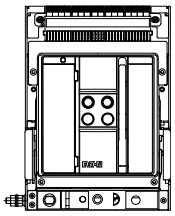
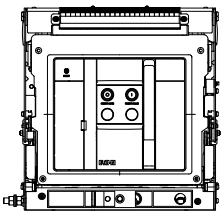
PT 10/20/25 Trip Unit User Manual
Power Trip (PT) Units

Instructions apply to:



CCC, new generation IZM61 series air circuit breaker



CCC, new generation IZM65 series air circuit breaker

CCC, new generation IZM67 series air circuit breaker

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 mis-installation 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 cassette 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 required to provide protection features.

1. Introduction

1.1 Introduction to PT unit

The Power Trip (PT) unit, along with current sensors and a trip actuator, is the subsystem of a circuit breaker which provides the protective function. The PT unit analyzes signals from the current sensors. If current level and time delay settings are exceeded, then the PT unit will trip the circuit breaker. The automatic over-load 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 side and the mechanical tripping parts of the circuit breaker.

The PT unit consists of three modules: a frame module, a control module and an auxiliary power 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. The auxiliary power module is EASY400-POW.

Figure 1. The PT Trip Unit.

1. Introduction

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 wirings are landed on the secondary contact system directly above the circuit breaker. See ZIM6 Air Circuit Breaker catalogue for the secondary terminal board definitions.

Figure 2. Series IZM6 Circuit Breakers

IZM61

IZM65/67

2. Protection and Metering Features

2.1 Trip Unit Functions

Table 1. Trip Unit Functions.

Trip Unit Type	Catalog Number	Protection style	LCD	Rotary switch	Ground fault	Modbus RTU	Zone interlock	Relay output	Digital input
PT 10	PT10	LSI		•					
	PT10G	LSIG		•	•				
PT 20	PT20	LSI	•						
	PT20G	LSIG	•		•				
	PT20C	LSI	•			•			
	PT20GC	LSIG	•		•	•			
PT 25	PT25	LSI	•			•	•	•	•
	PT25G	LSIG	•		•	•	•	•	•

Figure 3. PT10- Rotary Switch Trip Unit Series

Figure 4. PT20/25- LCD Trip Unit Series

2.2 Protection Features

Table 2. Protection Features

Protection			PT 10	PT 20/25
Long Delay Protection (L)	Curve Slope		I^2t	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 to 1.0 Adjustable step is: 0.01
	Long Delay Time @ 6 x (I_r)	Seconds	0.5, 1, 2, 4, 7, 10, 12, 15, 20, 24	0.5 - 24S ① Adjustable step is: 0.1S
	Thermal Memory		Included	Included
	High Load Alarm 1	% x (I_r)	OFF or % High Load Alarm 2 Adjustable step is: 1.0% ②	
	High Load Alarm 2	% x (I_r)	OFF or % High Load Alarm 1 to 120% Adjustable step is: 1.0% ②	
Short Delay Protection (S)	Curve Slope		Fixed, I^2t	Fixed, I^2t
	Short Delay Pickup	x (I_r)	1.5, 2, 2.5, 3, 4, 5, 6, 7, 8, 10	1.5~ 10S Adjustable step is 0.1S
	Short Delay Time 8 x (I_r) I2t	Seconds	0.1, 0.2, 0.3, 0.5	0.1 ~ 0.5 Adjustable step is 0.01
	Short Delay Time Flat	Seconds	0.05, 0.1, 0.2, 0.3, 0.4, 0.5	0.05~ 0.5 Adjustable step is 0.01
	Zone Interlock			Enable/Disable ③
Instantaneous Protection ①	Instantenous	x (I_n)	Off, 2, 4, 5, 6, 7, 8, 10, 12, 15	Off, 2 ~ 15 Adjustable step is 0.1
Neutral Protection	4th Pole or External Neutral Trip	% x (I_r)	0 (Off), 60, 100 ②	0 (Off), 60, 100
Ground (Earth) Fault Protection (Option G)	Ground Fault Pickup	x (I_n)	Off, 0.2, 0.4, 0.6, 0.8, 1.0	OFF, 0.2~ 1.0 Adjustable step is 0.01
	Ground Fault alarm	x (I_n)	0.2, 0.4, 0.6, 1.0	OFF, 0.2~ 1.0 Adjustable step is 0.01
	Ground Fault Delay at 0.625 x (I_n) I^2t	Seconds	0.1, 0.2, 0.3, 0.4, 0.5	0.1~ 0.5 Adjustable step is 0.01
	Ground Fault Delay Flat	Seconds	0.1, 0.2, 0.3, 0.4, 0.5	0.1~ 0.5 Adjustable step is 0.01
	Zone Interlock			Enable/Disable ③
	Thermal Memory		Included ②	Included
General	Over Temperature Trip	°C	85°C	85°C
	Health monitor alarm	%	1~50	1~50

① If I^4t, $I^{0.5}t$, and It slope is selected, not all times are available, consult time-current curves.
② These settings on PT10 series modified with PTM.
③ Only PT 25 supports zone interlocking.

Table 3. Advanced Protection Features (PT25 only, unless specified additionally)

Protection		Unit	Setting		Note
Voltage Protection	Over-voltage Pickup	V	180-720 adjustable	Interval of 1	
	Over-voltage Delay	s	1~ 300 adjustable	Interval of 1	
	Under-voltage Pickup	V	60-670 adjustable	Interval of 1	
	Under- voltage Delay	s	1- 300 adjustable	Interval of 1	
	Voltage Unbalance Pickup	% V	5- 25 adjustable	Interval of 1	
	Voltage Unbalance Delay	s	1- 300 adjustable	Interval of 1	
Current Protection	Current Unbalance Pickup	% A	5- 25 adjustable	Interval of 1	
	Current Unbalance Delay	s	1- 300 adjustable	Interval of 1	
	Phase Loss Pickup	% A	75		
	Phase Loss Delay	s	1- 240 adjustable	Interval of 1	
Power Protection	Reverse Power Pickup	kW	1- 65500 adjustable	Interval of 1	
	Reverse Power Delay	s	1- 300 adjustable	Interval of 1	
Frequency Protection	Over-frequency Pickup	Hz	40- 70 adjustable	Interval of 1	When Phase-A phase voltage exceeds 100V, the frequency metering will start
	Over-frequency Delay	s	0.2- 5 adjustable	Interval of 0.1	
	Under-frequency Pickup	Hz	40- 70 adjustable	Interval of 1	
	Under-frequency Delay	s	0.2- 5 adjustable	Interval of 0.1	
Phase Sequence Protection	Positive Sequence (A-B-C)		3-phase voltage sequence is the same as the setting, and the trip unit acts		When all three phase voltages exceed 100V, the phase sequence metering will start
	Reversed Sequence (A-C-B)				
Demand Protection	Current Demand Pickup	x (I_n)	0.2-1.0 adjustable	Interval of 0.1	PT20/25 supports this function
	Current Demand Delay	s	15-1500 adjustable	Interval of 1	
	Power Demand Pickup	kW	1- 65500 adjustable	Interval of 1	
	Power Demand Delay	s	15-1500 adjustable	Interval of 1	

2.3 Current and Voltage Metering Data

Table 4. Current and Voltage Metering Data

Current Metering	Unit	Accuracy ①	Notes
IA, IB, IC, IN, IG	Amperes	±1.5% of Reading	
Minimum IA, IB, IC, IN, IG	Amperes	±1.5% of Reading	Group values held until reset
Maximum IA, IB, IC, IN, IG	Amperes	±1.5% of Reading	Group values held until reset
Voltage Metering ②	**Unit**	**Accuracy ③**	**Notes**
VAB, VBC, VCA	Volts	±0.5% of Reading	Line to Line Voltage
Minimum VAB, VBC, VCA	Volts	±0.5% of Reading	Group values held until reset
Maximum VAB, VBC, VCA	Volts	±0.5% of Reading	Group values held until reset
VAN, VBN, VCN	Volts	±0.5% of Reading	Line to Neutral Voltage
Minimum VAN, VBN, VCN	Volts	±0.5% of Reading	Group values held until reset
Maximum VAN, VBN, VCN	Volts	±0.5% of Reading	Group values held until reset

① Accuracy applicable for 10% to 120% of In at the ambient temperature of 25°C.
② Only the PT25 supports this function.
③ Accuracy applicable for the voltage of 50 to 690Vac at the ambient temperature of 25°C.

2.4 Power and Energy③Metering Data

Table 5. Power and Energy Metering Data

Power Metering③	Unit	Accuracy①②	Notes
Real Power	kW	±2.5% of Reading	Approximately 1 second update
Apparent Power	kVA	±2.5% of Reading	Approximately 1 second update
Reactive Power	kvar	±2.5% of Reading	Approximately 1 second update
Real Demand	kW	±2.5% of Reading	Fixed window of 5 minutes
Apparent Demand	kVA	±2.5% of Reading	Fixed window of 5 minutes
Reactive Demand	kvar	±2.5% of Reading	Fixed window of 5 minutes
Real Demand (Peak)	kW	±2.5% of Reading	Value held until reset
Apparent Demand (Peak)	kVA	±2.5% of Reading	Value held until reset
Reactive Demand (Peak)	kvar	±2.5% of Reading	Value held until reset
Power Factor	-		Approximately 1 second update

Power Metering③	Unit	Accuracy①②	Notes
Real Energy Total	kWh	±2.5% of Reading	Forward + reverse
Real Energy Net	kWh	±2.5% of Reading	Forward - reverse
Real Energy Forward	kWh	±2.5% of Reading	Delivered by source to load
Real Energy Reverse	kWh	±2.5% of Reading	Delivered by load to source
Apparent Energy	kVAh	±2.5% of Reading	Energy
Reactive Energy Received	kvarh	±2.5% of Reading	Reactive energy in quadrants 1+2
Reactive Energy Delivered	kvarh	±2.5% of Reading	Reactive energy in quadrants 3+4
Reactive Energy Net	kvarh	±2.5% of Reading	Kvarh delivered – kvarh received
Reactive Energy Total	kvarh	±2.5% of Reading	Kvarh delivered + kvarh received

① Accuracy applicable for 10% to 120% of In at the ambient temperature of 25ºC.
② Accuracy applicable for the voltage range of 50 to 690Vac at the ambient temperature of 25ºC.
③ Only the PT25 supports this function.

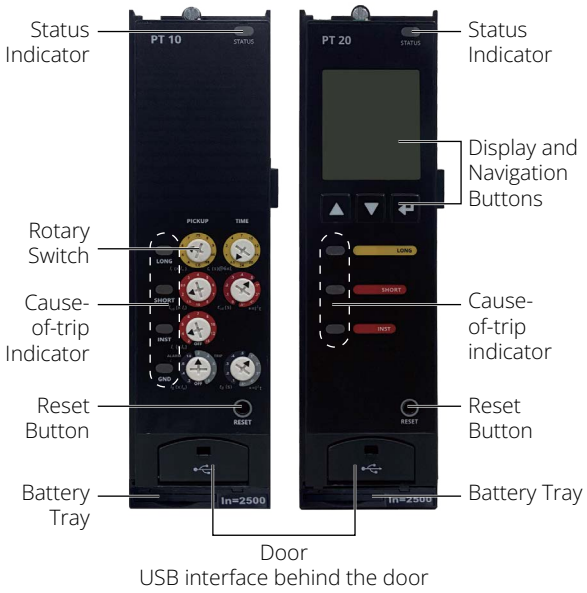
2.5 Time Current Curves

The Time-Current Curves (TCC) for the PT series trip units when used in Series IZM6 air circuit breakers are referenced to Series IZM6 Air Circuit Breaker catalogue. All protection settings shall be made according to recommendations.

3. Power Trip (PT) Units

The PT unit 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 PT unit styles.

Figure 5. PT20/25 Unit Front Face



3.1 Status Indicator

All PT 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 6. Status Indicator

The status indicator blinks red or orange if the trip unit detects an internal problem. Blinking red indicates that one or more below problems have occurred, including:

- Damaged trip actuator coil
- Firmware error
- Calibration error
- Mechanism error

Immediate action must be taken to rectify the problem and/or replace the trip unit.

Blinking orange indicates that one or more below problems have occurred, including:

- Battery low or not connected
- Auxiliary power voltage low
- Overload
- Thermal memory alarm
- Over temperature alarm
- Clock error

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 PT20/25 trip unit has a display on the front. 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). These buttons are used to control what information is shown on the display and to select certain configuration options:

Figure 7. 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 PT20/25 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 14 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.

3.3 Password Protection Functionality

The cybersecurity of your system is critical. The PT electronic trip unit has a four-digit password for protection. To change non-rotary switch settings, the password is required. When the change takes longer than 10 seconds, the authorization will time out. When wrong password is entered three times, there will be a ten-minute lockout period, during which access will be prohibited.

There are two levels of password: “Administrator” and “User”. The factory default is the administrator level, and the password is "0000". If needed, the administrator can create a user and decide whether that user can change the protection settings. Password security is enforced when changing settings over network communication using the LCD, PTM software, and other devices. The password can only be provided to those who need it. Changing the default password is key for comprehensive network security policy when the PT is installed or configured. The password is four-digit length, with numeric characters from 0 to 9.

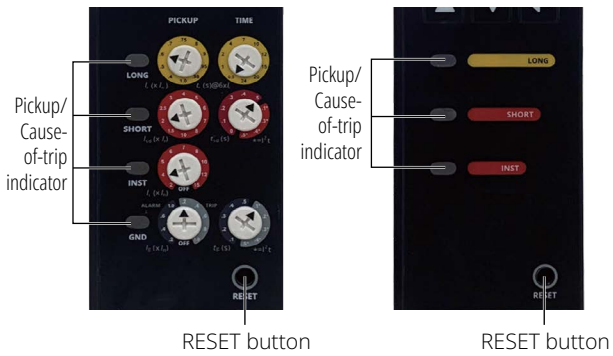
For PT20/25 electronic trip unit, settings are password protected to reduce the risk of unauthorized changes to the settings. The correct password ("0000" by factory default) must be entered in the “Edit Settings” menu to change the following settings:

- Language
- Communication configuration (for on-board Modbus)
- Thermal memory
- Power settings
- System voltage setting
- Usage frequency setting
- Circuit breaker early warning setting
- User management
- System time setting
- Relay setting
- Neutral pickup (100%, 60%, off)
- ZSI - Zone Selective Interlock (on or off)
- Edit password
- Long/short time delay protection settings
- Instantaneous protection settings
- Ground protection settings
- Over-voltage/under-voltage protection settings
- Voltage/current unbalance protection settings
- Reverse power protection settings
- Over-frequency/under-frequency protection settings
- Phase sequence protection settings
- Power/current demand protection settings
- Phase loss protection settings
- The PT10 password protection function is set by the PTM, and the thermal memory function can be enabled or disabled by writing the password in the PTM.

3.4 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 8. Pickup/Cause-of-Trip Indicators



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” – 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 (MCR) trip, High Instantaneous trip has occurred.
- “GND” – Ground trip or Ground alarm condition has occurred.

3.5 Rotary Switches (PT10 only)

Up to 7 rotary switches can be found on the PT10/10G trip unit's front panel. These 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 characteristics. 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.

Figure 9. PT10 Rotary Switch Area

3.6 Reset Button

The button labeled "RESET" can be depressed by using a small tool. Press this button to reset the blinking cause of trip indicator, clear locking alarm messages of the configurable relays, and reset the "Check Mark" next to ZSI on the display (lit on after the ZSI input signal is detected). (See Figure 5)

3.7 Door

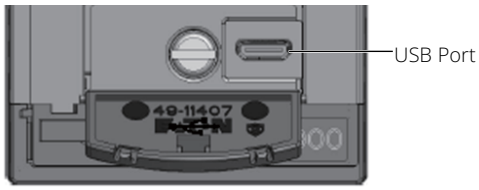
Near the bottom of the PT unit, there is a small door with the Universal Serial Bus (USB) icon. The door can be opened downward to expose the micro-B USB port.

Figure 10. Trip Unit Door

3.8 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 Trip 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 11. Behind the Trip Unit Door

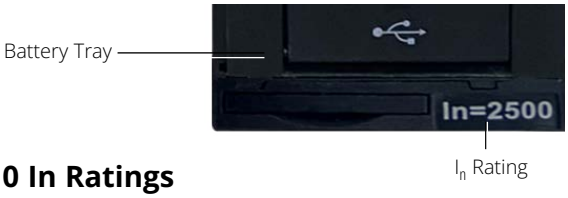


3.9 Battery

At the bottom of the trip unit is a small tray which holds the battery. When the trip unit is not powered, this battery supplies power to cause-of-trip indicators and real-time clock and assists the trip unit to record events. A battery icon at the bottom of the display (PT20/25 only) indicates remaining battery life. The battery life of the rotary switch type trip unit (PT10) can be checked using a computer. The battery plays no part in the protection functions of the trip system. This battery is the standard type of CR 2032 coin-cell.

When used for the first time, the battery protection insulation plastics needs to be manually removed to activate the battery.

Figure 12. Battery Tray



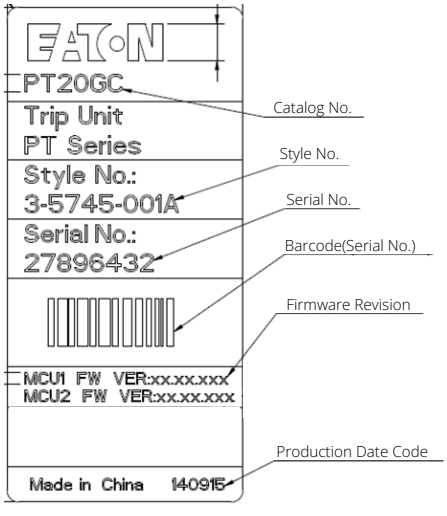
3.10 In Ratings

This legend shows the In rating of the breaker. It is also shown on the lower left corner of the display (PT20/25 style).

3.11 Side Labels

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

Figure 13. Typical PT Trip Unit Side Label



4. PT Protection Settings

The PT unit protection settings are designed to be 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 the Navigation buttons below the display (for PT20/25 style) or using rotary switches on the front of the trip unit (for PT10 style).

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 PT 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 (In). 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,

- For PT10, the "LONG" indicator will blink.
- For PT20/25, the "LONG" indicator will blink. The "LONG DELAY" message will be displayed if auxiliary power is present.

4.1.1 Long Delay Slope Selection

The I^2t settings 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. The PT 10 only support I^2t.

- $I^{0.5}t$ - 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 type 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 by the trip unit. This protects load circuits from the effects of repeated overload conditions. LTM is configured using the display and Navigation buttons or using the Power TRIP 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 (Ir), 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. It is recommended to disable the LTM in certain applications and field tests.

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 I2 t. There are six settings for the flat curve of PT10, ranging from 0.05 seconds (minimum time) to 0.5 seconds, and four settings for the I^2t inverse time curve, ranging from 0.1 seconds (minimum time) to 0.5 seconds.

The I^2t inverse time 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,

- For PT10, the "SHORT" indicator will blink.
- For PT20/25, the "SHORT" indicator will blink.

The "SHORT DELAY" 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 Settin

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

If a circuit breaker trips instantaneously,

- For PT10, the "INST" indicator will blink.
- For PT20/25, the "INST" indicator will blink. The "INST TRIP" message will be displayed if auxiliary power is present.

4.4 Ground Fault Settings

When the 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 PT 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. A trip unit can be set to alarm, trip or OFF for a ground fault.

1.The ground detection may be turned off by setting the rotary switch to "OFF"

2.With the alarm-only selection, four pickup levels are available. This set of pickup levels is labeled "Alarm".

3.The ground fault detection with an action of trip may also be selected. With detect and trip selection, this set of pickup levels is labeled "Trip".

If a ground fault causes the circuit breaker to trip,

- For PT10, the "GND" indicator will blink.
- For PT20/25, the "GND" indicator will blink.

The "GND TRIP" message will be displayed if auxiliary power is present.

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 PT unit provides selection for two different ground fault slopes: a fixed time (flat) or I^2t inverse time 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 I_n than the fixed time (flat) response.

PT10

The time delay and slope are selected on the corresponding rotary switch (PT10 rotary switch type). 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.

PT20/25

For PT20/25 units, Navigation buttons below the display can be used to make selections on the display.

4.4.3 Ground Fault Thermal Memory

In addition to standard ground fault protection, the PT 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 ground fault may not trip the circuit breaker. With the ground fault memory function, the trip unit "remembers" the sputtering ground current. The time delay due to 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.

- The thermal memory function can be enabled or disabled on PT20/25 using the display and navigation buttons or by using the PTM software.
- The thermal memory function can be enabled or disabled on PT10 using the PTM software.

4.4.4 Ground Fault Relay

If the Ground Fault Alarm option is selected on the LSIG 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 activate an alarm relay upon the conditions if auxiliary power is present and the PT25 trip unit is selected with the corresponding relay configured for the ground fault alarm option. 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 activate when the circuit breaker has tripped on a ground fault. You must then push the "RESET" button in order to reset the relay contact.

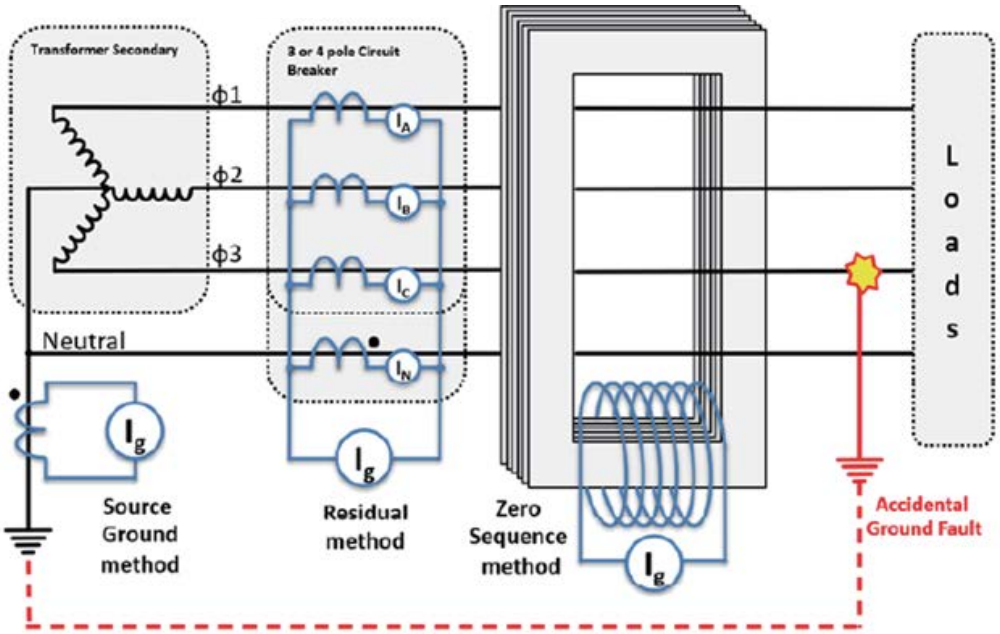
4.5 Ground Fault Sensing

The PT unit provides for three modes of sensing to detect ground fault currents: Residual, Source Ground, and Zero Sequence. More detailed descriptions, refer to the ground methods in Figure 14 below.

The ground sensing mode (Residual or Source/Zero Seq) is selected using the display and navigation buttons or by using the PTM software.

Neutral protection is provided independent of the Ground Fault function.

Figure 14. Grounding Method Desc



4.5.1 Residual Current Ground

Residual current sensing is the standard mode of ground fault sensing in Series PT units. 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 vector outputs of the three or four individual current sensors. If the sum is zero, then no ground fault exists. Residual current 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.

An external current sensor is required when a 3-pole circuit breaker performs residual current sensing.

- The ground pickup current is a multiple of the corresponding current when the rated current is less than 1200A.
- The ground pickup current is a multiple of 1200 (maximum by NEC) when the rated current is greater than or equal to 1200A.

Table 6. Residual Current Ground Settings

Settings	PT20/25	Adjustment range: 0.2 – 1.0 with 0.01 interval				
Rated current In	PT10	0.2	0.4	0.6	0.8	1.0
< 1200A	Ig=	0.2x(I_n)	0.4x(I_n)	0.6x(I_n)	0.8x(I_n)	1.0x(I_n)
>= 1200A	Ig=	0.2x1200	480	720	960	1200

4.5.2 Source and Zero Sequence Ground

The current sensor (4000:1) signal on the ground wire of the source ground receiving device directly measures the total ground current flowing through the ground conductor. When the current measured by the trip exceeds the ground fault setting, the circuit breaker will trip or alarm.

The ground circuit sensing method is usually applied when the main circuit breaker is used for a simple one-way power system. This method is also applicable to double-ended systems where a mid-point grounding electrode is employed.

This protection feature can be enabled by setting the ground fault type.

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

The Zero-sequence sensing method uses a single sensor that contains all phase and neutral wires in a four-wire system. If a ground fault occurs, the vector sum of all magnetic fields will not be zero, and the sensor will produce an output signal equivalent to the current flowing to ground. When the current measured by the trip unit exceeds the time delay ground fault setting, the circuit breaker trips or alarms.

The sensors used in both sensing methods are iron-core CTs, connected to frame secondary wiring terminals G1 and G2. The sensor ratio must be adapted to the trip device of 4000:1A.

Note: The starting current for both the return source ground and zero sequence ground are multiples of 400.

Table 7. Source and Zero Sequence Current Ground Settings

PT20/25	Adjustable range: 0.2~1.0, with interval of 0.01				
PT10	**0.2**	**0.4**	**0.6**	**0.8**	**1.0**
Ig=	0.2x400	160	240	320	400

4.6 Advanced Protections (PT25 only, unless specified elsewhere)

The PT25 provides a set of advanced protection features that can be configured to OFF (by default), Alarm or Trip.

Refer to Table 3 for the adjustment range and interval of the pickup and time delay parameters of the following advanced protection features.

4.6.1 Over-Voltage

The trip unit continuously monitors the line voltage rms values (VAB, VBC, VCA). If the line voltage at any phase is greater than the over-voltage setting, and the corresponding delay time setting is exceeded, the trip unit will act (OFF, Alarm or Trip).

4.6.2 Under-Voltage

If the line voltage at any phase is lower than the under-voltage setting, and the corresponding delay time setting is exceeded, the trip unit will act.

Note: If both over-voltage and under-voltage protection are enabled, the under-voltage setting should always be lower than the over-voltage setting.

4.6.3 Phase Sequence Protection

The phase sequence protection can be set to positive sequence (A-B-C), or negative (A-C-B) sequence action. When the phase sequence of the three phase voltages is the same as the setting, the trip unit will act.

Note: When the phase voltages at all three phases are greater than 100V, phase sequence metering will be activated.

4.6.4 Demand Protection

Current demand protection (PT20/25).

Current demand protection is a type of current protection mechanism for each phase. Different thresholds can be set for different phases (independent from each other), and the same time delay parameters are used for all three phases.

When the current of any of the three phases is greater than the protection threshold of that phase and the corresponding time delay setting is reached, the trip unit will act.

Power demand protection.

When the detected active power is greater than the defined power demand setting, and the corresponding time delay setting is reached, the trip device will act.

4.6.5 Frequency Protection

Over-frequency protection

When the frequency detected by the trip unit exceeds the over-frequency setting, and the corresponding time delay setting is exceeded, the trip device will act.

Under-frequency protection

If the frequency detected by the trip unit is lower than the under-frequency setting and the corresponding time delay setting is exceeded, the trip unit will act.

Note: When Phase A's phase voltage is greater than 100V, the frequency protection will be activated.

4.6.6 Voltage Unbalance

If the difference between the maximum and minimum values of the line voltage in three phases is greater than the voltage unbalance's voltage setting, and the corresponding time delay setting is exceeded, the trip unit will act.

Note: Voltage unbalance protection is effective only when the line voltage in at least one phase is greater than 84V.

The voltage unbalance protection is calculated as follows:

$$\frac{Max(Vab,Vbc,Vca)- Min(Vab,Vbc.Vca)}{Max(Vab,Vbc,Vca)} \times 100\%$$

4.6.7 Current Unbalance (PT20/25)

The trip unit continuously monitors the rms current value of each item (Ia, Ib, Ic). Unbalance protection prevents partial or complete absence of current in one or two phases. If the difference between the maximum and minimum values of the three-phase current is greater than the current unbalance's current setting, and the corresponding time delay setting is exceeded, the trip unit will act.

Note: Current unbalance protection is effective only when at least one phase current is greater than 50% of the Long Delay Pickup (LDPU or I_r) value.

The current unbalance and phase loss protection is calculated as follows:

$$\frac{Max(Ia,Ib,Ic)-Min(Ia.Ib.Ic)}{Max(Ia,Ib,Ic)} \times 100\%$$

4.6.8 Phase Loss Protection (PT20/25)

Phase loss protection is used in case of complete absence of one or two phases. If the difference between the maximum and minimum current values in the three phases is greater than 75% of the maximum current value, and the corresponding time delay setting is exceeded, the trip unit will act.

Note: Phase loss protection is effective only when at least one phase current is greater than 50% of the Long Delay Pickup (LDPU or I_r) value.

4.6.9 Reverse Power

The trip unit monitors the power value in real time. When the reverse active power exceeds the set value, and the set time delay is exceeded, the trip unit will take the corresponding action (Alarm or Open) when the function is enabled.

4.7 High Instantaneous Protection

The PT unit provides a high instantaneous trip function that will trip the circuit breaker at the withstand current rating of the circuit breaker. This function is factory set within the frame module and reacts to the peak current. 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 IZM6 frame modules have an High Instantaneous trip feature.

4.8 Making Current Release (MCR)

All PT 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 blink.

This non-adjustable trip function is subject to the circuit breaker's frame. Refer to time current curves for specific values.

4.9 Zone Selective Interlocking (ZSI)

The Zone Selective Interlocking (ZSI) function is provided only on PT25 trip units and can be enabled or disabled through the menu system or Power Trip Protection Manager software. The ZSI functions in conjunction with the Short Delay and Ground Fault protection functions. The 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 breaker).

When the 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). The restraining 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 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 AP02602002SC for detailed description and examples.

4.10 Event Recording and Waveform Capture

The PT 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, for example, storing waveforms of current and voltage experienced during the event.

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

4.11 Circuit Breaker Health Diagnosis

The PT unit includes an algorithm to monitor the health of the circuit breaker. The parameters monitored by the algorithm include short circuit, overload, operation, temperature, and operating time. The combination of all these parameters provides an overall picture of the circuit breaker condition and can be used for preventive maintenance and improved system reliability. This health monitoring algorithm is a tool and cannot be used to replace established circuit breaker maintenance or replacement.

The health monitor feature consists of index that track the cumulative service performed by the circuit breaker. The index starts from zero and increases to 10,000 points depending on the conditions under which the circuit breaker operates. The index remains in the frame module of the circuit breaker. Changing the trip unit does not change the accumulated points.

The health of the circuit breaker is represented by the health percentage calculated by the index. A new circuit breaker reports 100% health corresponding to 100% remaining service life.

The health alarm threshold ranges from 0% to 50%, with the adjustable step of 1%. The health values can be viewed through the PTM software. These values can also be viewed on the screen for PT20/25 devices.

Note:
The health percentage can be mapped to a configurable relay.

Circuit breakers that operate under normal conditions and report a health percentage of less than 100% have a cumulative service life within their normal service life. Regular maintenance should be carried out during this period, and if there are no signs of abnormal or excessive wear, damage or adverse environment, the circuit breaker is considered suitable for continued use. When the health percentage approaches zero, the circuit breaker should be carefully evaluated to determine its suitability for continued use. Based on the accumulated usage history, the circuit breaker may reach the end of its normal service life and should be carefully inspected to determine the required operation. It is best practice to plan the replacement of circuit breakers based on the condition of the circuit breaker, the maintenance performed, and your site-specific maintenance guidelines and standards.

4.11.1 Event and Log Matrix

Table 8. 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	10	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 completed	●						
Event – Opened by communications	●						With CAM supported module, closing release and shunt release
Event – Closed by communications	●						
Event – Time change (if >60 seconds)	●						Previous time is recorded
Alarm – Calibration	●	●					
Alarm – Setpoints fault	●	●					
Alarm – Battery low voltage	●	●					
Alarm – Control voltage low	●	●					
Alarm – Clock error	●	●					
Alarm – Memory error	●	●					
Alarm – Watchdog timer	●	●					
Alarm – Long delay pickup (test mode)	●	●					
Alarm – Ground fault (test mode)	●	●					
Alarm – Trip actuator (TA) fault	●	●					
Alarm - Operations count	●	●					
Alarm – Long delay pickup	●	●			●		
Alarm – Ground fault	●	●			●		
Alarm - Mechanism error	●	●			●		
Alarm – High load	●	●			●		
Trip – Over temperature	●		●				
Trip – Making current release (MCR)	●		●				
Trip – Test	●		●				
Trip – Long delay	●		●			●	
Trip – Short delay	●		●			●	
Trip – Instantaneous	●		●			●	
Trip – Ground	●		●			●	
Trip - Neutral	●		●			●	

Table 9. 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 (PT25 only) Power: Watts, Vars, VA (PT25 only) Demand: Watts, Vars, VA (PT25 only) Temperature Frequency (PT25 only) Power factor (PT25 only) Operations count
User Waveform or Alarm Waveform	Waveform of: IA, IB, IC, IN, IG Waveform of: VAB, VBC, VCA, VAN, VBN, VCN (PT 25 only) 1 cycle (64 data points)
Trip Waveform	Waveform: IA, IB, IC, IN, IG Waveform of: VAB, VBC, VCA, VAN, VBN, VCN (PT 25 only) 10 cycles (6400 data points)

5. Relay and Digital Input (PT25 only)

5.1 Relay Configuration

There are 3 relay modules integrated in the PT25 frame module which are used to indicate status information to other systems. Refer to Section 8 to know details about relay connections on the terminal block. Note that relays require auxiliary power to operate. The relays are rated at 6A and 250Vac, so please pay attention to release parameters when in use with the shunt release and closing release for remote control.

The relays can be configured to conditions in below table. Configuration is conveniently done using Power Trip Protection Manager software. Pick-up levels for High Load 1 Alarm, High Load 2 Alarm, Ground Fault Early Warning and Thermal Memory Alarm are also adjustable. The software is available as a download from the following link: **www.eaton.com.cn/PTM**.

	Description of relay operation	
Function name	**"The relay will close when..."**	**"The relay will open when ...."**
Overload Trip	there is a Long or Over-temperature trip	RESET button is pressed or communications reset command received
Neutral Trip	there is a Neutral Current trip	RESET button is pressed or communications reset command received
Short Delay Trip	there is a Short Delay trip	RESET button is pressed or communications reset command received
Instantaneous Trip	there is an Instantaneous trip or MCR trip	RESET button is pressed or communications reset command received
Short Circuit Trip	there is a Short, Inst or High Inst trip	RESET button is pressed or communications reset command received
Ground Fault Trip	there is a Ground Fault trip	RESET button is pressed or communications reset command received
All Trips	any of protective trip (Overload, Neutral, Short Delay, Instantaneous, Ground)	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 I_r)	current flow falls 5% below the set point
High Load 2	current flow is greater than set point (adjustable from 50% to 120% of I_r)	current flow falls 5% below the set point
Over Temperature Alarm	temperature exceeds 5 below the level of the temperature trip setting	temperature falls 5°C below the setting
Ground Fault Early Warning	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 detected 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 configuration	RESET button is pressed or communications reset command received
Breaker Health Alarm	the health value is at or above the set point	the health value is below the set point
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
Trip Contact	breaker is tripped	breaker is not tripped (it is open or closed)
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

	Description of relay operation	
Function name	**"The relay will close when..."**	**"The relay will open when ...."**
Mechanical Fault Trip	a mechanical fault occurs and is disengaged, the mechanism position is in the open position, but there is measurable current	the fault is removed
Mechanical Fault Alarm	a mechanism fault alarm occurs (TA fault, mechanism open, but there is measurable current)	Relevant fault is removed
Electrical Fault Alarm	electrical fault (configuration reading errors, clock faults, watchdog faults, breaker health alarm) alarm has occurred	Relevant fault is removed
Over-voltage Trip	over-voltage trip is active and over-voltage trip has occurred	RESET button is pressed or communications reset command received
Over-voltage Alarm	over-voltage alarm is active and over-voltage alarm has occurred	RESET button is pressed or communications reset command received
Under-voltage Trip	under-voltage trip is active and under-voltage trip has occurred	RESET button is pressed or communications reset command received
Under-voltage Alarm	under-voltage alarm is active and under-voltage alarm has occurred	RESET button is pressed or communications reset command received
Over-frequency Trip	over-frequency trip is active and over-frequency trip has occurred	RESET button is pressed or communications reset command received
Over-frequency Alarm	over-frequency alarm is active and over-frequency alarm has occurred	RESET button is pressed or communications reset command received
Under-frequency Trip	under-frequency trip is active and under-frequency trip has occurred	RESET button is pressed or communications reset command received
Under-frequency Alarm	under-frequency alarm is active and under-frequency alarm has occurred	RESET button is pressed or communications reset command received
Voltage Unbalance Trip	voltage unbalance trip is active and voltage unbalance trip has occurred	RESET button is pressed or communications reset command received
Voltage Unbalance Alarm	voltage unbalance alarm is active and voltage unbalance alarm has occurred	RESET button is pressed or communications reset command received
Current Unbalance Trip	current unbalance trip is active and current unbalance trip has occurred	RESET button is pressed or communications reset command received
Current Unbalance Alarm	current unbalance alarm is active and current unbalance alarm has occurred	RESET button is pressed or communications reset command received
Reverse Power Trip	reverse power trip is active and reverse power trip has occurred	RESET button is pressed or communications reset command received
Reverse Power Alarm	reverse power alarm is active and reverse power alarm has occurred	RESET button is pressed or communications reset command received
Phase Sequence Trip	phase sequence trip is active and phase sequence trip has occurred	RESET button is pressed or communications reset command received
Phase Sequence Alarm	phase sequence alarm is active and phase sequence alarm has occurred	RESET button is pressed or communications reset command received
Phase Loss Trip	phase loss trip is active and phase loss trip has occurred	RESET button is pressed or communications reset command received
Phase Loss Alarm	phase loss alarm is active and phase loss alarm has occurred	RESET button is pressed or communications reset command received
Power Demand Trip	power demand trip is active and power demand trip has occurred	RESET button is pressed or communications reset command received
Power Demand Alarm	power demand alarm is active and power demand alarm has occurred	RESET button is pressed or communications reset command received
OFF	relay is disabled	relay is disabled

5.2 Digital Input (DI)

The PT25 trip unit supports 2 sets of 220VAC digital inputs. The corresponding status value will be written upon receiving external 220VAC signal inputs. The status value can be read via Modbus communication or through the PTM software.

6. PT Communication Features

6.1 Integrated Modbus-Remote Terminal Unit (RTU) Port

A Modbus communication port is integrated into the PT20/25 trip unit. 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 Trip Protection Manager software (See Section 7.2)

Table 10. Factory Defaults

	Factory Default	Options
Slave address	001	001 to 247
Baud Rate	9600	9600, 19,200, 38,400, 57,600
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 PT series includes a micro-B USB port on the front of the trip unit. This USB connection may be used in conjunction with the Power Trip Protection Manager software to configure, control, and test the trip unit.

The USB can be used to supply power to the trip unit, change and save relevant settings.

7. Important System Components

7.1 Auxiliary Power

Providing auxiliary power to the PT 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 sensor 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 required to provide protection feature.

7.2 Power Trip Protection Manager (PTM) Configuration Software

Eaton's PTM is a Windows-based software that configures, controls, and tests Eaton PT 10/20/25 trip units. The user can create, modify, and save setting configurations for PT 10/20/25 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.cn/PTM**

8. Secondary Wiring Terminals Associated with the PT Trip Unit

Refer to the catalogue's secondary wiring terminals for all terminal number definitions.

Table 11. PT Secondary Terminal Block Features

Associated Feature	Name	Notes
Auxiliary Power	Us + Us -	+24V auxiliary power port
220VAC Digital Input	DI1 DI2 DIC	2 sets of 220VAC digital inputs, and support reading external 220VAC signal input via communication
Programmable Relay Output①	RELAY1 RELAY2 RELAY3 RELAYC	Normally Open (NO) contacts Rated at 6A, 250Vac/30Vdc Relays can be configured to operate under different conditions; refer to the relevant content for details. RELAYC is common connection
Neutral Sensor	N1, N2	Only available on 3-Pole circuit breakers; See Section 4.5.1
Ground Sensor – Source Ground or Zero Sequence Sensing	G1, G2	See Section 4.5.2
Voltage Metering Input	Ua Ub Uc Un	690VAC (L-L) and below Directly connected from the secondary terminal
Zone Selective Interlock (ZSI)	ZIN ZOUT ZCOM	Eaton 5V ZSI system Inter-connected to Eaton 5V ZSI enabled breakers in the system.
Modbus RTU	MODBA MODBB MODBG	Recommended Modbus cable has twisted-pair shield wires

①These relays can be reconfigured based on the factory default settings shown here. See Section 5: Relay Configuration.

9. Testing the Trip Unit and Circuit Breaker

Testing shall be accomplished before the circuit breaker's main circuit is energized, with the drawout circuit breaker either in TEST or DISCONNECTED cassette position or WITHDRAWN from the cassette.

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 values.

⚠ 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 cassette 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. Such operation requires the connection to auxiliary power.

9.2 Simulated Current Testing (Remote) via USB/PTM Configuration Software

The PTM software or USB communication is used to simulate testing of long delay trip, short delay trip, instantaneous trip, and ground (earth) fault trip. 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 PTM software, the test mode allows the user to enter a current to be injected, initiate the test, observe operation, and record the results.

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

9.3 Testing for Ground Fault Trip Units

9.3.1 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 instructions provided with the equipment. Make a written record of this test and make the results available to the authority having inspection jurisdiction.

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

9.3.2 Test Instructions

The wiring 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 specified 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 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 supplied) should not operate.

Repeat the test on the other two phases.

10. Maintenance of the PT Trip Unit

The trip unit itself requires no maintenance.

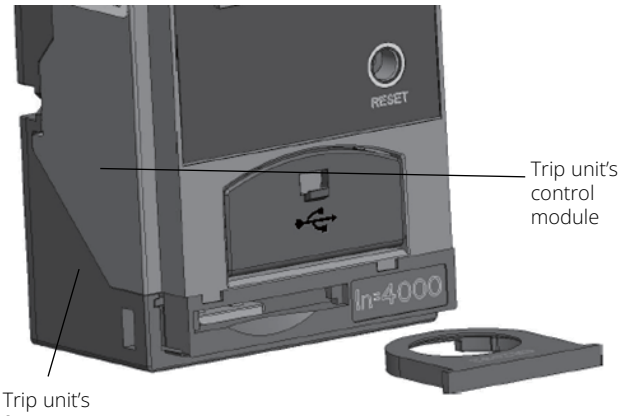
10.1 Replacing the Battery

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 out the battery tray for removal, then remove and discard the insulating tab, and re-insert the battery tray.

The 3 V button cell battery (CR 2032) is easily removed and replaced; pull out remove the battery tray for removal, remove the old battery from the holder, replace it 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. 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 15. Replacing the Battery



⚠ CAUTION

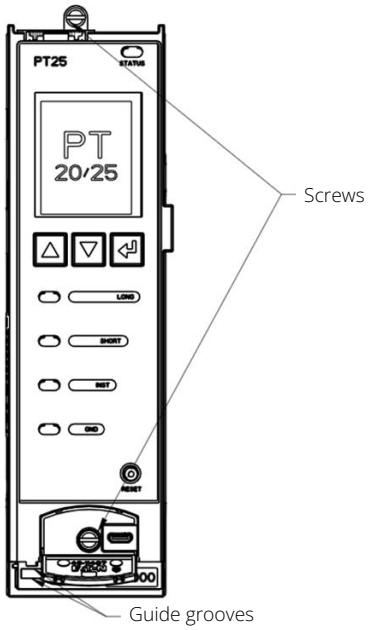
Exercise care when replacing the battery to ensure that it is installed correctly. Accidentally installing the battery in the reverse direction will not harm the trip unit nor the battery but will defeat the function of the battery.

10.2 Replacing the Trip Unit

The PT unit is designed as a field replaceable unit.

- Remove the circuit breaker front cover.
- Remove the trip unit harness from the top of the trip unit.
- Loosen the top and bottom screws using a screwdriver. Note that the bottom screw is located on the left side of the USB port and is covered by a door.
- Pull the trip unit's control module outward for removal.

Figure 16. Location of the Top and Bottom Trip Unit Screws



To install a new trip unit:

- First, connect the wiring harness at the top of the trip unit's control module (such harness is not available for certain trip unit styles).
- Align the trip unit's control module with the guide grooves of the frame module and press it down.
- Connect the control module tightly to the frame module of the trip unit, until the trip unit seats firmly in the housing.
- Secure the trip unit with the mounting screws using a screwdriver, with the maximum screw torque of 1.0N· 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 PTM software also provides printable copies of configuration and test results. If desired, make a copy and attach it to the side of the circuit breaker's cassette or another visible location. This information should be used and maintained by the responsible personnel.

Table 12. The PT Trip Unit Reference Information and Protection Settings.

PT 20/25 Trip Unit – Trip Function Settings

Circuit Breaker No./Location: **Circuit Breaker Order Reference:**

Amperes Rating (I_n): **Continuous Ampere Rating (I_r)**

Protection Settings (Circle the Selected Value)													
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	0.2	0.3	0.5	t_{sd}	sec
		Flat						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
						I^2t							

Protection Settings (Circle the Selected Value)						
	Default					
Language	English	Chinese				
Communication	No CAMS	Modbus Port				
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 Direction	Forward	Reverse				
ZSI	OFF	ON				

Appendix A - Modbus Communication Port Setting

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(16), MODBB(17), and MODBG(18) as a slave device. Recommended Modbus cable has shielded twisted-pair wires.

A.1 Viewing/Setting Modbus Setpoints

Modbus configuration can be viewed and set from the LCD display, using the PTM 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

Defintion	Modbus Register No.	Register Address (HEX)	Date Range
Slave ID	404000	0x0F9F	001 - 247
Baud rate	404001	0x0FA0	00 = 9600 bits/s 01 = 19200 bits/s 02 = 38400 bits/s 03 = 57600 bits/s
Parity check	404002	0x0FA1	00 = None 01 = Odd 02 = Even
Stop bit	404003	0x0FA2	00 = 1 bit 01 = 2 bits

A.2 Network Communication Protocol

The trip unit operates only via the Modbus RTU communication mode.

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 codes 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 can be read using function code 02. The status definitions are defined in Table A2. The first 16 bits are the actual status state while the last 16 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	0
1006	Test mode is active
1007	0
1008	0
1009	0
1010	Long Delay Pickup is active
1011	Zone Selective Interlock (ZSI) 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	0
1022	Test mode is active is valid
1023	0
1024	0
1025	0
1026	Long Delay Pickup is active is valid
1027	Zone Selective Interlock (ZSI) 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 Data Factor
404609	406145	1200	1800	Status cause: 404609 and 406415 high byte is primary status, shown in Table A14. 404609 and 406415 low byte is secondary status, shown in Table A15. 404610 and 406416 are cause-of-status, shown in Table A16.		
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
404835	406371	12E2	18E2	Phase A current demand	A	1
404837	406373	12E4	18E4	Phase B current demand	A	1
404839	406375	12E6	18E6	Phase C current demand	A	1
404843	406379	12EA	18EA	Phase N current demand	A	1
404845	406381	12EC	18EC	Real power demand	W	1

Table A3. Real Time Data

Register Number.		Register Addresses (HEX)		Objects		
IEEE Float	Fixed Point (FP)	IEEE Float	Fixed Point (FP)	Descriptions	Units	FP Data Factor
404847	406383	12EE	18EE	Reactive power demand	VAR	1
404849	406385	12F0	18F0	Apparent power demand	VA	1
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
404903	406439	1326	1926	Minimum power factor		10
404905	406441	1328	1928	Maximum power factor		10
404907	406443	132A	122A	Minimum frequency		10
404909	406445	132C	192C	Maximum frequency		10
404911	406447	132E	192E	Current unbalance		100
404913	406449	1330	1930	Voltage unbalance		100
404937	406473	1348	1948	Phase A current crest factor		100
404939	406475	134A	194A	Phase B current crest factor		100
404941	407477	134C	194C	Phase C current crest factor		100
404945	406481	1350	1950	Phase N current crest factor		100
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

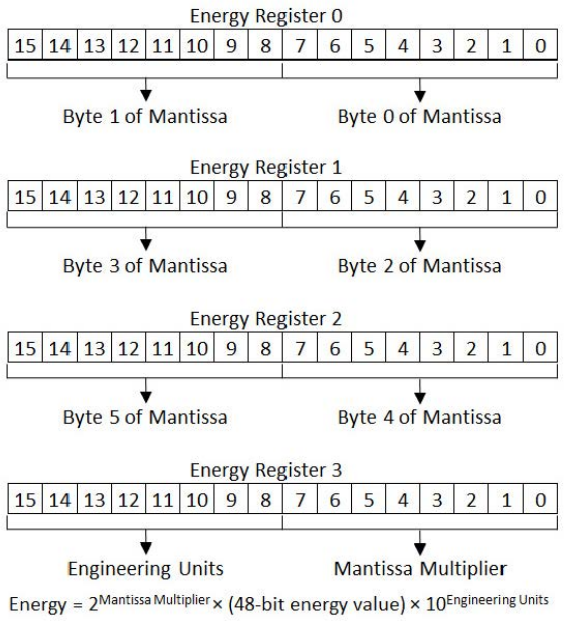
Table A3. Real Time Data

Register Number.		Register Addresses (HEX)		Objects		
IEEE Float	Fixed Point (FP)	IEEE Float	Fixed Point (FP)	Descriptions	Units	FP Data Factor
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	℃	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	Breaker health life point		1

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 a R/W register used to select the particular group. The high byte contains the requested group number, while the low byte must contain 255 (FFW). 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.

Group 0 is the system group, listed in Table A4. Group 1 and 5 are the protection groups, listed in Table A5.

Table A4. Setpoints Group 0: System Group

Register	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 Plug	R	Encoded	IZM61: 200A,400A,630A,800A,1000A,1250A,1600A IZM65: 400 A, 630 A, 800 A, 1000 A,1250 A, 1600 A, 2000 A, 2500 A IZM67: 2000 A, 2500 A,3200 A, 4000 A
403003	2-0	0x0007	Break Frame	R	Encoded	06 = IZM61 07 = IZM 65 08 = IZM 67
403004	4-0	0x000F	Style	R	Encoded	PT10 = 16 PT10G = 17 PT20 = 18 PT20G = 19 PT20C = 20 PT20GC = 21 PT25 = 22 PT25G = 23
403005			Style 2	R		Invalid
403006	0	0	Invalid	R		Invalid
403007	0	0	Invalid	R		Invalid
403008			Frequency	R	Unsigned	Range: 50, 60
403009	0	0x0001	Reverse Feed	R/W	Encoded	0 = Forward
						1 = Reverse
403010	1	0x003	Sign Convention		Encoded	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
403015	7-0	0x00FF	Relay 1 Configuration	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 = All trips 8 = High load alarm 1 9 = High load alarm 2 10 = Over temperature trip

Table A4. Setpoints Group 0: System Group (continued)

Register	Bit Field	Mask Field	Setpoint Name	R/W	Format	Value Definition
403015	7-0	0x00FF	Relay Configuration 1	R/W	Encoded	11 = Ground fault alarm 12 = Ground fault early warning 13 = Thermal memory alarm 14 = Watchdog fault 15 = Low battery 16 = Internal (hardware) fault 17 = Setpoint mismatch 18 = Breaker health low 19 = Communication fault 20 = All faults 21 = Auxiliary contact 22 = Bell contact 23 = ZSI active 24 = ZSI input 25 = ZSI output 26 = Open breaker pulse 27 = Close breaker pulse 28 = Remote control 29 = Mechanical fault trip 30 = Mechanical fault alarm 31 = Electrical fault alarm 32 = Over-voltage trip 33 = Over-voltage alarm 34 = Under-voltage trip 35 = Under-voltage alarm 36 = Over-frequency trip 37 = Under-frequency trip 38 = Over frequency alarm 39 = Under frequency alarm 40 = Voltage unbalance trip 41 = Voltage unbalance alarm 42 = Current unbalance trip 43 = Current unbalance alarm 45 = Reverse power protection alarm 46 = Phase sequence protection trip 47 = Phase sequence protection alarm 48 = Phase loss protection trip 49 = Phase loss protection alarm 50 = Power demand protection trip 51 = Power demand protection alarm 52 = AQD early warning
403016	7-0	0x00FF	Relay 2 Configuration	R/W	Encoded	See Relay 1 Configuration
403017	7-0	0x00FF	Relay 3 Configuration	R/W	Encoded	See Relay 1 Configuration
403018	0	0	Invalid	R		

Table A4. Setpoints Group 0: System Group (continued)

Register	Bit Field	Mask Field	Setpoint Name	R/W	Format	Value Definition
403019	0	0x0001	Demand Window Setpoint	R/W	Encoded	0 = Fixed 1 = Sliding
403020	7-0	0x00FF	Demand Interval	R/W		Unit: Minute (5 to 60 minutes)
403021	7-0	0x00FF	Breaker Health Alarm Threshold	R/W		Unit: Percentage (50 to 100)
403022	11-0	0x0FFF	System Voltage	R/W		Unit: Volt (208 to 690)
403023	0	0x0001	Neutral Transformer Style	R	Encoded	0 = Rogowski coil 1 = Current sensor
403024	0	0x0001	Ground Sensor Style	R	Encoded	0 = Rogowski coil 1 = Current sensor

Table A5. Setpoints Group 1: Protection Group.

Register	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 1 = Protection	R/W		0x01FF
403002	15-0	0xFFFF	Rating Information	R		IZM61: 200A,400A,630A,800A,1000A,1250A,1600A IZM65: 400 A, 630 A, 800 A, 1000 A,1250 A, 1600 A, 2000 A, 2500 A IZM67: 2000 A, 2500 A,3200 A, 4000 A
403003	2-0	0x007	Breaker Frame	R	Encoded	06 = IZM61 07 = IZM 65 08 = IZM 67
403004	3-0	0xFFFF	Style	R	Encoded	PT10 = 16 PT10G = 17 PT20 = 18 PT20G = 19 PT20C = 20 PT20GC = 21 PT25 = 22 PT25G = 23
403005			Style 2	R		Invalid
403006	0	0x001	Thermal Memory	R/W	Encoded	0 = Disabled 1 = Enabled
403007	0	0x001	ZSI	R/W	Encoded	0 = Disabled 1 = Enabled
403008	1-0	0x003	Curve Slope	R/W	Encoded	0 = $I^{0.5}t$ 1 = It 2 = I^2t 3 = I^4t
403009	6-0	0x007F	Long Delay Pickup (I_r)	R/W	Unsigned	40 ~100, step is 1 (indicating 0.40 I_n~1.00 I_n)
403010	7-0	0x00FF	Long Delay Time (t_r)	R/W	Unsigned	5~240, step is 1 (indicating 0.5s to 24s)
403011	6-0	0x007F	High Load Alarm 1	R/W	Unsigned	0: OFF 50<=High load alarm 1< High load alarm 2<=120 (%)
403012	0	0x0001	Short Delay Slope	R/W	Encoded	0 = Flat 1 = I^2t
403013	7-0	0x00FF	Short Delay Pickup (I_{sd})	R/W	Unsigned	15 ~100, step is 1 (indicating 1.5 I_r ~ 10.0 I_r)
403014	7-0	0x00FF	Short Delay Time (t_{sd})	R/W	Unsigned	Flat 5~50, step is 1 (indicating 0.05s to 0.50s) I^2t 10~50, step is 1 (indicating 0.10s to 0.50s)
403014			LCD Rotation	R		Invalid
403015	7-0	0x00FF	Instantaneous Pickup (L_i)	R/W	Unsigned	0 = OFF 20~150, step is 1 (indicating 2.0I_n~15.0I_n)
403016	0	0x0001	Ground Type	R/W	Encoded	0 = Residual 1 = Source/Zero
403017	0-1	0x0003	Ground Feature	R/W	Encoded	0 = Trip 1 = Alarm 2 = OFF
403018	0	0x0001	Ground Slope	R/W	Encoded	0 = Flat 1 = I^2t

Table A5. Setpoints Group 1: Protection Group. (continued)

Register	Bit Field	Mask Field	Setpoint Name	R/W	Format	Value Definition
403019	7-0	0x00FF	Ground Pickup (I_g)	R/W	Unsigned	0 = OFF 20~100, step is 1 (indicating $0.20I_n$~$1.00I_n$)
403020	7-0	0x00FF	Ground Time (t_g)	R/W	Unsigned	10~50, step is 1 (indicating 0.10~0.50 second)
403021	0	0x0001	Ground Fault Thermal memory	R/W	Encoded	0 = Disabled 1 = Enabled
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	Unsigned	0: OFF 50<=High load alarm 1< High load alarm 2<=120 (%)
403024	6-0	0x007F	Ground Fault Early Warning	R/W	Unsigned	50~100, step is 1 (indicating 50%~100%)
403025	6-0	0x007F	Thermal Memory Alarm Threshold Setting	R/W	Unsigned	50~100, step is 1 (indicating 50%~100%)

Table A5. Setpoints Group 5: Protection Group.

Register	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 5 = Protection	R/W		0x05FF
403002	2-0	0x000F	Over-Voltage Protection Setting	R/W	Encoded	0 Trip 1 Alarm 2 OFF
403003	11-0	0x0FFF	Over-Voltage Protection Threshold Setting	R/W	Unsigned	180~720, step is 1 (Unit: V)
403004	11-0	0x0FFF	Over-Voltage Protection Time Setting	R/W	Unsigned	1~300, step is 1 (Unit: seconds)
403005	2-0	0x000F	Under-Voltage Protection Setting	R/W	Encoded	0 Trip 1 Alarm 2 OFF
403006	11-0	0x0FFF	Under-Voltage Protection Threshold Setting	R/W	Unsigned	60~670, step is 1 (Unit: V)
403007	11-0	0x0FFF	Under-Voltage Protection Time Setting	R/W	Unsigned	1~300, step is 1 (Unit: Seconds)
403008	2-0	0x000F	Voltage Unbalance Protection Setting	R/W	Encoded	0 Trip 1 Alarm 2 OFF
403009	7-0	0x00FF	Voltage Unbalance Protection Threshold Setting	R/W	Unsigned	5~25, step is 1 (Unit: %)
403010	11-0	0x0FFF	Voltage Unbalance Protection Time Setting	R/W	Unsigned	1~300, step is 1 (Unit: Seconds)
403011	2-0	0x000F	Current Unbalance Protection Setting	R/W	Encoded	0 Trip 1 Alarm 2 OFF
403012	7-0	0x00FF	Current Unbalance Protection Threshold Setting	R/W	Unsigned	5~25, step is 1 (Unit: %)
403013	11-0	0x0FFF	Current Unbalance Protection Time Setting	R/W	Unsigned	1~300, step is 1 (Unit: Seconds)
403014	2-0	0x000F	Reverse Power Protection Setting	R/W	Encoded	0 Trip 1 Alarm 2 OFF
403015	15-0	0xFFFF	Reverse Power Protection Threshold Setting	R/W	Unsigned	1~65500, step is 1 (Unit: kW)
403016	11-0	0x0FFF	Reverse Power Protection Time Setting	R/W	Unsigned	1~300, step is 1 (Unit: Seconds)
403017	0	0x0000	Invalid	R		
403018	0	0x0000	Invalid	R		
403019	2-0	0x000F	Phase Loss Protection Setting	R/W	Encoded	0 Trip 1 Alarm 2 OFF
403020	11-0	0x0FFF	Phase Loss Protection Time Setting	R/W	Unsigned	1~240, step is 1 (Unit: Seconds)
403021	2-0	0x000F	Over-Frequency Protection Setting	R/W	Encoded	0 Trip 1 Alarm 2 OFF
403022	11-0	0x0FFF	Over-Frequency Protection Threshold Setting	R/W	Unsigned	40~70, step is 1 (Unit: Hz)

Table A5. Setpoints Group 5: Protection Group. (continued)

Register	Bit Field	Mask Field	Setpoint Name	R/W	Format	Value Definition
403023	11-0	0x0FFF	Over-Frequency Protection Time Setting	R/W	Unsigned	2~50, step is 1 (indicating 0.2~5 Seconds)
403024	2-0	0x000F	Under-Frequency Protection Setting	R/W	Encoded	0 Trip 1 Alarm 2 OFF
403025	11-0	0x0FFF	Under-Frequency Protection Threshold Setting	R/W	Unsigned	40~70, step is 1 (Unit: Hz)
403026	11-0	0x0FFF	Under-Frequency Protection Time Setting	R/W	Unsigned	2~50, step is 1 (indicating 0.2~5 Seconds)
403027	2-0	0x000F	Phase Sequence Protection Setting	R/W	Encoded	0 Trip 1 Alarm 2 OFF
403028	2-0	0x000F	Phase Sequence Protection Phase Sequence Setting	R/W	Encoded	0 A-B-C, positive sequence 1 A-C-B, negative sequence
403029	2-0	0x000F	Current Demand Protection Setting	R/W	Encoded	0 Trip 1 Alarm 2 OFF
403030	11-0	0x0FFF	Current Demand Protection Threshold Setting Phase A	R/W	Unsigned	20~100, step is 1 (indicating $0.2I_n$~$1.00I_n$)
403031	11-0	0x0FFF	Current Demand Protection Threshold Setting Phase B	R/W	Unsigned	20~100, step is 1 (indicating $0.2I_n$~$1.00I_n$)
403032	11-0	0x0FFF	Current Demand Protection Threshold Setting Phase C	R/W	Unsigned	20~100, step is 1 (indicating $0.2I_n$~$1.00I_n$)
403033	15-0	0xFFFF	Current Demand Protection Time Setting	R/W	Unsigned	15~1500, step is 1 (indicating 15~1500 seconds)
403034	2-0	0x000F	Power Demand Protection Setting	R/W	Encoded	0 Trip 1 Alarm 2 OFF
403035	15-0	0xFFFF	Power Demand Protection Threshold Setting	R/W	Unsigned	1~65550, step is 1 (indicating 1~65550kW)
403036	15-0	0xFFFF	Power Demand Protection Time Setting	R/W	Unsigned	15~1500, step is 1 (indicating 15~1500 seconds)

A.3.4 Event Register

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 type. 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 stores the selected event type's data content. This is a constant value for the three event types that 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	History Summary Event
408193	Encoded	R/W	Event type: Alarm = $8EFF_{16}$
408194	Unsigned 32	R	Earliest Event ID
408196	Unsigned 32	R	Latest Event ID
408198	Unsigned 32	R/W	Requested Event ID
408200	Unsigned 32	R	Previous Event ID
408202	Unsigned 32	R	Next Event ID
408204	Unsigned 32	R	Date/Time
408212	Date/Time	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 = Inactive 11 = Inactive 12 = Opened by Communications 13 = Closed by Communications

Table A8. Historical Trip/Major Alarm Time.

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. Major 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 (0x04B0/0x5100) 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 000016 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 access up 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 (low16/high16 Modbus register addresses). An example is: 4xxxx/4yyyyy ($XXXX+1_{16}$/$YYYY+1_{16}$).

Table 10. 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	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 used 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 first 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 act, 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 first complement command is invalid, the trip unit returns exception code 03.

Figure A2. Remote Control Data Format

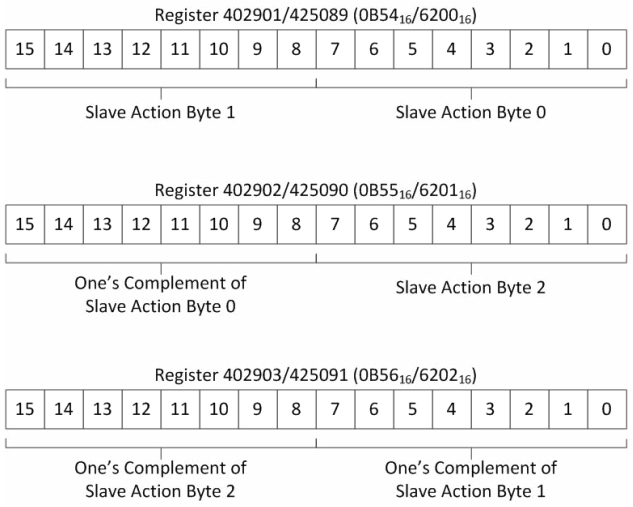


Table 11. Remote Control.

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

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: Enabled 2: Disabled	1: Relay 1 2: Relay 2 3: Relay 3

A.3.8 Date and Time

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

Table 12. 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 Diagnosis

The trip unit supports internal Modbus diagnostics to monitor internal Modbus port communication with function code 08. For different sub-function codes, diagnostics informa-tion 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 check 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	MCU3 Firmware Version
33	MCU3 Firmware Reversion
34	MCU3 Firmware Build
35	USB Version
36	USB Reversion
37	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
0x04	Alarmed
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

Code	Definition	Code	Definition
0x0000	Unknown	0x0001	Normal
0x0003	Instantaneous	0x0005	Instantaneous neutral over- current
0x000B	Over-voltage	0x000C	Under-voltage
0x000E	Aux-power under voltage	0x000F	Over-frequency
0x0010	Under-frequency	0x0011	Current unbalance
0x0012	Voltage unbalance	0x0013	Apparent power factor
0x001A	Power demand	0x001B	VA demand
0x001E	THD	0x001F	Operations count
0x0021	Control via communication	0x0025	Coil supervision
0x0028	Current demand	0x0029	Low battery
0x003D	Long delay	0x003E	Short delay
0x0041	Reverse power	0x0044	Phase sequence
0x004B	Making current release	0x004C	Fixed hardware instantaneous
0x004D	Setpoints error	0x004E	Over-temperature
0x0050	Long delay neutral over- current	0x0054	Ground fault
0x0055	Earth fault	0x0071	Calibration
0x0088	Real time clock	0x009A	Breaker mechanism fault
0x009E	Short delay neutral over-current	0x009F	Thermal memory alarm
0x00A0	Local test from LCD	0x00A1	High load alarm 2
0x00A2	Ground alarm early warning	0x00A2	Over-temperature alarm
0x07FD	Non-volatile memory error	0x07FE	Watchdog fault

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, excep-tion code 02 is returned.
- If the data in the query is illegal, exception code 03 is returned.
- If the trip unit doesn't support the query function, exception code 04 is returned.
- In certain circumstances, exception code 05(ACK) is returned.
- If the trip unit can't perform the current request at this time, a BUSY exception code 06 is returned.
- If the 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 of auxiliary power to circuit breaker terminals 19 and 20 and observe the status LED.	
Breaker trips and reports ground fault.	There actually is a ground fault.	Find the location of the fault.	
	In 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 and make sure 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 selective interlocking (ZSI) function is employed, connect a jumper from Zin to Zout 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 whether the ZSI setting in the Setting menu is OFF.	See Section 4.9: Zone Selective Interlocking.
	The trip unit settings are not correct. Is I^2t Slope or Flat selected?	Change the Ground Fault or Short Delay Times Settings.	See Section 4.2: Short Delay Pickup 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 and reports long delay fault.	Long Time Thermal Memory Function is selected.	Disable the Long Time Thermal 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 pickup and trip times are not correct.	Use an oscilloscope with a current probe to accurately verify current val-ues, 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 cre-ate a long time thermal memory trip as a result of the cumulative action of the short duration currents.	Disable the Long Time Thermal 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/PTM.	See Section 8.2: Functional Current Testing (Remote) via USB/ PTM. See Section 3.3: Pickup/Cause of Trip Indicators.
Cause of Trip LEDs are blinking 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.	
	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.

Table B1. Troubleshooting (Continued).

Symptom	Probable Cause	Possible Solutions	Reference
The LCD display is not energized.	The current flowing through the breaker is less than the minimum current requirement for the LCD display, or there is no auxiliary power (24 Vdc) connected to the controller.	Apply auxiliary power.	See Section 6.2: Auxiliary Power.
The Status LED indicator is red continuously or blinking red.	The circuit breaker MCR auxiliary switch is not indicating proper state.	Check the auxiliary switch.	See the Instructions for Auxiliary Switch.
	The circuit breaker mechanism is not properly closed	Contact your Eaton representative for factory assistance.	
	Internal memory problem.	Replace the trip unit.	
The circuit breaker is tripping, and the orange LED indicator (not red) is illuminated next to SHORT text.	The circuit breaker MCR auxiliary switch is not indicating proper state.	Check the MCR switch or contact your Eaton representative for factory assistance.	See Section 4.8: Making Current Release.
	The circuit breaker mechanism is not closed properly.	Contact your Eaton representative for factory assistance.	

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Eaton Corporation
Asia Pacific Headquarter
No.3, Lane 280, Linhong Road,
Changning District,
Shanghai 200335
Tel: 86-21-52000099
Fax: 86-21-52000200

Printed in China
Publication No.
July 2023

Eaton.com/recycling

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