x 20 mm (approx. 1/5 x 0.8 in) according to IEC 60127
 - 3.5 A time-lag miniature fuse 6.3 x 32 mm (approx. 1/4 x 1 1/4 in) according to UL 248-14

Power Consumption

- Power supply range: 19–300 Vdc
 - Power consumption in idle mode—7 W
 - Maximum power consumption—13 W
- Power supply range: 40–250 Vac (for frequencies of 40–70 Hz)
 - Power consumption in idle mode—7 W
 - Maximum power consumption—13 W

Real Time Clock

- Running reserve of the real time clock: 1 year min.

Display

- Display type: LCD with LED background illumination
- Resolution—graphics display: 128 x 64 pixel
- LED type: two colored: red/green
- Number of LEDs, Housing B2: 15

Digital Inputs

- Max. Input Voltage: 300 Vdc / 270 Vac
- Input Current: <4 mA
- Reaction Time: <20 ms
- Fallback Time: <30 ms

(Safe state of the digital Inputs)

- 4 Switching thresholds:
 - Un = 24 Vdc, 48 Vdc, 60 Vdc, 110 Vac / DC, 230 Vac / DC
 - Un = 24 Vdc
 - Switching threshold 1 ON: Min. 19.2 Vdc
 - Switching threshold 1 OFF: Max. 9.6 Vdc
 - Un = 48 V / 60 Vdc
 - Switching threshold 2 ON: Min. 42.6 Vdc
 - Switching threshold 2 OFF: Max. 21.3 Vdc
 - Un = 110 / 120 Vac / Vdc
 - Switching threshold 3 ON: Min. 88.0 Vdc / 88.0 Vac
 - Switching threshold 3 OFF: Max. 44.0 Vdc / 44.0 Vac
 - Un = 230 / 240 Vac / dc
 - Switching threshold 4 ON: Min. 184 Vdc / 184 Vac
 - Switching threshold 4 OFF: Max. 92 Vdc / 92 Vac
- Terminals: screw-type terminal

Current and Ground Current Measurement

- Nominal currents: 1 A / 5 A
- Max. measuring range:
 - Up to $40 \times I_n$ (phase currents)
 - Up to $25 \times I_n$ (ground current standard)
 - Up to $2.5 \times I_n$ (ground current sensitive)
- Continuous loading capacity: $4 \times I_n$ continuously
- Overcurrent proof:
 - $30 \times I_n / 10 \text{ s}$
 - $100 \times I_n / 1 \text{ s}$
 - $250 \times I_n / 10 \text{ ms}$ (1 half-wave)
- Power consumption:
 - Phase current inputs
 - At $I_n = 1 \text{ A}$ burden = 0.15 MVA
 - At $I_n = 5 \text{ A}$ burden = 0.15 MVA
 - Ground current input
 - At $I_n = 1 \text{ A}$ burden = 0.35 MVA
 - At $I_n = 5 \text{ A}$ burden = 0.35 MVA
- Frequency range: 50 Hz / 60 Hz $\pm 10\%$
- Terminals: screw-type terminals with integrated short-circuiters (contacts)

Relay Outputs

- Continuous current: 5 A AC/DC
- Maximum make current:
 - 25 A AC/25 A DC up to 30 V for 4 s
 - 30 A/230 Vac according to ANSI IEEE Std. C37.90-2005
 - 30 A/250 Vdc according to ANSI IEEE Std. C37.90-2005
- Maximum breaking current:
 - 5 A AC up to 125 Vac
 - 5 A DC up to 30 V (resistive)
 - 0.3 A DC at 300 V
- Maximum switching voltage: 250 Vac/250 Vdc
- Switching capacity: 1250 VA
- Contact type: changeover contact or NO contact
- Terminals: screw-type terminals

Supervision Contact (SC)

- Continuous current: 5 A at 120/240 Vac or 30 Vdc
- Maximum switch-on current: 15 A 120/240 Vac or 30 Vdc (max. 4 s)
- Maximum breaking current:
 - 5 A Vac up to 2120/240 Vac
 - 5 A Vdc up to 30 Vdc
 - 0.4 A at 125 Vdc
- Contact type: 1 changeover contact
- Terminals: screw-type terminals

Time Synchronization IRIG

- Nominal input voltage: 5 V
- Connection: screw-type terminals (twisted pair)

Front Interface RS-232

- Baud rates: 115,200 baud
- Handshake: RTS and CTS
- Connection: 9-pole D-Sub plug

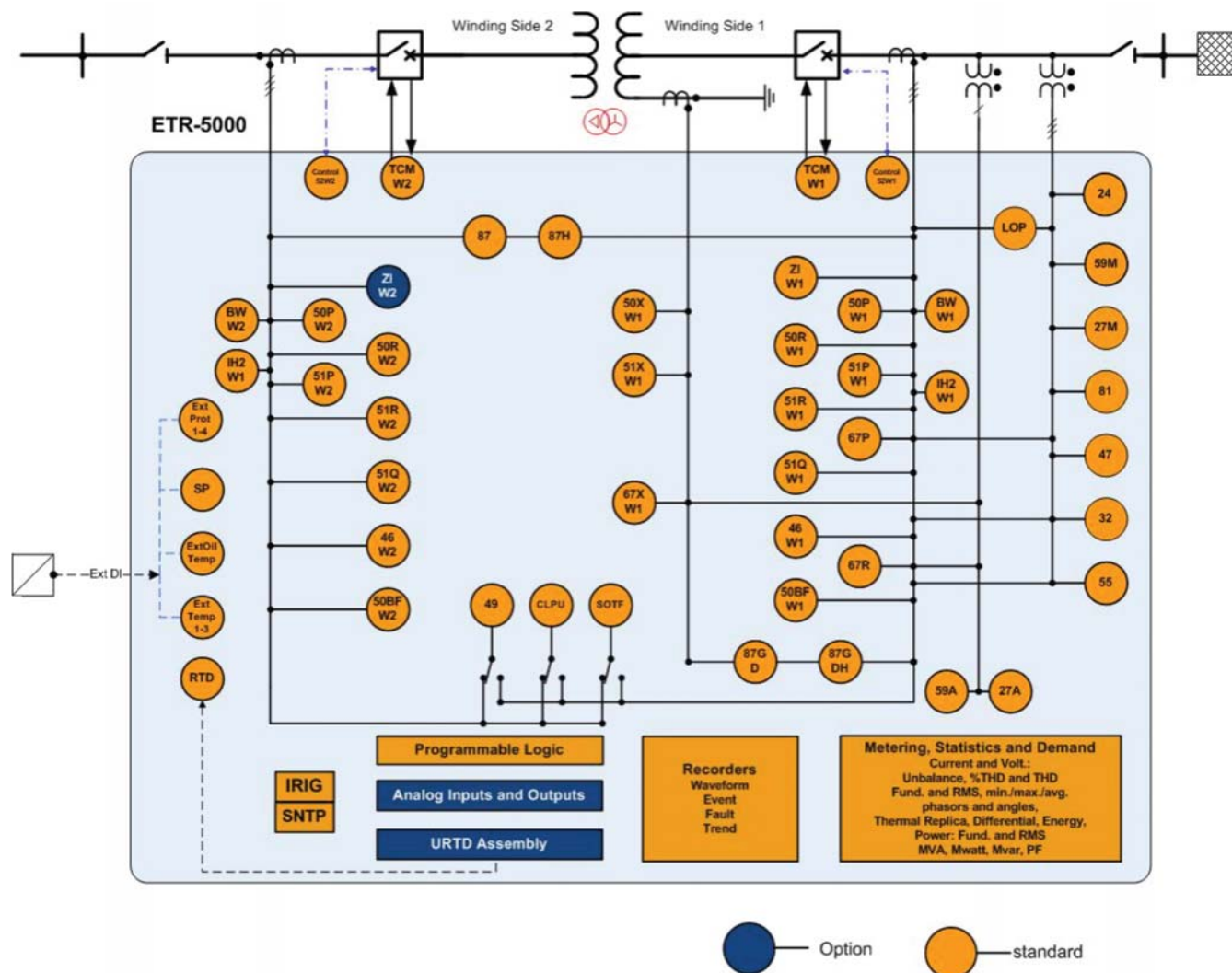
RS-485

- Master/slave: slave
- Connection: 6 screw-clamping terminals RM 3.5 mm (138 MIL) (terminating resistors internal)

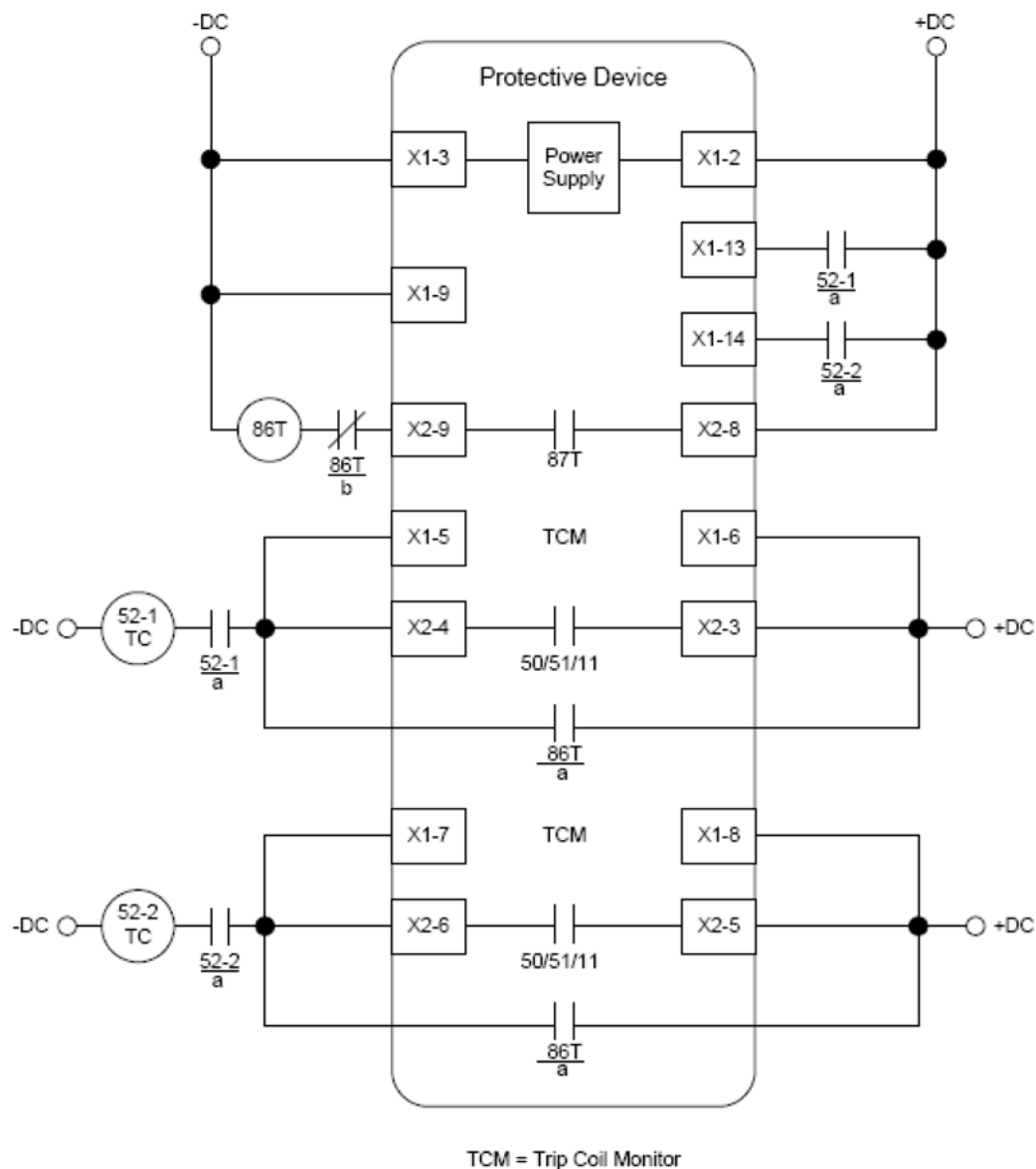
Zone Interlocking

- Nominal input level: 5 V
- Nominal output level: 5 V
- Connection: screw-type terminals (twisted pair)

Typical One-Line Diagram



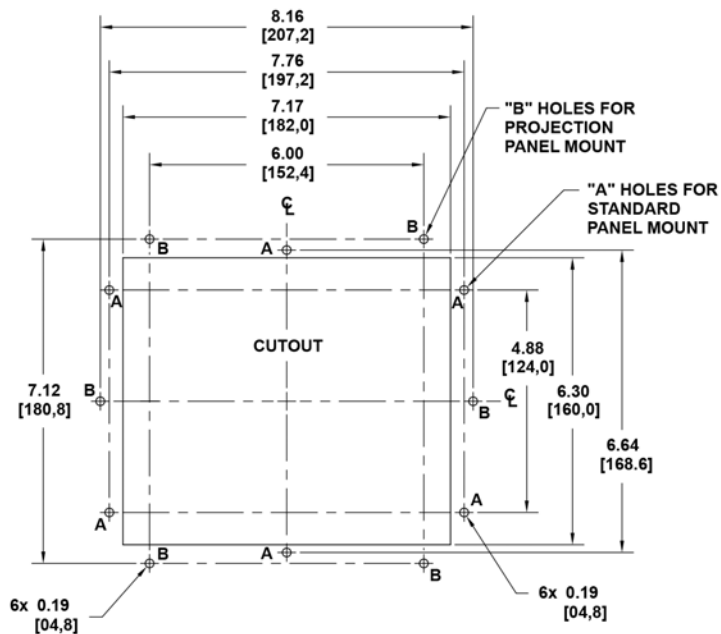
Typical Control Diagram



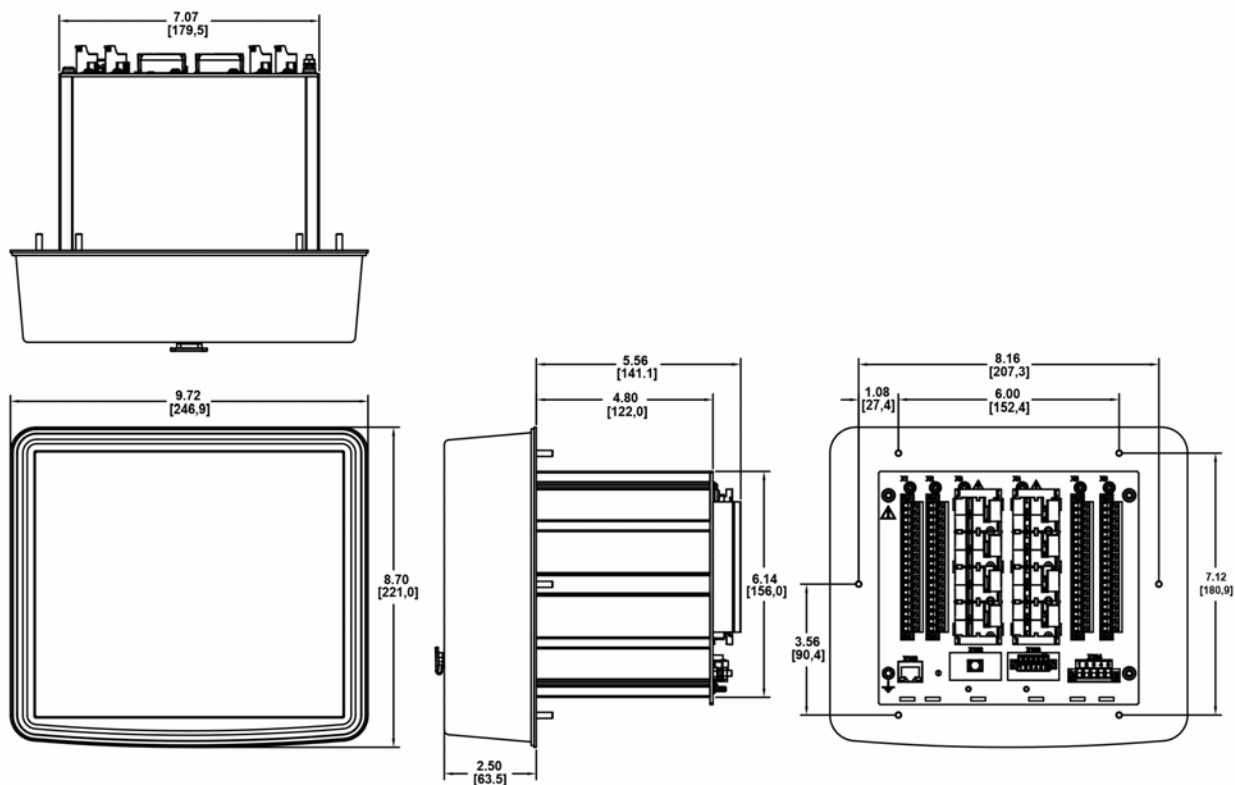
Dimensions

Approximate Dimensions in Inches (mm)

Drilling Plan

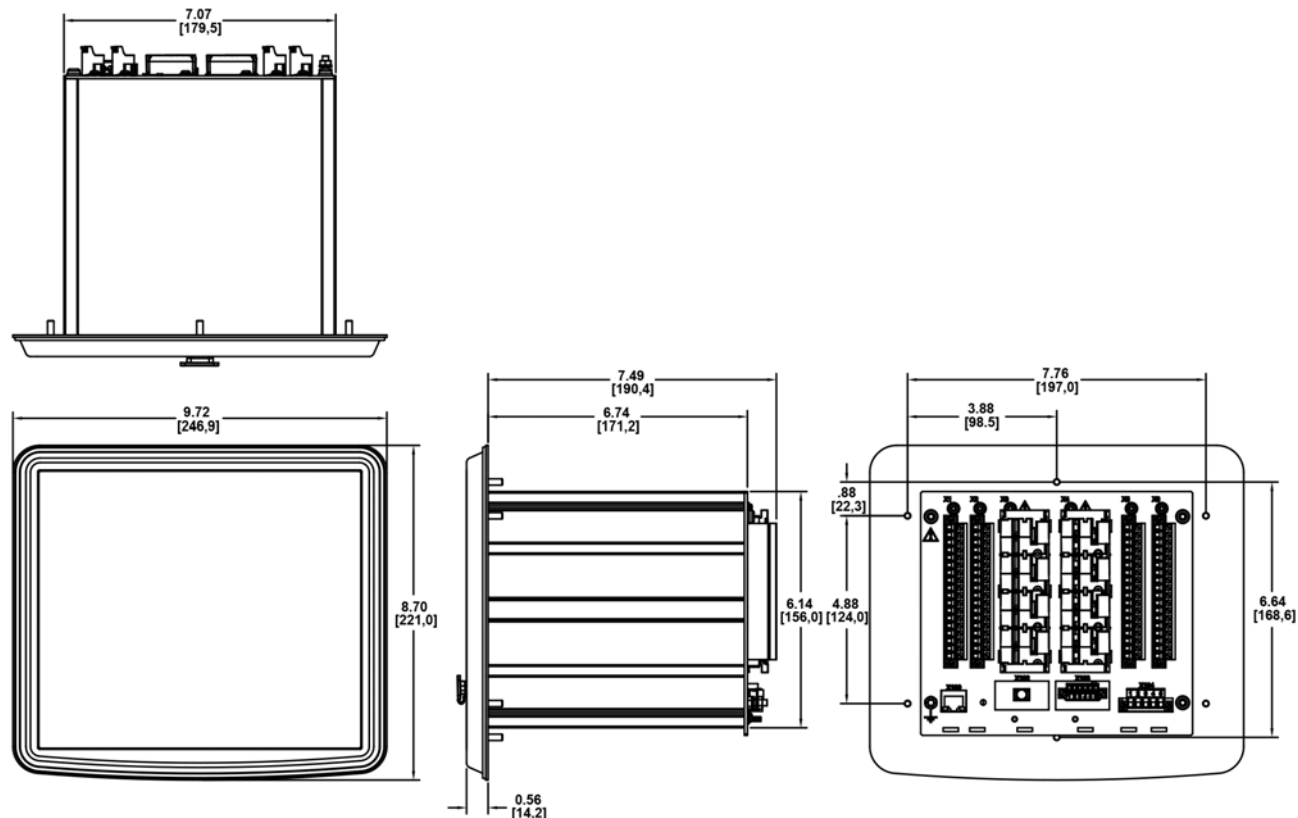


Projection Mount Front and Side Views



Approximate Dimensions in Inches (mm)

Standard Mount Front and Side Views



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EDR-3000 Feeder Protection	V3-T9-61
EDR-5000 Distribution Protection Relay	V3-T9-70
EBR—Line Differential Relay	V3-T9-83
EMR-3MP0 Motor Protection Relay	V3-T9-85
EMR-3000 Motor Protection Relay	V3-T9-87
EMR-4000 Motor Protection Relay	V3-T9-99
EMR-5000 Motor Protection Relay	V3-T9-112
ETR-4000 Transformer Protection Relay	V3-T9-124
ETR-5000 Transformer Protection Relay	V3-T9-136
EGR-5000 Generation Protection Relay	
Universal RTD Module	V3-T9-162

EGR-5000 Generation Protection Relay**Product Description**

Eaton's EGR-5000 generator protection relay is a multi-functional, microprocessor-based relay for any size generators. It may be used as a primary or backup protection in stand by generators, and cogeneration applications. The EGR-5000 generator protection relay provides voltage controlled, voltage restrained, and standard directional three phase overcurrent protection, as well as directional phase-residual and independent ground overcurrent protection, and breaker failure. Three phase over/under voltage, voltage unbalance, current unbalance, over/under and rate-of-change frequency, vector surge, power factor, directional vars, directional power, loss of excitation, overexcitation, phase differential, ground differential, and synch check functions are standard functions.

The EGR-5000 generator relay provides all required protection, control, monitoring and metering for any size generators in a single, compact case. The relay has eight current inputs rated for either 5 amperes or 1 ampere and four voltage inputs. Three of the voltage inputs are to be connected to the three-phase power voltage for voltage protection and for metering. They can be connected in wye-ground or open delta configuration. The fourth voltage is for independent single-phase undervoltage/overvoltage protection, or 100% ground protection for a high resistance grounded generator.

The maintenance mode password protected soft key, can be used for arc flash mitigation to change to an alternate settings group, set to have instantaneous elements only. The multiple setting groups can also be changed, via communications or a digital input.

An integral keypad and display is provided for direct user programming and retrieval of data without the need of a computer. Fourteen programmable LEDs provide quick indication of relay status.

A front port is provided for direct computer connection. An RS-485 and an Ethernet ports in the back are optional for local area networking using. Optional Modbus-RTU, Modbus-TCP, or IEC-61850 protocols are supported.

The EGR-5000 generator protection relay includes programmable logic functions. Logic gates and timers may be defined and arranged for customized applications. Programmable logic control functions make the EGR-5000 very flexible. Flash memory is used for the programming and all settings are stored in nonvolatile memory.

The EGR-5000 generator protection relay has mass memory for data storage and a real-time clock with 1 ms time resolution. The relay will log 300 sequence of event records, 20 detailed trip logs, minimum/ maximum values, load profiles, breaker wear information and waveform data.

The EGR-5000 has either eight programmable binary inputs, 2 analog inputs, 2 analog outputs, or 16 programmable binary inputs. It has 2 normally opened and 6 Form C heavy duty outputs and one Form C signal alarm relay. The EGR-5000 can be powered from 19 Vdc to 300 Vdc or 40 Vac to 250 Vac auxiliary power.

Application Description

Eaton's EGR-5000 generator protection relay has been designed for maximum user flexibility and simplicity. The EGR-5000 provides comprehensive protection, metering, and monitoring for any size synchronous or induction generators operating at 50 or 60 Hz. The base relay includes all the standard protection and metering functions. Protection features found in the EGR-5000 include:

Phase Differential Protection

This protection provides a method for rapidly detecting internal generator phase-to-phase or phase-to-ground faults. After the detection of this fault the generator is quickly removed from service to limit the extent of the damage. The EGR-5000 uses a dual slope percentage differential scheme; advanced CT saturation algorithms maintain immunity against external disturbances and ensures the fault is internal to the generator before triggering it to trip.

Ground Differential Protection

In low resistance grounded generators, ground protection may be provided by the 87GD differential, depending on the fault level and the differential relay sensitivity. Higher sensitivity and fast operation for ground faults may be obtained by an additional zero-sequence differential.

Directional Overcurrent Protection

The EGR-5000 generation protection relay provides complete three-phase and ground directional overcurrent protection. There are 14 independent ground overcurrent elements. The ground elements "X" use the independently measured ground (or neutral) current from a separate current-sensing input. The ground elements "R" uses a calculated 3I₀ residual current obtained from the sum of the three-phase currents.

This calculated current could be used for either the neutral or ground current in a three-phase, four-wire system. Each of the phase and ground overcurrent elements can be selected to operate based on fundamental or rms current.

Phase direction is a function used to supervise all phase current elements (50, 51). A quadrature voltage is compared to a corresponding phase current to establish the direction of the fault. This function is selectable to operate in the forward, reverse or both directions.

Ground direction is used to supervise ground current elements and is accomplished by using ground, negative sequence or residual currents supervised by zero, negative or positive sequence voltages or ground current. This function is selectable to operate in forward, reverse or both directions.

Voltage Restrained Overcurrent

Voltage restraint reduces the overcurrent pickup level (51P[2], 51P[3]), to protect the distribution system components against excessive damage and to prevent the generator and its auxiliaries from exceeding their thermal limitations. This modification of the pickup overcurrent level is compared to the corresponding phase input voltage. The EGR-5000 uses the simple linear model below to determine the effective pickup value.

Sync Check

The sync-check function is provided for double-ended power source applications. The sync-check monitors voltage magnitude, phase angle and slip frequency between the bus and line. It also incorporates breaker close time, dead bus dead line, dead bus live line and live bus live line features.

Reverse Power

Reverse power provides control for power flowing through a generator. There are three elements to be configured: operate in forward or reverse; or, under or over power conditions. Reverse power is typically applied to prevent generator motoring that can cause damage to the prime mover; while under power is generally applied to load loss and prevent an overspeed condition that could damage the prime mover.

Reverse Vars

Reverse vars can be used to detect loss of excitation in synchronous machines. There are three elements to be configured: operate in forward or reverse; or, under or over vars conditions.

Inverse Time Characteristics

There are 11 user-selectable inverse-time overcurrent curve characteristics.

The user can select from the ANSI, IEC or thermal curve families and can select instantaneous or time delay reset characteristics.

Breaker Failure

The EGR-5000 generator protection relay includes a breaker failure (50BF, 62BF) function that can be initiated from either an internal or external trip signal. This is an independent element that can be used to operate a lockout relay or trip an upstream breaker. The timer must be longer than the breaker operating time and the protective function reset times.

Voltage Protection

The EGR-5000 generator protection relay has four voltage-input circuits. There is a three-phase set designated as Main Voltage (M) and a single-phase voltage circuit designated as Auxiliary Voltage (A). Both include undervoltage (27) and overvoltage (59) protection. The three-phase voltage protection can be set to operate on a single-phase, two out of three phases, or all three-phase logic. The Main VTs also provide phase voltage unbalance/reversal (47 negative sequence) protection. Each element has an independent threshold set point and adjustable time delay.

100% Ground Stator Protection

In high impedance grounded generators, ground fault protection is provided by the detection of voltage in the neutral of the generator by an overvoltage element (59N) connected to the secondary of the distribution grounding transformer, this overvoltage element has to be desensitized for 3rd harmonic voltages normally present in the generator. Under normal conditions there is no voltage across the secondary of the grounded transformer, when one of the phases goes to ground, voltage appears across the resistor and the overvoltage element operates, indicating a ground conductor. However, the overvoltage element technique described above will protect around 90 percent to 95 percent of the winding. The last 5–10 percent is protected by detecting the decayed of the 3rd harmonic voltage using an undervoltage element (27TN) tuned to the 3rd harmonic voltage. In the EGR-5000 we can provide 100% stator ground protection by measuring the zero sequence voltage through the 4th voltage input, and combining the 59N and 27A elements. The 27A element has to be programmed to operate for 3rd harmonic zero sequence voltages.

Flexible Phase Rotation

The EGR-5000 generator protection relay can be applied on either an A-B-C or A-C-B phase rotation. A user setting permits correct operation and indication of the actual system configuration.

Frequency Protection

Operation of generators at off-nominal frequencies can have extremely detrimental effects on both the generator itself and the associated prime mover, in particular with steam turbine generators operating below normal frequency. The EGR-5000 relay provides six frequency elements that can be used to detect underfrequency/overfrequency, rate of change, and a vector surge (decoupling of two systems) protection on the Main VT inputs. Each element has an independent threshold set point and adjustable time delay.

Inadvertent Energization

If a generator is inadvertently brought on line with the power system, without being up to speed and synchronized, or it is at standstill when the breaker is closed severe damage could occur. The generator will act as an induction motor and very high currents will be induced in the stator and rotor components, resulting in rapid overheating and damage.

Negative Sequence Protection

Negative sequence overcurrent protection prevents the generators from rotor overheating damage. Unbalanced loads, fault conditions or open phasing will produce a negative sequence current to flow. The unbalanced currents induce double system frequency currents in the rotor, which quickly causes rotor overheating. Serious damage will occur to the generator if the unbalance is allowed to persist. The EGR-5000 provides a negative sequence definite time overcurrent element and a negative sequence timed over current tripping element to ensure the generator stays within its short time and continuous negative sequence current rated limits.

Overexcitation Protection

Generator overexcitation occurs when the ratio of voltage versus frequency is too high, and the rotor iron saturates due to high flux density. High flux density results in stray flux in components not designed to carry it, which in turn causes overheating and can potentially damage the generator. This protection is provided through a Volts/Hertz function with a programmable inverse time characteristic.

Loss of Excitation

Loss of field protection or loss of excitation is used to avoid unstable operation, potential loss of synchronism, and possible damage to synchronous generators. When a synchronous generator loses its field, the generator can continue to generate power as an induction generator, provided that it can obtain its excitation from the other machines on the system. During this condition, the rotor will quickly overheat due to the slip frequency currents induced in it. Loss of excitation in one machine could jeopardize the operation of other machines beyond their capability, and also the stability of the entire system. The EGR-5000 supports the two typical distance relaying schemes used for detecting the loss excitation. The two schemes differ mainly in that scheme 1 uses a negative offset mho element and scheme 2 uses a positive offset mho element with directional unit supervision.

Maintenance Mode

The Maintenance Mode can improve safety by providing a simple and reliable method to reduce fault clearing time and lower incident energy levels at energized panels. The Maintenance Mode allows the user to switch to more sensitive settings via a password protected soft key, communication or via a digital Input while maintenance work is being performed at an energized panel or device. The more sensitive settings provide greater security for maintenance personnel and helps reduce the possibility of injury.

Features, Benefits and Functions

Protection Features

- Dual-slope percentage restrained phase current differential (87)
- Unrestrained phase current differential (87H)
- Restricted ground fault/ Ground Differential (87GD)
- Unrestrained Restricted ground fault/ Ground Differential (87GDH)
- Thermal protection (49/51)
- Phase overcurrent elements:
 - Three instantaneous elements with timers (50P[1], 50P[2] and 50P[3])
 - Three inverse time overcurrent elements (51P[1], 51P[2] and 51P[3])
- 11 standard curves
- Instantaneous or time delay reset
- Voltage restraint (51P[2] and 51P[3])
- Directional control (all elements)
- Ground overcurrent elements:
 - Two instantaneous measured elements with timers (50X[1] and 50X[2])
 - Two instantaneous calculated elements with timers (50R[1] and 50R[2])
 - Two inverse time overcurrent measured elements (51X[1] and 51X[2])
 - Two inverse time overcurrent calculated elements (51R[1] and 51R[2])
- 11 standard curves
- Instantaneous or time delay reset
- Directional control (all elements)
- Breaker failure (50BF)
- Phase unbalance negative sequence overcurrent (46[1], 46[2])
- Phase voltage unbalance and sequence protection (47[1], 47[2])
- Main three-phase under/ overvoltage (27M[1], 27M[2], 59M[1], 59M[2])
- Auxiliary single-phase under/overvoltage (27A[1], 27A[2], 59A[1], 59A[2])
- Ground fault overvoltage relay (59N[1], 59N[2])
- Six frequency elements that can be assigned to: over frequency, under frequency, rate of change, or vector surge (81[1], 81[2], 81[3], 81[4], 81[5], 81[6])
- Apparent and displacement power factor (55A[1], 55A[2], 55D[1], 55D[2])
- Forward and reverse watts (32[1], 32[2], 32[3])
- Forward and reverse vars (32V[1], 32V[2], 32V[3])
- Overexcitation, volts-per-hertz (24[1], 24[2])
- 64S, 100% stator ground fault (27TN/ 59N)
- Generator unbalance (46G[1], 46G[2])
- Loss of excitation (40[1], 40[2])
- Sync check (25)
- Inadvertent energization (50/27)
- Lockout (86)
- Loss of Potential-LOP
- Zone interlocking for bus protection (87B)
- Switch onto fault protection
- Cold load pickup

Metering Features

- Generator hours of operation
 - Phase Differential Current
 - Ground Differential Current
- Amperes: positive, negative and zero sequence
- Ampere demand
- Volts: positive, negative and zero sequence
- Phase angles
- Volt-amperes and VA demand
- Watts and kW demand
- kWh (forward, reverse, net)

- Vars and kvar demand
- kvarh (lead, lag and net)
- Power factor
- Frequency
- Volts/Hertz
- 3rd Harmonic Voltage
- % THD V and I
- Magnitude THD V and I
- Minimum/maximum recording
- Sync values
- Trending (load profile over time)
- Temperature with remote URTD module

Monitoring Features

- Trip coil monitor
- Breaker wear
- Oscillography (7200 cycles total)
- Trip cause displays fault recorder data on HMI after fault event
- Fault data logs (up to 20 events)
- Sequence of events report (up to 300 events)
- Clock (1 ms time stamping)

Control Functions

- Breaker open/close
- Remote open/close
- Programmable I/O
- Programmable Logic
- Programmable LEDs
- Multiple setting groups
- Cold load pickup
- CT supervision

Communication Features

- Local HMI
- Password protected
- Addressable
- IIRIG-B
- Local communication port:
 - RS-232
- Remote communication port:
 - RS-485
 - Ethernet port
- Protocols:
 - Modbus-RTU (optional)
 - Modbus-TCP (optional)
 - IEC-61850 (optional)
- Configuration software

Monitoring and Metering

Sequence of Events Records

The EGR-5000 generator protection relay records a maximum of 300 events associated with the relay. An event is classified as a change of state as detected by the relay. These include relay pickups, dropouts, trips, contact closure, alarms, setting changes and self-diagnostic failures. Each event is date and time stamped to a 1 ms resolution. The events are stored in a FIFO log in chronological order.

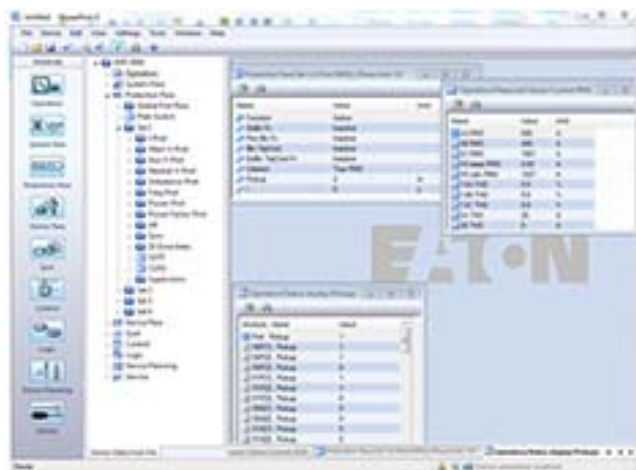
Trip Log

The EGR-5000 protection relay will store a maximum of 20 trip records in a FIFO trip log. Each trip record will be date and time stamped to a 1 ms resolution. The trip log record will include information on the type of fault, protection elements that operated, fault location and currents and voltages at the time of the fault.

PowerPort-E

PowerPort-E is the software program used to configure off-line protection setting files for all E-Series relay models. PowerPort-E is also used for viewing measured values of

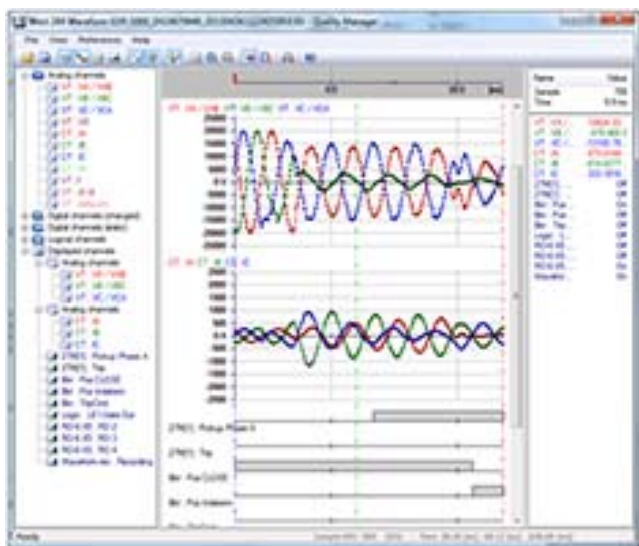
the relays in real-time, uploading/downloading setting files, and retrieving event log and waveform records.



Waveform Capture (Quality Manager)

The EGR-5000 relay provides oscillographic recording capabilities. The relay will record all measured signals along with the binary signals of pickup, trip, internal logic, and contact inputs. The EGR-5000 can record up to 7200 cycles of data. The number of records is proportional to the programmed size of each record; the maximum size per record is 600 cycles.

The waveform capture is initiated by up to 8 different triggers (i.e., trip/alarm events) or manually via communications or the HMI. PowerPort-E setting software is used to retrieve the records. Quality Manager is a separate software program downloaded with PowerPort-E used for analyzing the waveform and trending files retrieved from the relay.



Integral User Interface

The front panel user interface has a 128 x 64 pixel LCD display with background illumination for wide angle viewing in all light conditions. 17 programmable LEDs provide quick and easy visual display of power on, mode of operation, alarm and trip indication. Soft keys are provided for operation mode selection, scrolling through data and settings. In addition, the relay settings and test functions are password protected.

Load Profiling/Trending

The EGR-5000 relay automatically records selected quantities into non-volatile memory every 5, 10, 15, 30 or 60 minutes, depending on the trending report setting.

Programmable I/O

The EGR-5000 generator protection relay provides heavy-duty, trip-rated, 2NO and 6 Form C contacts. Two isolated inputs can be used for monitoring the trip circuit. One Form C contact is dedicated to the relay failure alarm function and is operated in a normally energized (failsafe) mode. There are up to 16 user-configurable discrete inputs that accept a wet contact and can operate through a wide range of power. Each input and output is user-programmable for maximum application flexibility.

The EGR-5000 also offers two optional analog inputs and two optional analog outputs. The analog inputs are available for providing protection and monitoring of generator bearing vibration. The analog inputs are field programmable to measure transducer signals that operate over a range of 0 to 20 mA, 4 to 20 mA, or 1 to 10 V. The two optional analog outputs can be used for signaling the value of measured analog quantities to external process control devices such as PLCs.

They can be programmed to operate over a 0 to 20 mA, 4–20 mA, or 1 to 10 V range. The analog outputs can be configured to signal a representation of most analog quantities measured by the EGR-5000 including, current, voltages, and RTD temperature.

Programmable Logic

The EGR-5000 generator protection relay provides logic gates and timers that the user can customize for special or unique applications. Each gate can be assigned a logic function of either AND, OR, NAND or NOR. Each gate can have a maximum of four input signals and each input signal can be required to be a NOT. Input signals can be external inputs received via the binary inputs or internal values associated with the protection, alarm or metering set points. Each gate has a unique output assignment and designation that can be used as the input to another gate. There are 24 independent timers that have adjustable pickup and dropout delay settings.

Standards and Certifications

Approvals

- UL listed file: E217753

Design Standards

- Generic Standard:
 - EN 61000-6-2
 - EN 61000-6-3
- Product Standard:
 - IEC 60255-6
 - EN 50178
 - UL 508 (Industrial Control Equipment)
 - CSA C22.2 No. 14-95 (Industrial Control Equipment)
 - ANSI C37.90



Catalog Number Selection

The catalog number identification chart defines the electrical characteristics and operation features included in the EGR-5000. For example, if the catalog number is EGR-5000-2A0BA1, the device would have the following:

EGR-5000

(A)—16 DI, 9 Outputs, Removable Terminals, Zone Interlocking, URTD Interface

(0)—5 A / 1 A Phase and Ground CTs, Power Supply Range: 19–300 Vdc, 40–250 Vac

(B)—Modbus-RTU (RS-485)

(A)—Without conformal coating

(1)—Projection panel mount

EGR-5000 Eaton Motor Relay**EGR-5000-2A 0 B A 1**

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Hardware Option 1

A = 16 DI, 9 outputs, removable terminals, zone interlocking, URTD interface
B = 8 DI, 9 outputs, 2 AI, 2 AO, removable terminals, zone interlocking, URTD interface

Hardware Option 2

0 = Phase current 5 A / 1 A, ground current 5 A / 1 A, power supply range: 19–300 Vdc, 40–250 Vac
1 = Phase current 5 A / 1 A, sensitive ground current 0.5 A / 0.1 A, power supply range: 19–300 Vdc, 40–250 Vac

Communication Options

B = Modbus/DNP3 RTU over RS-485
C = Modbus/DNP3 TCP over Ethernet RJ-45
D = PROFIBUS-DP over fiber optic ST
E = PROFIBUS-DP over D-Sub / RS-485
F = Modbus RTU or DNP3 RTU over fiber optic ST
G = Modbus/DNP3 RTU over D-Sub / RS-485
H = IEC 61850/Modbus/DNP3 TCP over Ethernet RJ-45
I = Modbus/DNP3 RTU over RS-485 or Modbus/DNP3 TCP over Ethernet RJ-45
K = IEC 61850/Modbus/DNP3 TCP over LC duplex fiber optic Ethernet
L = Modbus/DNP3 TCP over LC duplex fiber optic Ethernet

Conformal Coating Options

A = None
B = Conformal coated circuit boards

Mounting Options

0 = Standard mount
1 = Projection panel mount

Accessories**Standard Accessories EGR-5000**

Description	Catalog Number
UNVL RTD Mod with Modbus-RTU 48–240 Vac/48–250 Vdc	URTDII-01 ①
UNVL RTD Mod with Modbus-RTU 24–48 Vdc	URTDII-02 ①
E-Series RS-232 Null Modem Cable	66B2214G01
E-Series USB to RS-232 Converter	66B2214G02
E-Series RS-232 Cable and USB to RS-232 Converter	66B2214G03

Note

① See URTD section for fiber optic cables required to communicate to the EGR-5000.

Technical Data and Specifications

Climatic Environmental Conditions

- Storage temperature: -30 °C to +70 °C (-22 °F to +158 °F)
- Operating temperature: -20 °C to +60 °C (-4 °F to +140 °F)
- Permissible humidity at ann. average: <75% rel. (on 56d up to 95% rel.)
- Permissible installation altitude:
 - <2,000 m (6,561.67 ft) above sea level
 - If 4,000 m (13,123.35 ft) altitude applies, a changed classification of the operating and test voltages may be necessary

Degree of Protection EN 60529

- HMI front panel with seal: IP54
- Rear side terminals: IP20

Routine Test

- Insulation test acc. to IEC 60255-5: All tests to be carried out against ground and other input and output circuits
- Aux. voltage supply, digital inputs, current
 - Measuring inputs, signal relay outputs: - 2.5 kV (eff.) / 50 Hz
- Voltage measuring inputs: 3.0 kV (eff.) / 50 Hz
- All wire-bound communication interfaces: 1.5 kV DC
- Insulation test acc to IEC60255-5: All tests to be carried out against ground and other input and output circuits

Housing

- Housing B2: height / width 183 mm (7.205 in) / 212.7 mm (8.374 in)
- Housing depth (incl. terminals): 208 mm (8.189 in)
- Material, housing: aluminum extruded section
- Material, front panel: aluminum/foil front
- Mounting position: horizontal (±45° around the X-axis must be permitted)
- Weight: Approx. 4.2 kg (9.259 lb)

Current and Ground Current Measurement

- Nominal currents: 1 A / 5 A
- Max. measuring range:
 - Up to 40 x In (phase currents)
 - Up to 25 x In (ground current standard)
 - Up to 2.5 x In (ground current sensitive)
- Continuous loading capacity: 4 x In / continuously
- Overcurrent proof:
 - 30 x In / 10 s
 - 100 x In / 1 s
 - 250 x In / 10 ms (1 half-wave)
- Power consumption:
 - Phase current inputs
 - At In = 1 A S = 0.15 MVA
 - At In = 5 A S = 0.15 MVA
 - Ground current input
 - At In = 1 A S = 0.35 MVA
 - At In = 5 A S = 0.35 MVA
- Frequency range: 50 Hz / 60 Hz ±10%
- Terminals: screw-type terminals with integrated short-circuiters (contacts)

Connection cross sections:

- 1 x or 2 x 2.5 mm² (2 x AWG 14) with wire end ferrule
- 1 x or 2 x 4.0 mm² (2 x AWG 12) with ring cable sleeve or cable sleeve
- 1 x or 2 x 6 mm² (2 x AWG 10) with ring cable sleeve or cable sleeve
- The current measuring board's terminal blocks may be used as with 2 (double) conductors AWG 10,12,14 otherwise with single conductors only

Plug-in Connector with Integrated Short-Circuiter (Conventional Current Inputs)

- Nominal Current: 1 A and 5 A
- Continuous loading capacity: 4 x In / continuously
- Overcurrent withstand:
 - 30 x In / 10 s
 - 100 x In / 1 s
 - 250 x In / 10 ms (1 half-wave)
- Screws: M4, captive type acc. to VDEW
- Connection cross sections:
 - 1 x or 2 x 2.5 mm² (2 x AWG 14) with wire end ferrule
 - 1 x or 2 x 4.0 mm² (2 x AWG 12) with ring cable sleeve or cable sleeve
 - 1 x or 2 x 6 mm² (2 x AWG 10) with ring cable sleeve or cable sleeve
 - The current measuring board's terminal blocks may be used as with 2 (double) conductors AWG 10,12,14 otherwise with single conductors only

Voltage and Residual Voltage Measurement

- Nominal voltages: 100 V / 110 V / 230 V / 400 V (can be configured)
- Max. measuring range: 2 x nominal voltage
- Continuous loading capacity: 2 x nominal voltage (800 Vac)
- Power consumption:
 - at Vn = 100 V S = 0.1 MVA
 - at Vn = 110 V S = 0.1 MVA
 - at Vn = 230 V S = 0.4 MVA
 - at Vn = 400 V S = 1.0 MVA
- Frequency range: 50 Hz or 60 Hz ±10%
- Terminals: screw-type terminals

Frequency Measurement

- Nominal frequencies: 50 Hz / 60 Hz

Voltage Supply

- Aux. voltage: 24–270 Vdc / 48–230 Vac (-20/+10%)
- Buffer time in case of supply failure:
 - ≥50 ms at minimal aux. voltage
 - Interrupted communication is permitted
- Max. permissible making current:
 - 18 A peak value for <0.25 ms
 - 12 A peak value for <1 ms
- The voltage supply must be protected by a fuse of:
 - 2.5 A time-lag miniature fuse 5 x 20 mm (approx. 0.2 x 0.8 in) according to IEC 60127
 - 3.5 A time-lag miniature fuse 6.3 x 32 mm (approx. 0.25 x 1.25 in) according to UL 248-14

Power Consumption

- Power supply range: 24–270 Vdc
 - Power consumption in idle mode—7 W
 - Maximum power consumption—13 W
- Power supply range: 48–230 Vac (for frequencies of 40–70 Hz)
 - Power consumption in idle mode—7 VA
 - Maximum power consumption—13 VA

Display

- Display type: LCD with LED background illumination
- Resolution—graphics display: 128 x 64 pixel

LED

- LED type: two colored: red/green
- Number of LEDs, Housing B2: 15

Front Interface RS-232

- Baud rates: 115,200 baud
- Handshake: RTS and CTS
- Connection: 9-pole D-Sub plug

Real Time Clock

- Running reserve of the real time clock: 1 year min.

Digital Inputs

- Max. input voltage: 300 Vdc / 259 Vac
- Input current: <4 mA
- Reaction time: <20 ms
- Fallback time: <30 ms

(Safe state of the digital inputs)

- Switching thresholds: Un = 24 Vdc, 48 Vdc, 60 Vdc, 110 Vac / Vdc, 230 Vac / Vdc
 - Un = 24 Vdc
 - Switching threshold 1 ON: Min. 19.2 Vd
 - Switching threshold 1 OFF: Max. 9.6 Vdc
 - Un = 48 V / 60 Vdc
 - Switching threshold 2 ON: Min. 42.6 Vdc
 - Switching threshold 2 OFF: Max. 21.3 Vdc
 - Un = 110 / 120 Vac / Vdc
 - Switching threshold 3 ON: Min. 88.0 Vdc / 88.0 Vac
 - Switching threshold 3 OFF: Max. 44.0 Vdc / 44.0 Vac
 - Un = 230 / 240 Vac / Vdc
 - Switching threshold 4 ON: Min. 184 Vdc / 184 Vac
 - Switching threshold 4 OFF: Max. 92 Vdc / 92 Vac
- Terminals: screw-type terminal

Relay Outputs

- Continuous current: 5 A AC/DC
- Max. make current:
 - 25 A AC / 25 A DC up to 30 V for 4 s
 - 30 A / 230 Vac according to ANSI IEEE Std C37.90-2005
 - 30 A / 250 Vdc according to ANSI IEEE Std C37.90-2005
- Max. breaking current:
 - 5 A AC up to 250 Vac
 - 5 A DC up to 30 V (resistive)
 - 0.3 A DC at 300 V
- Max. switching voltage: 250 Vac / 250 Vdc
- Switching capacity: 1250 VA
- Contact type: Form C or normally open contact
- Terminals: screw-type terminals

Supervision Contact (SC)

- Continuous current: 5 A AC/DC
- Max. switch-on current: 15 A AC / 15 A DC up to 30 V for 4 s
- Max. breaking current:
 - 5 A AC up to 250 Vac
 - 5 A DC up to 30 Vdc
 - 0.4 A at 125 Vdc
- Contact type: 1 Form C contact
- Terminals: screw-type terminals

Time Synchronization IRIG-B00X

- Nominal input voltage: 5 V
- Connection: screw-type terminals (twisted pair)

Zone interlocking

Note: Only for zone interlock tripping outputs (zone interlock, semiconductor output): 5 Vdc, <2 mA for connection to electronic inputs only.

- Zone Out:
 - Output voltage (high) 4.75 to 5.25 Vdc
 - Output voltage (low) 0.0 to +0.5 Vdc
- Zone In:
 - Nominal input voltage +5 Vdc
 - Max. input voltage +5.5 Vdc
 - Switching threshold ON min. 4.0 Vdc
 - Switching threshold OFF max. 1.5 Vdc
 - Galvanic isolation 2.5 kV AC (to ground and other IO)
 - Connection: screw-type terminals (twisted pair)

RS-485

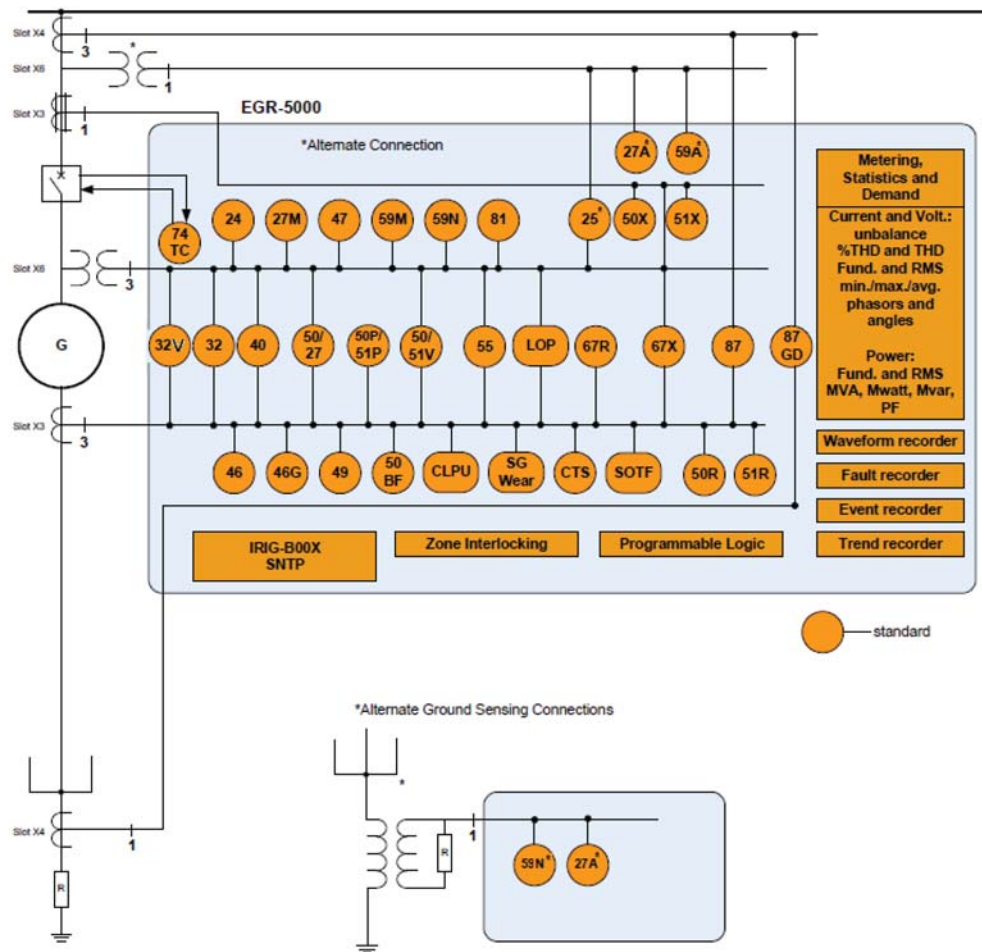
- Master/slave: slave
- Connection: six screw-clamping terminals RM 3.5 mm (138 MIL) (terminating resistors internal)

Note: The RS-485 interface is realized via terminals. The communication cable has to be shielded. The shielding has to be fixed at the screw that is marked with the ground symbol (rear side of the device).

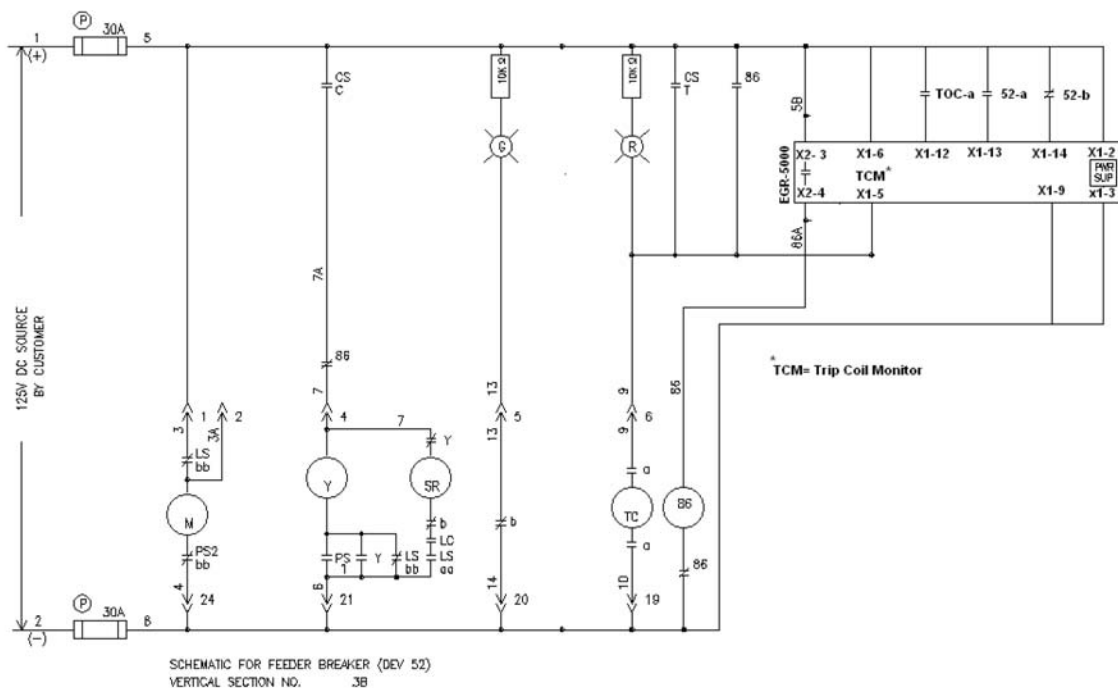
Typical AC Connections—High Impedance Grounded Generator with Phase Differential Protection, Wye VTs, Zero Sequence Ground Protection, and Either Synch-check or 100% Stator Ground Fault Protection



Typical One-Line Diagram

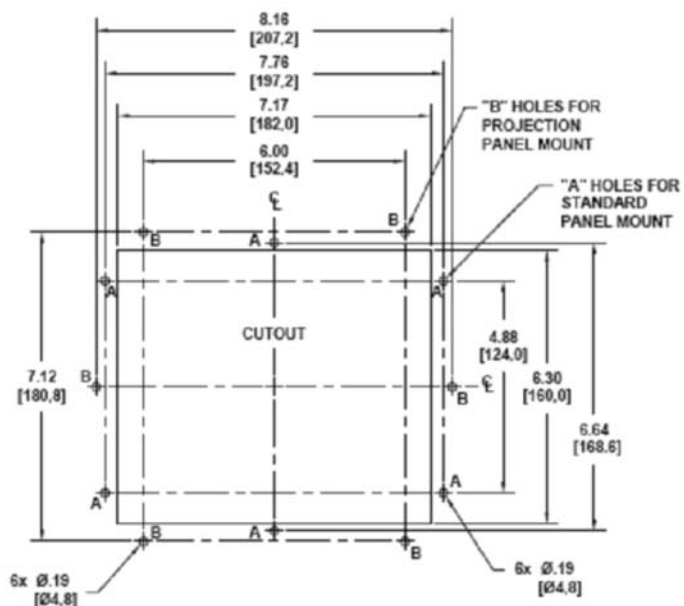
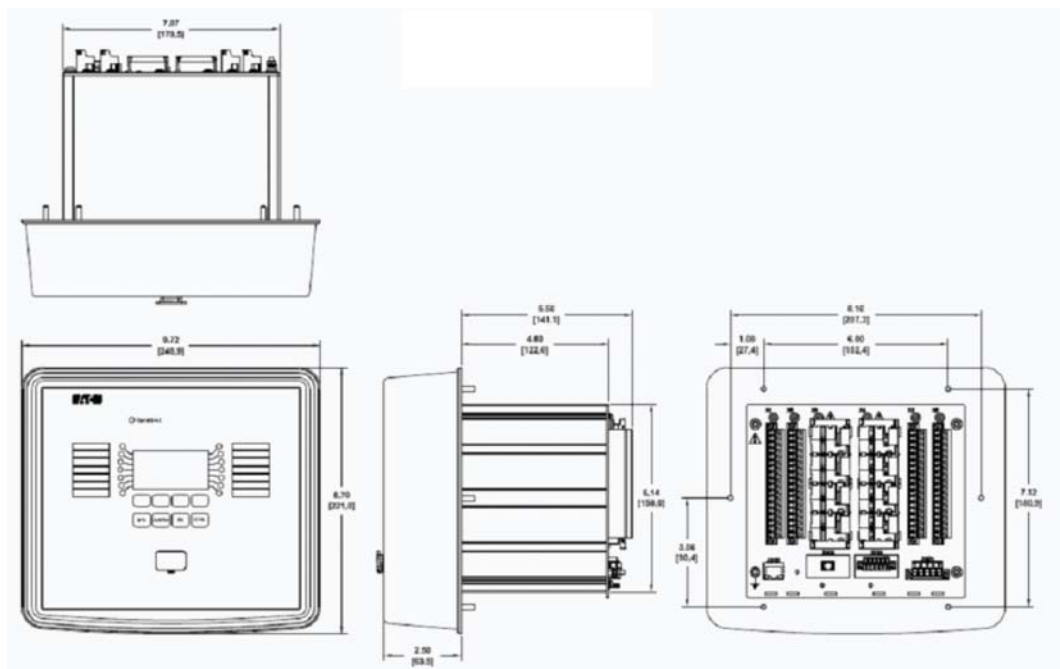


Typical Control Diagram



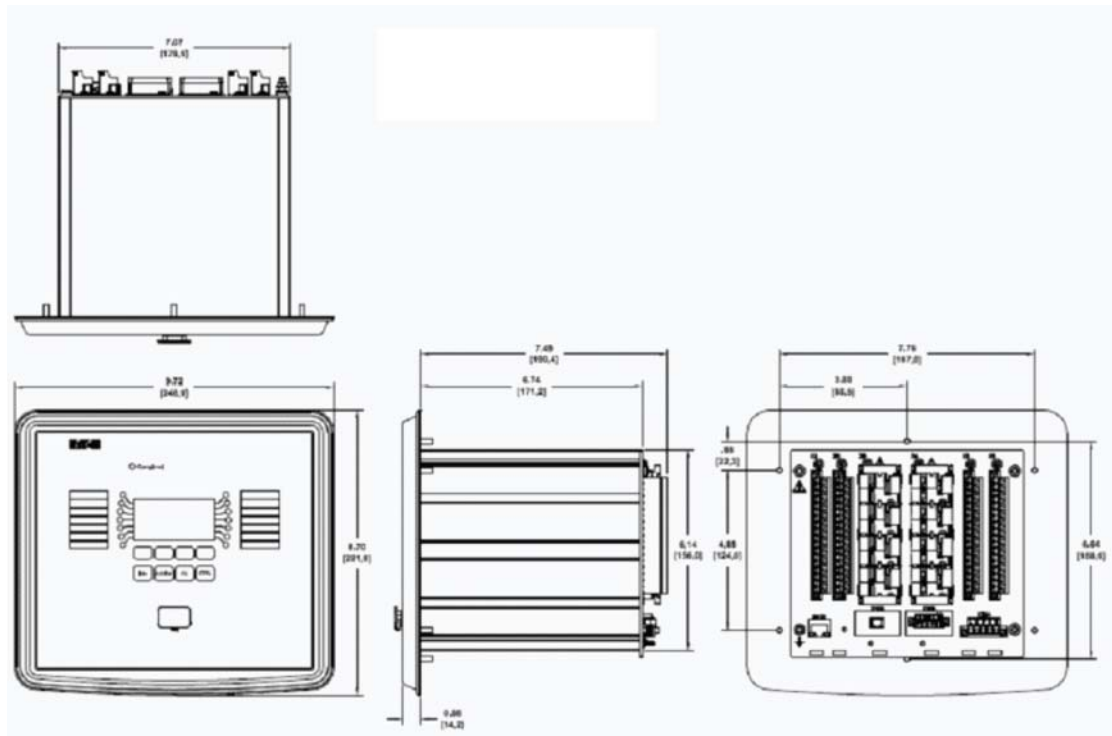
Dimensions

Approximate Dimensions in Inches (mm)

Drilling Plan**Projection Mount Front and Side Views**

Approximate Dimensions in Inches (mm)

Standard Mount Front and Side Views



Universal RTD Module



Contents

Description	Page
Product Selection Guide	V3-T9-53
Arc Flash Relay	V3-T9-59
EDR-3000 Feeder Protection	V3-T9-61
EDR-5000 Distribution Protection Relay	V3-T9-70
EBR—Line Differential Relay	V3-T9-83
EMR-3MP0 Motor Protection Relay	V3-T9-85
EMR-3000 Motor Protection Relay	V3-T9-87
EMR-4000 Motor Protection Relay	V3-T9-99
EMR-5000 Motor Protection Relay	V3-T9-112
ETR-4000 Transformer Protection Relay	V3-T9-124
ETR-5000 Transformer Protection Relay	V3-T9-136
EGR-5000 Generation Protection Relay	V3-T9-149
Universal RTD Module	

Universal RTD Module

Product Description

- Electronic Resistance Temperature Detector (RTD) provides motor temperature interface for the MP-3000 Motor Protection Relay
- Monitors up to 11 RTDs consisting of six motor windings, two motor bearings, two load bearings and one auxiliary
- Works with 10 ohm copper, 100 ohm platinum, 100 ohm nickel and 120 ohm nickel type RTDs
- Include fiber optic and electrical communication interfaces to the MP-3000 Motor Protection Relay

Application Description

URTD can be used with MP-3000, MP-4000, EMR-3000, EMR-4000, EMR-5000, ETR-4000, ETR-5000, and EGR-5000.

Eaton's URTD Module is most commonly used to provide motor temperature information to the MP-3000 Motor Protection Relay. The MP-3000 Motor Protection uses this information for monitoring, tripping and alarming. The MP-3000 Intel-I-Trip overload algorithm will adjust its trip characteristics based on the actual motor temperature reported by the URTD Module. This improves the protection by using an actual temperature value instead of the assumed NEMA Standard Ambient Temperature.

The URTD Module may be mounted close to the motor or at the protective relay.

Both electrical and fiber optic interface ports are provided to communicate temperature information to the MP-3000 relay. The electrical interface can transmit information using a three-conductor shielded cable with a maximum cable distance of 500 ft (152 m). The fiber optic link has a maximum distance of 400 ft (122 m).

The URTD Module may be used with the IQ-1000 and IQ-1000 II motor relays. It may also be applied as a standalone temperature monitoring device communicating, for example, transformer temperature information back to a remote computer or PLC. An optional PONI (Product Operated Network Interface) is required for standalone applications.

Features, Benefits and Functions

- Universal design works with any RTD type, simplifying installation and operation and reducing inventory
- Standalone design permits mounting the module close to the motor, reducing RTD wiring costs
- RTD diagnostics detects faulty RTDs and wiring, reducing unnecessary tripping and alarming

Product Selection

Universal RTD Module

Universal RTD Module



Description	Catalog Number
Universal RTD Module	URTD
48-240 Vac/48-250 Vdc power supply and Modbus-RTU communications	URTDII-01
24-48 Vdc and Modbus-RTU communications	URTDII-02

Options and Accessories

Additional Related Products from Eaton's Cutler-Hammer Series

Eaton provides fiber optic cables for connecting to the MP-3000 or IQ-1000 II Motor Protection Relays.

Fiber Optic Cables:

Length	Catalog Number
1	MPF0-1
5	MPF0-5
10	MPF0-10
25	MPF0-25
50	MPF0-50
75	MPF0-75
100	MPF0-100

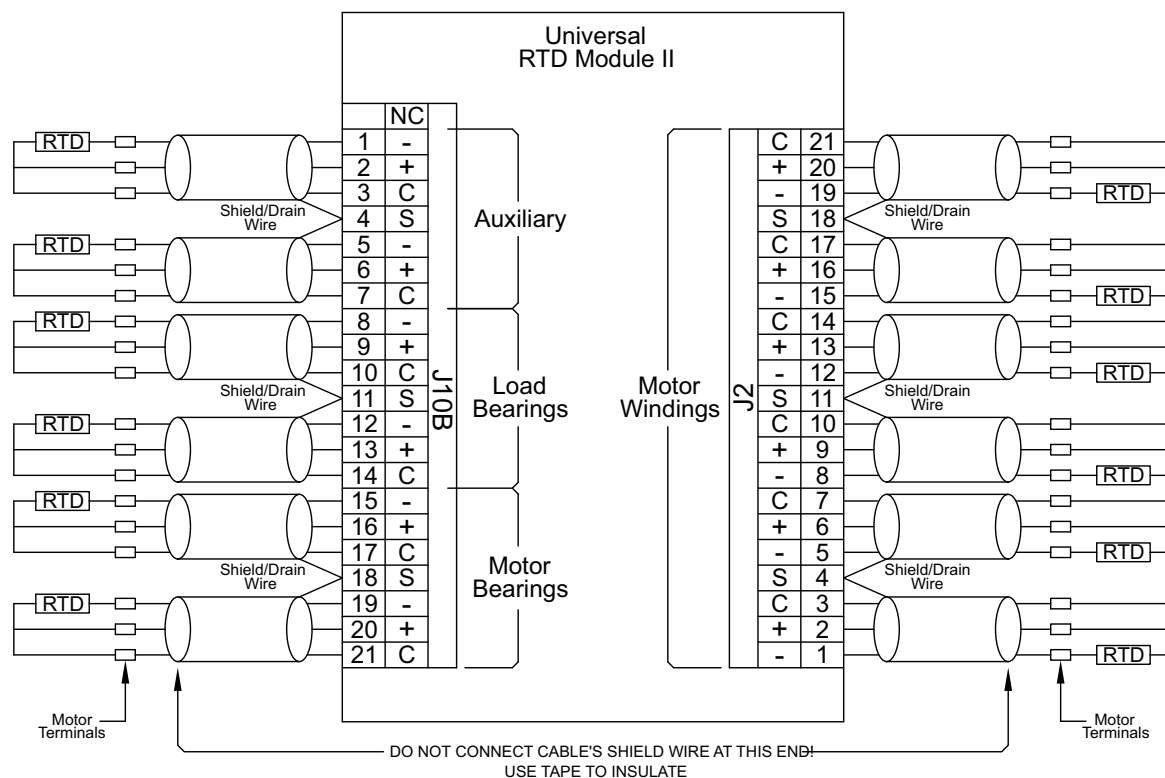
Technical Data and Specifications

Universal RTD Module

Specifications	URTDII-01	URTDII-02
Input power requirements	48–240 Vac / 48–250 Vdc	24–48 Vdc
Frequency	50/60 Hz or DC	DC
Power consumption	3.5 W	1 W
Operating temperature	–20° to +55 °C (–4° to +131 °F)	–20° to +55 °C (–4° to +131 °F)
Storage temperature	–40° to +85 °C (–40° to +185 °F)	–40° to +85 °C (–40° to +185 °F)
Humidity	0 to 95% R.H. noncondensing	0 to 95% R.H. noncondensing
Altitude	2000 m	2000 m
Pollution degree	2	2
Installation category	I	I

Wiring Diagram

RTD Wiring (Three-Lead Type)

**Note:**

1. Each shielded cable conductor must be connected on the URTDII as shown.
2. Use of three-lead RTDs is recommended.
3. RTDs must not be grounded at the motor, and no common connections between RTDs should be made at the motor.
4. A suitable earth ground should be connected to J10B-4, J10B-11, J10B-18, J2-4, J2-11, or J2-18. It is recommended that a ground connection is made to both sides of the unit.

Note

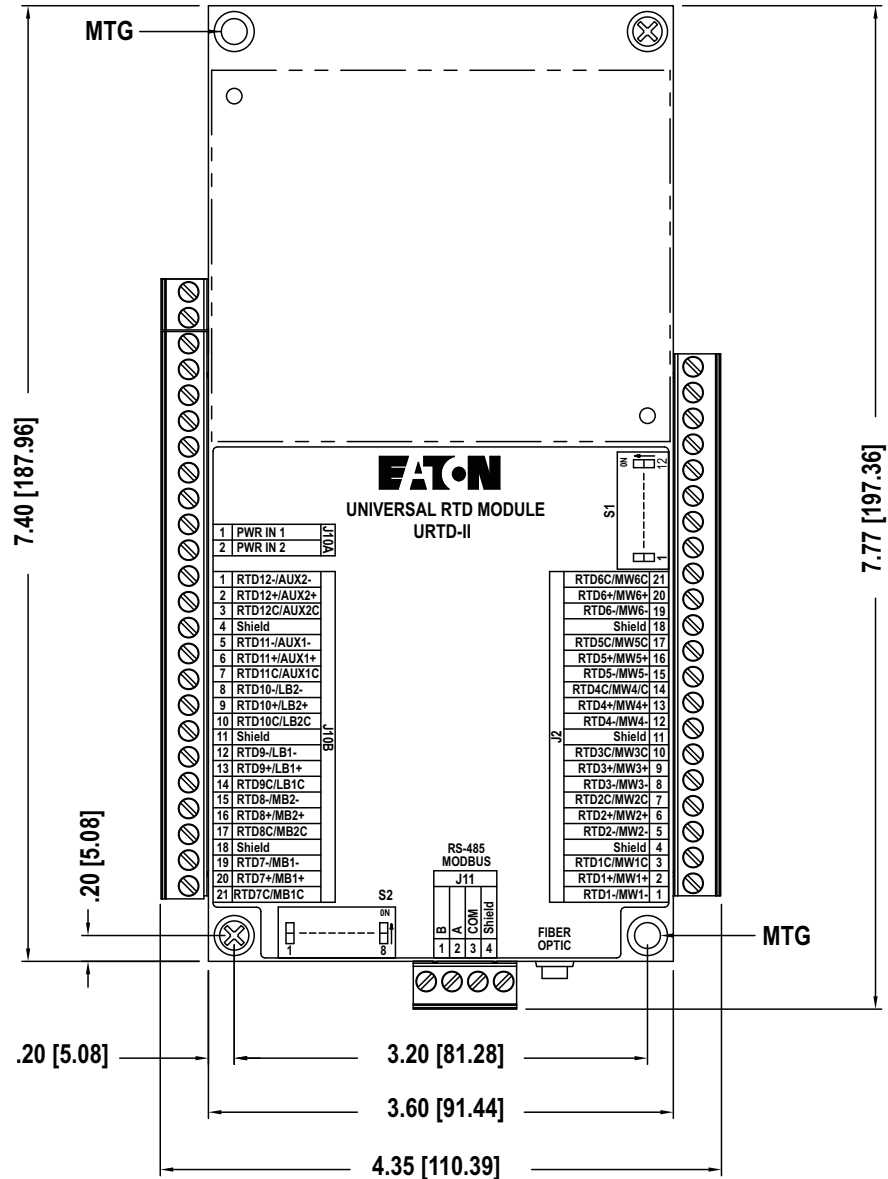
Showing a typical three-lead type RTD wiring connection.

Approximate Dimensions in Inches (mm)

ATC Universal RTD Module II
 Cat No.: URTDI-XX
 Style No.: 66D235GXX
 H.W.: X.XX F.W.: X.XX
 Serial No.: XXX-MMY

Pin headers (left to right):

- 1, 2
- 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21
- 1



Showing the URTD Module dimensions and terminal designations.

Power Xpert Gateway**Contents****Description****Page**

Power Xpert Gateway	
Product Selection Guide	V3-T9-168
Product Description	V3-T9-167
Standards and Certifications	V3-T9-170
Product Selection	V3-T9-170
Technical Data and Specifications	V3-T9-171
Dimensions	V3-T9-174
PXM1K-ETHMULTI Card for PXE Devices	V3-T9-175
mMINT	V3-T9-177

Power Xpert Gateway**Product Overview**

- Open communication architecture
 - Connects to both Eaton and third-party electrical equipment; communicates to INCOM™ and Modbus® RTU devices
 - Modbus TCP and BACnet/IP support facilitates integration with third-party monitoring solutions
 - Ethernet/web-based support uses your existing network infrastructure, reducing costs
- Flexible and expandable solutions
 - Stand-alone or small systems benefit from comprehensive, on-board web pages; no additional programming or software is necessary for virtually out-of-the-box, plug-and-play functionality
 - Larger systems, such as campus installations or power systems with remote locations can view multiple PXGs via Power Xpert Insight or a third-party monitoring system
 - Existing equipment can be connected to the PXG to reap the benefits of Power Xpert Architecture at minimal cost, without the need to upgrade
- Information at a glance
 - Using a standard web browser, view the PXG's web interfaces that include a Network tab, Alarms tab, individual device detail pop-outs and One Line graphics tab
 - Comprehensive, well-organized device web pages present measured parameters such as current, voltage, power, energy, frequency, power factor and voltage THD, just to name a few
 - Combine with Power Xpert Insight for viewing multiple gateways and other power system equipment for more extensive energy monitoring and capacity analysis

Product Description

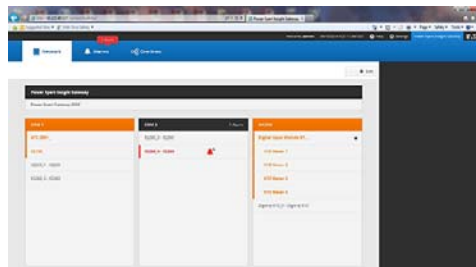
Through standard on-board web pages, Power Xpert Insight, or third-party software, Eaton's Power Xpert Gateway (PXG) 900 allows you to closely monitor the performance of your power and energy efficiency with easily accessed, real-time, web-enabled data. Eaton's PXG 900 provides a central point to connect devices to an Ethernet network. The gateway may be used as a standalone device to view one system or location, or it can be easily integrated into a large, multi-location system.

The PXG is our configurable data acquisition solution for facility equipment like switchgear, switchboards, motor control centers, etc. Power and energy data from the downstream devices are time stamped and stored in non-volatile memory. This interval data can be stored or updated to a destination of the user's choice through CSV. Data can also be accessed through any web browser directly on the PXG. Users can move data into Power Xpert Insight v. 3.2 or higher, BMS, BAS, building dashboards, custom software applications, or virtually any web interface.

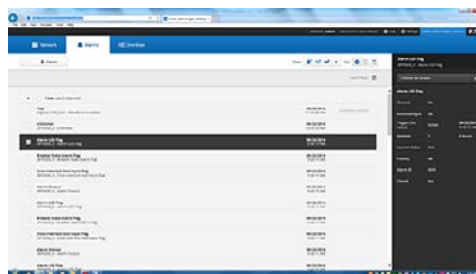
Application Description

The Power Xpert Gateway 900 (PXG 900) has been designed to be installed in electrical assemblies or systems—low and medium voltage switchgear, switchboards panelboards, transfer switches, and motor control centers to acquire and consolidate data available from components such as trip units, meters, relays, drives and I/O.

Power Xpert Gateway Screenshots



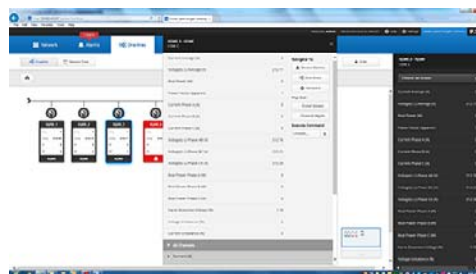
Network Tab



Alarms Tab



One-Lines Tab



Device Details



Trend Viewer

Product Selection Guide

Data acquisition and Integration Table for Supported Devices

Supported Devices

Protocol

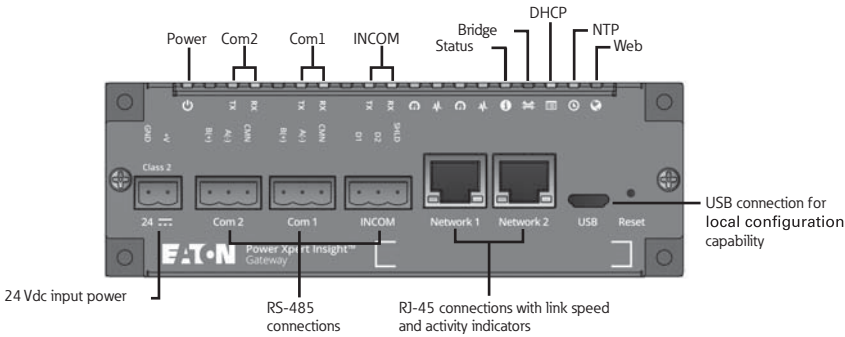
Family	Model	HTTP (Web Browser)	Power Xpert Insight	Modbus TCP (BMS and SCADA)	Pass-through INCOM (PowerNet)	SMTP (Email Client)	File Export (CSV File Format)	File export (COMTRADE File Format)	BACnet/IP
INCOM									
Accessory	BIM II	■	■	■	■	■	■		■
I/O	DIM	■	■	■	■	■	■		■
I/O	DIM-KYZ	■	■	■	■	■	■		■
Meter	IQ 220 / IQ 320	■	■	■	■	■	■		■
Meter	IQ 230 / IQ 330	■	■	■	■	■	■		■
Meter	IQ Analyzer (6000/6200)	■	■	■	■	■	■		■
Meter	IQ Analyzer (6400/6600)	■	■	■	■	■	■	■	■
Meter	IQ Data Plus II	■	■	■	■	■	■		■
Meter	IQ DP-4000	■	■	■	■	■	■		■
Meter	IQ Energy Sentinel	■	■	■	■	■	■		■
Meter	IQ Power Sentinel	■	■	■	■	■	■		■
Meter	IQMESII	■	■	■	■	■	■		■
Meter	PM3	■	■	■	■	■	■		■
Protection	Digitrip 520MC	■	■	■	■	■	■		■
Protection	Digitrip 810	■	■	■	■	■	■		■
Protection	Digitrip 910	■	■	■	■	■	■		■
Protection	Digitrip 1150/DT1150 V	■	■	■	■	■	■	■	■
Protection	Digitrip 3000	■	■	■	■	■	■		■
Protection	Digitrip 3200	■	■	■	■	■	■		■
Protection	Digitrip MV	■	■	■	■	■	■		■
Protection	Digitrip OPTIM 550	■	■	■	■	■	■		■
Protection	Digitrip OPTIM 750	■	■	■	■	■	■		■
Protection	Digitrip OPTIM 1050	■	■	■	■	■	■		■
Protection	FP-4000	■	■	■	■	■	■	■	■
Protection	FP-5000	■	■	■	■	■	■	■	■
Protection	FP-6000	■	■	■	■	■	■	■	■
Protection	IQ 500	■	■	■	■	■	■		■
Protection	MP-3000	■	■	■	■	■	■		■
Protection	MP-4000	■	■	■	■	■	■		■
Protection	MPCV Relay	■	■	■	■	■	■		■
Protection	NRX520I	■	■	■	■	■	■		■
Protection	NRX1150I	■	■	■	■	■	■		■
Protection	TC50	■	■	■	■	■	■		■
Protection	TC100	■	■	■	■	■	■		■
Protection	Universal RTD	■	■	■	■	■	■		■
Transfer switch	ATC-400	■	■	■	■	■	■		■
Transfer switch	ATC-600	■	■	■	■	■	■		■
Transfer switch	ATC-800	■	■	■	■	■	■		■

Supported Devices, continued

Protocol

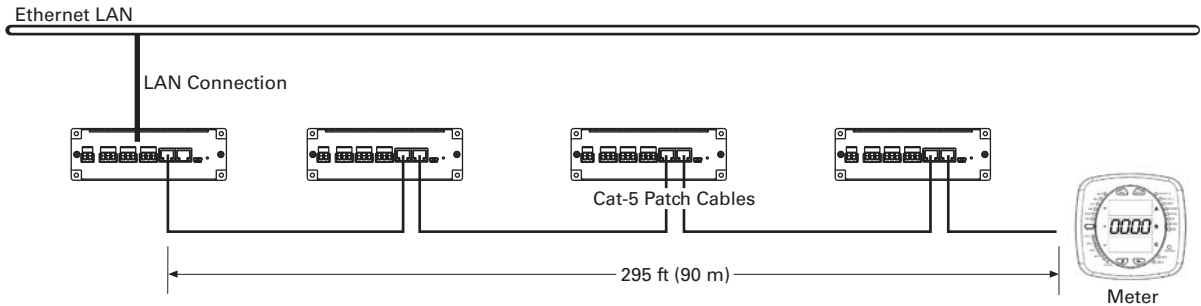
Family	Model	HTTP (Web Browser)	Power Xpert Insight	Modbus TCP (BMS and SCADA)	Pass-through INCOM (PowerNet)	SMTP (Email Client)	File Export (CSV File Format)	File export (COMTRADE File Format)	BACnet/IP
Modbus									
Drive	H-Max	■	■	■		■	■		■
Drive	M-Max	■	■	■		■	■		■
Drive	MX9000	■	■	■		■	■		■
Drive	SVX9000	■	■	■		■	■		■
Meter	E30/E31A042 1 phase BCM	■	■	■		■	■		■
Meter	EM19_M	■	■	■		■	■		■
Meter	ION 7350	■	■	■		■	■		■
Meter	ION 7550	■	■	■		■	■		■
Meter	ION 7650	■	■	■		■	■		■
Meter	IQ 130	■	■	■		■	■		■
Meter	IQ 140	■	■	■		■	■		■
Meter	IQ 150	■	■	■		■	■		■
Meter	IQ 230M / IQ 330M	■	■	■		■	■		■
Meter	IQ 250	■	■	■		■	■		■
Meter	IQ 260	■	■	■		■	■		■
Meter	IQ35MA1	■	■	■		■	■		■
Meter	IQ35MA2	■	■	■		■	■		■
Meter	Nexus 1200 Series	■	■	■		■	■		■
Meter	PM3_Modbus	■	■	■		■	■		■
Meter	SQD CM3000 Series	■	■	■		■	■		■
Meter	SQD CM4000 Series	■	■	■		■	■		■
Meter	SQD PM700 Series	■	■	■		■	■		■
Meter	SQD PM800 Series	■	■	■		■	■		■
Protection	ABB TPU 2000	■	■	■		■	■		■
Protection	C440	■	■	■		■	■		■
Protection	C441	■	■	■		■	■		■
Protection	EDR-3000	■	■	■		■	■		■
Protection	EDR-5000	■	■	■		■	■		■
Protection	EGR-4000	■	■	■		■	■		■
Protection	EGR-5000	■	■	■		■	■		■
Protection	EMR-3000	■	■	■		■	■		■
Protection	EMR-4000	■	■	■		■	■		■
Protection	EMR-5000	■	■	■		■	■		■
Protection	ETR-4000	■	■	■		■	■		■
Protection	ETR-5000	■	■	■		■	■		■
Protection	GE 369 Motor Relay	■	■	■		■	■		■
Protection	GE 469 Motor Relay	■	■	■		■	■		■
Protection	InsulGard	■	■	■		■	■		■
Protection	NRX520M	■	■	■		■	■		■
Protection	NRX1150M	■	■	■		■	■		■
Protection	Qualitrol 118	■	■	■		■	■		■
Starter	S611	■	■	■		■	■		■
Starter	S811	■	■	■		■	■		■
Transfer switch	ATC-300	■	■	■		■	■		■
Transfer switch	ATC-900	■	■	■		■	■		■

Power Xpert Gateway 900



PXG Daisy Chain Application

9



Note: In this configuration, if any of the PXG units go offline or lose power, the communication to the downstream Ethernet devices will lose connection to the LAN.

Standards and Certifications

- UL 508, Standard for Programmable Controller Equipment
- FCC, Class A, Part 15, Subpart B, Sections 15.107b and 15.109b
- EN55022: 1994 Class A, Information Technology Equipment
- EN 61000-6-2:2001 Electromagnetic Compatibility (EMC) Part 6-2: Immunity for Industrial Environments



Product Selection

PXG Part Numbers

	Description	Style Number	Catalog Number
	Power Xpert Gateway 900	66D2325G01	PXG900
	Enclosed version Cost-effective solution to add communications to new or existing equipment that has no physical space to install the PXG in the equipment structure. NEMA 12 enclosure rating. Prewired with a PSG60N24RP power supply and terminal blocks for ease of wiring of incoming power and connected devices.	—	PXG900-2A
	Power supply—24 Vdc	PSG60N24RP-A1	PSG60N24RP

Technical Data and Specifications**PXG part numbers**

Description	Style Number	Catalog Number
Power Xpert Gateway 900	66D2325G01	PXG900
Power supply—24 Vdc	PSG60N24RP-A1	PSG60N24RP

Memory

- Flash: 2 GB
- RAM: 1 GB

Communication Ports

- Network ports: Two 10/100BASE-T RJ-45 connectors
- Serial ports
 - Two RS-485 ports for connection to Modbus RTU devices
 - One dedicated RS-485 port for INCOM devices
- Configuration port: One USB port

Network Protocols Supported

- Modbus TCP/IP: Supports data access from Modbus TCP clients
- Web server: Supports data access from web browsers (HTTP and HTTPS)
- DHCP: Supports automatic IP address assignments, if enabled
- NTP: Supports time synchronization via a network time server for PXG synchronization
- SMTP: Supports mail server for email notification
- BACnet/IP: Supports data access from BACnet clients

Serial Protocols Supported

- INCOM
- Modbus RTU

Web Browsers Recommended

- Internet Explorer versions 10 and 11
- Google Chrome

Power Input

- Input voltage, nominal: 24 Vdc; 0.3 A minimum
- Input voltage range: $\pm 10\%$ nominal

Power Consumption

- 8 W maximum

Operating Temperature

- 32 °F to 140 °F (0 °C to 60 °C)

Ambient Storage Temperature

- 40 °F to +185 °F (–40 °C to +85 °C)

Relative Humidity

- 5 to 95% noncondensing at 122 °F (50 °C)

Size (H x D x L) in Inches

- 2.00 x 4.50 x 6.00

Weight

- 1.7 pounds

Supported Devices and Performance

PXG performance will vary depending upon the number and type of connected devices. This is driven by the following:

- Each supported device has a distinct number of channels to report back to the PXG, ranging from as few as 4 to over 900
- The channels are prioritized
- Device protocol, Modbus or INCOM
- Baud rate setting

For this reason, a PXG performance tool has been developed to assist in understanding the expected performance for a given application since all systems are unique. This tool can be found at www.eaton.com/pxg. For a high level performance comparison, see the table below for three examples.

How Long Does It Take	For This Combination of Devices (All Times in Seconds)		
	64 INCOM / 32 Modbus	15 INCOM / 15 Modbus	5 INCOM
Between value change in the UI (INCOM 9600)—Priority 1	21.9	3.7	1.4
Between value change in the UI (Modbus 57600)—Priority 1	3.5	1.6	—
Between value change in the UI (INCOM 9600)—Priority 2	44.3	7.4	2.6
Between value change in the UI (Modbus 57600)—Priority 2	7.0	3.1	—
Modbus server pass-through response time (57600) (local connection)	0.061	0.059	—
For the UI to show an alarm (INCOM device)	17.0	3.0	3.0
To boot up (all devices communicating)	399.0	85.0	51.0

Note: Features and specifications listed in this document are subject to change without notice and represent the maximum capabilities of the product with all options installed. Although every attempt has been made to ensure the accuracy of information contained within, Eaton makes no representation about the completeness, correctness, or accuracy and assumes no responsibility for any errors or omissions. Features and functionality may vary depending on selected options.

General Wiring Guidelines—RS-485 Network

When communicating over RS-485 networks to Eaton products, the following General Wiring Guidelines should be used.

Rule 1: Cable Selection—Twisted Shielded Pair (TSP)

Note: Cables specifically designed for RS-485 applications are highly recommended.

The RS-485 bus is a length of Twisted Shielded Pair (TSP) that includes a third conductor (used for the common wire), a braided shield accompanied by a drain wire, and nominal impedance of 120 ohms.

- Belden Wire and Cable Company Part Number 3106A or equivalent

Rule 2: Cable Intermixing

Any cable in the Belden 3106A family can be intermixed with each other in the Modbus network.

Rule 3: System Topology, Size and Capacity

- Strict daisy chain must be adhered to. A strict daisy chain configuration is one where the transmission line connects from one RS-485 receiver to the next. The transmission line appears as one continuous line to the RS-485 driver
- Maximum 32 devices
- Line termination: Maximum cable lengths of 4000 ft (1219 m); longer bus lengths will slow the data rate

Rule 4: Cable Splicing

The prime goal is to create a secure electrical connection while minimizing exposure to electrical transients. Ferrules are used to dress cable ends. Most devices have built-in terminal blocks that can be used for splicing. Additionally, terminal blocks should be utilized when splicing elsewhere in the gear or facility to ensure a secure electrical connection.

Rule 5: Cable Shielding

The cable shielding and outer jacket should not be stripped back beyond 1-1/2 inches. Three-pole terminal blocks are used to ensure a continuous metallic shield ground path. To ensure a secure electrical connection when daisy chaining devices that have built-in two-pole terminal blocks, mechanically crimp sleeves onto the two shield path drain wires.

Rule 6: Cable Grounding

Ground the communication network at only one point in the network, preferably by terminating the drain wire to ground at the EOL node (same location as the EOLR). A solid earth ground is accomplished by connecting the shield ground path's drain wire to a #14 AWG or larger multi-stranded wire that has an impedance path of 1 ohm or less to a known earth ground.

Note: The building electrical ground may not be effective since it may travel through many connections and considerable distances before reaching earth ground. In such cases, a new

ground path will be required since the effectiveness of this shield earth ground connection will affect the integrity of data transferred over the cable.

Rule 7: Cable Termination

End of Line Resistors (EOLR) are necessary to maintain signal strength and minimize reflections. EOLR must match the impedance of the TSP. Two EOLR are needed and should be located at both ends of the RS-485 bus. If there is only one device connected to the Modbus master, it is considered the last device in the network and should be terminated with a 120 ohm 1/4 watt terminating resistor.

Rule 8: Device Addressing

- Each device must have a unique slave address
- No two devices on the same RS-485 network can have the same slave address

Ethernet Cable Specifications

For complete specifications, refer to the IEEE 802.3 Ethernet specification.

RS-485 Wiring Guide—Three Terminal Devices

Device Name	A (– Wire)	B (+ Wire)	Common Wire	XCVR Common ^①	Data Bias
IQ 230M	12 (MOD2)	11 (MOD1)	10 (INCOM 3)	I 26V	None
IQ 250	(–) Older Models are Marked B (–)	(+) Older Models are Marked A (–) or A(+)	SH	I	None
IQ 260	(–) Older Models are Marked B (–)	(+) Older Models are Marked A (–) or A(+)	SH	I	None
IQ 330M	12 (MOD2)	11 (MOD1)	10 (INCOM 3)	I 26V	None
NETLINK	1 (DATA–)	2 (DATA+)	5 (GND)	E	None
InsulGard ^②	B	A	None	Floating	None
Bushing Gard ^② (InsulGard G3 ^②)	B	A	None	Floating	None
Power Xpert Meter 4000/6000/8000	Data A 750B-S	Data B 750B-S	Shield (COM)	I 300V	750 Ohm Switch Sel
Power Xpert Gateway 400/600	A(–)	B(+)	COM	I	—

Notes

^① Transceiver (XCVR) Common Connected to:

- I = Isolated
- NI = Non Isolated
- E = Earth Ground

^② Center terminal on InsulGard (marked with Ground symbol) is for shield splicing only and is electrically floating.

INCOM Network

INCOM was specifically designed with the intention of delivering a comprehensive and powerful energy management solution for use in electrical distribution environments while ensuring affordability, flexibility, simplicity and noise immunity. An INCOM network installed per the following rules will allow the user to fully realize all of the above advantages. (Refer to Eaton document TD17513 for specific system layout recommendations and details.)

Rule 1: Cable Selection—Twisted Shielded Pair

Approved cable types:

- Any of the cables in the Belden 9463 family
- Quabbin 6205
- CommScope 9022
- Manhattan Electric M4154
- IMPCABLE—a 600 V rated cable custom designed for INCOM—
Style # 2A95705G01

Rule 2: Cable Intermixing

Due to impedance differences between IMPCABLE and the Belden 9463 family, the main cable run(s) should be entirely for the 9463 family OR IMPCABLE: do not alternate between these types. The cable used for taps can be different from the main run.

Rule 3: System Topology, Size and Capacity

Supports daisy chain, star and multi-level network segment topologies.

Note: Star Segment Topology is not recommended for new designs.

See **Page V3-T9-174**. Surge protection is required for FSK networks that leave a building at the egress/ingress of the building.

- Supports distances up to 10,000 ft (3048 m) per segment when designed within the specifications of this guideline

- Supports up to 1000 devices on a single network segment
- Supports sub-network master devices and associated sub-networks
- Supports 1200 or 9600 baud rate
- Attenuation:
 - Total system capacity: 25 dB
 - Attenuation per device: 0.01 dB
 - Attenuation for approved wire types, see tables below

Cable Attenuation

Cable Type	Attenuation/ 1000 ft (305 m)
IMPCABLE	1.6 dB
Belden 9463 family	2.0 dB

Attenuation at Star

Number of Long Lines	Attenuation
3	3.5 dB
4	6 dB
5	8 dB

- Definitions:
 - Daisy chain:** point-to-point wiring between devices or clusters of devices
 - Star:** single point with a number of long lines emanating from it
 - Long line:** >200-foot (61 m) wire run
 - Simple tap:** <200-foot (61 m) connection to cluster of devices

Rule 4: Cable Splicing

The goal is to create a secure electrical connection while minimizing exposure to electrical transients. Ferrules are used to dress cable ends in order to avoid problems associated with frayed and loose wires. Besides facilitating cable installation, subsequent data line troubleshooting and downtime are minimized. Most INCOM devices have built-in three-pole terminal blocks for data lines and shield. For older INCOM devices that have only two terminals, shield continuity

must be ensured by other means. Additional terminal strips should be utilized when splicing elsewhere in the electrical enclosure or facility to ensure secure electrical connections. All devices, End of Line Termination Resistors and Taps should be wired in parallel across the cable.

Rule 5: Cable Shielding

The cable shielding and outer jacket should not be stripped back beyond 1.5 inches (38 mm). Terminal blocks are used at tap points to ensure a continuous metallic shield ground path. To ensure a secure electrical connection when daisy-chaining INCOM devices that have built-in two-pole terminal blocks, use crimp sleeves to join the two shield drain wires. The cable shield ground path for a main network and sub-network must not be joined. Each should have a separate connection to earth ground reference.

Rule 6: Cable Grounding

The shield should be continuous across a network segment and connected to the building's electrical system grounding electrode conductor. The 2005 NEC® provides the following guidance on grounding communication cables:

- When a communication cable enters a building, a primary protector is required and must be grounded as described in Section 800 IV. Specifically, Paragraphs 800.93 and 800.100 define grounding requirements for the primary protector.
- Grounding systems are generally covered by Section 250 III. The grounding electrode conductor is specifically covered by Paragraphs 250.62, 250.64, 250.66, 250.68 and 250.70.
- Bonding requirements between communication systems and the power distribution system is specified by Paragraph 250.94.

A solid earth ground is accomplished by connecting the shield ground path's drain wire to a #14 AWG or larger multi-stranded wire that has an impedance path of 1 ohm or less to the building's grounding electrode conductor.

Rule 7: Cable Termination

Each network segment requires a minimum of two End of Line Termination Resistors (EOLTRs). The EOLTRs maintain signal strength and minimize reflections. The EOLTRs should be 1/2 watt 100 ohm non-inductive resistors, such as carbon composition or metal film. Wire-wound resistors are not acceptable. Taps on network segments should not be terminated. Some INCOM devices have the EOLTR permanently installed and must be located at the end of a main run. Other INCOM devices have an EOLTR that can be switched to optionally terminate the network segment at the device. Care must be exercised when installing devices containing termination resistors that the switches are set appropriately. A minimum of two, up to a maximum of five EOLTRs must be installed on each network segment as dictated by network topology.

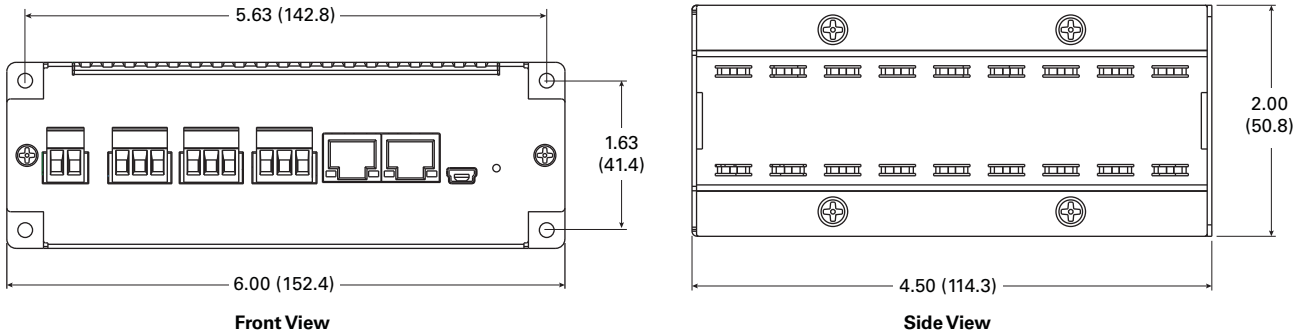
Rule 8: Device Address

In order to avoid the possibility of devices in a Main Network having the same addresses as those in Subnetworks, set Main Network device addresses at 100 or higher excluding addresses 901 to 908.

Dimensions

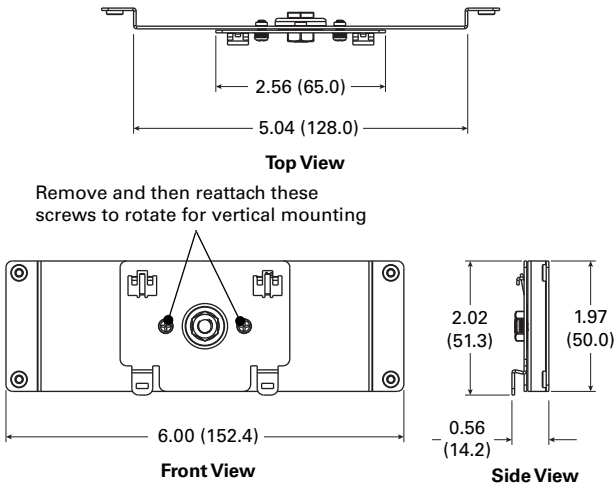
Approximate Dimensions in Inches (mm)

Power Xpert Gateway 900 with Standard Panel Mounting (Brackets Included)



9

Power Xpert Gateway 900 with DIN Rail Mounting



Power Xpert Gateway 900

Width	Height	Depth	Shipping Weight Lbs (kg)
6.00 (152.4)	2.00 (50.8)	4.50 (114.3)	1.70 (0.8)

PXM1K-ETHMULTI Card for PXE Devices

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PXM1K-ETHMULTI Card for PXE Devices

Information not available at this time.

Information not available at this time.

mMINT Module



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mMINT

Product Description

The mMINT (Modbus Master INCOM Network Translator) Module is an Eaton accessory product that provides communication between a Modbus RTU network and an INCOM (INdustrial COMmunications) network (see **Page V3-T9-178**). This module is transparent to the Modbus network. It communicates to a master on the Modbus network using the Modbus RTU (Remote Terminal Unit) protocol. It communicates to slave devices on the INCOM network using the IMPACC (Integrated Monitoring, Protection, And Control Communication) protocol.

Features

The mMINT module is a slave device on the Modbus network and as such requires a master that will exchange register objects with the mMINT module.

- Handles generic pass-through commands (Modbus/INCOM/Modbus)
- Capable of passing Modbus register objects from Eaton’s existing products and newer PnP (Plug-n-Play) products to a Modbus RTU master
- Data in IEEE Floating Point format and fixed point
- Modbus RTU communications data transfer rates of 1200, 9600 or 19,200 baud with one start bit, eight data bits, no parity, and either one or two stop bits

- Up to 32 products connected to INCOM network port (246 unique addresses maximum)
- Flashing Status LED to indicate an active module
- LED indicators for INCOM transmit and receive communications exchanges
- LED indicators for Modbus RS-485 transmit and receive communications exchanges
- Input power for the module from either 120 Vac or 24 to 125 Vdc
- DIN rail mount package
- 0 °C to 60 °C ambient operation

Standards and Certifications

- UL
- CSA
- CE mark



Product Selection

The catalog number of this product is mMINT.

Technical Data and Specifications

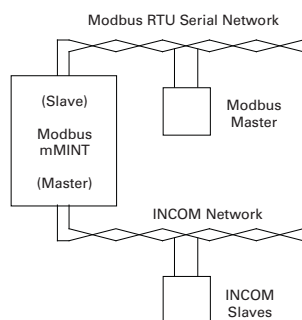
Module Mounting

When mounting the mMINT, verify that an 11 mm H x 28 mm W DIN rail is used and that it is within an enclosed space.

Simplified Wiring Rules

INCOM Network

The following simplified rules apply to a given system consisting of a single daisy-chained main cable link between master and slave devices (see below). For more complex considerations including star configurations, please refer to the IMPACC wiring specification T.D. 17513.



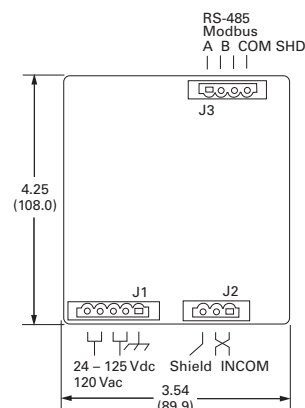
mMINT in a Communications Network

- Recommended INCOM cable styles are Belden 9463 or C-H style 2A957805G01
- The maximum system capacity is 10,000 feet of communications cable and 32 slave devices on the INCOM network under the mMINT
- Non-terminated taps, up to 200 feet in length, off the main link are permitted, but add to the total cable length
- Make sure that there is twisted-pair wire that is recommended for IMPACC network use. Use shielded twisted-pair wire to connect each slave to the INCOM network, daisy-chain style. The polarity of the twisted pair is not important

Modbus RS-485 Network

The following simplified rules apply to a given system consisting of a cable link between master and slave devices (see below). For more complex configurations, please refer to standard Modbus RTU wiring specification rules for the RS-485 network.

- The recommended Modbus cable has twisted-pair wires (24 AWG stranded 7x32 conductors with PVC insulation) having an aluminum/mylar foil shield with drain wire
- The maximum system capacity is 4000 feet of communications cable and 247 devices on the Modbus RTU network
- Make sure that there is twisted-pair wire that is recommended for Modbus RTU network use. Use shielded twisted-pair wire to connect each slave to the Modbus RTU network, daisy-chain style. The polarity of the twisted pair is critically important



mMINT Module Dimensions

Burden

- 24 Vac/dc 3 VA

Communications Speed

- INCOM: 1200, 9600 baud
- N2 Bus: 9600 baud

Note: Contact Eaton for availability and support for the N2 Gateway.