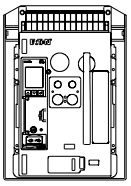
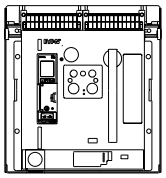
PXR 20/25 Trip Unit for Series NRX User Manual
Power Xpert® Release Trip Units

Instructions apply to:



Series NRX, Type NF Frame, UL489 / IEC, IZMX16



Series NRX, Type RF Frame, UL489 / IEC, IZMX40

Powering Business Worldwide

Contents

WARNING

Dangerous Electrical Voltage!

Do not attempt to install or perform maintenance on equipment while it is energized. Death or severe injury can result from contact with energized equipment. Always verify that no voltage is present before proceeding. Always follow safety procedures. Eaton is not liable for misapplication or misinstallation of its products.

Observe all recommendations, notes, cautions, and warnings related to the safety of personnel and equipment. Observe and comply with all general and local health and safety laws, codes, and procedures.

WARNING

Do not attempt to install, test, or perform maintenance on equipment while it is energized. Death or severe personal injury can result from contact with energized equipment. De-energize the circuit and disconnect the circuit breaker before performing maintenance or tests. Any tripping operation will cause disruption of service and possible personal injury, resulting in the unnecessary switching of connected equipment. Testing a circuit breaker while it is in-service and carrying load current is not recommended. Testing of a circuit breaker that results in the tripping of the circuit breaker should be done only with the circuit breaker in the test or disconnected cell positions or while the circuit breaker is on a test bench.

WARNING

Electrical shock or burn injury can occur when working on power systems. Always turn off the main power that is supplying the circuit breaker before conducting tests. Test out of the cell, if possible.

CAUTION

Exercise care when replacing the battery to ensure that it is installed correctly. Accidentally installing the battery in the reverse direction will not harm the trip unit nor the battery, but will defeat the function of the battery.

IMPORTANT

Auxiliary power is not required to provide current protection features. Protection is active well below any overload. The trip unit begins to power-up at very low levels of current at approximately NF frame = 60 A, RF Frame = 100 A. The display will power up at NF frame = 140 A, RF frame = 200 A.

1. Introduction

1.1 Introduction to the PXR 20/25

The Power Xpert Release (PXR) 20/25 trip unit, along with current sensors and a trip actuator, is the subsystem of a circuit breaker which provides the protective function. The PXR analyzes signals from the current sensors. If current level and time delay settings are exceeded, then the PXR trip unit will trip the circuit breaker. The automatic overload and short circuit tripping characteristics for a specific circuit breaker are determined by the current rating and user selected protection settings. There is no mechanical or direct magnetic action between the primary current and the mechanical tripping parts of the circuit breaker. External control voltage is not required for current protection functionality.

The PXR trip unit consists of two modules, the frame module and the control module. The control module contains a microcontroller that performs true RMS current sensing measurements and calculations for protection. It may be replaced in the field. The frame module is matched to the ratings of the circuit breaker and permanently attached to the circuit breaker frame. **It should not be removed or exchanged**.

Figure 1. The PXR Trip Unit.

The current sensors are internal to the circuit breaker frame and consist of two coils; one coil on an iron core and one coil on an air core (Rogowski coil). As current begins to flow through the circuit breaker, the iron core coil generates a secondary current which powers the trip unit. At the same time, the air core coil provides signals which are processed to determine the current through the circuit breaker.

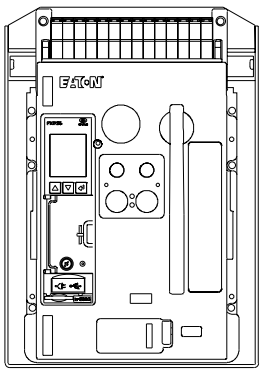
The mechanical action required to initiate tripping of the circuit breaker is provided by a special low-energy trip actuator. This trip actuator is an integral part of the circuit breaker mechanism which also includes a charging handle, and manual "Open" and "Close" buttons. The trip actuator is automatically reset by the mechanism.

The wiring diagrams show how certain functions of the trip unit are connected to external circuits. All wiring is landed on the secondary contact system directly above the circuit breaker. See Section 11 - "References" for the technical document number that contains the wiring diagrams.

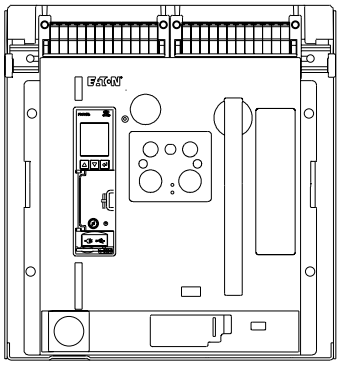
The PXR trip units are listed by Underwriters Laboratories Inc. (UL) and Canadian Standards Association (CSA) for use in Series NRX-NF and Series NRX- RF circuit breakers. All PXR units have also passed the IEC 60947-2 test program that includes EMC testing according to Appendix F. All trip units meet the low voltage and EMC directives and carry the CE mark.

For more on Series NRX low voltage power breakers go to www.eaton.com/seriesnrx

Figure 2. Series NRX-NF and NRX-RF Circuit Breakers.



NRX-NF



NRX-RF

2. Protection and Metering Features

2.1 Trip Unit Functions

Table 1. Trip Unit Functions.

Trip Unit Type	Catalog Number	Protection Style	High Load Alarm	Ground Fault	Maintenance Mode	Modbus RTU
PXR 20	PXR20V000L00C	LSI	•			
	PXR20V000L00M	LSI	•			•
	PXR20V000LG0C	LSIG		•		
	PXR20V000LG0M	LSIG		•		•
	PXR20V000LGAC	LSIGR		•	•	
	PXR20V000LGAM	LSIGR		•	•	•
	PXR20V000L0AC	LSIR	•		•	
	PXR20V000L0AM	LSIR	•		•	•
PXR 25	PXR25V000L00M	LSI	•			•
	PXR25V000LG0M	LSIG		•		•
	PXR25V000L0AM	LSIR	•		•	•
	PXR25V000LGAM	LSIGR		•	•	•

2.2 Protection Features

Table 2. Protection Features.

Protection			PXR 20	PXR 25
Long Delay Protection (L)	Slope		I^2t, I^4t, $I^{0.5}t$, It	I^2t, I^4t, $I^{0.5}t$, It
	Long Delay Pickup (I_r)	x (I_n)	0.4, 0.5, 0.6, 0.7, 0.75, 0.8, 0.9, 0.95, 0.98, 1.0	0.4, 0.5, 0.6, 0.7, 0.75, 0.8, 0.9, 0.95, 0.98, 1.0
	Long Delay Time @ 6 x (I_r)	Seconds	0.5, 1, 2, 4, 7, 10, 12, 15, 20, 24①	0.5, 1, 2, 4, 7, 10, 12, 15, 20, 24①
	Thermal Memory		Included	Included
	High Load Alarm	% x (I_r)	Fixed Level 85%	Fixed Level 85%
Short Delay Protection (S)	Short Delay Slope		Flat, I^2t	Flat, I^2t
	Short Delay Pickup	x (I_r)	1.5, 2, 2.5, 3, 4, 5, 6, 7, 8, 10	1.5, 2, 2.5, 3, 4, 5, 6, 7, 8, 10
	Short Delay Time at 8 x (I_r) I^2t	Seconds	0.1, 0.3, 0.4, 0.5	0.1, 0.3, 0.4, 0.5
	Short Delay Time Flat	Seconds	0.0, 0.1, 0.2, 0.3, 0.4, 0.5	0.0, 0.1, 0.2, 0.3, 0.4, 0.5
	Zone Interlock		Enable/Disable	Enable/Disable
Instantaneous Protection (I)	Instantaneous	x (I_n)	Off, 2, 4, 5, 6, 7, 8, 10, 12, 15	Off, 2, 4, 5, 6, 7, 8, 10, 12, 15
Neutral Protection	4th Pole or External Neutral Trip	% x (I_r)	0 (Off), 60, 100	0 (Off), 60, 100
Ground (Earth) Fault Protection (Option G)	Ground Fault Pickup	x (I_n)②	Off, 0.2, 0.4, 0.6, 0.8, 1.0	Off, 0.2, 0.4, 0.6, 0.8, 1.0
	Ground Fault Alarm	x (I_n)	0.2, 0.4, 0.6, 1.0	0.2, 0.4, 0.6, 1.0
	Ground Fault Delay at 0.625 x (I_n) I^2t	Seconds	0.1, 0.2, 0.3, 0.4, 0.5	0.1, 0.2, 0.3, 0.4, 0.5
	Ground Fault Delay Flat	Seconds	0.1, 0.2, 0.3, 0.4, 0.5	0.1, 0.2, 0.3, 0.4, 0.5
	Zone Interlock		Enable/Disable	Enable/Disable
	Thermal Memory		Included	Included
Maintenance Mode Protection (ARMS) (Option R)	Setting		Enable or Disable/Remote	Enable or Disable/Remote
	Relay Contact for Remote Indication of Mode		Included	Included
	Maintenance Mode Pickup	x (I_n)	2.5, 4.0, 6.0, 8.0, 10.0	2.5, 4.0, 6.0, 8.0, 10.0
General	Trip Unit Over Temperature Trip	Degrees	85°C (185°F) Fixed	85°C (185°F) Fixed

① If I^4T slope is selected not all times are available, consult time-current curves

② PXR 20/25 is limited to 1200A in ANSI/UL frames to comply with standards.

2.3 Current and Voltage Metering Data

Table 3. Current and Voltage Metering Data.

Current Metering	Units	Accuracy①	Notes
IA, IB, IC, IN, IG	Amperes	±1% of Reading	
Minimum IA, IB, IC, IN, IG	Amperes	±1% of Reading	Group Values Held Until Reset
Maximum IA, IB, IC, IN, IG	Amperes	±1% of Reading	Group Values Held Until Reset
THD for IA, IB, IC , IN		10% of Reading	Firmware version 02.02 and later
Voltage Metering③	**Units**	**Accuracy②**	**Notes**
VAB, VBC, VCA	Volts	±1% of Reading	Line to Line Voltage
Minimum VAB, VBC, VCA	Volts	±1% of Reading	Group Values Held Until Reset
Maximum VAB, VBC, VCA	Volts	±1% of Reading	Group Values Held Until Reset
THD for VAB, VBC, VCA ③		10% of Reading	Firmware version 02.02 and later
VAN, VBN, VCN	Volts	±1% of Reading	Line to Neutral Voltage
Minimum VAN, VBN, VCN	Volts	±1% of Reading	Group Values Held Until Reset
Maximum VAN, VBN, VCN	Volts	±1% of Reading	Group Values Held Until Reset
THD for VAN, VBN, VCN ③		10% of Reading	Firmware version 02.02 and later

① Accuracy applicable for 10% to 120% of In at 25°C (77°F).

② Accuracy applicable for the voltage range of 34 to 690 Vac at 25°C (77°F).

③ Only the PXR25 has this function.

2.4 Power and Energy Metering Data.

Table 4. Power and Energy Metering Data.

Power Metering③	Units	Accuracy ①②	Notes
Real	kW	±2% of Reading	Approximately 1 Second Update
Apparent	kVA	±2% of Reading	Approximately 1 Second Update
Reactive	kvar	±2% of Reading	Approximately 1 Second Update
Real Demand	kW	±2% of Reading	Fixed Window of 5 Minutes
Apparent Demand	kVA	±2% of Reading	Fixed Window of 5 Minutes
Reactive Demand	kvar	±2% of Reading	Fixed Window of 5 Minutes
Real Demand (Peak)	kW	±2% of Reading	Value Held Until Reset
Apparent Demand (Peak)	kVA	±2% of Reading	Value Held Until Reset
Reactive Demand (Peak)	kvar	±2% of Reading	Value Held Until Reset
Power Factor ④	-		Approximately 1 Second Update
Energy Metering③	**Units**	**Accuracy ①②**	**Notes**
Real Total	kWh	±2% of Reading	Forward + Reverse
Real Net	kWh	±2% of Reading	Forward - Reverse
Real Forward	kWh	±2% of Reading	Delivered by Source to Load
Real Reverse	kWh	±2% of Reading	Delivered by Load to Source
Apparent	kVAh	±2% of Reading	Energy
Reactive Received	kvarh	±2% of Reading	Reactive Energy in Quadrants 1 + 2
Reactive Delivered	kvarh	±2% of Reading	Reactive Energy in Quadrants 3 + 4
Reactive Net	kvarh	±2% of Reading	kvarh Delivered - kvarh Received
Reactive Total	kvarh	±2% of reading	kvarh Delivered + kvarh Received

① Accuracy applicable for 10% to 120% of In at 25°C (77°F).

② Accuracy applicable for the voltage range of 34 to 690 Vac at 25°C (77°F).

③ Only PXR25 has this function.

④ In firmware version 02.02 and later, the Power Factor calculation method can be selected as IEC, IEEE or Alternate IEEE under Edit Settings menu.

2.5 Time Current Curves

The Time-Current Curves (TCC) for the PXR 20/25 when used in Series NRX circuit breakers are referenced below. All protection settings shall be made by following the recommendations of the specifying engineer in charge of the installation.

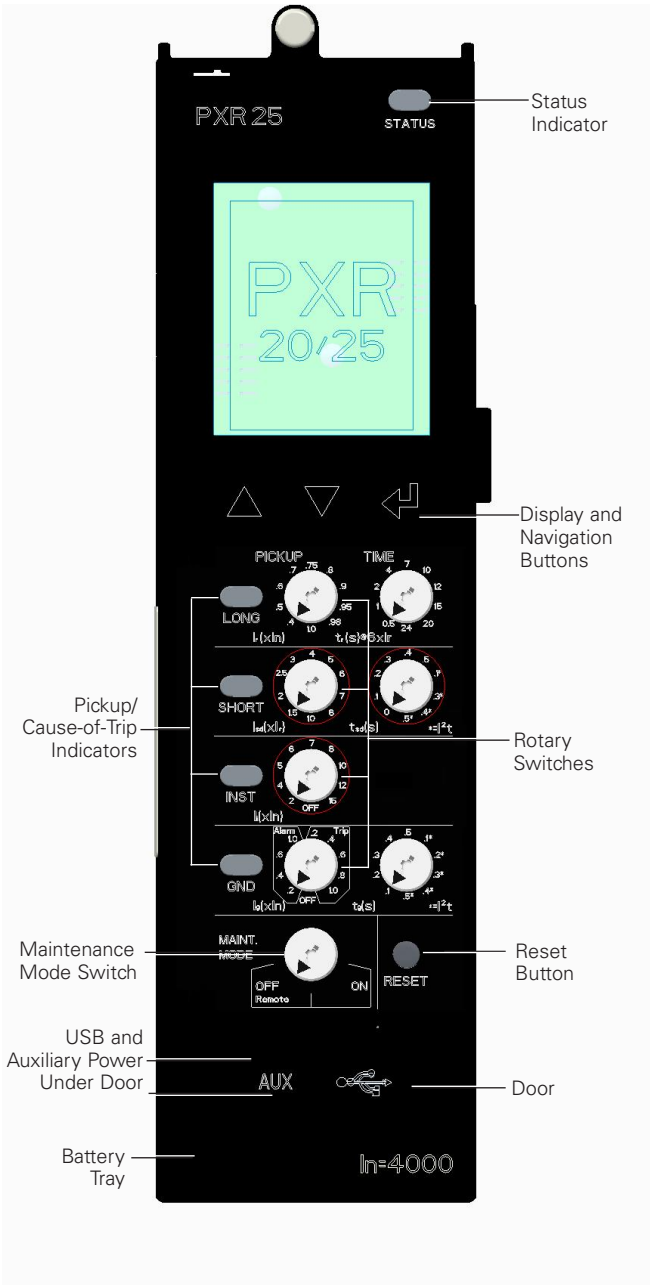
Time Current Curves for Series NRX Type NF and RF Frame with PXR 20/25 Trip Units are found in document AD 013001EN

Use the link/path below to access time-current curves at Eaton's Web site: http://www.eaton.com/TCC

3. Power Xpert® Release Trip Units

The PXR 20/25 is located on the front and to the left side of the circuit breaker. It is encased in a housing which provides protection to the electronics as well as providing an interface for a user to configure protection settings and monitor operation. Details of the interface and operation are contained in the sections which follow. Certain features are available only in selected PXR 20/25 trip unit styles.

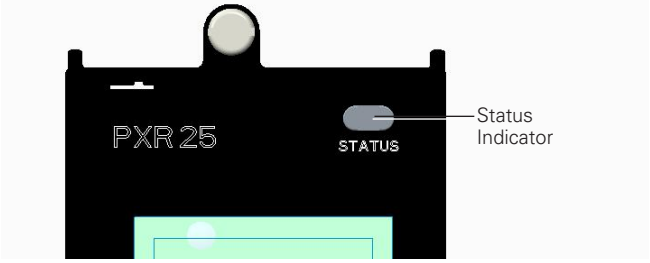
Figure 3. PXR Trip Unit Front Face.



3.1 Status Indicator

All PXR trip units have an indicator at the top right labeled "STATUS". During normal operation, this indicator blinks green (on and off approximately once each second), indicating that the trip unit is operating normally.

Figure 4. Status Indicator.



The status indicator blinks red if the trip unit detects an internal problem. This indicates a problem with the trip actuator coil, a firmware error, calibration error, or a mechanism error. Immediate action must be taken to rectify the problem and/or replace the trip unit. See Appendix B - "Troubleshooting" for details.

When the status indicator remains off, there is no auxiliary power applied or insufficient primary current to power the trip unit. This does not indicate a malfunction. The status indicator will resume blinking when auxiliary power is supplied or breaker load increases.

3.2 Display and Navigation Buttons

The PXR trip unit has a display on the front of the trip unit. This display provides information such as metered values, events, and the method to select certain configuration options. Information is presented on the display in either English or simplified Chinese. Back lighting is included with a power saving feature that after 30 seconds of inactivity will turn the backlight off.

There are three buttons below the display (see Figure 5). They are used to control what information is shown on the display and to select certain configuration options:

Figure 5. Display and Navigation Buttons.

Up Arrow Button	Used to move up in the menu display screens or increase an adjustment value.
Down Arrow Button	Used to move down in the menu display screens or decrease an adjustment value.
Enter Button	Used to enter the menu or setting and can also go back to the previous menu

When the PXR trip unit is initially powered-up, the display will briefly show a loading screen and then change to the "Main" menu. During this time, the trip unit is already functioning and performing protection operations. Depending on the trip unit style, there are up to 13 submenu selections from the main menu. Each submenu can be accessed by highlighting the appropriate submenu by pressing the Down or Up Arrow buttons, then the Enter button. A complete map of the information and navigation is included in IL0131128EN.

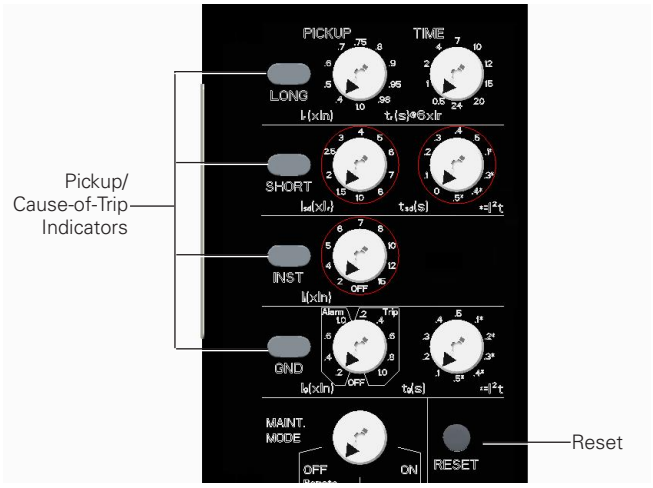
In firmware version 02.02 and later, digitally configured setpoints are password protected to reduce risk of unauthorized changes. You must enter the correct password (factory default is "0000") in the "Edit Settings" menu to change the following settings:

- Language
- Communication configuration (for on-board Modbus and external CAM)
- Thermal Memory
- Long Delay Curve selection (I2t, I4t, I0.5t, It)
- Neutral pickup (100%, 60%, off)
- Power Feed (forward or reverse)
- ZSI – Zone Selective Interlock (on or off)
- Maintenance Mode pickup (2.5, 4.0, 6.0, 8.0, 10.0 x In)
- Edit Password
- Set Time

3.3 Pickup/Cause-of-Trip Indicators

There are four pickup/cause-of-trip indicators on the face of the trip unit labeled "LONG", "SHORT", "INST", and "GND".

Figure 6. Pickup/Cause-of-Trip Indicators and Reset.



The appropriate cause-of-trip indicator illuminates when a current level pickup setting is exceeded. After a trip event, the indicator blinks (one second on, three seconds off) and the cause will be shown on the display if auxiliary power is applied. The indicators and the display can be cleared by pressing the RESET button.

Following is a list of conditions detected and displayed by the cause-of-trip indicators.

- "LONG" – Solid indicates Long Delay pickup. Blinking indicates a Long Delay trip or over-temperature trip has occurred.
- "SHORT" – Short Delay trip or mechanism error.
- "INST" – Instantaneous trip, Making Current Release trip, High Instantaneous trip, or Maintenance Mode trip has occurred.
- "GND" – Ground trip or Ground alarm condition has occurred.

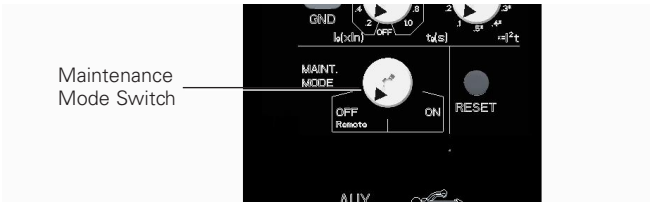
3.4 Rotary Switches

Depending on the trip unit style, up to 8 switches can be found on the trip unit's front panel. The top 7 rotary switches set protection settings using a surrounding legend indicating the value. These are the core protection settings. Each switch has ten positions and is set to achieve the appropriate trip-curve response. The "PICKUP" switches set the levels as a function of the breaker ratings. The "TIME" switches set the response in seconds. Each switch can be set using a small screwdriver, the arrow pointing to the selected value. When a change is made to the rotary switches, the display will temporarily change to indicate all of the selected settings.

3.5 Maintenance Mode Switch

The PXR trip unit incorporates the Arc Flash Reduction Maintenance System™ (ARMS). If equipped, this switch is labeled "MAINT. MODE" and has two positions labeled; "OFF/Remote" & "ON". A blue colored ring surrounding the maintenance mode switch is illuminated when ARMS is enabled.

Figure 7. Maintenance Mode Switch



3.6 Reset

The button labeled "RESET", located in the lower right face of the trip unit, can be depressed to reset the cause of trip indicators (see Figure 6).

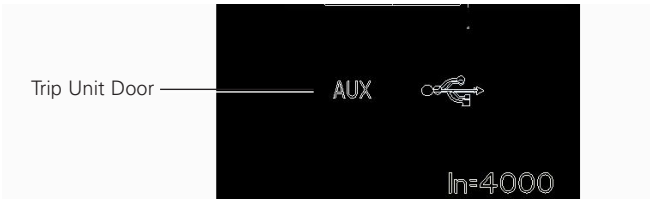
3.7 Tamper-Resistant Cover

A clear, plastic cover is provided which allows the settings to be viewed but not changed. Unauthorized access to change settings can be prevented by the insertion of a standard sealing wire through the security holes in order to meet applicable tamper-resistant requirements.

3.8 Door

Near the bottom of the PXR trip unit, there is a small door with "AUX" and the Universal Serial Bus (USB) icon. The door can be opened downward to expose the temporary auxiliary power port and the micro-B USB port.

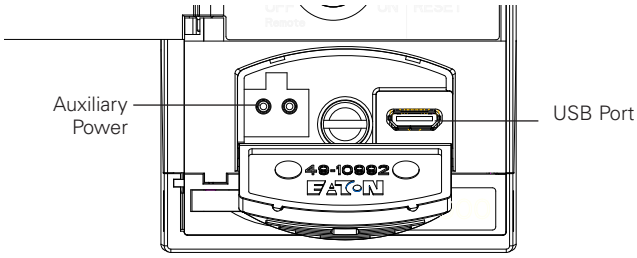
Figure 8. Trip Unit Door.



3.9 USB

The USB is a micro-B USB connector utilizing USB 2.0 protocol. This USB connection may be used in conjunction with the Power Xpert Protection Manager software to configure and monitor the trip unit. A USB connection will also typically provide power from the host side of the USB cable to power up the trip unit when another source of auxiliary power is not available. This connection is intended for temporary use while a user is configuring or monitoring the trip unit.

Figure 9. Behind the Trip Unit Door.



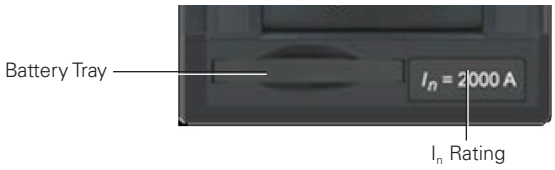
3.10 Temporary Auxiliary Power

The two-pin socket under the left side of the door (see Figure 9) accepts the mating connector from a Digitrip auxiliary power module (Catalog Number: PRTBAPMDV for U.S. power sockets, DTAUXPMEU for European power sockets, or DTAUXPMUK for U.K. power sockets). This power source may be used to power the trip unit when another source of auxiliary power is not available. This connection is intended for temporary use while a user is configuring or monitoring the trip unit.

3.11 Battery

At the bottom of the trip unit is a small tray which holds the battery. When the trip unit is not powered, this battery supports the cause-of-trip indicators. A battery icon at the bottom of the display indicates remaining battery life. The battery plays no part in the protection functions of the trip system. This battery is the standard type CR 2032 coin-cell.

Figure 10. Battery Tray.



3.12 I_n Rating

This legend shows the I_n rating of the breaker. It is also shown on the lower left corner of the display.

3.13 Side Labels

The side of the trip unit has agency certification, model, and manufacturing information printed on a label.

Figure 11. Typical PXR Trip Unit Side Label.

4. PXR Protection Settings

The PXR trip unit protection settings are designed to be easily customized to any application. Settings for long delay pickup, long delay time, short delay pickup, short delay time, instantaneous pickup, ground fault pickup, and ground fault time are all independently configurable. These functions are set using rotary switches on the front of the trip unit. Additional options are chosen using the display and navigation buttons or by using the Power Xpert Protection Manager configuration software.

Please refer to Table 2 for a detailed list of the configurable setting values.

Before placing any circuit breaker in operation, set each trip unit protection setting to the values specified by the engineer responsible for the installation.

4.1 Long Delay Pickup and Time Setting

The PXR trip unit offers a wide range of settings for Long Delay Pickup (LDPU or I_r). This setting ranges from 0.4 to 1.0 and is expressed as a multiple of the frame's current rating (I_n). The pickup value for Long Delay is 105% to 115% of the calculated value to ensure that the circuit breaker can carry the full rating of (I_r), without tripping.

The long delay time settings range from 0.5 to 24 seconds. They represent the total clearing times when the current value equals six times I_r. All times are referenced from the top of the tolerance band, ensuring that the time never exceeds that maximum setting. When an I^4t slope is selected, an overload creates a very long time delay which could exceed breaker ratings. Therefore, when a time delay above seven seconds is selected, seven seconds will be used instead.

If a long delay causes the circuit breaker to trip, the "LONG" indicator will be illuminated and the "Long Delay" message will be displayed if auxiliary power is present.

4.1.1 Long Delay Slope Selection

The I^2t setting is the factory default curve for long delay. The curve can be changed using the display and navigation buttons to several alternative curves to better match the requirements for protection and coordination.

- $I^{0.5}t$ - Slightly Inverse Time Curve
- It - Moderately Inverse Time Curve
- I^2t - Inverse Time Current Curve, used in standard distribution protection (factory default).
- I^4t - Extremely Inverse Time Current Curve, A steep protective slope for coordination with fuses or for special types of loads.

4.1.2 Long Delay Thermal Memory

In addition to the standard Long Delay protection, a Long Time Memory (LTM) function is supported. This protects load circuits from the effects of repeated overload conditions. LTM is configured using the display and navigation buttons or using the Power Xpert Protection Manager software.

As an example, if a circuit breaker is closed soon after a Long Delay trip, and the current again exceeds the Long Delay setting (I_r), the LTM automatically reduces the time to trip to allow for the fact that the load conductor temperature is already higher than normal because of the prior overload condition. Each time the overload condition is repeated, the LTM causes the circuit breaker to trip in a progressively shorter time. When the load current returns to normal, the LTM begins to reset (after about ten minutes it will have reset fully) so the next long delay trip time will again correspond to the setting value.

4.2 Short Delay Pickup and Time Settings

Settings for Short Delay Pickup (SDPU or I_{sd}) are expressed as multiples ranging from 1.5 to 10 for the long delay pickup current setting (I_r).

The short delay time (t_{sd}) is selected in conjunction with one of two short delay slopes, flat, or I^2t. There are six settings for the flat curve and four settings for I^2t, ranging from 0 seconds (minimum time) to 0.5 seconds.

The I^2t response curve will provide a longer time delay for currents below eight times I_r as compared with a flat response curve. For currents greater than eight times I_r, the I^2t response flattens out to the flat response.

If a short delay causes the circuit breaker to trip, the "SHORT" indicator will be illuminated and the "Short Delay Trip" message will be displayed if auxiliary power is present.

The Zone Selective Interlocking (ZSI) feature may affect the tripping times for the short delay protective function. Please refer to the section on ZSI.

4.3 Instantaneous Pickup Setting

The instantaneous (I_i) setting is expressed as multiples ranging from 2 to 15 of the I_n value or can be set to "OFF". The instantaneous protection trips the breaker with no intentional time delay.

4.4 Ground Fault Settings

When the PXR 20/25 trip unit includes ground fault protection features, the distribution system characteristics (such as system grounding, number of sources, and number and location of ground points) must be considered along with the manner and location in which the circuit breaker is applied to the system. To ensure correct ground fault equipment performance and compliance, you must conduct the field testing required to comply with country or regional requirements.

4.4.1 Ground Fault Pickup

The PXR trip unit provides flexibility in detecting and acting on ground currents. A ground fault alarm can provide an early warning of a ground fault condition and a ground fault trip can provide protection under these conditions. Three modes of operation are selectable from the front of the trip unit.

1. The ground detection may be turned off by setting the rotary switch to "OFF".
2. The ground fault detection pickup level with an alarm only action may be selected using the rotary switch. With the alarm-only selection, four levels of pickup level are available. This set of pickup levels is labeled "Alarm".
3. The ground fault detection pickup level with an action of trip may also be selected using the rotary switch. With detect and trip selection, five levels of pickup level are available, this set is labeled "Trip". If a ground fault causes the circuit breaker to trip, the "GND" indicator will be illuminated and the "Ground Fault Trip" message will be displayed when auxiliary power is present.

Note: For ANSI/UL breakers, the pickup level will have a maximum of 1200A per standards.

Note: Your application may require ground fault protection. Please consider NEC and/or applicable codes to determine required mode of operation ("OFF", "Alarm", or "Trip")

4.4.2 Ground Fault Time

The PXR trip unit provides selection for two different ground fault slopes: a fixed time (flat) or I^2t response. The slope should be chosen to match selective coordination needs. The I^2t response provides a longer time delay for current below 0.625 x In than the fixed time (flat) response.

The time delay and slope are selected on a single rotary switch. The I^2t response time selections are indicated with an asterisk (*) while the fixed time (flat) response time selections are indicated without an asterisk. Both have a range from 0.1 seconds to 0.5 seconds.

4.4.3 Ground Fault Thermal Memory

In addition to standard ground fault protection, the PXR trip unit also has a ground fault memory function that serves to protect loads in the event of a sputtering arc to ground. Without this function, the ground fault protection timer resets each time the arc goes out, so that a sputtering fault may not trip the circuit breaker. With the ground fault memory function, the trip unit "remembers" the sputtering ground current. The memory decays with time, the time interval equals 6.25 times the ground fault time. For example, with a 0.4 second setting, the function will reset in 2.5 seconds.

4.4.4 Ground Fault Relay

If the Ground Fault Alarm option is selected on the LSIG or LSIGR style trip units, a red ground Alarm indicator will illuminate to show the presence of ground current in excess of the Ground Alarm setting. The trip unit will energize an alarm relay upon this condition if auxiliary power is present. The indicator and relay will reset automatically when the ground current reduces to a value less than the ground fault pickup setting.

If the Ground Fault Trip option is selected, the alarm relay can be configured to indicate when the circuit breaker has tripped on a ground fault. You must then push the "RESET" button in order to reset the relay contact.

4.5 Ground Fault Sensing

The PXR 20/25 trip unit provides for three modes of sensing to detect ground fault currents: Residual, Source Ground, and Zero Sequence. The mode (Residual or Source/Zero Seq) is selected using the display and navigation buttons or by using the configuration software. Neutral protection is provided independent of the Ground Fault function.

4.5.1 Residual Current Sensing

Residual sensing is the standard mode of ground fault sensing in Series NRX circuit breakers. This mode uses one current sensor on each phase conductor and one on the neutral for a four-wire system. This mode of sensing sums the outputs of the three or four individual current sensors. If the sum is zero, then no ground fault exists. Residual ground fault sensing features are adaptable to main and feeder circuit breaker applications. If an external neutral sensor is used with reverse feed breaker applications, the proper polarity of the neutral needs to be considered.

4.5.2 Source Ground Sensing

The ground return method is usually applied when ground fault protection is desired only on the main circuit breaker in a simple radial system. This method is also applicable to double-ended systems where a mid-point grounding electrode is employed.

For this mode of sensing, a single 400 A current sensor mounted on the equipment-bonding jumper will directly measure the total ground current flowing in the grounding conductor. Setting the ground fault type will enable this protection. Refer to Table 5 for sensor style number.

4.5.3 Zero Sequence Sensing

Zero Sequence sensing, also referred to as vectorial summation, is applicable to mains, feeders, and special schemes involving zone protection.

4.5.4 Ground Sensors

Table 5. Ground Sensors.

Ground (Earth) Sensing Method	Instruction Leaflet Number	Sensor Style	IZMX Type Code
Residual NF Frame	IL0131090EN	5721B76G12	IZMX-CT16-N
Residual RF Frame	IL0131094EN	70C1718G11	IZMX-CT40-N
Source Ground or Zero Sequence	IL0131089EN	70C1527G04	IZMX-CT-NGS

4.6 Maintenance Mode

The PXR trip units support Eaton's Arc Flash Reduction Maintenance System™ (ARMS), also referred to as Maintenance Mode. When enabled, the trip unit will trip the breaker with no intentional delay whenever the configured pickup level is exceeded. When enabled, the Maintenance Mode function operates regardless of the Instantaneous settings. If Maintenance Mode causes the circuit breaker to trip, the "INST" indicator will be illuminated and the "ARMS Trip" message will be displayed if auxiliary power is present.

The Maintenance Mode pickup level setting is configured using the display and navigation buttons. For the NF frame- and the RF frame the settings are 2.5, 4.0, 6.0, 8.0 or 10.0 (x I_n). The adjustable current settings allow for different levels of protection. A higher level may be needed when, for example, another load fed from this breaker may contain motors that are being started and create large inrush currents over the lowest trip current level. The selection of one of the reduction settings should be determined and selected by a person who is experienced in power system analysis.

4.6.1 Enabling Maintenance Mode

There are three ways to enable the Maintenance Mode function, locally, remotely using a contact, or remotely using communications. A blue colored ring surrounding the switch always illuminates to confirm when the function is enabled. An additional normally open contact is available on the secondary terminal block which can also be used to indicate when Maintenance Mode is active.

For locally actuating the Maintenance Mode function, use the selector switch on the front of the trip unit. When in the ON position, Maintenance Mode is enabled and cannot be turned-off remotely.

When this switch is in the OFF/Remote position, Maintenance Mode can be remotely actuated by a contact wired to the secondary terminal block of the breaker.

A third method to actuate Maintenance Mode is via communications. This can be done by a Communications Adapter Module (CAM) or by the configuration software using the USB port. When Maintenance Mode is enabled in either of these ways, it must also be disabled via communications. Moving the switch from "OFF/Remote" to "ON" and back to "OFF/Remote" will not disable Maintenance Mode.

4.7 High Instantaneous

The PXR trip unit provides a high instantaneous trip function that will trip the circuit breaker at the withstand rating of the circuit breaker frame. This function is factory set within the frame module and reacts to the peak current level. It is always active regardless of the user's instantaneous adjustment selection, including "OFF". The instantaneous ("INST") indicator shows this cause of trip.

All Series NRX NF frame modules have an High Instantaneous trip feature. Selected Series NRX RF frame modules also have the High Instantaneous feature.

4.8 Making Current Release (MCR)

All PXR trip unit styles have a Making Current Release (MCR) function. This safety feature prevents the circuit breaker from being closed and latched-in on a faulted circuit. The MCR is enabled only for the first two cycles of current following the initial circuit breaker closing operation. The circuit breaker will trip with no delay and the instantaneous ("INST") indicator will show the cause of trip.

This non-adjustable release is set by the frame module of the circuit breaker. Refer to time current curves for specific values.

4.9 Zone Selective Interlocking (ZSI)

The Zone Selective Interlocking (ZSI) function is provided on all trip units and can be enabled or disabled through the menu system or Power Xpert Protection Manager software. ZSI functions in conjunction with the Short Delay and Ground Fault protection functions. ZSI provides the fastest possible tripping for faults within the zone of protection of the circuit breaker and also provides positive coordination among all circuit breakers in the system (mains, ties, feeders, and downstream circuit breakers).

When ZSI is enabled, a fault within the zone of protection will immediately trip the breaker and send a signal to upstream trip units to restrain them from tripping immediately. The restraining signal causes the upstream circuit breakers to follow their set coordination time delays so that the service is interrupted to the isolated fault area only while the fault is cleared in the shortest time possible.

The ZSI is wired using a set of three wires labeled Zone In (Zin), Zone Out (Zout), and Zone Common (Zcom) on the secondary terminals above the circuit breaker. These signals are compatible will all Eaton circuit breakers which have the ZSI function. The zone out signal is sent whenever the ground fault pickup is exceeded or when the short delay pickup value of two times I_r is exceeded. This provides maximum selectivity for coordination with larger upstream circuit breakers. For the furthest downstream breaker the use of a self-interlocking jumper may or may not be needed depending on the application. If immediate tripping is desired on the last breaker the Zin on that breaker can be left open while the Zout is wired to the Zin of the breaker upstream from it. If a time delay is desired on the last breaker then a jumper from the Zout of that breaker should wired to the Zin of the same breaker to provide a self-interlocking feature. Refer to Eaton Application Note AP02602002E for detailed description and examples.

4.10 Event Recording and Waveform Capture

The PXR trip unit will record information surrounding events, alarms, and trips into a set of logs. For simple events, only the reason and a time-stamp (based on the trip unit's real-time clock) are stored. More important events additionally store a snap-shot of real-time values (currents and voltages). The most important events additionally store more information, storing waveforms of current and voltage experienced during the event.

Each log can store a set number of events and is managed as a first-in first-out buffer (FIFO). As the information is stored for the most recent event, the information from the oldest event is eliminated.

4.10.1 Event and Log Matrix

Table 6. Event and Log Matrix.

Event	Event Code & Time-stamp	Alarm Snapshot	Trip Snapshot	User Waveform	Alarm Waveform	Trip Waveform	Notes
	200	10	10	1	1	6	Quantity Stored
User Initiated Capture				●			USB or Network Triggered
Power Up - Clock OK	●						
Power Up - Clock Bad	●						
Event - Setpoints Download	●						
Event - Enter Test Mode	●						
Event - Exit Test Mode	●						
Event - Test Complete	●						
Event - Enter Maintenance Mode	●						Indicator on Front Also Illuminates
Event - Exit Maintenance Mode	●						
Event - Opened By Communications	●						w/ CAM Supported Module, Spring Release and Shunt Trip
Event - Closed By Communications	●						
Event - Time Change (if > 60 seconds)	●						Previous Time Is Recorded
Alarm - Calibration	●	●					
Alarm - Setpoints Fault	●	●					
Alarm - Battery Low Voltage	●	●					
Alarm - Low Control Voltage	●	●					
Alarm - RTC Error	●	●					
Alarm - NV Memory Error	●	●					
Alarm - Watchdog Timer	●	●					
Alarm - Long Delay Pickup (Test Mode)	●	●					
Alarm - Ground Fault (Test Mode)	●	●					
Alarm - Trip Actuator Fault	●	●					
Alarm - Operations Count	●	●					
Alarm - Long Delay Pickup	●	●			●		
Alarm - Ground Fault	●	●			●		
Alarm - Mechanism Error	●	●			●		
Alarm - High Load	●	●			●		
Trip - Over Temperature	●		●				
Trip - Making Current Release	●		●				
Trip - Test	●		●				
Trip - Long Delay	●		●			●	
Trip - Short Delay	●		●			●	
Trip - Instantaneous	●		●			●	
Trip - Ground	●		●			●	
Trip - Maintenance Mode	●		●			●	
Trip - Neutral	●		●			●	

Table 7. Information Stored.

Event Code and Time-stamp	Event Cause and Time-stamp Status: Primary, Secondary
Alarm Snapshot or Trip Snapshot	Current: IA, IB, IC, IN, IG Voltages: VAB, VBC, VCA, VAN, VBN, VCN (PXR 25 Only) Power: Watts, Vars, VA (PXR 25 Only) Demand: Watts, Vars, VA (PXR 25 Only) Temperature Frequency Power Factor Operations Count
User Waveform or Alarm Waveform	Waveform of: IA, IB, IC, IN, IG Waveform of: VAB, VBC, VCA, VAN, VBN, VCN (PXR 25 Only) 1 Cycle (64 Data Points)
Trip Waveform	Waveform: IA, IB, IC, IN, IG Waveform of: VAB, VBC, VCA, VAN, VBN, VCN (PXR 25 Only) 6 Cycles (384 Data Points)

5. Relay Configuration

There are 3 relays in the PXR frame module which are used to indicate status information to other systems. Reference section 8 – Secondary Wiring Terminals Associated with the PXR Trip Unit for their connections on the terminal block. Note that relays require auxiliary power to operate.

In firmware version 02.02 and later, the relays can be configured to indicate additional conditions. Configuration is conveniently done using Power Xpert Protection Manager software. Pick-up levels for High Load 1 Alarm, High Load 2 Alarm, Ground Fault Pre-Alarm and Thermal Memory alarm are also configurable.

Function Name	Description of Relay Operation: "The relay will close when ... "	"The relay will open when ... "
Overload Trip	there was a Long or Over-temperature trip	RESET button is pressed or communications reset command received
Neutral Trip	there was a Neutral Current trip	RESET button is pressed or communications reset command received
Short Delay Trip	there was a Short Delay trip	RESET button is pressed or communications reset command received
Instantaneous Trip	there was an Instantaneous trip or MCR	RESET button is pressed or communications reset command received
Short Circuit Trip	there was a Short, Inst or Override trip	RESET button is pressed or communications reset command received
Ground Fault Trip	there was a Ground Fault trip	RESET button is pressed or communications reset command received
Maint. Mode Trip	there was a Maintenance Mode trip	RESET button is pressed or communications reset command received
All Trips	any of protective trip (Overload, Neutral, Short, Instantaneous, Ground, Maint. Mode)	RESET button is pressed or communications reset command received
High Load 1	current flow is greater than set point (adjustable from 50% to 120% of Ir)	current flow falls 5% below the set point
High Load 2	current flow is greater than set point (adjustable from 50% to 120% of Ir)	current flow falls 5% below the set point
High Temperature	temperature exceeds 5C below the level of the temperature trip setting	temperature falls 5C below the setting
Ground Fault Pre-Alarm	ground current is greater than the set point (adjustable from 50% to 100%)	ground current falls 5% below the set point
Thermal Memory	the Thermal Memory value is greater than set point (adjustable from 50% to 100%)	Thermal Memory falls 5% below the set point
Watchdog	auxiliary power is active and the trip unit is healthy and operating	there is an error in the trip unit from any of the self-diagnostics
Low Battery	the battery is below 1 bar (20%)	the battery value is 1 bar (20%) or higher
Internal (HW) Fault	there is an internal fault detected	RESET button is pressed or communications reset command received
Setpoint Mismatch	a setpoint in the trip unit does not match the CAM's copy	RESET button is pressed or if a reset command sent by any communication
Breaker Health Alarm	the health value is below 25%	the health value is at or above 25%
Communication Error	any external communications error occurs	RESET button is pressed or communications reset command received
All Faults	any of Internal Fault, Setpoint Mismatch, Breaker Health Alarm, or Communication Error faults	all of Internal Fault, Setpoint Mismatch, Breaker Health Alarm, or Communication Error are inactive
Aux Contact	breaker is closed	breaker is open
Bell Contact	breaker is tripped	breaker is not tripped (it is open or closed)
Maintenance Mode Active	the trip unit is in the Maintenance Mode	when the trip unit exits Maintenance Mode
ZSI Active	the ZSI function active	ZSI is not active
ZSI Input Received	a ZSI INPUT signal is received	RESET button is pressed or communications reset command received
ZSI Output Sent	a ZSI OUTPUT signal is sent	RESET button is pressed or communications reset command received
Open Breaker Pulse	an OPEN breaker command from any of the communications channels is received	2 seconds after the OPEN breaker command is received
Close Breaker Pulse	a CLOSE breaker command from any of the communications channels is received	2 seconds after the CLOSE breaker command is received
Output	an Output ON command for the relay specified was received on one of the communications channels	an Output OFF is received on any of the communications channels
Off	relay is disabled	relay is disabled

6. PXR Communication Features

6.1 Integrated Modbus-Remote Terminal Unit (RTU) Port

A Modbus communication port is integrated into the PXR trip unit for certain styles. The trip unit responds to messages from the master using the Remote Terminal Unit (RTU) protocol. Modbus port configuration can be viewed and set using the display and navigation buttons or using Power Xpert Protection Manager software (See Section 6.3).

Table 8. Factory Defaults

	Factory Default	Options
Slave address	001	001 to 247
Baud Rate	9600	9600 or 19,200
Parity	Even	Even, odd, none
Stop bits	1	1 or 2

The trip unit uses Modbus function codes 02, 03, 04, 06, 08, and 16 and supports up to 122 registers (244 bytes) in a single Modbus transaction. The detailed Modbus register map is shown in Appendix A – "Modbus Communication Port Register Map".

6.2 USB Port

The PXR includes a micro-B USB port on the front of the trip unit. This USB connection may be used in conjunction with the Power Xpert Protection Manager software to configure, control, and test the trip unit.

6.3 External Communications Adapter Modules (CAMs)

The NRX circuit breakers with PXR 20/25 trip units are equipped to handle a flexible and modular system of Communication Adapter Modules (CAMs). These modules provide communication from the trip unit to a field bus network. Various networks are supported by the following modules, listed with their instruction leaflet:

- ICAM - INCOM: IL0131124EN
- MCAM - Modbus RTU: IL0131091EN
- PCAM - PROFIBUS: IL0131092EN
- ECAM - ETHERNET: IL0131125EN

These modules are remotely mounted on a DIN rail and wired into the trip unit using the circuit breaker's secondary terminal block. The wiring harness as described in the module's instruction leaflet must be used. The field bus is then wired to a connection on the CAM Supported module.

An added feature of the CAMs is the option to open (using a shunt-trip) or close (using a spring release) the circuit breaker if so equipped and wired. There is also a jumper on the front of each CAM Supported module that will enable or disable the remote communication control capability. It may be desirable to put this jumper in the disable position when maintenance work or testing is being done on the circuit breaker.

7. Important System Components

7.1 Potential Transformer (PT) Module

For the PXR 25, a Potential or Voltage Transformer (PT) module provides the signals to measure the system voltage and calculate power and energy. The PT module is a wye to wye configuration, using a three-wire input to generate the four-wire output signal for the trip unit. It is mounted externally to the circuit breaker and wired to the secondary terminals.

The power and energy metering and the protection functions are calculated with the convention that power flow is from line to load through the circuit breaker. This assumes the top side conductor to be the line side. If the distribution system is configured such that the bottom side is the incoming side, the power values will indicate reverse power. This can be changed by using the display and navigation buttons.

7.2 Auxiliary Power

Providing auxiliary power to the PXR trip unit will provide full functionality even when the circuit breaker is open or when the circuit breaker is under very light load such that the self-powering current transformer cannot provide sufficient energy to fully power the trip unit. Auxiliary power is connected to the circuit breaker's secondary terminal block.

⚠ IMPORTANT

Auxiliary power is not required to provide current protection features. Protection is active well below any overload. The trip unit begins to power-up at very low levels of current (approximately NF frame = 60 A, RF frame = 100 A).

7.3 Power Xpert Protection Manager (PXPM) Configuration Software

Eaton's PXPM is a Microsoft® Windows-based software that configures, controls, and tests Eaton PXR 20/25 trip units. The user can create, modify, and save setting configurations for PXR 20/25 trip units. The software further allows the user to reset trip units, adjust trip unit's date and time, capture current or voltage waveforms, and perform trip or no-trip tests.

The software is available as a download from the following link: http://www.eaton.com/PXPM

8. Secondary Wiring Terminals Associated with the PXR Trip Unit

Refer to TD013001EN - "Series NRX with PXR Circuit Breaker Wiring Diagrams" for all terminal numbers.

Table 9. PXR Secondary Terminal Block Features.

Associated Feature	Name	Notes
Neutral Sensor - Residual Ground and Overcurrent Sensing	N1, N2	Only available on 3-Pole circuit breakers; See Section 4.5
Ground Sensor - Source Ground or Zero Sequence Sensing	G1, G2	See Section 4.5
Ground Fault or High Load Alarm Relay ①	ALM2, ALMC	Normally Open Contact
Trip Alarm Relay ①	ALM3, ALMC	Normally Open Contact , Non-Latching
Maintenance Mode - Enable Input	ARMSIN, AGND	Customer supplied dry contact, wetted from the trip unit. When closed, puts the trip unit into Maintenance Mode. A high quality gold plated or palladium contact is required in this application.
Maintenance Mode – Indicator Contact ①	ALM1, ALMC	Normally open, closes when Maintenance Mode is enabled.
Zone Selective Interlock (ZSI)	ZIN, ZOUT, ZCOM	These should connect to other ZSI enabled breakers in the system.
Modbus	MODBA, MODBB, MODBG	Recommended Modbus cable has twisted-pair wires having an aluminum/Mylar foil shield with drain wire.
Communication Adapter Modules (CAMs)	CMM1, CMM2, CMM3, CMM4	See Section 5.3

① These relays can be reconfigured from the factory default shown here. See section 5 Relay Configuration.

9. Testing the Trip Unit and Circuit Breaker

Testing prior to startup shall be accomplished with the circuit breaker either in a de-energized system, or in TEST or DISCONNECTED cassette position, or WITHDRAWN from the cell.

Note: Since time-current settings are based on desired system coordination and protection schemes, the protection settings, if altered during any test sequence, should be reset to their as-found conditions.

⚠ WARNING

Do not attempt to install, test, or perform maintenance on equipment while it is energized. Death or severe personal injury can result from contact with energized equipment. De-energize the circuit and disconnect the circuit breaker before performing maintenance or tests.

⚠ CAUTION

Any tripping operation will cause disruption of service and possible personal injury, resulting in the unnecessary switching of connected equipment. Testing a circuit breaker while it is in-service and carrying load current is not recommended. Testing of a circuit breaker that results in the tripping of the circuit breaker should be done only with the circuit breaker in the test or disconnected cell positions or while the circuit breaker is on a test bench.

The system will prevent a test if more than 5% of the rated current (In) is sensed. A password is required to prevent unauthorized use which could lead to the tripping of the breaker. The default password is 0000.

9.1 Functional Opening Test (Local) via Display

This feature allows a simple functional open test command only from the face of the trip unit. This test is a command sent to the microprocessor to exercise the components such as the trip actuator and the interface to the breaker mechanism.

9.2 Functional Current Testing (Remote) via USB/PXPM

The Functional Current Testing uses the PXPM software to control testing of long delay trip, short delay trip, instantaneous trip, maintenance mode, and ground (earth) fault trip via the USB communication. The Functional Current Test feature allows for testing on any phase including neutral. The trip unit's display is used to observe the current being injected and the elapsed time until trip. On the PXPM software, the test mode allows the user to enter a current to be injected, initiate the test, observe operation, and record the results.

The PXR 20/25 trip unit has two built-in test modes available for use. One is an internal simulated current test and the other is an internal secondary injected current test. Either mode can be configured for opening or not opening the breaker.

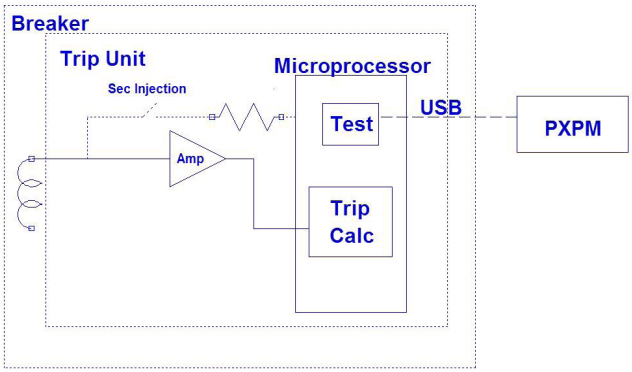
9.2.1 Internal Simulated Test

This is a test to verify the trip unit's firmware integrity. The test current values are simulated in the trip unit's firmware algorithm to check its integrity.

9.2.2 Internal Secondary Injection Test

The trip unit uses an independent built-in circuit to generate a test signal which is injected into the sensor input circuit (See Figure 12). This test feature replaces the need for an external secondary injection test kit.

Figure 12. Sensor Input Circuit



9.3 Current Sensor Test (Remote) via USB/PXPM

The PXPM software has another mode that can inject current to test for continuity of each sensor. This includes the neutral sensor which can be tested whether or not there is a sensor installed.

9.4 Testing for Ground Fault Trip Units – Primary Injection

9.4.1 Codes and Regulations

Many local or country building codes require that any ground fault protection system be performance tested when first installed. Conduct tests in accordance with the approved instructions provided with the equipment. Make a written record of this test and make the results available to the authority having inspection jurisdiction.

Using Power Xpert Protection Manager software, you can print out a copy of the circuit breaker's settings to keep with the testing records.

9.4.2 Test Instructions

The interconnected system must be evaluated only by qualified personnel and in accordance with the equipment assembler's detailed instructions.

⚠ WARNING

Electrical shock or burn injury can occur when working on power systems. Always turn off the main power that is supplying the circuit breaker before conducting tests. Test out of the cell, if possible.

To avoid improper operations following apparently correct simulated test operations, the polarity of the neutral sensor connections (if used) must agree with the equipment assembler's detailed instructions. Where a question exists, consult the specifying engineer and/or equipment assembler.

Verify the grounding points of the system using high voltage testers and resistance bridges to ensure that ground paths do not exist that could bypass the sensors.

Use a low voltage (0 to 24 volts), high-current, AC source to apply a test current of 125 % of the ground pickup setting through one phase of the circuit breaker. This should cause the circuit breaker to trip in less than one second and operate the alarm indicator, if one is supplied. Reset the circuit breaker and the alarm indicator. Repeat the test on the other two phases.

Apply the same current as described above through one phase of the circuit breaker, returning through the neutral sensor if a neutral sensor is used. The breaker should not trip, and the alarm indicator, if one is supplied, should not operate. Repeat the test on the other two phases.

10. Maintenance of the PXR Trip Unit

The trip unit itself requires no maintenance.

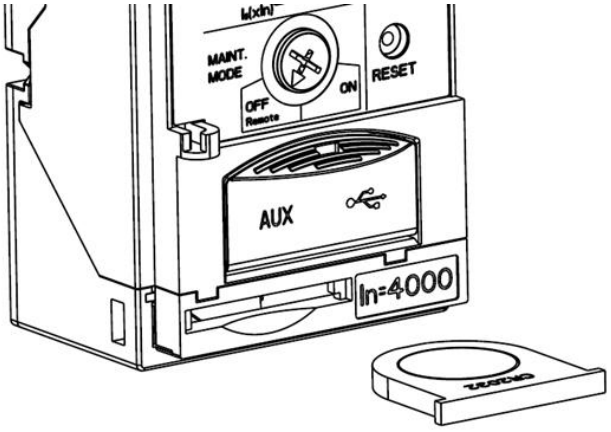
10.1 Replacing the Battery

The battery is provided to maintain the LED indication of the cause of trip. A battery icon at the bottom of the display indicates remaining battery life. The battery plays no part in the protection function of the trip system. The battery can be replaced at any time, even while the circuit breaker is in-service, without affecting the operation of the circuit breaker or its protection functions.

On the initial installation of the circuit breaker, pull to remove the battery tray, remove and discard the insulating tab, and then re-insert the battery tray.

The 3 V lithium battery (CR 2032) is easily removed and replaced; pull to remove the battery tray, remove the old battery from the holder, replace with a new one (observe proper polarity as marked on the tray), and then re-insert the battery tray into the slot on the frame module. The replacement battery should be the same type as that already in the trip unit or an equivalent. Accidentally installing the battery in the reverse direction will not harm the battery nor the trip unit, but will defeat the function of the battery.

Figure 13. Replacing the Battery.



⚠ CAUTION

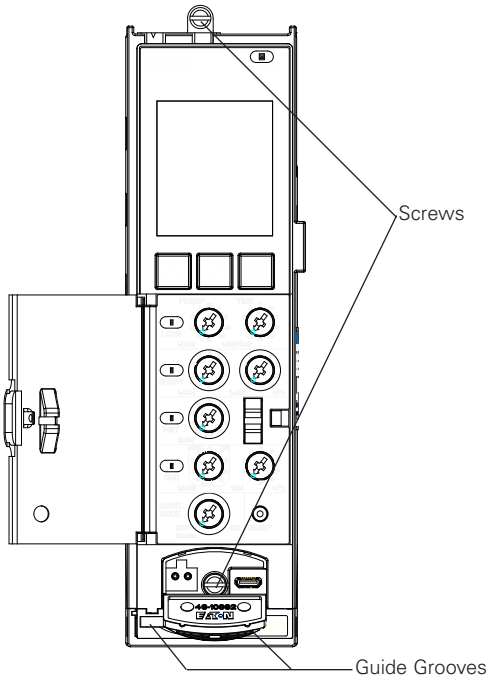
Exercise care when replacing the battery to ensure that it is installed correctly. Accidentally installing the battery in the reverse direction will not harm the trip unit nor the battery, but will defeat the function of the battery.

10.2 Replacing the Trip Unit

The PXR trip unit is designed as a field replaceable unit.

Remove the circuit breaker front cover. Use a screwdriver to loosen the top and bottom screws. Note that the bottom screw is located between the 2-pin auxiliary power socket and USB port, and is covered by a door. Pull the unit outward to disengage the molded, 40-pin connector from the frame module printed circuit board. Remove the wiring connector and harness from the top of the trip unit.

Figure 14. Location of the Top and Bottom Trip Unit Screws.



To install the new trip unit, first connect the wiring harness at the top of the trip unit. Then, to mount the trip unit, align it with the two guide grooves of the frame module. Keep it parallel with the receiving, molded housing. Press the unit into the circuit breaker until the trip unit seats firmly into the receiving housing. Secure it in place with the two screws supplied using a screwdriver with a maximum screw torque of 1.0 N·M (8.9 lbf/in.). Replace the circuit breaker front cover.

11. Record Keeping

The forms in this section can be used to record reference information and the initial protection settings. The Power Xpert Protection Manager software also provides printable copies of configuration and test results. If desired, make a copy and attach it to the interior of the circuit breaker cell door or another visible location. This information should be used and maintained by those personnel in your organization that have the responsibility for protection equipment.

Table 10. PXR Trip Unit Reference Information and Protection Settings.

Series NRX PXR 20/25 Trip Unit - Trip Function Settings

Circuit No./Address:	**Breaker Shop Order Reference:**
Rating Amperes (I_n):	**Continuous Ampere Rating (I_r):**

Protection Settings (Circle Selection)												
Long Delay	Pickup	0.4	0.5	0.6	0.7	.75	0.8	0.9	.95	.98	1.0	I_r	A
	Time	0.5	1	2	4	7	10	12	15	20	24	t_r	sec
Short Delay	Pickup	1.5	2	2.5	3	4	5	6	7	8	10	I_{sd}	A
	Time	.05	0.1	0.2	0.3	0.4	0.5	0.1	0.3	0.4	0.5	t_{sd}	sec
		Flat Curve						I^2t Curve					
Instantaneous	Pickup	2	4	5	6	7	8	10	12	15	OFF	I_i	A
Ground	Pickup	0.2	0.4	0.6	1.0	0.2	0.4	0.6	0.8	1.0	OFF	I_g	A
		Alarm only				Trip							
	Time	0.1	0.2	0.3	0.4	0.5	0.1	0.2	0.3	0.4	0.5	t_g	sec
		Flat Curve				I^2t Curve							

Settings (Circle Selection)						
	Default					
Language	English	Chinese				
Communication	No CAMS	Modbus Port	Modbus CAM	INCOM CAM	Ethernet CAM	Profibus-DP CAM
Long Delay Curve	I^2t	$I^{0.5}t$	It	I^4t		
Ground Fault	Residual	Source/Zero Seq				
Neutral	N = 100%	N = 60%	N = 0%			
Power Feed	Forward	Reverse				
ZSI	OFF	ON				
Maintenance Mode	R5 = 2.5xIn	R4 = 4.0xIn	R3 = 6.0xIn	R2 = 8.0xIn	R1 = 10.0xIn	

12. References – Series NRX with PXR

Table 11. Document References.

TD013001EN	Circuit Breaker Wiring Diagrams
IL0131094EN	Instructions for Neutral Current Sensor - Type RF
IL0131090EN	Instructions for Neutral Current Sensor - Type NF
IL0131089EN	Instructions for Source Ground and Zero Sequence Ground Sensor
IL0131125EN	Installation Instructions for Ethernet Communications Adapter Module (ECAM)
IL0131124EN	Instructions for INCOM Communications Adapter Module (ICAM)
IL0131091EN	Instructions for Modbus Communications Adapter Module (MCAM)
IL0131092EN	Instructions for PROFIBUS DP Communications Adapter Module (PCAM)
MN013001EN	Type NF Low Voltage Power (Air) Circuit Breaker Instruction Manual
MN013002EN	Type RF Low Voltage Power (Air) Circuit Breaker Instruction Manual
IL0131087EN	Instructions for Undervoltage Release, Shunt Trip and Overcurrent Trip Switch
IL0131088EN	Instructions for Spring Release, Latch Check Switch, and Motor Operator
IL0131097EN	Instructions for Cassette Cell Switch - Type NF
IL0131095EN	Instructions for Cassette Cell Switch - Type RF
IL0131096EN	Instructions for Auxiliary Switch
IL0131093EN	Instructions for Secondary Terminal Blocks
AD013001EN	Time Current Current Curves
IL0131128EN	PXR 20/25 Trip Unit For Series NRX Screen Navigation Guide
IL0131126EN	Remote Reset Trip Indicator
IL01301074E	Installation and Operation Instructions for Series NRX PT Module

Appendix A – Modbus Communication Port

Modbus communication ports are integrated for certain trip unit styles. This provides communication from the trip unit to a field Modbus bus network.

When powered, the trip unit will be able to communicate via the secondary terminals labeled MODBA(33), MODBB(34), and MODBG(35) as a slave device. Recommended Modbus cable has twisted-pair wires having an aluminum/mylar foil shield with drain wire.

A.1 Viewing/Setting Modbus Setpoints

Modbus configuration can be viewed and set from the LCD display, using the Power Xpert Protection Manager software and through Modbus communication. To view from Modbus, the settings are stored beginning at register 404000 and extending through 404003 and may be read by using function code 03 or 04, listed in Table A1. These four registers can be written one by one with function code 06 to change the Modbus setting. If the data written into these registers are out of range, the trip unit would result in an exception code 03.

Trip units are shipped with a factory set default address of 001, 9600 bits/second baud rate, even parity, and 1 stop bit.

Table A1. Modbus Settings.

Definition	Modbus Register Number	Data Range
Slave ID	404000	001 - 247
Baud rate	404001	00 = 9600 bits/s
		01 = 19200 bits/s
Parity	404002	00 = None
		01 = Odd
		02 = Even
Stop bit	404003	00 = 1 bit
		01 = 2 bits

A.2 Network Communication Protocol

Only the Modbus RTU communication mode is recognized by the trip unit.

The trip unit can support a maximum of 122 registers (244 data bytes) in a single Modbus transaction.

The trip unit responds to a limited number of Modbus function codes. These are function codes 02, 03, 04, 06, 08, and 16. Function code 03 and 04 are used interchangeably to obtain register data.

A.3 Modbus Register Map

A.3.1 Input Status (Discrete Inputs)

Input status bits 101001 through 101032 may be available using function code 02. The status definitions are defined in Table A2. The first 16 bits are the actual status state while the last16 bits indicate whether the corresponding status state is valid, or supported by the trip unit.

Table A2. Input Status Definitions.

Input	Definition
1001	Breaker is in the closed position
1002	Un-acknowledged trip condition
1003	Active or un- acknowledged alarm
1004	0
1005	Maintenance mode is active
1006	Test mode is active
1007	0
1008	0
1009	0
1010	Long delay pickup is active
1011	Zone Interlock is active
1012	0
1013	“Ground” is source ground
1014	0
1015	0
1016	0
1017	Breaker is in the closed position is valid
1018	Un-acknowledged trip condition is valid
1019	Active or un- acknowledged alarm is valid
1020	0
1021	Maintenance mode is active is valid
1022	Test mode is active is valid
1023	0
1024	0
1025	0
1026	Long delay pickup is active is valid
1027	Zone Interlock is active is valid
1028	0
1029	“Ground” is source ground is valid
1030	0
1031	0
1032	0

A.3.2 Real Time Data

The data changing in real time, such as current, voltage, power, and so on are shown in Table A3. Real time data can be obtained either in IEEE floating point or in fixed point format. For data shown in fixed point format, each result would be the real time data multiplied by a scale factor. The scale factors are shown as the last column in Table A3. Energy objects can only be obtained in fixed point format.

Each data object occupies two registers (four bytes) in length, except for certain energy objects. These energy objects occupy four registers. Since these objects have the capability to change in real time, a complete data object must be obtained in a single transaction to avoid data tearing. Attempting to access a partial data object will result in an exception code 84. (See Section A.3.11)

Table A3. Real Time Data.

Register Number		Register Addresses (HEX)		Objects		
IEEE Float	Fixed Point (FP)	IEEE Float	Fixed Point (FP)	Descriptions	Units	FP Scale Factor
404609	406145	1200	1800	Status cause : 404609 and 406415 high byte is primary status, shown in Table B14. 404609 and 406415 low byte is secondary status, shown in Table B15. 404610 and 406416 are cause-of-status, shown in Table B16.		
404611	406147	1202	1802	IA	A	10
404613	406149	1204	1804	IB	A	10
404615	406151	1206	1806	IC	A	10
404617	406153	1208	1808	IG	A	10
404619	406155	120A	180A	IN	A	10
404623	406159	120E	180E	VAB	V	10
404625	406161	1210	1810	VBC	V	10
404627	406163	1212	1812	VCA	V	10
404631	406167	1216	1816	VAN	V	10
404633	406169	1218	1818	VBN	V	10
404635	406171	121A	181A	VCN	V	10
404651	406187	122A	182A	Real 3 phase power	W	1
404653	406189	122C	182C	Reactive 3 phase power	VAR	1
404655	406191	122E	182E	Apparent 3 phase power	VA	1
404659	406195	1232	1832	Power factor		100
404661	406197	1234	1834	Frequency	Hz	10
404697	406233	1258	1858	Real power peak demand	W	1
404719	406255	126E	186E	Product ID		
404721	406257	1270	1870	Frequency	Hz	100
	406259		1872	Forward energy	KWh	1
	406261		1874	Reverse energy	KWh	1
	406263		1876	Total energy	KWh	1
	406271		187E	Apparent energy	kVAh	1
404765	406301	129C	189C	Temperature	°C	1
	406305		18A0	Forward energy	Wh	1
	406309		18A4	Reverse energy	Wh	1
	406313		18A8	Total energy	Wh	1
	406329		18B8	Apparent energy	Vah	1
404797	406333	12BC	18BC	Reactive power peak demand	VAR	1
404799	406335	12BE	18BE	Apparent power peak demand	VA	1
404845	406381	12EC	18EC	Real power demand	W	1
404847	406383	12EE	18EE	Reactive power demand	VAR	1
404849	406385	12F0	18F0	Apparent power demand	VA	1

Table A3. Real Time Data (Continued).

Register Number		Register Addresses (HEX)		Objects		FP Scale Factor
IEEE Float	Fixed Point (FP)	IEEE Float	Fixed Point (FP)	Descriptions	Units	
404851	406387	12F2	18F2	Minimum IA	A	10
404853	406389	12F4	18F4	Maximum IA	A	10
404855	406391	12F6	18F6	Minimum IB	A	10
404857	406393	12F8	18F8	Maximum IB	A	10
404859	406395	12FA	18FA	Minimum IC	A	10
404861	406397	12FC	18FC	Maximum IC	A	10
404863	406399	12FE	18FE	Minimum IG	A	10
404865	406401	1300	1900	Maximum IG	A	10
404867	406403	1302	1902	Minimum IN	A	10
404869	406405	1304	1904	Maximum IN	A	10
404871	406407	1306	1906	Minimum VAB	V	10
404873	406409	1308	1908	Maximum VAB	V	10
404875	406411	130A	190A	Minimum VBC	V	10
404877	406413	130C	190C	Maximum VBC	V	10
404879	406415	130E	190E	Minimum VCA	V	10
404881	406417	1310	1910	Maximum VCA	V	10
404883	406419	1312	1912	Minimum VAN	V	10
404885	406421	1314	1914	Maximum VAN	V	10
404887	406423	1316	1916	Minimum VBN	V	10
404889	406425	1318	1918	Maximum VBN	V	10
404891	406427	131A	191A	Minimum VCN	V	10
404893	406429	131C	191C	Maximum VCN	V	10
404959	406495	135E	195E	INST/SDT/HIGH_INST count		1
404961	406497	1360	1960	LFT/GFT count		1
404963	406499	1362	1962	Operations count		1
404965	406501	1364	1964	Short Delay Trip count		1
404967	406503	1366	1966	Inst Delay Trip count		1
404969	406505	1368	1968	High Current Delay Trip count		1
404971	406507	136A	196A	Long Delay Trip count		1
404973	406509	136C	196C	Ground Fault Trip count		1
404975	406511	136E	196E	Total Trip count		1
404977	406513	1370	1970	Test Trip count		1
404979	406515	1372	1972	Open by Comm count		1
404981	406517	1374	1974	Manual Open count		1
404983	406519	1376	1976	Time of Last Operation (Year, Month, Day, Hour, Minute, Second)		1
404995	406531	1382	1982	Max Device Temperature	°C	1
404997	406533	1384	1984	Time of Max Device Temperature (Year, Month, Day, Hour, Minute, Second)		1
405009	406545	1390	1990	Running Time: Minute		1
405011	406547	1392	1992	Running Time: Hour		1
405013	406549	1394	1994	Running Time: Day		1
405015	406551	1396	1996	Life point		1

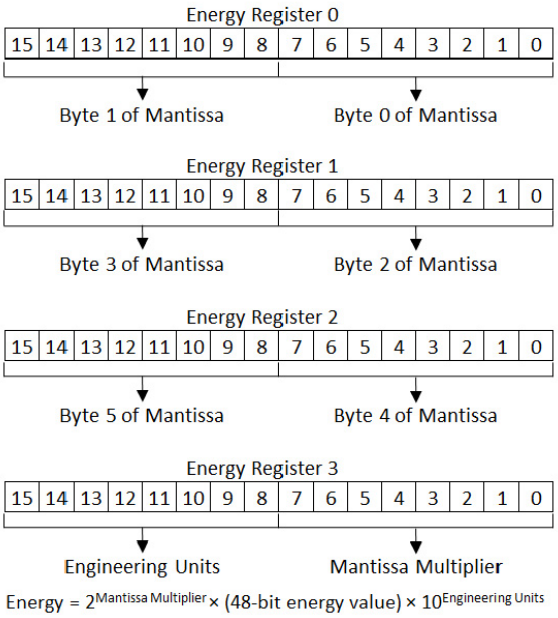
In firmware version 02.02 and later, the following are supported:

Register Number		Register Address(HEX)		Objects		
IEEE Float	**Fixed Point(FP)**	**IEEE Float**	**Fixed Point(FP)**	**Descriptions**	**Units**	**FP Scale factor**
404915	406451	1332	1932	Ia% THD	%	100
404917	406453	1334	1934	Ib% THD	%	100
404919	406455	1336	1936	Ic% THD	%	100
404923	406459	133A	193A	In% THD	%	100
404925	406461	133C	193C	Vab% THD	%	100
404927	406463	133E	193E	Vbc% THD	%	100
404929	406465	1340	1940	Vca% THD	%	100
404931	406467	1342	1942	Van% THD	%	100
404933	406469	1344	1944	Vbn% THD	%	100
404935	406471	1346	1946	Vcn% THD	%	100

Energy objects can be obtained in two-register, fixed point data format and four-register encoded format. Floating point data format is not supported.

The two-register format is presented in units of kilowatt-hours. The four registers encoded energy object occupies Register 3 through Register 0. Register 3 is the high order register and Register 0 is the low order register. Register 3 high byte contains value corresponding to engineering units (power of 10 signed exponent). Register 3 low byte contains a mantissa multiplier value (power of 2 exponent). Register 2 through Register 0 contains a 48-bit energy mantissa in units of watt-hours. The data format of four registers is shown in Figure A1.

Figure A1. Four-register Energy Data Format.



A.3.3 Setpoints Register

The trip unit's setpoints are organized into groups. Each group can be considered a binary array of information which can be obtained through Modbus register access. Register 403001 is an R/W register used to select the particular group. The high byte contains the requested group number, while the low byte must contain 255 (FF_{16}). The setpoints register can be read using function code 03 or 04. Register 403001 can be written using function code 06 or 16. For trip units which support write setpoint capabilities, the setpoints should be written one by one using function code 06. Before reading or writing the setpoints, register 403001 should be written to choose corresponding group.

Setpoints Group 0 is the system group, listed in Table A4. Setpoints Group 1 is the protection group, listed in Table A5.

Table A4. Setpoints Group 0: System Group.
Applies to firmware version 02.00 and 02.01

Register	Bit Field	Mask Field	Setpoint Name	R/W	Format	Value Definition
403001	15-0	0xFFFF	Group 0 = System	R/W		$0x00FF_{16}$
403002	12-0	0x1FFF	Rating Plug	R	Encoded	NRX NF: 200, 250, 300, 400, 500, 600, 630, 800, 1000, 1200, 1250, 1600 NRX RF: 800, 1000, 1200, 1250, 1600, 2000, 2500, 3000, 3200, 4000
403003	2-0	0x0007	Break Frame	R	Encoded	0 = NRX NF 1 = NRX RF
403004	3-0	0x000F	Style	R	Encoded	0 = PXR20V000L00C 1 = PXR20V000L00M 2 = PXR20V000LG0C 3 = PXR20V000LG0M 4 = PXR20V000LGAC 5 = PXR20V000LGAM 6 = PXR25V000L00M 7 = PXR25V000LG0M 8 = PXR25V000L0AM 9 = PXR25V000LGAM 10 = PXR20V000L0AM 11 = PXR20V000L0AC
403005	8	0x0100	Maintenance Mode: State	R	Encoded	0 = Off 1 = On
	0	0x0001	Maintenance Mode: Local Control	R/W	Encoded	0 = Off 1 = On
403006	2-0	0x0007	ARMs level	R/W	Encoded	1 = 2.5 x In 2 = 4.0 x In 3 = 6.0 x In 4 = 8.0 x In 5 = 10.0 x In
403007			Frequency	R	Unsigned	Range: 50, 60, 400
403008	0	0x0001	Rev Feed	R/W	Encoded	0 = Forward, 1 = Reverse
403009	0	0x0001	Language	R/W	Encoded	0 = English, 1 = Chinese

Table A4 Setpoints Group 0: System Group
Applies to firmware version 02.02 and later

Register Number	Bit Field	Mask Field	Setpoint Name	R/W	Format	Value Definition
403000	15-0	0xFFFF	Password	W		factory default = 0000
403001	15-0	0xFFFF	Group 0 = System	R/W		0x00FF
403002	12-0	0x1FFF	Rating Information	R	Encoded	NRX NF: 200, 250, 300, 400, 500, 600, 630, 800, 1000, 1200, 1250, 1600. NRX RF: 800, 1000, 1200, 1250, 1600, 2000, 2500, 3000, 3200, 4000 Magnum STD: 200, 250, 300, 320, 400, 500, 600, 630, 800, 1000, 1200, 1250, 1600, 2000, 2500, 3000, 3200, 4000 Magnum Double: 3000, 3200, 4000, 5000, 6300
403003	2-0	0x0007	Breaker Frame	R	Encoded	0 = NRX NF 1 = NRX RF 2 = Magnum STD 4 = Magnum Double
403004	3-0	0x000F	Style	R	Encoded	0 = PXR20V000L00C 1 = PXR20V000L00M 2 = PXR20V000LG0C 3 = PXR20V000LG0M 4 = PXR20V000LGAC 5 = PXR20V000LGAM 6 = PXR25V000L00M 7 = PXR25V000LG0M 8 = PXR25V000L0AM 9 = PXR25V000LGAM 10 = PXR20V000L0AM 11 = PXR20V000L0AC
403005			Style 2	R		Invalid
403006	8	0x0100	Maintenance Mode: Enable	R/W	Encoded	b08: MM state b07: MM rotary switch on/off b06: MM rotary switch position valid or not b01: MM remote control b00: MM local control
403007	0	0x0001	Maintenance Mode: Level	R/W	Encoded	1 : 2.5*In 2 : 4.0*In 3 : 6.0*In 4 : 8.0*In 5 : 10.0*In
403008			Frequency	R	Unsigned	Range: 50, 60 , 400
403009	0	0x0001	Rev Feed	R/W	Encoded	0 = Forward 1 = Reverse
403010	1	0x0003	Sign Convention			0 : IEC 1 : IEEE 2 : IEEEalt
403011			Power Window	R		Invalid
403012			Power Interval	R		Invalid
403013	0	0x0001	Language	R/W	Encoded	0 = English 1 = Chinese
403014			LCD Rotation	R		Invalid

Table A4 Setpoints Group 0: System Group (Continued)
Applies to firmware version 02.02 and later

Register Number	Bit Field	Mask Field	Setpoint Name	R/W	Format	Value Definition
403015	4-0	0x001F	Relay Configuration 1	R/W	Encoded	0 = OFF 1 = Overload trip 2 = neutral trip 3 = short delay trip 4 = short circuit trip 5 = instantaneous trip 6 = ground fault trip 7 = maintenance mode trip 8 = all trips 9 = high load alarm 1 10 = high load alarm 2 11 = high temperature 12 = ground fault 13 = thermal memory 14 = watchdog 15 = low battery 16 = internal fault 17 = setpoint mismatch 18 = low health 19 = communication fault 20 = all faults 21 = aux contact 22 = bell contact 23 = maintenance mode active 24 = ZSI active 25 = ZSI input 26 = ZSI output 27 = open breaker pulse 28 = close breaker pulse 29 = remote control
403016	4-0	0x001F	Relay Configuration 2	R/W	Encoded	Same as Relay Configuration 1
403017	4-0	0x001F	Relay Configuration 3	R/W	Encoded	Same as Relay Configuration 1
403018			Pole A Location	R		Invalid
403019			Reserved			
403020			Reserved			
403021			Reserved			

Table A5. Setpoints Group 1: Protection Group.
Applies to firmware version 02.00 and 02.01

Register	Bit Field	Mask Field	Setpoint Name	R/W	Format	Value Definition	Units
403001	15-0	0xFFFF	Group 1 = Protection	R/W		$0x01FF_{16}$	
403002	12-0	0x1FFF	Rating Plug	R	Encoded	NRX NF: 200, 250, 300, 400, 500, 600, 630, 800, 1000, 1200, 1250, 1600 NRX RF: 800, 1000, 1200, 1250, 1600, 2000, 2500, 3000, 3200, 4000	A
403003	2-0	0x0007	Break Frame	R	Encoded	0 = NRX NF 1 = NRX RF	
403004	3-0	0x000F	Style	R	Encoded	0 = PXR20V000L00C 1 = PXR20V000L00M 2 = PXR20V000LG0C 3 = PXR20V000LG0M 4 = PXR20V000LGAC 5 = PXR20V000LGAM 6 = PXR25V000L00M 7 = PXR25V000LG0M 8 = PXR25V000L0AM 9 = PXR25V000LGAM 10 = PXR20V000L0AM 11 = PXR20V000L0AC	
403005	0	0x0001	Therm.Memory	R/W	Encoded	0 = Disable, 1 = Enable	
403006	0	0x0001	ZSI	R/W	Encoded	0 = Disable, 1 = Enable	
403007	0-1	0x0003	Curve Slope	R/W	Encoded	$0 = I^{0.5}t$ 1 = It $2 = I^2t$ $3 = I^4t$	
403008			Long Delay Pickup (I_r)	R	Unsigned	40 = 0.4 50 = 0.5 60 = 0.6 70 = 0.7 75 = 0.75 80 = 0.8 90 = 0.9 95 = 0.95 98 = 0.98 100 = 1.0	xIn
403009			Long Delay Time (t_r)	R	Unsigned	5 = 0.5 10 = 1 20 = 2 40 = 4 70 = 7 100 = 10 120 = 12 150 =15 200 = 20 240 = 24	Sec
403010			High Load Alarm	R	Unsigned	For PXR 20 Series: N/A For PXR 25 Series: 85	%
403011	0	0x0001	Short Delay Slope	R	Encoded	0 = Flat , $1 = I^2t$	
403012			Short Delay Pick UP (I_{sd})	R	Unsigned	15 = 1.5 20 = 2.0 25 = 2.5 30 = 3.0 40 = 4.0 50 = 5.0 60 = 6.0 70 = 7.0 80 = 8.0 100 = 10.0	xIr

Table A5. Setpoints Group 1: Protection Group (Continued).
Applies to firmware version 02.00 and 02.01

Register	Bit Field	Mask Field	Setpoint Name	R/W	Format	Value Definition		Units
403013			Short Delay Time (t_{sd})	R	Unsigned	5 = 50	10 = 100	ms
						20 = 200	30 = 300	
						40 = 400	50 = 500	
403014			Inst. Pickup (I_i)	R	Unsigned	0 = OFF	20 = 2	xIn
						40 = 4	50 = 5	
						60 = 6	70 =7	
						80 = 8	100 = 10	
						120 = 12	150 = 15	
403015	0	0x0001	Ground Sensing	R/W	Encoded	0 = Residual, 1 = Source/Zero		
403016			Ground Feature	R	Encoded	0 = Trip, 1 = Alarm, 2 = OFF		
403017	0	0x0001	Ground Slope	R	Encoded	0 = Flat, 1 = I^2t		
403018			Ground Pickup (I_g)	R	Unsigned	0 = OFF	20 = 0.2	xIn
						40 = 0.4	60 = 0.6	
						80 = 0.8	100 = 1.0	
403019			Ground Time(t_g)	R	Unsigned	10 = 0.1	20 = 0.2	Sec
						30 = 0.3	40 = 0.4	
						50 = 0.5		
403020			Neutral Protection Ratio	R/W	Encoded	0, 60, 100		%

Table A5 Setpoints Group 1: Protection Group
Applies to firmware version 02.02 and later

Register	Bit Field	Mask Field	Setpoints Name	R/W	Format	Value Definition
403001	15-0	0xFFFF	Group 1 = Protection	R/W		0x01FF
403002	12-0	0x1FFF	Rating Information	R	Encoded	NRX NF: 200, 250, 300, 400, 500, 600, 630, 800, 1000, 1200, 1250, 1600. NRX RF: 800, 1000, 1200, 1250, 1600, 2000, 2500, 3000, 3200, 4000 Magnum STD: 200, 250, 300, 320, 400, 500, 600, 630, 800, 1000, 1200, 1250, 1600, 2000, 2500, 3000, 3200, 4000 Magnum Double: 3000, 3200, 4000, 5000, 6300
403003	2-0	0x0007	Breaker Frame	R	Encoded	0 = NRX NF 1 = NRX RF 2 = Magnum STD 4 = Magnum Double

Table A5 Setpoints Group 1: Protection Group (Continued)
Applies to firmware version 02.02 and later

Register	Bit Field	Mask Field	Setpoints Name	R/W	Format	Value Definition
403004	3-0	0x000F	Style	R	Encoded	0 = PXR20V000L00C 1 = PXR20V000L00M 2 = PXR20V000LG0C 3 = PXR20V000LG0M 4 = PXR20V000LGAC 5 = PXR20V000LGAM 6 = PXR25V000L00M 7 = PXR25V000LG0M 8 = PXR25V000L0AM 9 = PXR25V000LGAM 10 = PXR20V000L0AM 11 = PXR20V000L0AC
403005			Style 2			Invalid
403006	0	0x0001	Thermal Memory	R/W	Encoded	0 = Disable 1 = Enable
403007	0	0x0001	ZSI	R/W	Encoded	0 = Disable 1 = Enable
403008	1-0	0x0003	Curve Slope	R/W	Encoded	0 = I0.5T 1 = IT 2 = I2T 3 = I4T
403009	6-0	0x007F	LD Pick Up (Ir)	R	Unsigned	40 = 0.4xIn 50 = 0.5xIn 60 = 0.6xIn 0 = 0.7xIn 75 = 0.75xIn 80 = 0.8xIn 90 = 0.9xIn 95 = 0.95xIn 98 = 0.98xIn 100 = 1.0xIn
403010	7-0	0x00FF	LD Time (tr)	R	Unsigned	5 = 0.5s 10 = 1s 20 = 2s 40 = 4s 70 = 7s 100 = 10s 120 = 12s 150 =15s 200 = 20s 240 = 24s
403011	6-0	0x007F	High Load Alarm 1	R	Unsigned	50 = 50%Ir 55 = 55%Ir : etcetera : 115 = 115%Ir Step is: 5%Ir
403012	0	0x0001	SD Slope	R	Encoded	0 = Flat 1 = I2T
403013			SD Pick UP (Isd)	R	Unsigned	15 = 1.5xIr 20 = 2.0xIr 25 = 2.5xIr 40 = 4.0xIr 50 = 5.0xIr 60 = 6.0xIr 70 = 7.0xIr 80 = 8.0xIr 100 = 10.0xIr

Table A5 Setpoints Group 1: Protection Group (Continued)
Applies to firmware version 02.02 and later

Register	Bit Field	Mask Field	Setpoints Name	R/W	Format	Value Definition
403014			SD Time (tsd)	R	Unsigned	5 = 50ms 10 = 100ms 20 = 200ms 30 = 300ms 40 = 400ms 50 = 500ms
403015			Instantaneous Pick Up(Ii)	R	Unsigned	0 = OFF 20 = 2xIn 40 = 4xIn 50 = 5xIn 60 = 6xIn 70 =7xIn 80 = 8xIn 100 = 10xIn 120 = 12xIn 150 = 15xIn
403016	0	0x0001	Ground Sensing	R/W	Encoded	0 = Residual 1 = Source/zero
403017	0-1	0x0003	Ground Feature	R	Encoded	0 = Trip 1 = Alarm 2 = OFF
403018	0	0x0001	Ground Slope	R	Encoded	0 = Flat 1 = I2T
403019			Ground Pick Up(Ig)	R	Unsigned	0 = OFF 20 = 0.2xIn 40 = 0.4xIn 60 = 0.6xIn 80 = 0.8xIn 100 = 1.0xIn
403020			Ground Time(tg)	R	Unsigned	10 = 0.1s 20 = 0.2s 30 = 0.3s 40 = 0.4s 50 = 0.5s
403021	0	0x0001	Ground Fault Thermal Memory	R/W	Encoded	0 = Disable 1 = Enable
403022	6-0	0x007F	Neutral Protection Ratio	R/W	Unsigned	0 = 0% 60 = 60% 100 = 100%
403023	6-0	0x007F	High Load Alarm 2	R/W		55 = 55%Ir : etcetera 120 = 120%Ir Step is: 5%Ir
403024	6-0	0x007F	GF PreAlarm	R/W		50 = 50%Ir 55 = 55%Ir : etcetera : 100 = 100%Ir Step is: 5%Ir
403025	6-0	0x007F	Thermal Memory Alarm	R/W		50 = 50%Ir 55 = 55%Ir : etcetera : 100 = 100%Ir Step is: 5%Ir

A.3.4 Event Registers

The triggering of an event in the trip unit can provide historical data object values at the instant in time the event occurs or occurring around the time of the event. The trip unit categorizes the event information into classifications to provide various numbers of each types. Modbus communication can only have the access to obtain the historical summary, trip, and alarm event data, as shown in Table A6.

Table A6. Event Classification.

Event Type	Number Stored	Event Register Description
Historical Summary	200	Table A7
Historical Trip	10	Table A8
Historical Alarm	10	Table A8 and Table A9

A single triggering can place information into multiple event types. For example, the occurrence of an event triggered by a circuit breaker trip may provide both historical summary (see Table A7) and historical trip information (see Table A8).

Access to event information is based on the selection of event type and event ID. Register 408193 is a R/W register used to select the event type, using function code 06 or 16 to write. The event information may be read by using function code 03 or 04.

When the event type selection is written in register 408193, the earliest and latest event ID can be obtained in registers 408194 and 408196 respectively to determine the range of events saved for the selected event type. Register 408198 is a R/W register used to select the requested event ID and is written with function code 16. If the request event exists in the trip unit, registers 408200 and 408202 provide the Previous Event ID and Next Event ID respectively. If the requested event does not exist in the trip unit, exception code 0x87 is returned.

The date and time when the requested event happened is read in registers 408204 through 408211. This value corresponds to the time of occurrence of the historical event.

Register 408212 provides an indication of the selected event type's data content. This is a constant value for the three event types Modbus port supports.

Event data also provides a validity bit for each data object, starting from register 408213. Bit 0 set to be 1 indicates that the first data object is valid and bit 1 is used to indicate the second data object is valid. The number of validity bit registers is calculated as (number of data objects - 1)/16. The registers listed in Tables A7, A8, and A9 are the data objects. A request out of the range of the registers address would result in exception code 02.

Table A7. Historical Summary Event.

Register	Format	R/W	Historical Summary Event
408193	Encoded	R/W	Event type: Alarm = $8EFF_{16}$
408194	Unsigned32	R	Earliest Event ID
408196	Unsigned32	R	Latest Event ID
408198	Unsigned32	R/W	Requested Event ID
408200	Unsigned32	R	Previous Event ID
408202	Unsigned32	R	Next Event ID
408204	Date/Time	R	Date/Time
408212	Encoded	R	Format of Data: 0000_{16}, 0001_{16}, 0004_{16}, 0005_{16}, 0006_{16}
408213	B0	R	Object Validity Bit
408214	Encoded	R	Event Cause: 00 = Power Up – Time OK 01 = Setpoints Download 02 = Time Adjusted 03 = Trip 04 = Alarm 05 = Enter Test Mode 06 = Exit Test Mode 08 = Power Up - No Time 09 = Test Completed 10 = Maintenance Mode Active 11 = Maintenance Mode Inactive 12 = Opened by Communications 13 = Closed by Communications

Table A8. Historical Trip/Major Alarm Event.

Register	Format	R/W	Descriptions	Units
408193	Encoded	R/W	Event Type: Trip = $80FF_{16}$ Alarm = $81FF_{16}$	
408194	Unsigned32	R	Earliest Event ID	
408196	Unsigned32	R	Latest Event ID	
408198	Unsigned32	R/W	Requested Event ID	
408200	Unsigned32	R	Previous Event ID	
408202	Unsigned32	R	Next Event ID	
408204	Date/Time	R	Date/Time	
408212	Encoded	R	Format of Data: Trip = 0004_{16}, Major Alarm = 0005_{16}	
408213	B15-B00	R	Object Validity Bits	
408214	B31-B16	R	Object Validity Bits	
408215	Encoded	R	Status Cause (Primary, Secondary, cause)	
408217	Unsigned32	R	IA	A
408219	Unsigned32	R	IB	A
408221	Unsigned32	R	IC	A
408223	Unsigned32	R	IN	A
408225	Unsigned32	R	IG Source	A
408227	Unsigned32	R	IG Residual	A
408229	Unsigned16	R	VAB	V
408230	Unsigned16	R	VBC	V
408231	Unsigned16	R	VCA	V
408232	Unsigned16	R	VAN	V
408233	Unsigned16	R	VBN	V
408234	Unsigned16	R	VCN	V
408235	Signed32	R	Real 3 Phase Power	W
408237	Signed32	R	Reactive 3 Phase Power	VAR
408239	Unsigned32	R	Apparent 3 Phase Power	VA
408241	Signed32	R	Real 3 Phase Power Demand	W
408243	Signed32	R	Reactive 3 Phase Power Demand	VAR
408245	Unsigned32	R	Apparent 3 Phase Power Demand	VA
408247	Singed16	R	Device Temperature	1/10 °C
408248	Unsigned16	R	Frequency	1/10 Hz
408249	Singed16	R	Apparent Power Factor	1/100 pf
408250	Unsigned16	R	Operations Count	
408251	B31-B00	R	Binary Status with Validity Bits	

Table A9. Minor Alarm Event.

Register	Format	R/W	Descriptions	Units
408193	Encoded	R/W	Event type: Alarm = $81FF_{16}$	
408194	Unsigned32	R	Earliest Event ID	
408196	Unsigned32	R	Latest Event ID	
408198	Unsigned32	R/W	Requested Event ID	
408200	Unsigned32	R	Previous Event ID	
408202	Unsigned32	R	Next Event ID	
408204	Date/Time	R	Date/Time	
408212	Encoded	R	Format of Data: Minor Alarm = 0006_{16}	
408213	B0	R	Object Validity Bits	
408214	Encoded	R	Status Cause (Primary, Secondary, Cause)	

A.3.5 Block of Registers

A block of registers can be established in trip unit to remap the data object registers. The block of registers is stored in non-volatile memory. Function code 16 is used to load the object assignments for the block of registers. The block assignments are stored beginning at 401001/420481 (0x03E8/0x5000). Only the first data object register address is assigned within the block of registers. For example, although data object IA occupies register 0x1202 and 0x1203, only register 0x1202 is loaded into the block of assignment registers. Verification of this block of assignment registers can be read from trip unit with a function code 03 or 04 from these 401001/420481 (0x03E8/0x5000) registers.

Data pertaining to the objects configured in the block of assignment registers is mapped into registers starting at 401201/420737 (0x 04B0/0x5100) and continuing in successive order for each object assigned. The number of objects and their placement order in this data block of registers is dependent on the configuration of the block of assignment registers. The total number of data block of registers is limited to 100.

The data can be obtained from the data block of registers by a read function code 03 or 04. The address of the starting object must be aligned with a starting address of an object within the data block of registers. The number of registers to obtain must align with an ending address of an object within the data block of registers.

A.3.6 Configuration Registers

Non-volatile register 402001/425345 ($0x07D0_{16}$/$0x6300_{16}$) is used to configure the trip unit to respond to a group of data objects, of which some objects are invalid within that group. When non-zero (default value), any attempt to access a group of data objects that contain an invalid object will result in an illegal data object code 02. When register 402001/425345 ($0x07D0_{16}$/$0x6300_{16}$) is set to zero, the trip unit will respond to a group of objects with data contained in the valid objects of the group along with an illegal value, if available, or else 0000_{16} data contained in the invalid objects.

Non-volatile register 402002/425346 ($0x07D1_{16}$/$0x6301_{16}$) is used to configure the data transmission order of 32-bit floating point data. If non-zero (default value), the floating point low order word is first in the Modbus register space. When the register is set to be 0, the floating point high order word is first in the Modbus register space. Non-volatile register 402003/425347 ($0x07D2_{16}$/$0x6302_{16}$) is used to configure the data transmission order of 32-bit fixed point data. If non-zero (default value), the fixed point low order word is first in the Modbus register space. When the register is set to be 0, the fixed point high order word is first in the Modbus register space.

To accommodate Modbus master that can only access to register 9999, some Eaton registers initially assigned above 9999 have been assigned dual access, both at the original register(to provide compatibility) and at a new register assignment below 9999. The format is given as low/high register numbers followed by (low_{16}/$high_{16}$ Modbus register addresses). An example is: 40xxxx/4yyyyy ($XXXX+1_{16}$/$YYYY+1_{16}$).

Table A10. Configuration Registers.

Register Definition	R/W	Modbus Register Number	Modbus Register Address	Number
Mapped block of registers configuration	R/W	401001/420481	0x03E8/0x5000	100
Mapped block of registers data	R	401201/420737	0x04B0/0x5100	100*2
Invalid object access configuration	R/W	402001/425345	0x07D0/0x6300	1
Floating point data word order configuration	R/W	402002/425346	0x07D1/0x6301	1
Fixed point data word order configuration	R/W	402003/425347	0x07D2/0x6302	1
Remote control	R/W	402901/425089	0x0B54/0x6200	3
Date and time register	R/W	402921	0x0B68	8

A.3.7 Remote Control

A set of registers is reserved for the trip unit remote control, starting from 402901/425089 through 402903/425091. These three registers should be written together with a "slave action number" and its first complement using function code 16. The data format registers are shown as Figure A2. The "slave action number" and its function are listed in Table A11, their support being product dependent.

If the "slave action number" and its one's complement command is valid, the trip unit will execute the action. Once the command is successfully acknowledged by the trip unit, it returns a normal function code 16 response to Modbus master. Since it may take some time for the trip unit to take action, Modbus master may further determine if the product completed the slave action function successfully after the normal response. If the "slave action number" and its one's complement command is invalid, the trip unit returns exception code 03.

Figure A2. Remote Control Data Format.

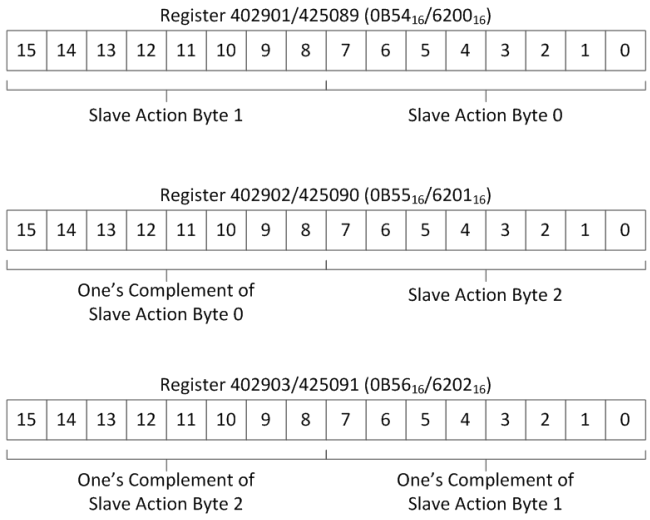


Table A11. Remote Control.

Control Group	Definition	Byte 2	Byte 1	Byte 0
Reset	Reset trip	0	0	2
	Reset powered up indication	0	0	3
	Reset peak demand watts	0	0	4
	Reset energies	0	0	8
	Reset operations count	0	1	2
	Reset runtime	0	1	3
	Reset all min/max values	0	1	4
	Reset min/max currents	0	1	13
	Reset min/max line-to-line voltages	0	1	14
	Reset min/max line-to-neutral voltages	0	1	15
	Reset trip count	0	5	1
	Reset temperature	0	5	2
	Reset all diagnostics information	0	5	3
Maintenance Mode	Enable Maintenance Mode	1	0	8
	Disable Maintenance Mode	1	0	9

In firmware version 02.02 and later, the following are supported.

Control Group	Definition	Byte 2	Byte 1	Byte 0
Open/Close Breaker	Open Breaker (for 2 seconds opens relay which is assigned to function "Open Command")	1	0	0
	Close Breaker (for 2 seconds closes relay which is assigned to function "Close Command")	1	0	1
Relay Remote Control	Relay Output	4	1: activate 2: deactivate	1: relay1 2: relay2 3: relay 3

A.3.8 Date and Time

The trip unit supports Modbus master read real-time clock information. Eight registers, starting from register number 402921, are reserved for this information, as defined in Table A10. Detailed information is listed in Table A12.

Table A12. Real Time Clock.

Definition	Modbus Register Number	Modbus Register Address	Data Range
Month	402921	0x0B68	1-12
Day	402922	0x0B69	1-31
Year	402923	0x0B6A	
Day of week	402924	0x0B6B	1 = Sunday 7 = Saturday
Hour	402925	0x0B6C	0-23
Minute	402926	0x0B6D	0-59
Second	402927	0x0B6E	0-59
1/100th second	402928	0x0B6F	-

A.3.9 Internal Diagnostics

The trip unit supports internal Modbus diagnostics to monitor internal Modbus port communication with function code 08. For different sub-function codes, diagnostics information is listed in Table A13.

Table A13. Diagnostics.

Sub-function code	Action
0	Echo query
1	Restart communication
4	Force listen
10	Clear counters
11	Modbus UART bus message count
12	Modbus UART CRC error count
13	Exception count
14	Slave message count
15	Slave no response count
16	Slave NAK count
17	Slave busy count
18	Modbus UART over run error count
20	Clear Modbus UART counters
23	Modbus UART framing error count
24	Modbus UART noise error count
25	Modbus UART parity error count
26	MCU1 Firmware Version
27	MCU1 Firmware Reversion
28	MCU1 Firmware Build
29	MCU2 Firmware Version
30	MCU2 Firmware Reversion
31	MCU2 Firmware Build
32	USB Version
33	USB Reversion
34	Reset block of registers

A.3.10 Primary Status /Secondary Status/Cause Code Definitions

Table A14. Primary Status Code Definitions.

Code	Definition
0x01	Open
0x02	Closed
0x03	Tripped
0z04	Alarmed (firmware version 02.02 and later)
0x0D	Picked-up

Table A15. Secondary Status Code Definitions

Code	Definition
0x01	Not applicable
0x03	Test mode
0x07	Powered-up since last trip/alarm reset
0x08	Alarm

Table A16. Cause Code Definitions
Applies to firmware version 02.00 and 02.01.

Code	Definition	Code	Definition
0x0000	Unknown	0x0040	Bad/missing rating plug
0x0001	Normal	0x0041	Reverse power
0x0003	Instantaneous	0x0044	Reverse sequence
0x000B	Over voltage	0x0045	Phase current loss
0x000C	Under voltage	0x0049	Phase currents near pickup, high load alarm
0x000E	Aux-power under power	0x004B	Making current release
0x000F	Over-frequency	0x004C	Fixed hardware instantaneous
0x0010	Under-frequency	0x004D	Setpoints error
0x0011	Current un-balance	0x004E	Over temperature
0x0012	Voltage un-balance	0x0050	Long delay neutral over current
0x0013	Apparent power factor	0x0054	Ground fault
0x001A	Power demand	0x0055	Earth fault
0x001B	VA demand	0x0071	Calibration
0x001E	THD	0x0088	Real time clock
0x001F	Operations count	0x0099	MM mode
0x0021	Control via communication	0x009A	Breaker mechanism fault
0x0025	Coil supervision	0x07FC	RAM error
0x0027	Diagnostics warning	0x07FD	Non-volatile memory error
0x003D	Long delay	0x07FE	Watchdog fault
0x003E	Short delay	0x07FF	ROM error
		0x0800	Local test from LCD

Table A16. Cause Code Definitions
Applies to firmware version 02.02 and later.

Code	Definition	Code	Definition
0x0000	Unknown	0x004E	Over temperature
0x0001	Normal	0x0050	Long delay neutral over current
0x0003	Instantaneous	0x0054	Ground Fault
0x0005	Instant. neutral over current	0x0055	Earth fault
0x000E	Aux-power under power	0x0071	Calibration
0x001F	Operations count	0x0088	Real time clock
0x0021	Control via communication	0x0099	MM mode
0x0025	Coil supervision	0x009A	Breaker mechanism fault
0x0029	Battery low alarm	0x07FD	Non-volatile memory error
0x003D	Long delay	0x07FE	Watchdog fault
0x003E	Short delay	0x009E	Short Delay Neutral Over current
0x0049	High load alarm 1	0x009F	Thermal memory alarm
0x004B	Making current release	0x00A0	Local test from LCD
0x004C	Fixed hardware instantaneous	0x00A1	High Load Alarm 2
0x004D	Setpoints error	0x00A2	Ground Fault Pre-Alarm

A.3.11 Exception Codes

When there's error in request or response, trip unit would respond an exception code.

- If the function code in the query is not supported by trip unit, exception code 01 is returned in the response, also used for the unsupported sub-function code in Modbus diagnostics.
- If the requested data register/ bit address is illegal, exception code 02 is returned.
- If the data in the query is illegal, exception code 03 is returned.
- If trip unit doesn't support the query function, exception code 04 is returned.
- In certain circumstances, exception code 05(ACK) is returned.
- If trip unit can't perform the current request at this time, a BUSY exception code 06 is returned.
- If trip unit can't perform the requested action, a NAK exception code 07 is returned.
- If only a partial register is used in the query, exception code 132 is returned.
- If the requested event entry doesn't exist, exception code 135 is returned.

Appendix B – Troubleshooting

Table B1. Troubleshooting ·

Symptom	Probable Cause	Possible Solutions	Reference
The Trip Unit Status LED is not blinking.	Current is not flowing through the circuit breaker sensors to the trip unit.	Connect +24 Vdc and ground auxiliary power to circuit breaker terminals 19 and 20 and observe the status LED.	
Breaker trips on ground fault.	There actually is a ground fault.	Find the location of the fault.	
	On three-pole, four-wire residual systems, the neutral current sensor may not have the correct ratio or be properly connected.	Check the ground fault setting is residual or source/zero ground. Check that the connections from the neutral current sensor to the breaker are not reversed.	See Sections 4.4 - 4.5: Ground Fault Settings and Ground Fault Sensing.
	High inrush phase currents may cause fictitious ground pickup momentarily.	If the zone interlocking function is employed, connect a jumper from Zout to Zin to provide some time delay.	See Section 4.9: Zone Selective Interlocking.
	The trip unit is malfunctioning.	Replace the trip unit.	
Breaker trips too rapidly on ground fault or short delay (zone selective interlocking not used).	ZSI function is ON.	Check the ZSI setting in the Setting menu is OFF.	See Section 4.9: Zone Selective Interlocking.
	The trip unit settings are not correct. Is I2t Slope or Flat selected?	Change the Ground Fault or Short Delay Settings.	See Section 4.2: Short Delay Pickup and Time Settings. See Sections 4.4 - 4.5: Ground Fault Settings and Ground Fault Sensing.
	The trip unit is malfunctioning.	Replace the trip unit.	
The breaker trips too rapidly on long delay.	Long Time Memory is selected.	Disable the Long Time Memory for Long Delay Times setting.	See Section 4.1: Long Delay Pickup and Time Setting.
	The trip unit settings are not correct.	Change the Long Delay settings.	See Section 4.1: Long Delay Pickup and Time Setting.
The primary injection current source is not putting out the correct current.	Primary injection testing pick up and trip times are not correct.	Use an oscilloscope with a current probe to accurately verify current values, times, and that there are no inrush spikes of current observed.	
	Single Phase Testing.	When testing single phase, the current can “bleed” into other un-energized phases and reduce the value of current in the testing phase.	
	It is possible, when using the high current “pulse” testing technique, to create a long time memory trip as a result of the cumulative action of the short duration currents.	Disable the Long Time Memory feature for Long Delay Time setting.	See Section 4.1: Long Delay Pickup and Time Setting.
	Precise pickup levels are difficult to control and repeat for primary injection testers as high current levels.	Use functional current testing (remote) via USB/PXPM.	See Section 8.2: Functional Current Testing (Remote) via USB/PXPM
Cause of Trip LEDs are flashing and breaker is closed.	The trip unit was not reset from a previous event.	Depress the Reset pushbutton to clear the LED or test flashing.	See Section 3.3: Pickup/Cause of Trip Indicators.
	The battery voltage is too low to reset the latch circuit on the cause of trip LEDs.	Replace the battery.	See Section 9.1: Replacing the Battery.
The LCD display is not energized.	No auxiliary power (24 Vdc) on terminals 19 and 20 when the current through the breaker is less than the minimum current requirement for the LCD display.	Apply auxiliary power.	See Section 6.2: Auxiliary Power.

Table B1. Troubleshooting (Continued).

Symptom	Probable Cause	Possible Solutions	Reference
The Status LED is red continuously or flashing red.	The circuit breaker MCR auxiliary switch is not indicating proper state.	Check the auxiliary switch for continuity.	See Document IL0131096EN: Instructions for Auxiliary Switch.
	The circuit breaker mechanism not properly closing.	Check with your Eaton representative for factory assistance.	
	Internal memory problem.	Replace the trip unit.	
The circuit breaker is tripping and the orange LED (not red) is illuminated next to SHORT text.	The circuit breaker MCR auxiliary switch is not indicating proper state.	Check the MCR switch or check with your Eaton representative for factory assistance.	See Section 4.8: Making Current Release.
	The circuit breaker mechanism not closing properly.	Check with your Eaton representative for factory assistance.	
The Maintenance Mode will not shut off.	Faulty remote switch or local switch.	Verify the remote switch or local switch is not on.	See Section 3.5: Maintenance Mode Switch.
	The Maintenance Mode was initially enabled by communications and the communications link is not available.	Restore the communications link if possible and check for possible wiring errors. Enter the programming mode and change the setting to disable the Maintenance Mode.	See Section 4.6: Maintenance Mode.

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Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
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Printed in USA
Publication No. MN013003EN / TBG1224
August 2020

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