PXR10, PXR20, PXR25

Electronic trip unit
Power Xpert Release PXR
for NZM... circuit breakers

Powering Business Worldwide

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Original operating manual
The German-language edition of this document is the original operating manual.

Translation of the original operating manual
All editions of this document other than those in German language are translations of the original operating manual.

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See revision protocol in the "About this manual" chapter.

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Editing: René Wiegand

Danger!
Dangerous electrical voltage!

Before commencing the installation

- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally retriggered.
- Verify isolation from the supply.
- Ground and short-circuit.
- Cover or enclose neighbouring units that are live.
- Follow the engineering instructions (IL) of the device concerned.
- Only suitably qualified personnel in accordance with EN 50110-1/-2 (VDE 0105 Part 100) may work on this device/system.
- Before installation and before touching the device ensure that you are free of electrostatic charge.
- The functional earth (FE) must be connected to the protective earth (PE) or to the potential equalizing. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so that inductive or capacitive interference do not impair the automation functions.
- Install automation devices and related operating elements in such a way that they are well protected against unintentional operation.
- Suitable safety hardware and software measures should be implemented for the I/O connection so that a cable or wire breakage on the signal side does not result in undefined states in the automation device.
- Ensure a reliable electrical isolation of the low voltage for the 24 V supply. Only use power supply units complying with IEC 60364-4-41 or HD 384.4.41 S2 (VDE 0100 part 410).
- Deviations of the mains voltage from the nominal value must not exceed the tolerance limits given in the technical data, otherwise this may cause malfunction and dangerous operation.
- Emergency-Stop devices complying with IEC/EN 60204-1 must be effective in all operating modes of the automation devices. Unlatching the emergency switching off devices must not cause restart.
- Built-in devices for enclosures or cabinets must only be run and operated in an installed state, desk-top devices or portable devices only when the housing is closed.
- Measures should be taken to ensure the proper restart of programs interrupted after a voltage dip or failure. This should not cause dangerous operating states even for a short time. If necessary, emergency switching off devices should be implemented.
- Wherever faults in the automation system may cause damage to persons or property, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (for example, by means of separate limit switches, mechanical interlocks, etc.).
- During operation, and depending on their degree of protection, variable frequency drives may have live, uninsulated, moving, and/or rotating parts, as well as hot surfaces.
- The impermissible removal of the required cover, improper installation or incorrect operation of the motor or variable frequency drive can cause the failure of the device and serious injury and/or material damage.
- Comply with all applicable national accident prevention regulations (e.g. BGV A3) when working with energized variable frequency drives.
- The electrical installation must be carried out in accordance with the relevant regulations (e.g. with regard to cable cross sections, fuses, PE).
- All transport, installation, commissioning and maintenance work must only be carried out by trained personnel (observe IEC 60364, HD 384 or DIN VDE 0100 and national accident prevention regulations).
- If applicable, systems in which variable frequency drives are installed must be equipped with additional monitoring and protective devices in accordance with the applicable safety regulations, e.g., the German Equipment and Product Safety Act, accident prevention regulations, etc. Making changes to the variable frequency drives by using the operating software is allowed.
- Keep all covers and doors closed during operation.
- When designing the machine, the user must incorporate mechanisms and measures that limit the consequences of a drive controller malfunction or failure (an increase in motor speed or the motor's sudden stop) so as to prevent hazards to people and property, e.g.:
  - Additional stand-alone devices for monitoring parameters that are relevant to safety (speed, travel, end positions, etc.)
  - Electrical and non-electrical safety devices (interlocks or mechanical locks) for mechanisms that protect the entire system
  - Due to the possibility of there being capacitors that are still holding a charge, do not touch live device parts or terminals immediately after disconnecting the variable frequency drives from the supply voltage. Heed the corresponding labels on the variable frequency drives

Table of contents

0 About this manual

This manual covers the PXR10, PXR20 and PXR25 electronic trip units of the NZM digital circuit breaker as well as the relevant accessories.

The manual describes the various versions of the product series, as well as their installation and operation.

0.1 List of revisions

Publication date	Page	Keyword	new	modified	deleted
01/21	79	Industrial Ethernet Communication Adapter Modules (ECAM)	✓		
07/19		First edition	–	–	–

0.2 Target group

This manual is intended for authorized personnel who are qualified to install, commission and service an NZM circuit breaker.

CAUTION

The installation must be carried out by a qualified electrician.

ELECTRIC HAZARD! DANGER OF DEATH!

Work on or assembly of this product may only be carried out by qualified electricians or otherwise qualified personnel.

0.3 Abbreviations and symbols

The following abbreviations are used in this manual:

Table 1: Abbreviations used

Abbreviation	Meaning
ARMS	Arc Flash Reduction Maintenance System™
ECAM	Ethernet communication adapter module
G	Ground fault (= ground-fault protection I_g)
I	Instantaneous (= instantaneous short-circuit protection I_i)
I_g	Ground-fault trip
I_i	Non-delayed instantaneous trip
I_n	Rated operational current
I_r	Overload release
I_{sd}	Short-time delayed short-circuit release
L	Long delay (= overload protection I_r)
PXPM	"Power Xpert Protection Manager" (software)
PXR	"Power Xpert Release"
RTU	Remote terminal unit
S	Short delay (= short-time delayed short-circuit protection I_{sd})
t_g	Ground-fault delay time
t_r	Time-lag
t_{sd}	Duration of short-time delay
ZSI	Zone selective interlocking

The abbreviation PXR:
For the PXR10, PXR20 and PXR25 versions, the abbreviation PXR is used if a statement applies equally to all three.

The symbols used in this manual have the following meanings:

▶ indicates an action to be taken.

0.3.1 Safety warning concerning property damage

CAUTION

Indicates a potentially hazardous situation that may result in property damage.

0.3.2 Safety warning concerning personal injury hazards

CAUTION

Indicates a potentially hazardous situation that may result in moderate or minor injury

WARNING

Indicates a potentially hazardous situation that may result in death or serious injury

DANGER

Indicates an imminently hazardous situation that will result in death or serious injury

0.3.3 Tips

Indicates useful tips.

0.4 Additional documents

For further information, please consult the following documentation and/or software:

Title	Type	Address
IL012099ZU "Frame size 2 circuit-breaker base unit"	Instruction leaflet	
IL012100ZU "Frame size 3 circuit-breaker base unit"	Instruction leaflet	
IL012101ZU "Frame size 4 circuit-breaker base unit"	Instruction leaflet	
IL012102ZU "Interface module for circuit breaker"	Instruction leaflet	
IL012103ZU "External communication link for circuit breaker"	Instruction leaflet	
IL012104ZU "Internal communication link for circuit breaker"	Instruction leaflet	
IL012141ZU "Shunt release, undervoltage release, relay module, early-make auxiliary switch"	Instruction leaflet	
IL012143ZU "Shunt release, undervoltage release, relay module, early-make auxiliary switch"	Instruction leaflet	
IL019224E "Connection cable for Modbus TCP and Profibus communication modules"	Instruction leaflet	
"Setting-Specific Representation of Tripping Characteristics and Competent Assessment of their Interaction"	White paper	www.eaton.eu/ecm/groups/public/@pub/@europe/@electrical/documents/content/pct_998455.pdf
"More safety when working on live electrical circuits"	White paper	
"Improved lifecycle management thanks to digital circuit protection"	White paper	
"xSpider" (graphical design system for the planning of low-voltage networks)	Software	www.eaton.com/xspider
"Power Xpert Protection Manager"	Software	www.eaton.com/PXPM

1 Function

1.1 General information

The subsystem of the new NZM circuit breakers (the NZM2, NZM3 and NZM4 series) consists of current sensors and a trip actuator in conjunction with the PXR (Power Xpert Release) electronic trip. The electronic trip units PXR10, PXR20 and PXR25 in particular ensure the protection function of the circuit breaker.

In addition to its main function (= protection), the PXR electronic trip unit makes it possible

- to check the protection functions of the circuit breaker (and to log them using the PXPM software),
- to access the circuit breaker information,
- and to adjust the circuit breaker settings.

1.2 Technical background

The PXR trip unit analyzes signals transmitted by Rogowski current sensors. As soon as the current and/or time-delay thresholds are exceeded, the PXR trip unit will cause the circuit breaker to trip.

The automatic overload and short-circuit tripping characteristics for a given circuit breaker depend on

- the specific PXR trip unit version,
- the rated operational current I_n,
- and the protection settings selected by the user.

The current protection functions do not require any external control voltage.

The PXR trip unit consists of a micro-controller module that performs rms current measurements as well as calculations for the protection functions.

It shall not be removed or replaced.

The current sensors are integrated in the circuit breaker and consist of two coils per phase: an iron-core coil (for self-supply) and a Rogowski coil for current measurement.

As soon as a current flows through the circuit breaker, the iron-core coil will generate a secondary current that supplies the PXR trip unit. At the same time, the Rogowski coil emits signals that make it possible to determine the current flowing through the circuit breaker.

The mechanical action required to initiate the tripping of the NZM circuit breaker is carried out by means of a low-energy trip element. This trip element is an integral part of the circuit breaker mechanism. This also includes a toggle lever for manual “opening” and “closing”.

All wiring is done via the interface or relay module,
→ chapter 7, “Auxiliary wiring terminals”, page 41.

The wiring diagrams in the instruction leaflets show how certain trip unit functions are connected to external circuits.

See instruction leaflet IL012102ZU.

1.3 Standards, guidelines, approvals

All PXR electronic trip units have passed IEC 60947-2 testing, which also includes an EMC test according to Annex F and Annex J.
All trip units comply with the EU’s low-voltage and EMC directives (CISPR11, class A and B) and carry the CE mark.

The PXR trip units are also certified for use in the NZM...NA series circuit breakers by Underwriters Laboratories Inc. (UL) and the Canadian Standards Association (CSA).

Further information on the NZM digital circuit breakers can be found on the Eaton website:

www.eaton.com/digitalNZM

2 Design

The PXR trip unit housing is located in the lower part of the NZM circuit breaker and contains the protection functions for the electronic components, as well as an interface for configuring the protection settings and monitoring functions.

Some functions are only available on certain versions of the PXR trip unit.

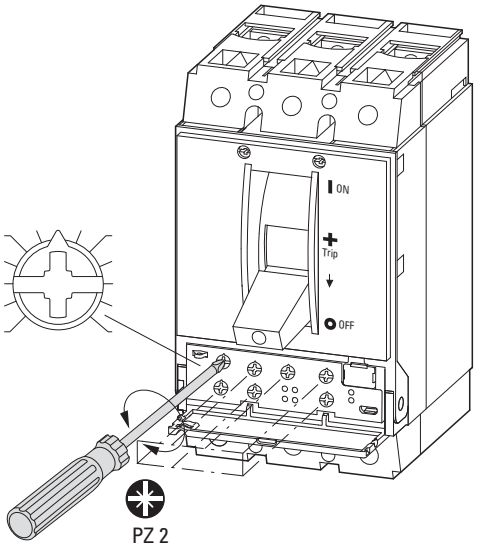


Figure 1: NZM circuit breaker with PXR trip unit

Please note:

The operator interfaces of the trip units differ from one another:

The PXR10 and PXR20 versions are fitted with rotary switches, while on the PXR25 version, an LCD display is used for indicating and adjusting the settings.

2.1 Operator interface

2.1.1 Rotary switch on the PXR10 and PXR20 trip units

Depending on the type of trip unit, there are up to seven rotary switches at the front of the unit.

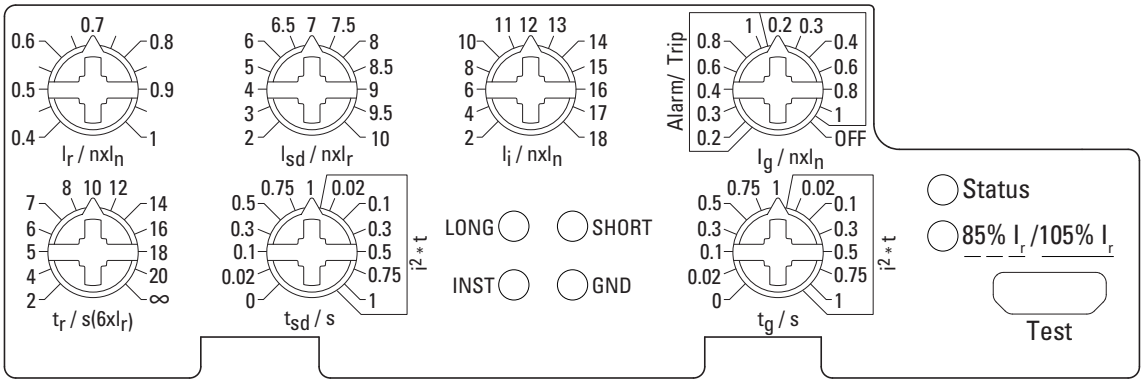


Figure 2: PXR10 and PXR20 overview

Table 2: PXR10 and PXR20 functions

Version	Release	I_r	t_r	I_{sd}	t_{sd}	I_i	I_g	t_g
PXR10	-AX(-NA)	✓	–	–	–	✓	–	–
PXR20	-MX(-NA)	✓	✓	–	–	✓	–	–
	-VX(-NA)	✓	✓	✓	✓	✓	–	–
	-VX-T(-NA)	✓	✓	✓	✓	✓	✓	✓

These rotary switches are used to set the protection settings, in line with the key as indicated. They control the core protection settings. Each rotary switch has 13 positions and is set in such a way that the corresponding tripping characteristic will be reached. The "PICKUP" switches (upper row) set the threshold values for the circuit breaker. The "TIME" switches (t_r, t_{sd}, t_g) in the lower row set the delay time in (milli-)seconds. By means of a PZ2 screwdriver or a slotted screwdriver the switches can be adjusted so that the arrow points to the selected value. For the time functions t_{sd} and t_g, either the flat or the I^2t- characteristic can be selected. The function I_g can distinguish between "trip", "alarm" and "OFF". If "trip" is selected, the circuit breaker will trip according to the characteristic curve. If the alarm is set, an alarm message will either be transmitted via the corresponding communication register and the **GND** LED, or an alarm message will be sent via the relay module (if used and configured accordingly).

2.1.2 LCD display on the PXR25 trip units

On the PXR25 trip units, the device settings are indicated and adjusted via an LCD display at the front.

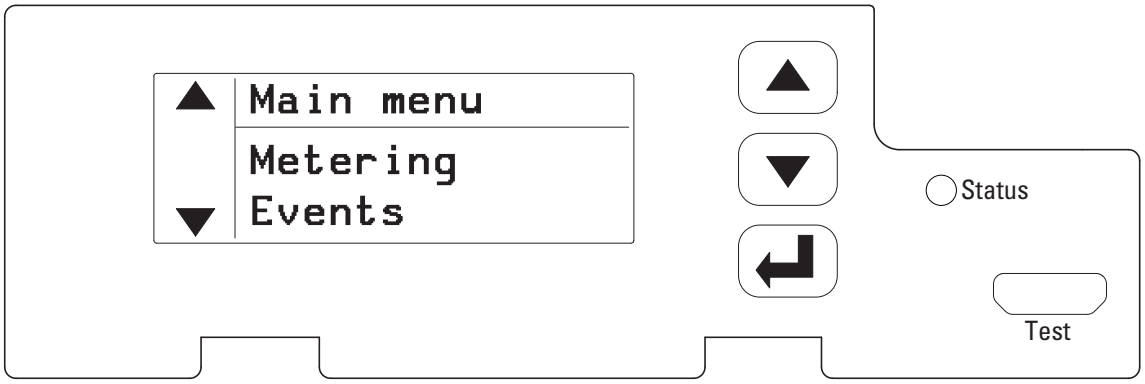


Figure 3: LCD display on the PXR25

Table 3: PXR25 functions

Version	Release	I_r	t_r	I_{sd}	t_{sd}	I_i	I_g	t_g
PXR25	-PX(-NA)	✓	✓	✓	✓	✓	–	–
	-PMX(-NA)	✓	✓	–	–	✓	–	–
	-PX...-TZ(TAZ)(-NA)	✓	✓	✓	✓	✓	✓	✓

Table 4: Settings

	I_r	t_r	I_{sd}	t_{sd}	I_i	I_g	t_g
Settings range	0.4 - 1	2 - 20 s	2 - 10	0 - 1000 ms	2 - 18	0.2 - 1	0 - 1000 ms
Increments	1 A	0.1 s	1 A	10 ms	1 A	1 A	10 ms
Options	I^2t	• ∞ • OFF	• I^2t • Flat	–	–	• Alarm • Trip • OFF	• I^2t • Flat

The LCD display indicates the recorded values and events and can be used to select certain configurations. The default display language is English.

The following languages are pre-installed:

- English
- German
- French
- Italian
- Polish
- Dutch
- Norwegian
- Swedish

→ Additional language packs can be installed via the **Power Xpert Protection Manager** configuration software.

In addition to the display, three indicator and navigation buttons enable the selection of certain configurations and allow users to determine the information to be shown on the display.

Table 5: Indicator/navigation buttons

Button	Description
 Up arrow button	This button is used to move up in the navigation menu, or to set a value to higher.
 Down arrow button	This button is used to move down in the navigation menu, or to set a value to lower.
 Enter button	This button is used to enter the navigation menu, to call up a specific setting or to return to the previous menu item.

Even before the display is active, the trip unit is already in operation and the protection functions are activated. The protection functions are set as absolute values via the display. Depending on the type of trip unit, the main menu will contain different sub-menus. A menu item can be called up by selecting the corresponding sub-menu. To do this, press the up arrow or down arrow button and then the enter button. If no button is pressed for some time, the screensaver will automatically be activated, and will remain on. The screensaver displays a summary of the most important settings and data readings. Use the arrow keys to switch between the different displays in screensaver mode. Press the enter button to return to the main menu. The status LED indicates if the trip unit is ready for operation. During normal operation, this LED will flash green.

Also see → chapter 12, “PXR25 Navigation menu”, page 161 for a graphical representation of the navigation menu.

2.2 Micro-USB connection

The PXR trip unit has a type-B Micro-USB connection based on the USB 2.0 protocol.

Configuration via the "Power Xpert Protection Manager" software

The USB port can be connected to a computer to configure and monitor the PXR trip unit via the Power Xpert Protection Manager software.

External power supply

The USB connection can also be used to power the trip unit from the host side of the USB cable if no other power source is available. For this purpose, a standard portable battery pack can be used, such as the power banks typically used to charge mobile phones. A nominal voltage of 5 V shall not be exceeded. Devices with 12 V or 20 V, according to USB-PD (USB Power Delivery) specification, shall not be used.This connection is intended to be used temporarily while the user configures and monitors the trip unit, activates the trip indicators after a trip, or reads the fault memory.

Table 6: Using the Micro-USB interface

	Description
Standard Micro-USB on USB-A cable	Temporary connection for using the Power Xpert Protection Manager
Standard Micro-USB power bank	To establish a temporary connection for supplying power to the trip unit if the unit is not self-supplying.

2.3 LED Status indication

Flashing

All PXR trip units have a **Status** LED for indicating the device status.

During normal operation, this indicator will flash green (approximately once per second) to indicate that the trip unit is operating normally.

The **Status** LED will flash red if the trip unit has detected an internal fault. This could be a problem with the trip actuator or trip unit, as well as firmware error or a calibration error. In this case, immediate action must be taken to remedy the fault and/or replace the unit.

For troubleshooting, also see
→ chapter 11, “Troubleshooting”, page 159.

LED does not light up

If the status indicator does not light up, either no auxiliary power is available, or the trip unit’s primary supply is insufficient. This therefore does not constitute a malfunction. The **Status** LED will flash again if the auxiliary power supply is activated, or if the load on the circuit breaker rises to a level greater than 15 %.

2.4 Trip reason indicator

PXR10

The PXR10 trip units are not equipped with any indicators.

PXR20

The PXR20 trip units are equipped with up to four trip-reason indicators at the front. These indicators are marked **LONG**, **SHORT**, **INST** and **GND**.

Table 7: PXR20 trip-reason indicators

Trip unit	LONG	SHORT	INST	GND
MX	✓	–	✓	–
VX	✓	✓	✓	–
VX-T	✓	✓	✓	✓

Once the circuit breaker has tripped, the indicator will flash permanently if auxiliary power (24 V DC power) is available. Alternatively, once the circuit breaker has tripped, a standard portable battery pack (power bank) can be used to temporarily supply auxiliary power via the Micro-USB connection of the trip unit.

The indicators and the display can be reset to the OFF position by moving the-toggle or using PXPM software to reset. If the circuit breaker does not have any auxiliary power supply, the indicators will not be active.

The tripping message will also be stored in the event log of the PXR trip unit.

The following table lists the readout reasons that the indicators are able to recognize and indicate.

Table 8: Trip-reason indicators

Indicator	Description
LONG	A overload- or overtemperature-induced shutdown has occurred.
SHORT	The short-time delayed short-circuit protection has been triggered.
INST	The instantaneous short-circuit protection has been triggered, or an inrush-current trip, a high instantaneous trip or a maintenance mode trip has occurred.
GND	An ground-fault trip has occurred.

PXR25

The PXR25 indicates the trip reason via the LCD-display.

2.5 Overload indicator

PXR10, PXR20

The PXR10 and PXR20 trip units are equipped with an orange overload LED for load and overload warnings, which are triggered at 85 % (LED on) and 105 % (LED flashing) of I_r, respectively. Once the current has dropped below the threshold again, the indicator will switch off or return to its previous state. The threshold values are fixed.

PXR25

On the PXR25 trip unit, the threshold values for load and overload warnings can be adjusted via the LCD display.

2.6 Tamper-proof cover

The NZM digital circuit breaker is equipped with a transparent plastic cover. When this cover is closed, the settings can be displayed but not changed. In order to comply with the applicable tamper-proof requirements, any unauthorized changes to the settings can be prevented by inserting a standard seal into the safety hole.

On the PXR25 trip unit, the protection settings are additionally password protected. The PXR25 trip unit cover features openings above the up and down arrow keys. This makes it possible to view the "screensaver" display and the values it depicts. The enter button cannot be pressed while the cover is closed. It is therefore not possible to switch from the screensaver to the main menu while the cover is closed.

3 Protection and measurement functions

3.1 Trip unit functions

The following table lists the available functions for the various PXR trip unit types.

Table 9: Overview of the available functions

PXR version	Release	Overload protection	Short-time delayed short-circuit protection	Instantaneous short-circuit protection	Ground-fault protection	ARMS maintenance mode	ZSI zone-selective interlocking	Current measurement	Data collection incl. Class 1 energy metering	USB interface	Communications enabled	Status LED	Overload LED / indicator	Trip-reason indicator	Interface module	Relay module (optional)
PXR10	-AX	✓	–	✓	–	–	–	✓	–	✓	–	✓	✓	–	–	–
PXR20	-MX	✓	–	✓	–	–	–	✓	–	✓	✓	✓	✓	✓	optional	✓
	-VX	✓	✓	✓	–	–	–	✓	–	✓	✓	✓	✓	✓	optional	✓
	-VX…-T	✓	✓	✓	✓	–	–	✓	–	✓	✓	✓	✓	✓	optional	✓
PXR25	-PX	✓	✓	✓	–	–	–	✓	✓	✓	✓	✓	✓	✓	✓	✓
	-PX…-TZ(TAZ)	✓	✓	✓	✓	✓[1)]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	-PMX	✓	–	✓	–	–	–	✓	✓	✓	✓	✓	✓	✓	✓	✓

1) NZM3 and NZM4 only

3.2 Protection functions

Table 10: Protection functions

Trip unit	Release	I_r	t_r	I_{sd}	t_{sd}	I_i	I_g	t_g
PXR10	-AX(-NA)	✓	–	–	–	✓	–	–
PXR20	-MX(-NA)	✓	✓	–	–	✓	–	–
	-VX(-NA)	✓	✓	✓	✓	✓	–	–
	-VX…-T(-NA)	✓	✓	✓	✓	✓	✓	✓
PXR25	-PX(-NA)	✓	✓	✓	✓	✓	–	–
	-PXM(-NA)	✓	✓	–	–	✓	–	–
	-PX...-TZ(TAZ)(-NA)	✓	✓	✓	✓	✓	✓	✓

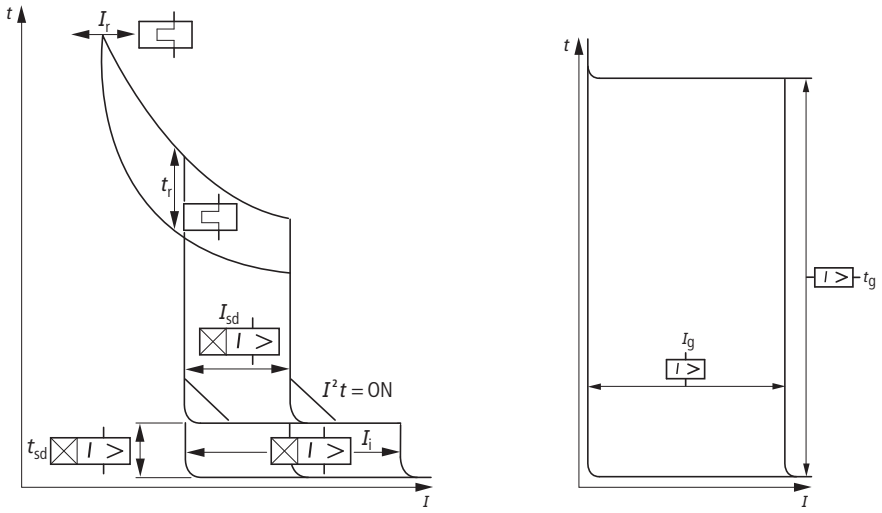


Figure 4: Main LSIG tripping characteristic

L = **l**ong delay (= overload protection I_r)
S = **s**hort delay (= short-time delayed short-circuit protection I_{sd})
I = **i**nstantaneous (= instantaneous short-circuit protection I_i)
G = **g**round fault (= ground-fault protection I_g)

→ To evaluate the tripping characteristics, please refer to the Eaton publication "Setting-specific representation of tripping characteristics and competent assessment of their interaction",

which is available for download on the Eaton website:
www.eaton.eu/ecm/groups/public/@pub/@europe/@electrical/documents/content/pct_998455_de.pdf

→ The xSpider software is available on the Eaton website at

www.xspider.eaton.eu

3.3 Measuring functions

An NZM circuit breaker with PXR trip unit can be used to measure the following values – the scope of the available measurement functions depends on the specific PXR version.

Table 11: Measurement functions of the different PXR versions

Function (value to be measured)	PXR10	PXR20	PXR25
Current	✓	✓	✓
Voltage	–	–	✓
Power	–	–	✓
Energy	–	–	✓
Others (e. g. cos φ)	–	–	✓

Table 12: Current and voltage measurements

Measurement[1)]	Unit of measure	Note
Current measurement[2)]		
IL1, IL2, IL3, IN, IG	A	
Minimum IL1, IL2, IL3, IN, IG	A	Group values are held until reset
Maximum IL1, IL2, IL3, IN, IG	A	Group values are held until reset
Voltage measurement		
VL1-L2, VL2-L3, VL3-L1	V	Voltage phase – phase
Minimum VL1-L2, VL2-L3, VL3-L1	V	Group values are held until reset
Maximum VL1-L2, VL2-L3, VL3-L1	V	Group values are held until reset
VL1-N, VL2-N, VL3-N	V	Voltage phase – neutral
Minimum VL1-N, VL2-N, VL3-N	V	Group values are held until reset
Maximum VL1-N, VL2-N, VL3-N	V	Group values are held until reset

1) PXR10 / PXR20: Accuracy of current measurement: 5 % valid for 40 % to 100 % of I_n.
PXR25: Accuracy of measurement: 0.5 %
Current measurement: valid for 10 % to 120 % of I_n at 25 °C (77 °F)
Voltage measurement: valid for 34 - 690 V AC at 25 °C (77 °F)

2) $I < 0.02 * I_n \rightarrow I = 0$ (PXR25)
$I < 0.05 * I_n \rightarrow I = 0$ (PXR10 / PXR20)

The current and voltage data are recorded at a frequency of 3,600 Hz.

The values recorded by the measurement functions are calculated at a frequency of 1 Hz. The delay time for internal transmission of these data is approximately 250 ms in the case of Modbus, and up to several seconds in the case CAM communications. Data are transmitted during the specific time periods. CAM transmission intervals of several seconds will cause the loss of real-time data packets, depending on the CAM type. Power data (current, voltage, power) take the form of cumulative data and are thus not affected.

If the internal Modbus RTU is used, no recorded "intermediate data" is lost.

3.4 Power and energy measurements

The following power and energy values can be measured.

Table 13: Power and energy measurements

Measurement[1)]	Unit of measure	Note
Power measurement		
Active power	kW	Updated after approximately 1 second
Apparent power	kVA	Updated after approximately 1 second
Reactive power	kvar	Updated after approximately 1 second
Active power requirement	kW	Fixed window of 5 to 60 minutes
Apparent power requirement	kVA	Fixed window of 5 to 60 minutes
Reactive power requirement	kvar	Fixed window of 5 to 60 minutes
Active power requirement (peak)	kW	Value is held until reset
Apparent power requirement (peak)	kVA	Value is held until reset
Reactive power demand (peak)	kvar	Value is held until reset
Power factor	–	Updated after approximately 1 second
Energy measurement		
Active energy (forward)	kWh	From the source to the load
Active energy (reverse)	kWh	From the load to the source
Net active energy	kWh	"Active energy (forward)" - "active energy (reverse)"
Total active energy	kWh	"Active energy (forward)" + "active energy (reverse)"
Apparent energy	kVAh	
Reactive energy (forward)	kvarh	From the source to the load
Reactive energy (reverse)	kvarh	From the load to the source
Net reactive energy	kvarh	"Reactive energy (forward)" - "reactive energy (reverse)"
Total reactive energy	kvarh	"Reactive energy (forward)" + "reactive energy (reverse)"

1) Accuracy: Class 1 (derived from IEC61557-12)

The power and energy values are calculated and updated internally at a frequency of 1 Hz.

3.5 Time/current characteristics

The time/current characteristics of the PXR trip units on the NZM circuit breakers can be found in Eaton's xSpider software via the link listed below.

→ The xSpider software is available on the Eaton website at: www.xspider.eaton.eu

→ Any adjustments to the protection functions should be carried out in accordance with the recommendations of the technician responsible for installing the circuit breakers.

3.6 Voltage tap of the neutral conductor on the PXR25

If a 3-pole circuit-breaker is used in a network with neutral conductor (N-conductor), a voltage tap is necessary to ensure energy metering with maximum accuracy. The voltage tap is connected inside the circuit breaker. Should this not be carried out, the PXR trip unit will assume that the network is 100 % balanced.

If this is not carried out, deviations due to star-point shifts will impair the accuracy of the measurement function. The 3-pole PXR25 circuit breakers are equipped with a pre-configured cable that can be used to tap the voltage of the N conductor. No separate protection is required.

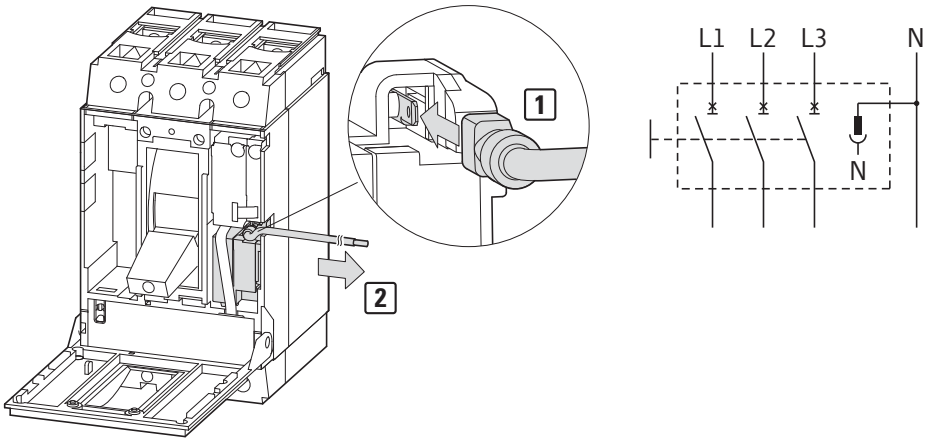


Figure 5: Connecting the N conductor on the NZM2 and NZM3

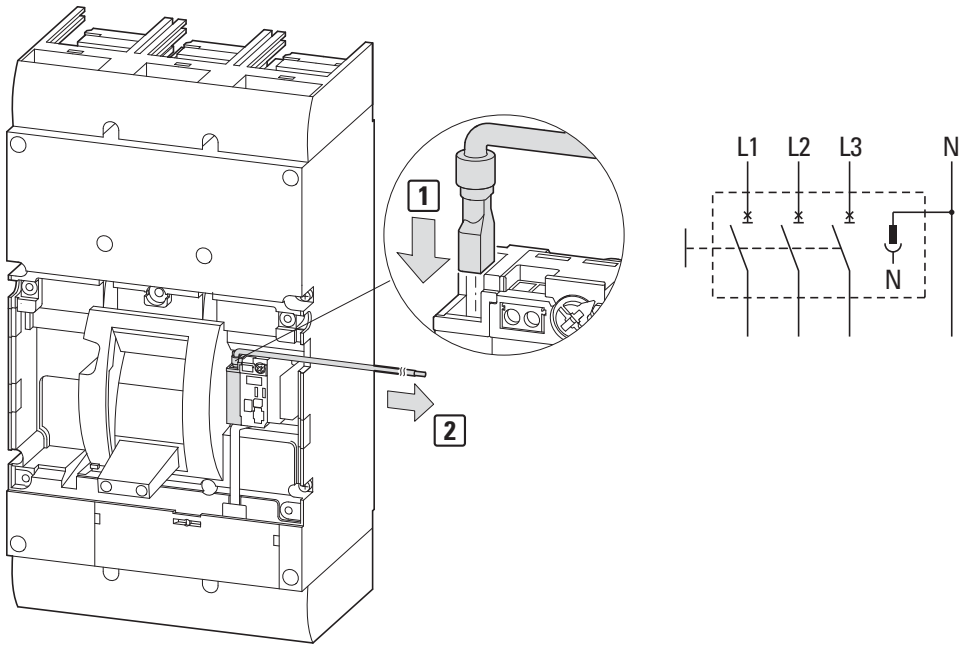


Figure 6: Connecting the N conductor on the NZM4

4 Protection settings

The protection settings of the PXR trip unit are designed so that they can be easily adapted to any application.

The following settings can be configured, independently of one another:

- Overload release I_r
- Time lag t_r
- Short-time delayed short-circuit release I_{sd},
- Duration of short-time delay t_{sd},
- Instantaneous trip I_i,
- Ground-fault trip I_g,
- Ground-fault delay time t_g.

The settings can be adjusted using the rotary switches (on the PXR10 and PXR20 trip units) or the display (on the PXR25 trip unit) at the front of the trip unit.
Additional options can be selected via the display (on the PXR25 trip unit only), the navigation buttons, the **Power Xpert Protection Manager** configuration software (on all PXR variants) or the communication link.

The minimum and maximum protection settings vary depending on the frame size, rated operational current and version of the trip unit.

Before putting the circuit breaker into service, the protection settings of each trip unit should be set to the values specified by the technician responsible for installing the circuit breaker.

4.1 Overload release

Each PXR trip unit offers a variety of settings for theoverload release I_r.
The settings range from 40 % to 100 % of the rated operational current I_n.

Depending on the version, the duration of the time lag t_r is up to 20 seconds. The value corresponds to the entire trip time if the current is equal to six times of I_r. The reference value for the duration is the upper end of the tolerance range. This ensures that the maximum duration is not exceeded. If the infinity setting (?) is selected, the overload release will be deactivated.

As soon as an overload causes the circuit breaker to trip, the **LONG** indicator will light up, provided that auxiliary power is available (on the PXR20), or a message will appear on the display (on the PXR25).

4.2 Overload pre-warning

The overload pre-warning function warns of an overload tripping before it occurs. The function is similar to the thermal motor image of the PKE motor-protective circuit-breaker. With the digital NZM, however, this function is not limited to the motor protection versions. The occurring overload is evaluated and a value in the range from 0 % to 100 % is the output.
The value increases with the overload and decreases as soon as it is no longer present. If the value reaches 100 %, the breaker trips. The speed of the rising is determined by the height of the overload. If an increasing value is detected, countermeasures can be initiated by the user. The function can be read out via the communication connection, see here.

4.3 Thermal memory

In addition to the standard long-delay protection, the long-term memory function ("thermal memory") protects the load circuits against the effects of repeated overloads. The thermal memory is enabled by default and can be configured using the display and navigation buttons or the Power Xpert Protection Manager configuration software.

Example

If a circuit breaker is closed immediately after an overload trip has occurred, and the current again exceeds the threshold value of the overload protection I_r, the thermal memory will automatically reduce the trip time, as it is assumed that the temperature in the load circuit is already higher than normal due to the previous overload. Should an overload occur repeatedly, the thermal memory will trip the circuit breaker at ever shorter intervals.
As soon as the load current falls back to within its normal range, the thermal memory will start to reset. As such, the overload delay time of the next trip will again correspond to the set value. When checking the tripping characteristic, the thermal memory can be disabled in order to obtain accurate test results. It is absolutely essential to reactivate the thermal memory after the testing has been completed! This function enables the circuit breaker to protect both downstream cables (outgoing cables) and equipment as well as its own integrity against excessive heating in the event of repeated overcurrents.

4.4 Short-time delayed short-circuit release

The short-time delayed short-circuit release I_{sd} can be set to 2 to 10 times the threshold value of the overload release I_r.

The duration of the short-time delay t_{sd} is selected in together with one of two short delay slopes, "flat" or I^2t. The duration can be set to a range from 0 seconds (the minimum interval) to 1 second.

Zone selective interlocking (ZSI) may affect the trip times of the short-time delay protection function and thereby accelerate tripping.

For further information, please refer to
→ section 4.10, "Zone selective interlocking (ZSI)", page 31.

As soon as a short-time delayed overload has caused the circuit breaker to trip, the **SHORT** indicator will light up, provided that auxiliary power is available (on the PXR20), or a message will appear on the display (on the PXR25).

4.5 Instantaneous short-circuit release

The instantaneous short-circuit release I_i can be set to 2 to 18 times of the rated operational current I_n. The maximum value depends on the specific circuit breaker, its rated operational current, as well as the trip unit type. The instantaneous short-circuit protection trips the circuit breaker without any time delay.

As soon as an instantaneous short-circuit has caused the circuit breaker to trip, the **INST** indicator will light up, provided that auxiliary power is available (on the PXR20), or a message will appear on the display (on the PXR25).

4.6 Ground-fault settings

If a PXR20 or PXR25 trip unit is equipped with ground-fault protection, the characteristics (e.g. the grounding system, the number of sources, and the number and location of the ground points) of the distribution system must be taken into account, together with the manner in which the circuit breaker will be used in the system.

The versatile PXR trip unit can both detect ground-fault currents and respond to them. A ground-fault alarm ensures early warning in the event of a ground fault, while a ground-fault trip provides protection in this case.

The following three modes of operation can be selected.

Table 14: Settings ground-fault protection

Mode	Description
OFF	The ground-fault detection can be turned off by setting the rotary switch to "OFF".
ALARM	It is possible to set threshold values for alarm-only ground-fault detection. When the alarm mode is selected, threshold values can be set. This set of threshold values is marked "alarm".
TRIP	It is also possible to set threshold values for the ground-fault detection with trip. When detection and trip mode is selected, threshold values can be set. This set of threshold values is marked "trip".

The PXR trip unit allows for the selection of two different ground-fault slopes:

- Flat waveform ("flat")
- I^2t waveform.

The slope should be chosen in accordance with the individual coordination requirements. The I^2t response allows for a shorter time delay than the fixed-time response ("flat").

The time delay t_g and the slope should be selected together. If the selected response time is I^2t, this will be marked separately, while this is is not the case for the "flat" response time. Both have a range of up to 1 second.

As soon as a ground fault causes the circuit breaker to trip, the **GND** indicator will light up, provided that auxiliary power is available (on the PXR20), or a message will appear on the display (on the PXR25).

In addition to ground-fault protection, the PXR trip unit is also equipped with a ground-fault memory function (thermal memory for ground-fault protection) to protect against recurrent loads if an arc to earth occurs. Without this function, the ground-fault protection timer would be reset each time an arc is quenched, and the arc would not necessarily cause the circuit breaker to trip. The ground-fault memory function enables the trip unit to "remember" the ground-fault current. The memory will be erased with time, and the time interval corresponds to 6.25 times of the ground-fault time.

Internal current sensors are used to detect the presence of a ground fault. If the sum of the currents of the individual phases (and, if a four-pole circuit breaker is used, of the neutral conductor in a four-wire network) does not equal zero, an alarm will be triggered in line with the ground-fault protection settings. If a 3-pole circuit breaker is used in a neutral network, the neutral current will not be detected. In this case, a ground-fault trip may occur if the threshold values of the ground-fault release are exceeded.

4.7 Instantaneous release (override)

The PXR trip unit is equipped with a high instantaneous trip function that will trip the circuit breaker in line with the short-circuit rating of the circuit breaker. The function will respond to the peak current level (this is a default setting). This setting is always active, regardless of which settings have been selected for the instantaneous short-circuit protection. It is controlled by a secondary processor for redundant tripping. The **INST** indicator of the instantaneous short-circuit protection indicates this type of trip reason.

4.8 Digital bypass

Should the main processor malfunction, the secondary processor will take over at 1.2 x I_n.

If the value exceeds 1.2 x I_n, the circuit breaker will trip immediately.

4.9 Maintenance mode (ARMS)

The PXR25 trip units support Eaton's Arc Flash Reduction Maintenance System™ (ARMS). This is also known as the maintenance mode. If enabled, the trip unit will trip the circuit breaker with no intentional delay whenever the configured threshold value is exceeded. If enabled, the maintenance mode will operate independently of the overload and short-circuit protection settings. If the maintenance mode causes the circuit breaker to trip, the message "ARMS trip" will be displayed, provided that auxiliary power is available.

The maintenance mode is configured either via the display and the navigation buttons, or via USB or the communication link. The settings allow for different protection levels.

The following settings are available:

- 2.5 x I_n
- 4 x I_n
- 6 x I_n
- 8 x I_n
- 10 x I_n

A higher protection level may be required if, for example, the circuit breaker protects another load with motors that need to be started, and which generate high inrush currents above the lowest trip-current level.

→ The reduction settings should be determined by an individual with experience in power system analysis.

The maintenance mode offers protection against arc faults with low current values, which due to impedance do not reach the threshold value of the instantaneous short-circuit release. ARMS will recognize these currents as an immediate danger and will switch off without any delay, thereby reducing the energy released in the event of an arc fault. This also offers effective protection for maintenance personnel in the vicinity.

Activating the maintenance mode

There are three options for activating the maintenance mode:

- locally via the display,
- remotely via a contact,
- remotely via the communication interface.

The LCD display will indicate if the function is activated, and this information can also be read out via the communication link.

To activate the maintenance mode locally, use the display and the control buttons on the trip unit. If the maintenance mode has been activated locally, remote deactivation is not possible. The maintenance mode can only be deactivated via the same channel through which it was activated (for example, locally if it was activated locally).

The maintenance mode can be activated remotely via a normally open contact (e.g. a door switch) that has been wired to the interface module of the circuit breaker.

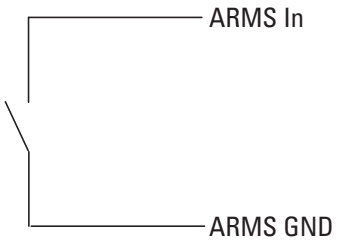


Figure 7: ARMS wiring

The maintenance mode can also be activated through the communication interface. This can either be done using a communication module or via the configuration software and the USB port.

If the maintenance mode is activated using one of these methods, the deactivation must also be carried out in the same way.

4.10 Zone selective interlocking (ZSI)

The ZSI function (ZSI = zone selective interlocking) can be activated or deactivated either via the navigation menu, or via the Power Xpert Protection Manager software and a communication link. The ZSI function can be used in conjunction with the short-time protection functions and the ground-fault protection. ZSI ensures that the circuit breaker trips as fast as possible in the event of any faults within its zone of protection, while also enabling safe coordination among all circuit breakers in the system (the main power supply, nodes, feeders and any downstream circuit breakers).

If ZSI is enabled, a fault within the zone of protection will immediately trip the circuit breaker and send a corresponding restraining signal to any upstream trip units to prevent them from tripping instantly. This restraining signal will cause all upstream circuit breakers to continue operating with their own coordination delays, to ensure that the supply is only interrupted locally.

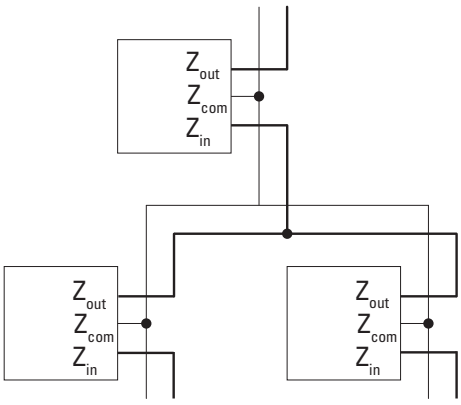


Figure 8: ZSI circuits

The ZSI function is connected to the interface module of the circuit breaker via three wires, which are marked

- Zone In (Z_{in}),
- Zone Out (Z_{out}),
- Zone Common (Z_{com}).

These signals are compatible with all Eaton circuit breakers that have the ZSI function. An output signal will be transmitted each time the ground-fault threshold or the short-time delay threshold is exceeded. This provides maximum selectivity for coordination with larger upstream circuit breakers. Depending on the application, a self-locking jumper may be required for the farthest upstream circuit breaker. If immediate tripping is desired on the last circuit breaker, the Z_{in} wire of that circuit breaker can be left open, while the Z_{out} wire then has to be connected to the Z_{in} of the next upstream circuit breaker. If a time delay is desired on the last circuit breaker, a jumper from the Z_{out} wire of that circuit breaker can be connected to the Z_{in} wire of the same breaker to provide for self-interlocking.

4.11 Event logging and waveform capture

The PXR trip unit records information about events, alarms and trips in various logs. For "ordinary" events, only the reason and a time-stamp (based on the trip unit's real-time clock) will be stored. For more "complex" events, the real-time values (currents and voltages) will additionally be stored. For the most important events, additional information, such as the current and voltage waveforms during the event, will also be stored.

Each log can store a specified number of events and is managed as a first-in-first-out (FIFO) buffer. When saving the information of the most recent event, the information of the oldest event will be deleted if the maximum number of events for the respective log has been exceeded.

Table 15: Event and log matrix

Event	Event code + time stamp	Alarm messages	Tripping	Waveform capture	Alarm waveform	Trip waveform	Note
	200	10	10	1	1	6	quantity stored
User-initiated capture				✓			Initiated via USB or network
Start up - status OK	✓						
Start up - status incorrect	✓						
Event - download setpoints	✓						
Event - enter test mode	✓						
Event - exit test mode	✓						
Event - test complete	✓						
Event - enter maintenance mode	✓						
Event - exit maintenance mode	✓						
Event - opened via communications	✓						Open/trip command via communication channel
Event - closed via communications	✓						
Event - time change (if > 60 seconds)	✓						Previous time is recorded
Alarm - calibration	✓	✓					
Alarm - setpoint fault	✓	✓					
Alarm - low control voltage	✓	✓					
Alarm - RTC error	✓	✓					
Alarm - NV memory error	✓	✓					
Alarm - watchdog timer	✓	✓					
Alarm - overload release (test mode)	✓	✓					
Alarm - ground fault (test mode)	✓	✓					
Alarm - trip-actuator fault	✓	✓					
Alarm - residual life	✓	✓					
Alarm - overload release	✓	✓			✓		
Alarm - ground fault	✓	✓			✓		
Alarm - mechanical error	✓	✓			✓		
Alarm - high load	✓	✓			✓		
Trip - overtemperature	✓		✓				
Trip - making-current release	✓		✓				
Trip - test	✓		✓				
Trip - overload protection	✓		✓			✓	
Trip - short-time delayed	✓		✓			✓	
Trip - instantaneous	✓		✓			✓	
Trip - ground fault	✓		✓			✓	
Trip - maintenance mode	✓		✓			✓	
Trip - neutral conductor	✓		✓			✓	

Table 16: Event codes

Event code and time stamp	Logged event

Alarm snapshot or trip-snapshot	• Current:
	  • I_{L1} (IA)
	  • I_{L2} (IB)
	  • I_{L3} (IC)
	  • I_G (IG)
	  • I_N (IN)
	• Voltage (only on the PXR25):
	  • U_{L1-L2} (VAB)
	  • U_{L2-L3} (VBC)
	  • U_{L3-L1} (VCA)
	  • U_{L1-N} (VAN)
	  • U_{L2-N} (VBN)
	  • U_{L3-N} (VCN)
	• Power: W, var, VA (only on the PXR25)
	• Energy: Wh, Varh, VAh (only on the PXR25)
	• Frequency
	• Power factor
	• Operations counter

User waveform or alarm waveform	Waveform of:
	  • I_{L1} (IA)
	  • I_{L2} (IB)
	  • I_{L3} (IC)
	  • I_G (IG)
	  • I_N (IN)
	Waveform (only on the PXR25) of:
	  • U_{L1-L2} (VAB)
	  • U_{L2-L3} (VBC)
	  • U_{L3-L1} (VCA)
	  • U_{L1-N} (VAN)
	  • U_{L2-N} (VBN)
	  • U_{L3-N} (VCN)
	1 cycle (64 data points)

Trip waveform	Waveform of:
	  • I_{L1} (IA)
	  • I_{L2} (IB)
	  • I_{L3} (IC)
	  • I_G (IG)
	  • I_N (IN)
	Waveform (only on the PXR25) of:
	  • U_{L1-L2} (VAB)
	  • U_{L2-L3} (VBC)
	  • U_{L3-L1} (VCA)
	  • U_{L1-N} (VAN)
	  • U_{L2-N} (VBN)
	  • U_{L3-N} (VCN)
	6 cycles (384 data points)

→ To use event logging in all operating states, an external power supply is required.

4.12 Residual-life indicator

Figure 9: Residual-life indicator ("residual life")

The NZM digital circuit breaker (with PXR25) contains a residual-life indicator ("residual life"), which indicates the degree of wear on the contact system. This is determined by the number of operations and the loads that occur in the process. Residual life is expressed as a percentage. From a starting value of 100 % it decreases with every operation.

> *CAUTION*
> If the residual-life indicator reaches a value below 25 %, we recommend replacing the device during the next maintenance interval of the machine or system.

In this condition, the device will still be able to carry the rated operational current and can safely switch off at least one further overcurrent.

→ To use the residual-life indicator in all operating states, an external power supply is required.

→ If you have any questions or feedback regarding the residual-life indicator, please contact your local Eaton technical support.

5 Communication functions

The circuit breakers with PXR trip units are equipped with a dual communication interface.

On the one hand, an internal Modbus RTU module can be used. In addition, an external communication adapter module (CAM) can also be connected in parallel. In order for the communication function to be enabled, the communication modules need to be connected via the interface module. In the case of the PXR25 trip units, the interface module is included as standard. In the case of the PXR20 trip units, an interface module can be optionally installed.

It is not possible to use an interface module with the PXR10 trip units.

5.1 Integrated Modbus communication module

An integrated Modbus communication module is available as an optional accessory for the PXR20 and PXR25 trip units. This Modbus module also has to be connected to the interface module. The trip unit will respond to messages from the Modbus master using the RTU (remote terminal unit) protocol via an RS485 connection. The Modbus port can be configured using the display and the navigation keys, or using the Power Xpert Protection Manager software.

Table 17: Modbus default settings

	Default settings (as delivered)	**Options**
Slave address	002	001 - 247
Baud rate	19,200 bit/s	• 9,600 bit/s • 19,200 bit/s • 38,400 bit/s • 57,600 bit/s
Parity	even	• even • odd • no parity
Number of stop bits	1	• 1 • 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.

For a detailed overview of all Modbus registers, see → chapter 9, "Modbus RTU – integrated Modbus port specification", page 49.

The integrated Modbus communication module is a CISPR11, class A equipment.

CAUTION

This product has been designed for environment A. Use of this product in environment B may cause unwanted electromagnetic disturbances in which case the user may be required to take adequate mitigation measures.

5.2 External communication adapter modules

Circuit breakers with PXR20 or PXR25 trip units are designed for flexible and modular systems that include communication adapter modules (CAMs). These modules allow the trip unit to communicate with a fieldbus network.

→ The CAM modules can also be used for the IZMX air circuit breakers.

The following modules support different networks.

Table 18: Communication adapter modules

Protocol	Module / connection cable	Instruction leaflet
Profibus DP	PXR-PCAM	IL019224E
Modbus TCP	PXR-ECAM-MTCP	IL019224E
EtherNet/IP	PXR-ECAM-IP	IL012384ZU
EtherCAT	PXR-ECAM-ECT	IL012384ZU
Profinet	PXR-ECAM-PNET	IL012384ZU
–	PXR-XCAM-NZMCABLE	IL012103ZU

The modules are either mounted in a decentralized manner on a DIN rail, or screwed directly onto a mounting plate and wired to the PXR trip unit via the interface module of the circuit breaker. This requires the use of the connection cable (PXR-XCAM-NZMCABLE), as described in the instruction leaflet of the module. The fieldbus is wired to an interface on the module.

The CAM modules are equipped with two relay outputs and three digital inputs. The outputs and inputs can be configured for various functions.

→ The PXR-XCAM-NZMCABLE cable is not included in the delivery of the CAM... and has to be ordered separately.

6 System components

6.1 External power supply

The auxiliary power supply to the PXR trip unit enables its full functionality, even if the circuit breaker is open, or if the circuit breaker is operating with a load that is so low (less than 15 % of I_n) that the current transformers are unable to provide sufficient power for the trip unit's own power supply.

An external power supply is required for the following functions:

- Communication link,
- Relay module functionality,
- Residual-life indicator (only on the PXR25)
- Event logging

The auxiliary power supply has to be connected to the interface module of the circuit breaker.

The current protection functions do not require any auxiliary power supply.

Table 19: External power supply requirements

	Value
Rated control voltage U_S	24 V DC
Tolerance	±20 %
Maximum current consumption	0.1 A
Fuse protection	2 A

6.2 Electromagnetic compatibility

The electromagnetic compatibility of electronic components in circuit-breakers is certified according to the product standard IEC/EN60947-2.

The configurations tested are standard configurations of typical applications. However, in practical applications, electromagnetic interferences cannot be completely excluded under worst case conditions. In such critical applications, the immunity of switch gear and control gear can be further improved. EATON recommends in such critical applications the use of a snap-on ferrite (e.g. type WE 74271132 by Würth Electronic). The ferrite should be installed on the external 24 V DC power line in close proximity to the circuit-breaker.

6.3 Real-time clock

The PXR trip unit is equipped with an integrated real-time clock for displaying the year, month, day, day of the week, hour, minute and second.
This clock can be set and read using the Power Xpert Protection Manager (→ section 6.4, "Power Xpert Protection Manager (PXPM)", page 40) or any of the communication channels, as well as via the display (in the case of the PXR25 trip unit). The clock makes it possible to add a time stamp to events that are recorded in the historical memory.

> *CAUTION*
>
> The real-time clock is not backed by a battery!
> It thus needs to be permanently connected to the external 24 V DC power supply.
> Should this power supply be interrupted, the real-time clock has to be set up again.

6.4 Power Xpert Protection Manager (PXPM)

Eaton's free **Power Xpert Protection Manager** (**PXPM**) is a Microsoft® Windows-based software for configuring, controlling and testing the Eaton PXR trip units.

It enables users to create, modify and save the configurations of PXR trip units. The software also makes it possible to reset the trip units, set the date and time, and record the current or voltage waveforms. In addition, tripping tests can also be performed via the PXPM. Some feature of the software may require to obtain a license.

→ The Power Xpert Protection Manager (PXPM) can be downloaded free of charge via the following link:

http://www.eaton.com/PXPM

7 Auxiliary wiring terminals

7.1 Interface module

Table 20: Presence and installation of the interface module

Trip unit	NZM2(3)(4)-XBSM… interface module
PXR10	the interface module cannot be installed!
PXR20	installation is optional
PXR25	included as standard

The interface module offers various connections and functions.
The number of connections varies depending on the version of the module. Please note that for all circuit breakers with PXR technology, the appropriate modules must be installed, otherwise the full range of circuit-breaker functions cannot be used. The circuit breakers for which each module can be used are outlined in the data sheet of the respective interface module, as well as on the relevant catalogue page (in the form of an overview).

The interface module has the following functions and connections, which are illustrated below using three versions as examples:

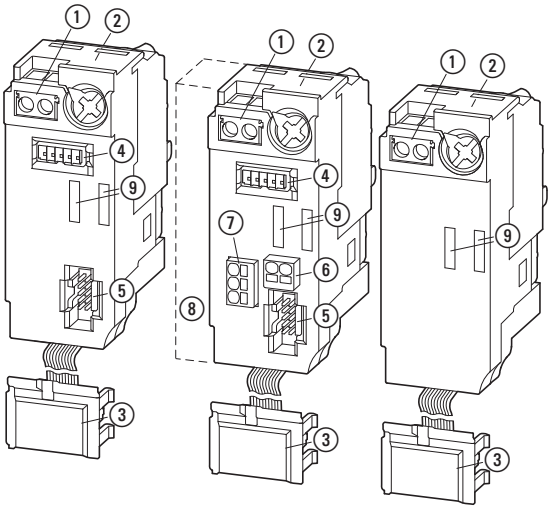


Figure 10: Functions and connections

① 24 V DC terminal (±10 %)
② Detection of the breaker status (I, +, O)
③ Connection to the trip unit
④ CAM connection
⑤ Connection to the internal communication module
⑥ ARMS remote switching (only on the NZM3 and the NZM4)
⑦ ZSI connection
⑧ VN connection for the voltage tap of the neutral conductor (only on the NZM4)
⑨ Status indication of the remote operator

Replacing the interface module

The interface module, which is pre-installed in all PXR25 trip units, rarely needs to be replaced. For all PXR20 devices, the interface module is an optional accessory that is required, among other things, for connecting a communication module. On PXR20 devices it can also be retrofitted.

Voltage tap for the neutral conductor

The VN connection is located on the side of the interface module (only on the 3-pole NZM4 circuit breakers with energy metering (PXR25)). On the 3-pole NZM4 circuit breakers with energy metering (PXR25), the VN module, which occupies slot HIA 4.1, is already pre-installed. The voltage tap for the neutral connector is connected at the VN module. This is necessary to ensure measurements with maximum accuracy. Otherwise the electronic trip unit will not be "familiar" with the star point of the system. The VN module contains a chain of resistors that is calibrated to the overall system.

When replacing the interface module of a 3-pole NZM4 circuit breaker with energy metering (PXR25), do not remove or replace the VN module. It may be removed briefly to replace an old interface module and must then be reinstalled together with the new interface module, → section 3.6, "Voltage tap of the neutral conductor on the PXR25", page 23.

The PXR20 trip units do not have a voltage tap for the neutral conductor, as they do not measure the voltage.

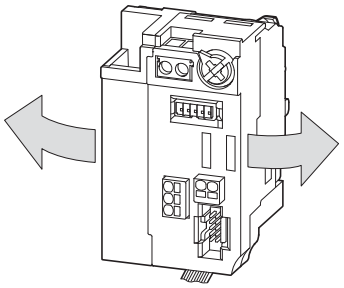


Figure 11: Removing the interface module

7.2 Relay module

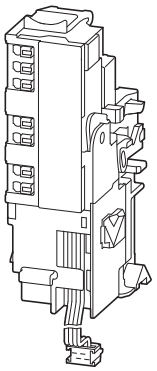


Figure 12: Relay module

The relay module is an optional accessory for circuit breakers with PXR trip unit and is equipped with two relay outputs for command and signaling purposes.

Use of the relay module requires the interface module and a 24-V-DC-power supply. The two relays can be configured via the PXR trip unit display, the communication link or the Power Xpert Protection Manager software.

The relays can be set to respond to various alarm or trip conditions. It is also possible to control them automatically or manually via the communication link. For example, it is possible to switch the remote operator of the circuit breaker, or a downstream contactor can be “dropped” in order to prevent the circuit breaker from tripping in the event of a slight overload.

Table 21: Relay configuration

Value	Function	Indication on the display (only on the PXR25)	Description
0x0000	Relay OFF		This setting deactivates the relay.
0x0001	Overload release	(0 -> 1): trip - overload (1 -> 0): status - device has been reset	The relay will respond if the breaker has tripped due to an overload. This includes tripping due to the overload characteristic or to excessive temperature. The relay will drop out once the device has been reset or a reset command has been issued via the communication interface.
0x0002	Neutral conductor trip	(0 -> 1): trip - neutral (1 -> 0): status - device has been reset	The relay will respond if the breaker has tripped due to a neutral conductor trip. The relay will drop out once the device has been reset or a reset command has been issued via the communication interface.
0x0003	Short-circuit trip	(0 -> 1): trip - short circuit (1 -> 0): status - device has been reset	The relay will respond if the breaker has tripped due to a short circuit. This includes short-time delayed tripping, instantaneous tripping or an override. The relay will drop out once the device has been reset or a reset command has been issued via the communication interface.
0x0004	Short-time delayed trip	(0 -> 1): trip - short-time delayed (1 -> 0): status - device has been reset	The relay will respond if the breaker has tripped due to a short-time delayed short circuit. The relay will drop out once the device has been reset or a reset command has been issued via the communication interface.
0x0005	Instantaneous trip	(0 -> 1): trip - instantaneous (1 -> 0): status - device has been reset	The relay will respond if the breaker has tripped due to an instantaneous short circuit. The relay will drop out once the device has been reset or a reset command has been issued via the communication interface.
0x0006	Ground-fault trip	(0 -> 1): trip - ground fault (1 -> 0): status - device has been reset	The relay will respond if the breaker has tripped due to a ground fault. The relay will drop out once the device has been reset or a reset command has been issued via the communication interface.
0x0007	Trip due to maintenance mode	(0 -> 1): trip - ARMS (1 -> 0): status - device has been reset	The relay will respond if the breaker has tripped due to maintenance mode. The relay will drop out once the device has been reset or a reset command has been issued via the communication interface.
0x0008	General trip alarm Default setting for relay 1 – for breakers without maintenance mode	(0 -> 1): trip - general trip (1 -> 0): status - device has been reset	The relay will respond if the breaker has tripped (trip reasons 4-10). The relay will drop out once the device has been reset or a reset command has been issued via the communication interface.
0x0040	Load alarm 1 Default setting for relay 2 – for breakers without ground-fault protection	(0 -> 1): alarm - load is active (1 -> 0): alarm - load is not active	The relay will respond if load alarm 1 is active. The alarm can be set to between 50 % and 120 % of I_r. The relay will drop out again with a hysteresis of 5 % below the set threshold value. Default settings: 85 %
0x0041	Load alarm 2	(0 -> 1): alarm - overload is active (1 -> 0): alarm - overload is not active	The relay will respond if load alarm 2 is active. The alarm can be set to between 50 % and 120 % of I_r. The relay will drop out again with a hysteresis of 5 % below the set threshold value. Default settings: 105 %

Value	Function	Indication on the display (only on the PXR25)	Description
0x0042	Overtemperature	(0 -> 1): alarm - overtemperature is active (1 -> 0): alarm - overtemperature is not active	The relay will respond if the internal circuit breaker temperature is too high. The relay will respond at 5 °C below the threshold of the overtemperature release. The relay will drop out again with a hysteresis of 5 °C.
0x0043	Ground-fault pre-alarm Default setting for relay 2 – for breakers with ground-fault protection	(0 -> 1): alarm - ground fault is active (1 -> 0): alarm - ground fault is not active	The relay will respond if the adjustable threshold value of between 50 % and 100 % of I_g is exceeded. If the setting "ground-fault alarm" has been selected, the threshold will be set to 100 % of I_g. The relay will drop out again with a hysteresis of 5 %. Default settings: 75 %
0x0044	Thermal memory (trip is imminent)	(0 -> 1): alarm - thermal memory full (75 %) (1 -> 0): alarm - thermal memory normal	The relay will respond if the thermal memory of the breaker is 75 % full. The relay will drop out again with a hysteresis of 5 %.
0x0045	Watchdog	(0 -> 1): alarm - watchdog is active (1 -> 0): alarm - watchdog is not active	The relay will respond if an external power supply is available and the trip unit is functioning normally. The relay will drop out if a fault has occurred that can be detected by the trip unit's internal diagnostics. If the external power supply is interrupted, the relay will also drop out.
0x0047	Internal error	(0 -> 1): alarm - internal error has been detected (1 -> 0): alarm - internal error has been reset	The relay will respond if a fault has occurred that can be detected by the trip unit's internal diagnostics. The relay will drop out, either if the device has been reset, or a reset command has been sent via the communication interface, provided that the fault is no longer present.
0x0048	Settings error	(0 -> 1): alarm - settings error has been detected (1 -> 0): alarm - settings error has been reset	The relay will respond, if a settings error has been detected.
0x0049	Low residual life	(0 -> 1): alarm - residual life is less than x % (adjustable threshold)	The relay will respond if an adjustable threshold value of between 0 % and 50 % of residual life is exceeded (default value: 25 %)
0x004A	Communication error	(0 -> 1): alarm - communication error (1 -> 0): alarm - communication error has been reset	The relay will respond, if an external communication error has been detected. The relay will open if the device has been reset, or a reset command has been sent via the communication interface. If the error continues to persist, the relay will again respond. **Note:** Detects only external communication errors. Internal communication errors are covered by position 18.
0x004B	General alarm	(0 -> 1): alarm - general alarm (1 -> 0): alarm - general alarm has been reset	The relay will respond in the event of an alarm (alarm reasons 12 to 21). The relay will drop out once the alarm is no longer active.
0x0020	Standard auxiliary contact (HIN)	(0 -> 1): status: device is closed (1 -> 0): status - device is open	The relay will respond if the circuit breaker is in the "closed" contactor state. The contactor states "open" and "tripped" will cause the relay to drop out.
0x0021	Trip-indicating auxiliary switch (HIA)	(0 -> 1): status - device has tripped (1 -> 0): status - device has been reset	The relay will respond if the circuit breaker is in the "tripped" contactor state. Once this is no longer the case, the relay will drop out.

Value	Function	Indication on the display (only on the PXR25)	Description
0x0022	Maintenance mode active Default setting for relay 1 – for breakers with maintenance mode	(0 -> 1): safety - maintenance mode is active (1 -> 0): safety - maintenance mode is not active	The relay will respond if the maintenance mode has been activated. The relay will drop out if the maintenance mode has been deactivated.
0x0023	Zone selective interlocking is operational	(0 -> 1): safety - ZSI is active (1 -> 0): safety - ZSI is not active	The relay will respond if zone selective interlocking has been activated (is operational). The relay will drop out if zone selective interlocking has been deactivated.
0x0024	ZSI input signal has been received	(0 -> 1): safety - ZSI input is active (1 -> 0): safety - ZSI input is not active	The relay will respond if the Zin input of zone selective interlocking is active. The subordinate switch will receive a blocking signal. The relay will drop out once the device has been reset or a reset command has been issued via the communication interface. This function can be used to check the ZSI functionality.
0x0025	ZSI output signal has been sent	(0 -> 1): safety - ZSI output is active (1 -> 0): safety - ZSI ouput is not active	The relay will respond if the Zout output of zone selective interlocking is active. This breaker will send a blocking signal. The relay will drop out once the device has been reset or a reset command has been issued via the communication interface. This function can be used to check the ZSI functionality.
0x0028	Relay controls	(0 -> 1): controls - relay is active (1 -> 0): controls - relay is not active	The relay will respond if the trip unit has received the command “close relay” via the communication interface. The relay will drop out if it has received the command “open relay” via the communication interface, or if the external power supply of the breaker has been interrupted.

8 Testing the trip unit and the circuit breaker

Testing should be carried out prior to commissioning if the circuit breaker is located in a de-energized system or in a system with withdrawable or plug-in mechanism, and is in the TEST POSITION, DISCONNECTED or WITHDRAWN.

→ Since the time-current settings form the basis for the desired system coordination and protection schemes, the protection settings, if altered during a test sequence, must be reset to their as-found conditions.

WARNING

Do not attempt to install, test, or perform maintenance on the equipment while it is energized.
Direct contact with live parts may result in immediate death or serious injury.
De-energize the circuit and disconnect the circuit breaker before performing any maintenance work or testing. Follow the five safety rules!

CAUTION

Once the device has tripped, the power supply will be interrupted, which may result in unnecessary switching operations of subordinate devices. Testing may be carried out even if the circuit breaker is energized and in service.
Testing that will result in the tripping of the circuit breaker should only be carried out with the circuit breaker in the test or disconnected 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 I_n is detected.

A password is required to prevent any unauthorized access that may cause the circuit breaker to trip.

→ **Password:**
The default password is 0000.
This can be changed in the device settings.

8.1 Testing (remote) of the circuit-breaker via USB/PXPM

The protection function uses the **Power Xpert Protection Manager** software to control the testing via the USB communication.

The test mode of the PXPM software allows users to start the trip test, to monitor the process and to record the results. The test results can be printed out and saved in PDF format.

8.2 Testing the ground-fault releases - primary injection

Most local and national building codes require that all ground fault protection systems be subjected to performance testing when first installed.
Such testing must be performed in accordance with the applicable local and national regulations.

You can also use the **Power Xpert Protection Manager** software to save and print a copy of the circuit-breaker settings for your testing records.

9 Modbus RTU – integrated Modbus port specification

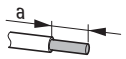
The internal Modbus communication module is an optional accessory for digital NZM circuit breakers with PXR technology.

This module enables the communication between the release and a Modbus RTU fieldbus.

If supplied with a voltage of 24 V DC, the trip unit can communicate as a slave device via the Modbus A, Modbus B and Modbus COM contacts.

The Modbus cable has to comply with the following specifications:

- at least one pair of twisted wires (signal cable Modbus A, Modbus B)
- at least one ground wire (Modbus COM)
- HF-compatible shielding (including HF-compatible grounding)
- compatibility with the respective environmental conditions (temperature, humidity, chemical resistance, etc.)
- The cross section of the wire is as follows:

	**a = 6 mm (a = 0.24 ″)**
	0.15 - 0.5 mm^2 AWG26 - AWG20
	0.20 - 0.5 mm^2 AWG26 - AWG20
	0.25- 0.5 mm^2 AWG26 - AWG21
	2.0 x 0.4 mm

The wiring is done as follows:

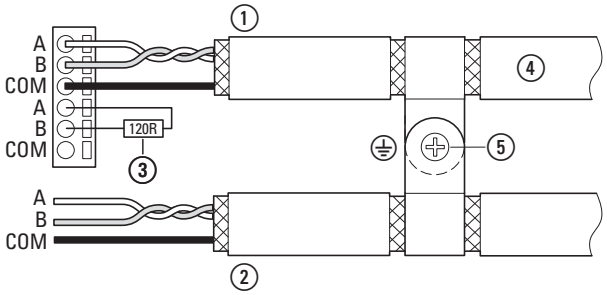


Figure 13: Wiring

① Modbus RTU input cable
② Modbus RTU output cable
③ Bus termination resistor (for the final node)
④ Modbus RTU-compatible cable: triple wire; two twisted signal wires; one shielded COM wire
⑤ HF-compatible functional grounding

9.1 Indication/configuration of the Modbus parameters

The **Power Xpert Protection Manager** software and the Modbus communication link can be used to display and configure the setpoints of the Modbus module via USB commands on the LCD display.

The Modbus communication settings are stored in registers 404000 to 404003 and can be read by means of the function codes 03 or 04, as listed in → table 24. The Modbus settings can be changed by writing these four registers one after the other with function code 06. If the data written in these registers are outside the range, the trip unit will return the exception code 03.

The default settings of the PXR trip units are as follows:

- Address: 2
- Baud rate: 19,200 bit/s
- even parity
- 1 stop bit

Table 22: Modbus settings

Setting value	Modbus register number	Data range
Slave ID	404000	001 - 247
Baud rate	404001	00: 9,600 bit/s 01: 19,200 bit/s 02: 38,400 bit/s 03: 57,600 bit/s
Parity	404002	00: none 01: odd 02: even
Stop bit	404003	00: 1 bit 01: 2 bits

9.2 Network communication protocol

- The release will only recognize the Modbus RTU communication module.
- The trip unit is able to support a maximum of 122 registers (244 data bytes) in a single Modbus transaction.
- The release will only react 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.

9.3 Modbus register map

- There are seven different release types in the NZM digital circuit breaker family. As a result, the devices access the registers differently, since not all versions support all functions.
- Release type -AX does not support an internal Modbus connection; register access is therefore not possible.
- Release types -VX...-T and -PX...-TZ and -TAZ support the ground-fault protection function. For these types, the ground-fault setpoints of group 1 (ground current I_g) can be accessed in the real-time data.
- Release types -PX, -PMX and -PX...TZ and -PX...-TAZ support voltage measurement and are thus equipped for extended measurement data. For these types, the voltage-related objects (voltage, power, energy, and the power factor) can be used in the real-time data.
- Release type -PX...-TAZ supports the maintenance mode. For this type, the maintenance mode setpoints can be accessed in group 0 and in the "Remote Control" group.

9.3.1 Input status (discrete inputs)

The input status bits 101001 to 101032 can be accessed via function code 02. The statuses are defined in → table 23.

The first 16 bits (1001 to 1016) indicate the current status, while the last 16 bits (1017 to 1032) indicate whether the corresponding status is valid.

Table 23: Input status

Input	Description or value	Input	Description or value
1001	The breaker is in the closed position	1017	The breaker is in the closed position and is valid
1002	Unacknowledged trip condition	1018	Unacknowledged trip condition is valid
1003	Active or unacknowledged alarm	1019	Active or unacknowledged alarm is valid
1004	0	1020	0
1005	Maintenance mode is active	1021	Maintenance mode is active and valid
1006	Test mode is active	1022	Test mode is active and valid
1007	0	1023	0
1008	0	1024	0
1009	0	1025	0
1010	Overload mode is active (an overload is present)	1026	Overload mode is active and valid (an overload is present)
1011	Zone selectivity (ZSI) is active	1027	Zone selectivity (ZSI) is active and valid
1012	0	1028	0
1013	0	1029	0
1014	0	1030	0
1015	0	1031	0
1016	0	1032	0

9.3.2 Real-time data object register

Data that are subject to real-time changes, such as current, voltage and power, are displayed in → table 24.

Real-time data can be obtained either in IEEE floating-point or fixed-point format. For data displayed in fixed-point format, each result is presented as a multiplication of the real-time data with a scaling factor. Energy objects can only be obtained in fixed-point format (FP).

Registers for which the IEEE floating-point value is not specified are only supported in fixed-point format.

Each data object occupies two registers (4 bytes), with the exception of certain energy objects. These energy objects in question occupy four registers (8 bytes). As these objects can be changed in real time, the complete data object must be obtained in a single transaction to avoid any "data cracks". Any attempt to access a partial data object will return the exception code 04.

For more information on the exception codes, see → section 9.3.14, "Exception codes", page 78.

Table 24: Real-time data register

Register number		Register address (HEX)		Object		
IEEE floating point	Fixed point (FP)	IEEE floating point	Fixed point (FP)	Description (Values in brackets reflect the American notation.)	Unit	Scale factor (FP)
404609	406145	1200	1800	Cause of status: High byte = primary status Low byte = secondary status		–
404610	406146	1201	1801	Cause code:		
404611	406147	1202	1802	I_{L1} (IA)	A	10
404613	406149	1204	1804	I_{L2} (IB)	A	10
404615	406151	1206	1806	I_{L3} (IC)	A	10
404617	406153	1208	1808	I_G (IG)	A	10
404619	406155	120A	180A	I_N (IN)	A	10
404623	406159	120E	180E	U_{L1-L2} (VAB)	V	10
404625	406161	1210	1810	U_{L2-L3} (VBC)	V	10
404627	406163	1212	1812	U_{L3-L1} (VCA)	V	10
404631	406167	1216	1816	U_{L1-N} (VAN)	V	10
404633	406169	1218	1818	U_{L2-N} (VBN)	V	10
404635	406171	121A	181A	U_{L3-N} (VCN)	V	10
404651	406187	122A	182A	Active 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	Peak active power demand	W	1
404719	406255	126E	186E	Product ID	–	–
404721	406257	1270	1870	Frequency	Hz	100
—	406259	—	1872	Active energy (forward)	kWh	1
—	406261	—	1874	Active energy (reverse)	kWh	1
—	406263	—	1876	Active energy combined (= forward + reverse)	kWh	1
—	406271	—	187E	Apparent energy	kVAh	1
—	406305	—	18A0	Active energy (forward)	Wh	1
—	406309	—	18A4	Active energy (reverse)	Wh	1
—	406313	—	18A8	Active energy combined (= forward + reverse)	Wh	1
—	406329	—	18B8	Apparent energy	VAh	1
404797	406333	12BC	18BC	Peak reactive power demand	Var	1
404799	406335	12BE	18BE	Peak apparent power demand	VA	1
404845	406381	12EC	18EC	Active power demand	W	1
404847	406383	12EE	18EE	Reactive power demand	Var	1
404849	406385	12F0	18F0	Apparent power demand	VA	1

Register number		Register address (HEX)		Object		
IEEE floating point	Fixed point (FP)	IEEE floating point	Fixed point (FP)	Description (Values in brackets reflect the American notation.)	Unit	Scale factor (FP)
404851	406387	12F2	18F2	Minimum value - I_{L1} (IA)	A	10
404853	406389	12F4	18F4	Maximum value - I_{L1} (IA)	A	10
404855	406391	12F6	18F6	Minimum value - I_{L2} (IB)	A	10
404857	406393	12F8	18F8	Maximum value - I_{L2} (IB)	A	10
404859	406395	12FA	18FA	Minimum value - I_{L3} (IC)	A	10
404861	406397	12FC	18FC	Maximum value - I_{L3} (IC)	A	10
404863	406399	12FE	18FE	Minimum value - I_G (IG)	A	10
404865	406401	1300	1900	Maximum value - I_G (IG)	A	10
404867	406403	1302	1902	Minimum value - I_N (IN)	A	10
404869	406405	1304	1904	Maximum value - I_N (IN)	A	10
404871	406407	1306	1906	Minimum value - U_{L1} (VA)	V	10
404873	406409	1308	1908	Maximum value - U_{L1} (VA)	V	10
404875	406411	130A	190A	Minimum value - U_{L2} (VB)	V	10
404877	406413	130C	190C	Maximum value - U_{L2} (VB)	V	10
404879	406415	130E	190E	Minimum value - U_{L3} (VC)	V	10
404881	406417	1310	1910	Maximum value - U_{L3} (VC)	V	10
404883	406419	1312	1912	Minimum value - U_{L1-N} (VAN)	V	10
404885	406421	1314	1914	Maximum value - U_{L1-N} (VAN)	V	10
404887	406423	1316	1916	Minimum value - U_{L2-N} (VAN)	V	10
404889	406425	1318	1918	Maximum value - U_{L2-N} (VAN)	V	10
404891	406427	131A	191A	Minimum value - U_{L3-N} (VAN)	V	10
404893	406429	131C	191C	Maximum value - U_{L3-N} (VAN)	V	10
404895	406431	131E	191E	Overload pre-warning	%	1
404959	406495	135E	195E	Counter - I_{sd}, I_i tripping	–	1
404961	406497	1360	1960	Counter - I_r, I_g tripping	–	1
404963	406499	1362	1962	Operations counter	–	1
404965	406501	1364	1964	Counter - I_{sd} tripping	–	1
404967	406503	1366	1966	Counter - I_i tripping	–	1
404969	406505	1368	1968	Counter - bypass tripping	–	1
404971	406507	136A	196A	Counter - I_r tripping	–	1
404973	406509	136C	196C	Counter - I_g tripping	–	1
404975	406511	136E	196E	Counter - trips total	–	1
404977	406513	1370	1970	Counter - test mode tripping	–	1
404979	406515	1372	1972	Counter - number of openings via the communication interface	–	1

Register number		Register address (HEX)		Object		
IEEE floating point	Fixed point (FP)	IEEE floating point	Fixed point (FP)	Description (Values in brackets reflect the American notation.)	Unit	Scale factor (FP)
404981	406517	1374	1974	Counter - external actuation[1)]	–	1
404983	406519	1376	1976	Time of last actuation (year, month, day, hour, minute, second)		–
405009	406545	1390	1990	Operating time[2)] in minutes	min	1
405011	406547	1392	1992	Operating time[2)] in hours	h	1
405013	406549	1394	1994	Operating time[2)] in days	d	1
405015	406551	1396	1996	Residual life[3)]	points	–

1) An external actuation is a switching operation that is not initiated by the trip unit, such as manual switching, switching via an externally wired remote operator or the actuation of a push-to-trip button.
2) The operating time counter will start as soon as the device is energized, either autonomously or through an external power supply.
3) 0 points ≙ 100 % residual life
10.000 points ≙ 0 % residual life
Conversion formula: Residual life expressed as a percentage = 100 - (point value / 100)

Power objects are presented as fixed-point values in either the two-register fixed-point data format or the four-register coding format.
The two-register format is displayed in kilowatt hours.

The structure of the four-register format and the calculation of the energy values are outlined below.

Energy register 0

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Byte 1 of the mantissa								Byte 0 of the mantissa							

Energy register 1

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Byte 3 of the mantissa								Byte 2 of the mantissa							

Energy register 2

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Byte 5 of the mantissa								Byte 4 of the mantissa							

Energy register 3

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
a = technical unit								b = mantissa factor							

The energy value (four-register energy value) is calculated as follows:

$$\text{Energy} = 2^{a} \times \text{48-bit energy value} \times 10^{b}$$

9.3.3 Setting register

The release set points are arranged in four groups (groups 0 to 3).

Each group can be conceived as a binary array of information that is obtained by accessing the Modbus register. Register 403001 is a R/W register that is used to select the respective group (default: group 0). The high byte contains the desired group number, while the low byte must contain the value 255 (0x0FF). The setting register can be read out with function codes 03 or 04. Function code 06 can be used to write to register 403001. For trip units that support settings, the settings of groups 0, 1, 2 and 3 should be written one after the other using function code 06. Before reading or writing the settings, the appropriate group should be selected by writing to register 403001. Prior to writing the settings, the correct password must be entered, and the settings have to be written within 10 seconds of the password check.

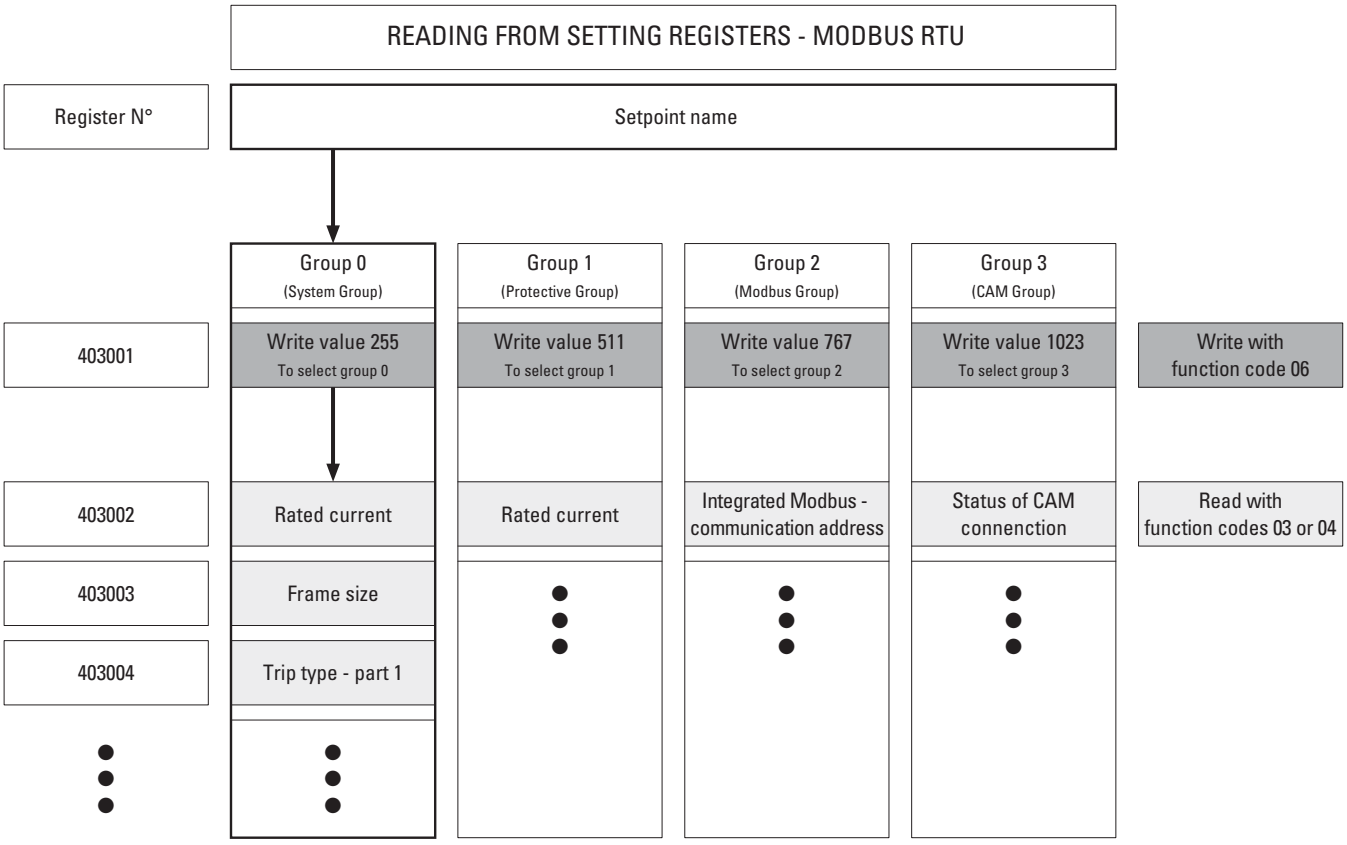


Figure 14: Reading from setting registers – Modbus RTU

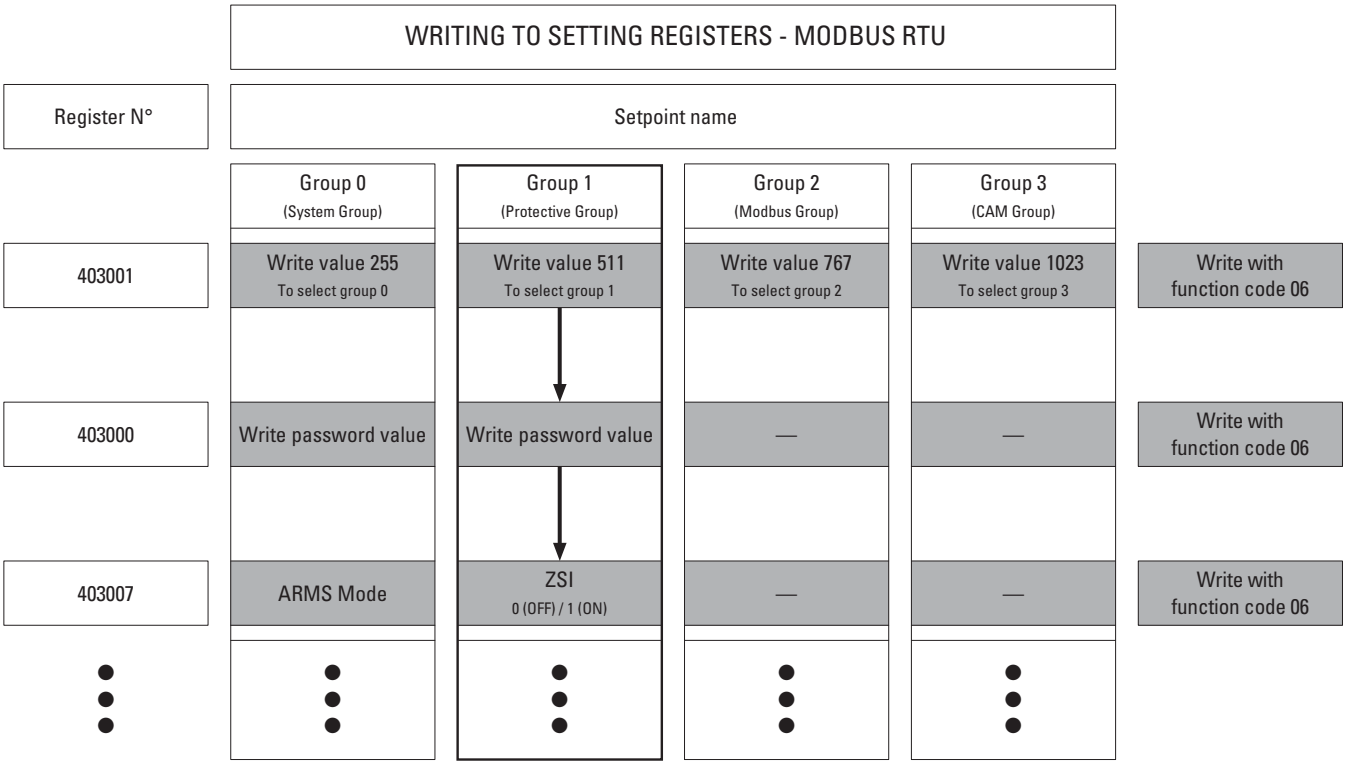


Figure 15: Writing to setting registers – Modbus RTU

The setting groups are assigned as follows:

- Group 0: System group
- Group 1: Protective group
- Group 2: Modbus group
- Group 3: CAM group

Table 25: Setting group 0: "System group"

Register number	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
403000	15 - 0		Password	W	–	0000 (default setting)	–
403001	15 - 0	0xFFFFFF	Group 0 = system	R/W		0x00FF	–
403002	12 - 0	0x1FFFF	Rated current	R	Encoded	NZM2: 25, 40, 63, 90, 100, 140, 160, 200, 220, 250, 300 NZM3: 250, 350, 400, 450, 600, 630 NZM4: 550, 600, 630, 800, 875, 1000, 1200, 1250, 1400, 1600	A
403003	2 - 0	0x0007	Frame size	R	Encoded	The frame size indicates the breaker type. 11: NZM2 12: NZM3 13: NZM4	–
403004	3 - 0	0x000F	Trip type version – part 1	R	Encoded	Bit 0: LdSel: with overload protection I_r = 1 Bit 1: SdSel: with short-time delayed short-circuit protection I_{sd} = 1 Bit 2: InstSel: with instantaneous short-circuit release I_i = 1 Bit 3: GfSel: with ground-fault protection I_g = 1 Bit 4: ARMSel: with maintenance mode = 1 Bit 5: OvrideSel: with instantaneous release function = 1 Bit 6: not used Bit 7: MotorSel: with motor-protection function = 1 Bit 8: NeuSenorSel: 0: 3-pole device 1: 4-pole device Bit 9: ThermalSel: with thermal memory = 1 Bit 12: VoltSel: with voltage meter = 1 Bit 13: 0: PXR20 1: PXR25	–
403005			Trip type version - part 2	R	Encoded	Bit 0: ModbusSel: with integrated Modbus RTU = 1 Bit 1: CAMSel: with CAM RS422 = 1 Bit 2: IOModuleSel: with IO module = 1 Bit 3: RelaySel: with relay module = 1 Bit 4: ZSISel: with zone selectivity = 1 Bit 12: NZM_ACB_Sel: degree of protection NZM = 1, IZMX = 0 Bit 13: IECSel: Standard IEC = 1, UL = 0	–

Register number	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
403006	8	0x0100	Maintenance mode: state	R	Encoded	0: off 1: on	–
	BBE	0x0001	Maintenance mode: remote control	R/W	Encoded	0: off 1: on	–
403007	2 - 0	0x0007	Maintenance mode: Trip setting	R/W	Encoded	1: 2.5 x I_n 2: 4 x I_n 3: 6 x I_n 4: 8 x I_n 5: 10 x I_n	A
403009[1)]	0	0x0001	Direction of incoming supply	R/W	Encoded	0: forward 1: reverse **Note:** only available on the PXR25	
403010[1)]	0	0x0001	Sign convention	R/W	Encoded	Sign convention: 0: IEC 1: IEEE 2: IEEE old	
403011[1)]			Power demand window	R/W	Encoded	Power demand: 0: fixed 1: sliding	
403012[1)]			Power demand interval	R/W	Encoded	Power demand: 5 - 60 min (1 min increments)	
403015			Configuration of relay 1	R/W	Encoded	Configuration of relay 1 and relay 2: → table 21, page 44	
403016			Configuration of relay 2	R/W	Encoded		
403018[1)]			Phase sequence – phase L1 (A)	R/W	Encoded	Phase L1 (A) 0: counterclockwise 1: clockwise	
403021[1)]		0xBCC	Alarm - Residual Life	R/W	Encoded	Range: 50 - 100, step size 1, default value: 75 Alarm level value 100 ≙ 0 % residual life Alarm level value 75 ≙ 25 % residual life Formula for conversion: Alarm level expressed as a percentage = 100 - point value	

1) PXR25 only!!

In setting group 0, the maintenance mode setting (register 403006) can be divided into two parts. The high byte is read only, and is used for the status indication of the maintenance mode, the comprehensive results of the maintenance mode rotary switch, the secondary terminal, and the communication settings. The low byte can be configured and is used to indicate the maintenance mode settings via the communication port (e.g. Modbus, CAM or USB).

The respective protection settings may vary according to the size, type and rated operational current of the release.

Table 26: Setting group 1: "protection group"

Register number	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
403000	15 – 0	0xFFFFFF	Password	W	Encoded	0000 (default setting)	
403001	15 – 0	0xFFFFFF	Group 1 = protection	R/W		0x01FF	
403002	12 – 0	0x1FFFF	Rated current	R	Encoded	NZM2: 25, 40, 63, 90, 100, 140, 160, 200, 220, 250, 300 NZM3: 250, 350, 400, 450, 600, 630 NZM4: 550, 600, 630, 800, 875, 1000, 1200, 1250, 1400, 1600	A
403003	2 – 0	0x0007	Frame size	R	Encoded	The frame size indicates the breaker type. 11: NZM2 12: NZM3 13: NZM4	
403004	3 – 0	0x000F	Trip type version - part 1	R	Encoded	Bit 0: LdSel: with overload protection I_r = 1 Bit 1: SdSel: with short-time delayed short-circuit protection I_{sd} = 1 Bit 2: InstSel: with instantaneous short-circuit release I_i = 1 Bit 3: GfSel: with ground-fault protection I_g = 1 Bit 4: ARMSel: with maintenance mode = 1 Bit 5: OvrideSel: with instantaneous release function = 1 Bit 6: not used Bit 7: MotorSel: with motor-protection function = 1 Bit 8: NeuSenorSel: 4-pole device = 1 3-pole device = 0 Bit 9: ThermalSel: with thermal memory = 1 Bit 12: VoltSel: with voltage meter = 1 Bit 13: 0: PXR20 1: PXR25	
403005			Trip type version - part 2	R	Encoded	Bit 0: ModbusSel: with integrated Modbus RTU = 1 Bit 1: CAMSel: with CAM RS422 = 1 Bit 2: IOModuleSel: with IO module = 1 Bit 3: RelaySel: with relay module = 1 Bit 4: ZSISel: with zone selectivity = 1 Bit 12: NZM_ACB_Sel: degree of protection 0: IZMX 1: NZM Bit 13: IECSel: 0: UL 1: Standard IEC	

Register number	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
403006	0	0x0001	Thermal memory (overload protection)	R/W	Encoded	Activates/deactivates the thermal memory of the overload protection. Recommended for repetitive testing only. Among other things, the thermal memory protects the switch against overheating during repeated overloads. Reactivate the thermal memory after testing: 0: switched off 1: switched on	–
403007	0	0x0001	ZSI	R/W	Encoded	ZSI, zone-selectivity: If enabled for releases with ground-fault protection, ZSI is implemented for both the short-time delayed short-circuit release and for ground-fault protection. If enabled for releases without ground-fault protection, ZSI is only implemented for the short-time delayed short-circuit release. 0: switched off 1: switched on	–
403008	0 – 1	0x0003	Overload release - waveform	R/W	Encoded	Waveform of the overload release 2: I^2t (default setting)	–
403009			Settings - overload release (I_r)	R/W	Unsigned	Settings – overload ($I_r = x * I_n$): NZM PXR20: R NZM PXR25: R/W NZM PXR20: 40: 0.4 45: 0.45 50: 0.5 55: 0.55 60: 0.6 65: 0.65 70: 0.7 75: 0.75 80: 0.8 85: 0.85 90: 0.9 95: 0.95 100: 1.0 The following applies to the NZM PXR25: General value range: 20 - 1600 (in increments of 1 (1 A)) **Caution:** The value range depends on the type: (e.g. a 250-A switch can be set in the range from 40 % to 100 % of I_n (value range: 100 - 250)	A

Register number	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
403010			Settings - overload delay time (t_r)	R/W	Unsigned	Settings - overload delay time (t_r = x [s]) NZM PXR20: R NZM PXR25: R/W NZM PXR20: 20: 2 40: 4 50: 5 60: 6 70: 7 80: 8 100: 10 120: 12 140: 14 160: 16 180: 18 200: 20 32767: ∞ (overload protection deactivated)	s
403011[1)]			Load alarm 1	R/W	Unsigned	Load alarm 1 level (AL1 = n % x I_r): 50 - 120 (in increments of 1)	%
403012	0	0x0001	Short-time delayed short-circuit release - waveform	R/W	Encoded	Waveform of the short-time delayed short-circuit release 0: flat (default setting) 1: I^2t	–
403013			Settings - short-time delayed short-circuit release (I_{sd})	R/W	Unsigned	Settings – short-time delayed short-circuit release (I_{sd} = n x I_r): NZM PXR20: R NZM PXR25: R/W NZM PXR20: 20: 2.0 30: 3.0 40: 4.0 50: 5.0 60: 6.0 65: 6.5 70: 7.0 75: 7.5 80: 8.0 85: 8.5 90: 9.0 95: 9.5 100: 10.0 The following applies to the NZM PXR25: The value range [20 - 100] corresponds to 2 to 10, in increments of 0.1 (1 for values)	A

Register number	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
403014			Settings - delay time of the short-time delayed short-circuit release (t_{sd})	R/W	Unsigned	Settings - delay time of the short-time delayed short-circuit release (t_{sd} = x [ms]) NZM PXR20: R NZM PXR25: R/W NZM PXR20: 0: 0 (no delay) 2: 20 10: 100 30: 300 50: 500 75: 750 100: 1000 The following applies to the NZM PXR25: The value range [0 - 100] corresponds to 0 to 1,000 ms, respectively, in increments of 0.1 (10 for values)	ms
403015			Settings - instantaneous short-circuit release (I_i)	R/W	Unsigned	Settings - instantaneous short-circuit release (I_i = n x I_n) NZM PXR20: R NZM PXR25: R/W NZM PXR20: 20: 2 30: 3 40: 4 50: 5 60: 6 70: 7 80: 8 90: 9 100: 10 110: 11 120: 12 140: 14 160: 16 180: 18 The following applies to the NZM PXR25: The value range [20 - 180] corresponds to 2 to 18, in increments of 0.1 (1 for values)	A
403016	0	0x0001	Type of ground-fault detection	R	Unsigned	Type of ground-fault detection: 0: differential current detection	–
403017	0 – 1	0x0003	Settings - functioning of the ground-fault protection	R/W	Encoded	Type of ground-fault protection 0: trip 1: alarm 2: OFF	–
403018	0	0x0001	ground-fault release - waveform	R/W	Encoded	ground-fault release - waveform: 0: flat 1: I^2t	–

Register number	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
403019			Settings - ground-fault release (I_g)	R/W	Unsigned	Settings - ground-fault release (I_g = n x I_n) NZM PXR20: R NZM PXR25: R/W NZM PXR20: 20: 0.2 30: 0.3 40: 0.4 60: 0.6 80: 0.8 100: 1.0 The following applies to the NZM PXR25: The value range [20 - 100] corresponds to 0.2 to 1.0, in increments of 0.1 (10 for values)	A
403020			Settings - delay time of the ground-fault release (t_g)	R/W	Unsigned	Settings – delay time of the ground-fault release (t_g = x [ms]) NZM PXR20: R NZM PXR25: R/W NZM PXR20: 0: 0 (no delay) 2: 20 10: 100 30: 300 50: 500 75: 750 100: 1000 The following applies to the NZM PXR25: The value range [0 - 100] corresponds to 0 to 1,000 ms, respectively, in increments of 10 ms (10 for values)	ms
403021			Thermal memory (ground-fault protection)	R/W	Encoded	Activates/deactivates the thermal memory of the ground-fault protection. Recommended for repetitive testing only. Among other things, the thermal memory protects the switch against overheating during repeated overloads. Must be reactivated after testing! 0: switched off 1: switched on	–

Register number	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
403022			Settings - neutral protection	R/W	Unsigned	Adjusts the neutral protection of an NZM PXR25 breaker with a "/VAR" variably adjustable neutral conductor 0 = 0 % 60 = 60 % 100 = 100 % (default setting) The lower setting affects the LSI protection functions of the switch, but not the ground-fault protection function ("G"). **Note:** L = **l**ong delay (= overload protection I_r) S = **s**hort delay (= short-time delayed short-circuit protection I_{sd}) I = **i**nstantaneous (= instantaneous short-circuit protection I_i) G = **g**round fault (= ground fault protection I_g)	%
403023[1)]			Load alarm 2	R/W	Unsigned	Load alarm 2 level (AL2 = x % x I_r): 50 - 120 (in increments of 1)	%
403024			Pre-alarm of the ground-fault release	R/W		If the ground-fault protection function is set to "trip" (see register 403017), a pre-alarm can also be set. ($GF_{pre\text{-}alarm}$ = x % x I_g) 50 - 100 (in increments of 5 %)	%

1) Function is not supported by PXR20!

Table 27: Setting group 2: "Modbus" group

Register number	Bit field	Mask field	Setpoint name	R/W	Format	Value	Unit
403000	15 - 0	0xFFFF	Password	W	Encoded	0000 (default setting)	–
403001	15 - 0	0xFFFF	Group 2 = on-board Modbus	R/W	Encoded	0x02FF	–
403002	15 - 0		Integrated Modbus - communication address	R/W	Encoded	001 - 247 (default setting 002)	–
403003	15 - 0		Integrated Modbus - baud rate	R/W	Encoded	00: 9,600 bit/s 01: 19,200 bit/s (default setting) 02: 38,400 bit/s 02: 57,600 bit/s	–
403004	15 - 0		Integrated Modbus - parity	R/W	Encoded	00: none 01: odd 02: even (default setting)	–
403005	15 - 0		Integrated Modbus - stop bit	R/W	Encoded	00: 1 bit 01: 2 bits (default setting)	–

Table 28: Setpoint values for group 3: "CAM" group

Register number	Bit field	Mask field	Setpoint name	R/W	Format	Value	Unit
403000	15 – 0	0xFFFF	Password	W	Encoded	0000 (default setting)	–
403001	15 – 0	0xFFFF	Group 3 - communication adapter module (CAM)	R	Encoded	0x03FF	–
403002	15 – 0		Status of the CAM connection	R	Encoded	Specifies which CAM is connected 0: no external CAM has been connected 1: external Modbus RTU 2: INCOM CAM (IZMX only) 3: EtherNetCAM 4: Profibus DP CAM	–
403003	15 – 0		CAM communication address	R	Encoded	001 - 247	–
403004	15 – 0		CAM baud rate	R	Encoded	0: 1,200 bit/s 1: 4,800 bit/s 2: 9,600 bit/s 3: 19,200 bit/s	–
403005	15 – 0		CAM parity	R	Encoded	0: none 1: odd 2: even	–
403006			CAM stop bit	R		0: 1 bit 1: 2 bits	–
403007			INCOM CAM address	R		0001 - 4094	–
403008			INCOM CAM baud rate	R		1: 9,600 bit/s see IL01301033e P8: for the communication adapter module of the NRX INCOM series, the baud rate is fixed at 9,600 and is represented by a value of 01.	–
403009			Ethernet CAM DHCP activated	R		0: false 1: true	–
403010			Ethernet CAM IP address MSB	R		000 - 255	–
403011			Ethernet CAM IP address LSB	R		000 - 255	–
403012			Ethernet CAM IP address MSB	R		000 - 255	–
403013			Ethernet CAM IP address LSB	R		000 - 255	–
403014			Ethernet CAM subnet mask	R		16 - 32	–
403015			Ethernet CAM standard gateway	R		000 - 255	–
403016			Ethernet CAM standard gateway	R		000 - 255	–
403017			Ethernet CAM reset pin	R		000 - 255	–
403018			Profibus DP CAM address	R		001 - 125	–

9.3.4 Event logs

A trip event provides historical values for the data objects at time the event occurred. The trip unit classifies the event information in order to be able to provide a different quantity for each type. The Modbus communication can only access the historical summary, as well as the trip and event data.

Table 29: Event classification

Event type	Quantity of numbers stored	Description of the event log
Summary	200	→ table 30
Tripping	10	→ table 31
Alarms	10	→ table 31 and → table 32

A single trip may be registered under multiple event types. For example, a protective trip may be recorded in the summary log (→ table 30) as well as in the trip log (→ table 31).

Event information is accessed by selecting the event type and the event ID. Register 408193 is a R/W register for selecting the event type and must be written with function codes 06 or 16. The event information can be read with function codes 03 or 04.

If the event type selection is written to register 408193, the first and last event ID can be retrieved from registers 408194 and 408196, respectively, in order to determine the range of events that have been stored for the selected event type. Register 408198 is a R/W register for selecting the ID of the event in question and must be written with function code 16. If the requested event has been recorded by the device, registers 408200 and 408202 will supply both the ID of the previous event and that of the next event. If the device has not recorded the event in question, it will return the exception code 07.

The date and time at which the requested event occurred are read in logs 408204 to 408211, with the same date and time description as in → table 35, page 77. This value corresponds to the time at which the historical event occurred.

Log 408212 indicates the data content of the selected event type. This is a constant value for the three event types supported by the Modbus port.

The event data also provide a validity bit for each data object, starting with register 408213. If bit 0 is set to 1, the initial data will be valid for the current trip type, bit 1 for the second data object, bit 2 for the third data object, and so forth.

The number of valid bit registers is calculated as:
(number of data objects - 1)/16

The following registers are assigned to the data objects. Any request outside the range of the register address will return the exception code 02.

Table 30: Event summary

Register number	Format	R/W	Description (historical event overview)
408193	Encoded	R/W	Event type: summary = 0x8EFF
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	Date/time	R	Date/time
408212	Encoded	R	Data format: 0x0000, 0x0001, 0x0004, 0x0005, 0x0005, 0x0006
408213	B0	R	Valid bit of the object
408214	Encoded	R	Cause of event: 00: boot process - time OK 01: download of the setpoint values 02: time has been adjusted 03: trip 04: alarm 05: test mode has been selected 06: exiting the test mode 08: boot process - no time 09: test completed 10: maintenance mode activated 11: maintenance mode deactivated 12: opened via the communication interface 13: closed via the communication interface

Table 31: Historical trip / major alarm event

Register number	Format	R/W	Description	Unit
408193	Encoded	R/W	Event type: Trip: 0x80FF Alarm: 0x81FF	–
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	Date/time	R	Date/time	–
408212	Encoded	R	Data format: Trip: 0x0004 Main alarm: 0x0005	–
408213	Bit 15 - Bit 0	R	Validity bits of the object	–
408214	Bit 31 - Bit 16	R	Validity bits of the object	–
408215	Encoded	R	Status reason (primary, secondary, reason)	–

Register number	Format	R/W	Description	Unit
408217	Unsigned 32	R	I_{L1} / IA	A
408219	Unsigned 32	R	I_{L2} / IB	A
408221	Unsigned 32	R	I_{L3} / IC	A
408223	Unsigned 32	R	I_N / IN	A
408227	Unsigned 32	R	I_G / IG residual	A
408229	Unsigned 16	R	U_{L1-L2} (VAB)	V
408230	Unsigned 16	R	U_{L2-L3} (VBC)	V
408231	Unsigned 16	R	U_{L3-L1} (VCA)	V
408232	Unsigned 16	R	U_{L1-N} (VAN)	V
408233	Unsigned 16	R	U_{L2-N} (VBN)	V
408234	Unsigned 16	R	U_{L3-N} (VCN)	V
408235	Signed 32	R	Active 3-phase power	W
408237	Signed 32	R	Reactive 3-phase power	VAR
408239	Unsigned 32	R	Apparent 3-phase power	VA
408241	Signed 32	R	Active power demand	W
408243	Signed 32	R	Reactive power demand	VAR
408245	Unsigned 32	R	Apparent power demand	VA
408248	Unsigned 32	R	Frequency	1/10 Hz
408250	Unsigned 32	R	Number of operations	–
408251	Bit 31 - Bit 0	R	Binary status with valid bits	–

Table 32: Minor alarm event

Register number	Format	R/W	Description
408193	Encoded	R/W	Event type summary = 0x81FF
408194	Signed 32	R	Earliest event ID
408196	Signed 32	R	Latest event ID
408198	Signed 32	R/W	Requested event ID
408200	Signed 32	R	Previous event ID
408202	Signed 32	R	Next event ID
408204	Date/time	R	Date/time
408212	Encoded	R	Data format Small alarm: 0x0006
408213	Bit 0	R	Valid bits of the object
408214	Encoded	R	Status reason (primary, secondary, reason code)

9.3.5 Block of registers

The data object registers of an Eaton product can be rearranged by setting up a block of registers based on the register column in → table 26, page 61. The block of registers is stored in the non-volatile memory.

Function code 16 will load the object assignments for the block of registers. The block assignments are stored starting with registers 401001/420481 (0x03E8/0x5000). Only the first register address of the data object is assigned within the block. For example, although the data object "I_{L1} (I_A)" occupies registers 0x1202 and 0x1203, only register 0x1202 will be loaded into the assigned block of registers. The verification of this block of assigned registers can be read by the release from the registers 401001/420481 (0x03E8/0x5000) using the function codes 03 or 04.

The data of the objects configured in the assigned block of registers are mapped to the registers starting with 401201/420737 (0x04B0/0x5100) and continue successively for each assigned object. The number of objects and their order in this data block depends on the configuration of the assigned block of registers. The total number of data blocks in the registers is limited to 100.

The data can be obtained from the data block of the registers by reading function codes 03 or 04. The address of the start object must match the start address of an object in the data block of the registers. The number of registers to be obtained must match the end address of an object within the data block of the registers.

Table 33: Configuration register

Definition of the register	R/W	Modbus register number		Modbus register address		Number
		Low	High	Low	High	
Assigned block of the register configuration	R/W	401001	420481	0x03E8	0x5000	100
Assigned block of register data	R	401201	420737	0x04B0	0x5100	100 x 2
Invalid object access configuration	R/W	402001	425345	0x07D0	0x6300	1
Configuration of the word order of floating-point data	R/W	402002	425346	0x07D1	0x6301	1
Configuration of the word order of fixed-point data	R/W	402003	425347	0x07D2	0x6302	1
Remote control	R/W	402901	425089	0x0B54	0x6200	3
Time and date register	R/W	402921		0x0B68		8

9.3.6 Configuration register

The non-volatile register 402001/425345 (0x07D0/0x6300) is used to configure the release to respond to a group of data objects, some of which are invalid for this particular group, for example because they are not supported by the release type, etc.

If a value is not equal to zero (default setting), any attempt to access a group of data objects containing an invalid object will return the error code 02.

If the register 402001/425345 (0x07D0/0x6300) is set to 0, the release will respond to a group of objects featuring data that are contained in the valid objects of the group. Since no data are available for the invalid objects, the information in the register is not defined. These registers may contain 0x00000000, and a value of 0xFFFFFF may be used to represent an invalid unsigned fixed-point object. The value 0x80000000 may be used to represent an invalid signed fixed-point object.

NAN = 0x7FF20000 may be used to represent an invalid floating-point value (NAN = not a number = invalid floating-point value). This makes it possible to access a register block with a single read command, even if some of the relevant registers are not implemented in this particular block, in order to avoid having to use multiple read commands that contain only the implemented registers. The application thus ensures the selection of the implemented registers. The start register number must be a valid object. If the start register number accesses an invalid object, exception code 02 will be returned for the invalid data object regardless of this configuration setting.

The non-volatile register 402002/425346 (0x07D1/0x6301) is used to configure the data transfer sequence of 32-bit floating-point data. If not equal to 0 (default setting), the low-order word for the floating-point value will be displayed first in the Modbus register range. If the register is set to 0, the high-order word for the floating-point number will be displayed first in the Modbus register range.

The non-volatile register 402003/425347 (0x07D2/0x6302) is used to configure the data transfer sequence of 32-bit fixed-point data. If the value is not equal to 0 (default setting), the low-order fixed-point word will be displayed first in the Modbus register range. If the register is set to 0, the high-order fixed-point word will be displayed first in the Modbus register range.

The registers 402001/425345 to 402003/425347 (0x07D0/0x6300 to 0x07D2/0x6300) are configured via the write function codes 06 or 16.

In order to support Modbus masters that can only access register 9999, some Eaton registers that were originally assigned to registers above 9999 have been granted double access, both to the original register (to ensure compatibility) and to a new assigned register below 9999. The format is given as a low/high register number followed by (low 16/high 16 Modbus) register addresses.

For example: 4xxxx/4yyyy ($XXXX+1_{16}$/$YYYY+1_{16}$).

9.3.7 Remote control

A range of registers is reserved for the remote control of the release, starting with 402901/425089 to 402903/425091. These three registers should be written using function code 16, together with a "slave action code" and the corresponding ones' complement. The data format registers are shown below.

Data format for remote control

Register 402901 (0x6200)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Byte 1 (slave action)								Byte 0 (slave action)							

Register 402902 (0x6201)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Ones' complement of byte 0 (slave action)								Byte 2 (slave action)							

Register 402903 (0x6202)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Ones' complement of byte 2 (slave action)								Ones' complement of byte 1 (slave action)							

The "slave action code" and its functioning are listed in → table 34, and whether it is supported depends on the specific product.

If the "slave action code" and the associated ones' complement command are valid, the release will perform the action in question. Check breaker status to verify if the requested action has been executed successfully. If so, it will return a normal function code 16 response to the Modbus master. Since it may take some time for the release to become active, the Modbus master can also query the release (e.g. by reading its status) to determine whether the slave action function has been successfully completed following the normal response. If the "slave action code" and the associated ones' complement command are invalid, the release will return the exception code 03.

Table 34: Remote control

Command group	Definition	Bit		
		Byte 2	Byte 1	Byte 0
Reset	Reset the trip	0	0	2
	Reset the min./max. values of the L-N voltages[1)]	0	1	15
	Reset the min./max. values of the L-L voltages[1)]	0	1	14
	Reset the peak power demand[1)]	0	0	4
	Reset all min./max. values	0	1	4
	Reset the energy[1)]	0	0	8
	Reset the power-up display	0	0	3
Maintenance mode	Activate the maintenance mode	1	0	8
	Deactivate the maintenance mode	1	0	9

1) PXR25 only!

9.3.8 Date and time

The release supports the reading and writing of real-time clock information by the Modbus master. Eight registers, starting with register number 402921, are reserved for this purpose (→ table 35, page 74). The system clock can be set using function code 16.

Table 35: Real-time clock

Modbus register number	Modbus register address	Definition	Data range
402921	0x0B68	Month	1 - 12
402922	0x0B69	Day	1 - 31
402923	0x0B6A	Year	2000 - 2099
402924	0x0B6B	Day of the week	1: Sunday … 7: Saturday
402925	0x0B6C	Hour	0 - 23
402926	0x0B6D	Minute	0 - 59
402927	0x0B6E	Seconds	0 - 59
402928	0x0B6F	1/100 of a second	0 - 99

9.3.9 Internal diagnostics

The release supports the Modbus diagnostics for monitoring the internal Modbus communication using function code 08.

Table 36: Diagnostics

Sub-function code	Data	Action
0		Echo query
1	0000: The counters are retained 00FF: Clear all counters	Restart the communication interface
4	0000	Force listen
10	0000	Clear counters
11	0000	Number of Modbus UART bus messages
12	0000	Number of Modbus UART CRC errors
13	0000	Number of exceptions
14	0000	Number of slave messages
15	0000	Number of slave non-responses
16	0000	Number of slave NAKs[1)]
17	0000	Number of "slave busy" messages
18	0000	Number of Modbus UART run errors
20	0000	Clear Modbus UART counters
23	0000	Number of "incorrect Modbus UART character length" errors [2)]
24	0000	Number of "Modbus UART performance failure" errors [3)]
25	0000	Number of Modbus UART parity errors
26	0000	MCU1 firmware version
27	0000	MCU1 firmware revision
28	0000	MCU1 firmware build
29	0000	MCU2 firmware version
30	0000	MCU2 firmware revision
31	0000	MCU2 firmware build
32	0000	USB firmware version
33	0000	USB firmware revision
34	0000	Reset the block of registers
35	0000	COM-MCU firmware version
36	0000	COM-MCU firmware revision
37	0000	COM-MCU firmware version

1) NAK = not acknowledged
2) Framing error
3) Noise error

9.3.10 Primary status codes

Table 37: Primary status codes

Code	Meaning
0x01	open
0x02	closed
0x03	tripped
0x04	Alarm active
0x0D	Threshold value active

9.3.11 Secondary status codes

Table 38: Secondary status codes

Code	Meaning
0x01	not applicable
0x03	Test mode
0x07	has been switched on since last trip / triggered alarm
0x08	alarm

9.3.12 Reason codes

Table 39: Reason codes

Code	Meaning
0x0000	unknown
0x0001	normal
0x0003	Instantaneous short circuit
0x000E	Auxiliary power supply too low
0x0011	Current imbalance
0x0021	Control via the communication interface
0x0025	Coil monitoring
0x002B	Diagnostic warning #2 (configuration read error)
0x003D	Overload
0x003E	Short-time delay
0x0049	Phase currents are close to the threshold value, load alarm
0x004C	Override
0x004D	Setpoint error
0x004E	Overtemperature
0x0050	Overload (neutral conductor)
0x0054	Ground fault
0x0071	Calibration

Code	Meaning
0x0088	Real-time clock
0x0099	Maintenance mode
0x009A	Fault in the breaker mechanism
0x07FC	Digital bypass
0x07FD	Non-volatile memory failure
0x07FE	Watchdog fault
0x07FF	Motor alarm or motor tripping

9.3.13 Device information

The device information (fixed data range) includes, for example, the device name, model name, catalogue number, version number, serial number, date code, firmware version 1 and 2, USB version, and product ID.

Table 40: Reason code definitions

Register number	Modbus address	Description	Format	Range	Register	Comment
404497	0x1190	Device name	ASCII	16 characters	8	EATON PXR20 EATON PXR25
404505	0x1198	Model name	ASCII	16 characters	8	PXR 20/25 MCCB
404513	0x11A0	Catalogue number	ASCII	32 characters	16	internal catalogue number (max. 20 characters)
404529	0x11B0	Style number	ASCII	32 characters	16	internal version number (max. 20 characters)
404545	0x11C0	Serial number	ASCII	32 characters	16	if supported
404561	0x11D0	Date code	ASCII	12 characters	6	yy.mm.dd
404567	0x11D6	Firmware version 1	ASCII	16 characters	8	Sample version 01.02.0033
404575	0x11DE	Firmware version 2	ASCII	16 characters	8	Sample version 01.02.0033
404583	0x11E6	USB version	ASCII	16 characters	8	Sample version 01.02.0033
404591	0x11EE	Release family	U16	16-bit	1	PXR10: 0x02 PXR20: 0x01 PXR25: 0x01
404592	0x11EF	Standard	U16	16-bit	1	IEC only: 0x01 UL only: 0x02 UL/IEC: 0x03
404593	0x11F0	Poles	U16	16-bit	1	3-pole / 4-pole
404607	0x11FE	Product ID	Bitmap	32-bit	2	ppppppvvvvdddddd Division code (dddddd) 6 (0x06) Product code (pppppp): 2: NZM2 PXR 3: NZM3 PXR 4: NZM4 PXR Comm version (vvvv) 0

9.3.14 Exception codes

If there is an error in the request or the response, the release will return an exception code.

Table 41: Exception codes

Exception code	Reason
01	The function code in the query is not supported by the trip unit. **Note:** This exception code is also used for unsupported sub-function codes in Modbus diagnostics.
02	The requested data register or bit address is not supported.
03	The data in the query are not supported.
04	The trip unit does not support this query or only part of a register is used in the query.
05	ACK = acknowledged
06	The trip unit is unable to execute the current request at this time.
07	NAK = not acknowledged The trip unit is unable to execute the request.

10 Industrial Ethernet Communication Adapter Modules (ECAM)

The Ethernet communication adapter modules (ECAM) are optional accessories for digital NZM circuit breakers with PXR20 or PXR25 technology.

These modules are designed to connect with the circuit breaker's internal communication module and expand the communication capabilities into EtherNet/IP, EtherCAT or Profinet interfaces.

For operation, an interface module (included in the PXR25, available as an accessory for PXR20) and an internal Modbus RTU module are also required.

A supply of 24 V DC must be connected to the interface module (→ figure 10, page 41), as well as to the Ethernet communication adapter modules (→ figure 16) below.

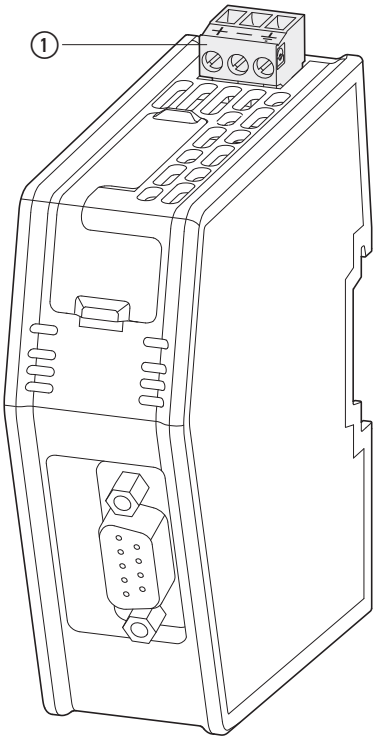


Figure 16: Ethernet communication adapter modules power supply wiring

① 24 V DC terminal (±10 %)

The Modbus cable, which is connected to the ECAM, must comply with the specifications on → page 49 of this manual.

The fieldbus wiring is done as follows:

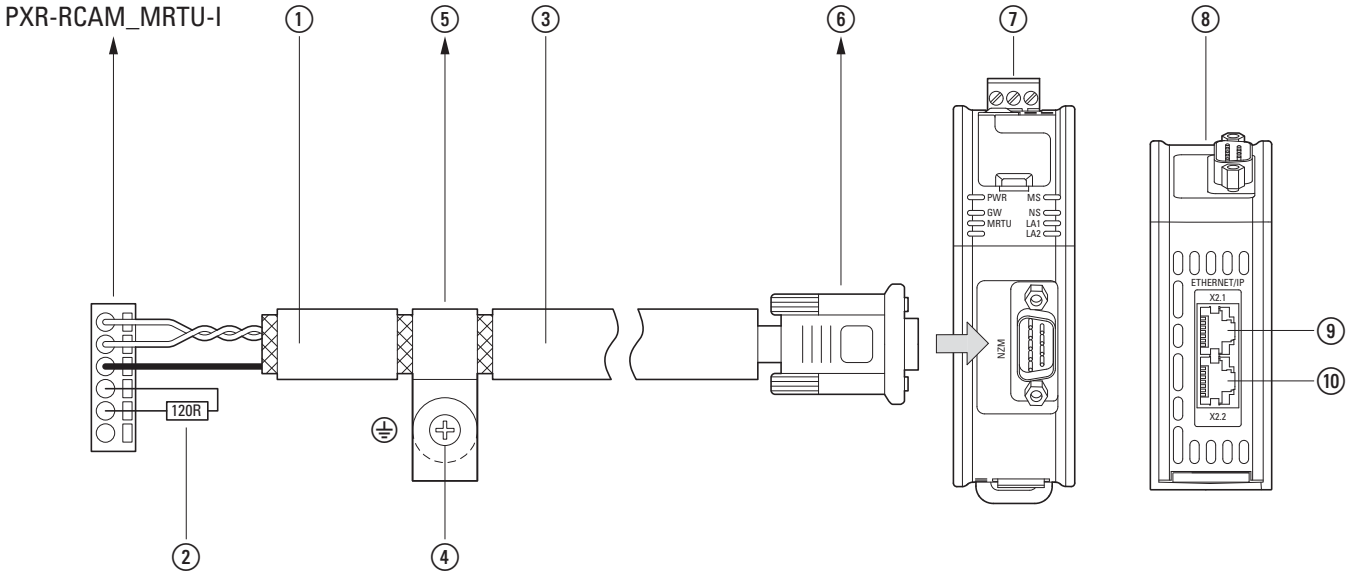


Figure 17: Ethernet communication adapter modules wiring

① Modbus RTU input
② Bus termination resistor (for the final node)
③ Modbus RTU-compatible cable:triple wire: two twisted signal wires; one shielded COM wire
④ HF-compatible functional grounding
⑤ Modbus cable
⑥ RS-485 Sub DB9 male connector
⑦ Front view
⑧ Bottom view
⑨ RJ45 input
⑩ RJ45 output

The Sub DB9 male connector wiring must be done as follows:

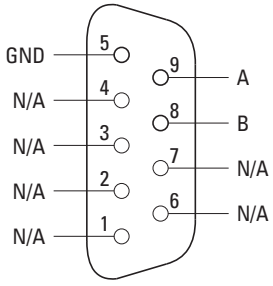
Sub DB9 male connector	Pin	Signal	Description
	1	Not available	Not used
	2	Not available	Not used
	3	Not available	Not used
	4	Not available	Not used
	5	GND	Ground
	6	Not available	Output for external bus termination
	7	Not available	Not used
	8	B	NZM Line B
	9	A	NZM Line A
	Connector	Shield	Functional earth (braided shield)

Figure 18: Sub DB9 Male connector wiring

The ECAM has 8 red/green LEDs.

The following → tables 42 and 43 describe their behaviour.

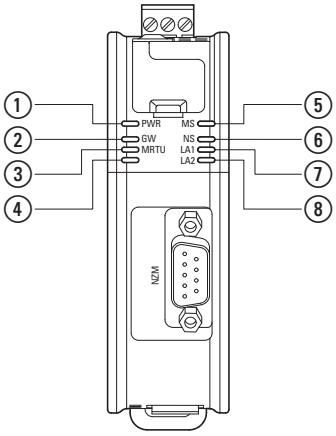


Figure 19: Front panel LEDs

Table 42: LEDs behaviour description - EtherCAT

Number	Name	Function
①	PWR	Indicates power presence
②	GW	Gateway Application
③	MRTU	Modbus RTU Activity
④	–	Not used
⑤	RUN	RUN
⑥	ERR	ERROR
⑦	LA1	Link Activity Port 1
⑧	LA2	Link Activity Port 2

Table 43: LEDs behaviour description – EtherNet/IP and Profinet

Number	Name	Function
①	PWR	Indicates power presence
②	GW	Gateway Application
③	MRTU	Modbus RTU Activity
④	–	Not used
⑤	NS	Network Status
⑥	MS	Module Status
⑦	LA1	Link Activity Port 1
⑧	LA2	Link Activity Port 2

10.1 EtherNet/IP

The PXR-ECAM-IP is designed to connect with an electronic trip unit's internal communication module (PXR-RCAM-MRTU-I) Modbus-RTU link and expand the communication capabilities into EtherNet/IP. The PXR-ECAM-IP is intended for use with PXR20 or PXR25 moulded case circuit breakers (MCCB).

This section details the data and functions available for the Digital NZM with PXR20 or PXR25 trip units via the PXR-ECAM-IP register map. Depending upon trip unit capabilities, a large number of features are accessible through the registers as following described.

10.1.1 Configuration of the Modbus parameters

In order to synchronize the communication between the breaker Modbus RTU (slave device) and the ECAM (which acts as the Modbus RTU master device), the slave ID (Modbus RTU slave), baud rate and parity bit settings of both devices must be configured with the same values.

The ECAM's Modbus RTU slave ID (which the master device addresses to), baud rate and parity bit settings can be configured via ADIs 500-502.

Both, Modbus Slave (PXR-RCAM-MRTU-I) and Modbus Master (PXR-ECAM-IP) have the same default parameters. In case the Modbus RTU slave parameters are not changed from the default values, the values of this communication module do not need to be changed as well.
The ADIs 500, 501 and 502 only provide the possibility to do so, if desired by the user.
The stop bit is automatically set up and the value is 1.

The default settings of the Modbus Slave and Modbus Master are as follows:

Table 44: EtherNet/IP Modbus settings

Setting value	ADI Number	Data range	Default value
Slave ID	500	1 - 247	2
Baud rate	501	00: 9,600 bit/s 01: 19,200 bit/s 02: 38,400 bit/s 03: 57,600 bit/s	01
Parity	502	00: none 01: odd 02: even	02

The valid parameter values will be applied instantly. Writing parameter values outside valid ranges have no effect.

After a power-cycle, meaning the switch off and then on of the module, the PXR-ECAM-IP does not save configured values but returns them to default values.

The Modbus communication parameters of the NZM breaker (Modbus RTU slave) cannot be configured via Ethernet communication adapter module (ECAM).

10.1.2 IP configuration/DIP Switch Settings

The DIP switches are used to configure the device's fieldbus addresses. Flipping a single switch adds the switch specific value to the total address value. As a result, values in a range from 0 to 255 can be configured that way.

Table 45: Fieldbus address configuration via DIP switch

Switch	1	2	3	4	5	6	7	8
Value	1	2	4	8	16	32	64	128

For example, flipping switches 4 and 6 results in the address 40.

Figure 20: DIP switches flipping example

The valid settings for EtherNet/IP are shown on → table 46.

Table 46: Fieldbus address configuration via DIP switch

Switches Setting Value	**Remarks**
000	If the DIP switches are set to 0, the IP address settings stored in the NV-memory of the device are used. The factory default behaviour is DHCP. The IP address settings can be configured by the IPconfig tool. The tool can be downloaded here: https://www.eaton.com/digitalnzm
001	If the DIP switches are set to 1, the address settings of the device are as follows: IP address: 192.168.1.1 Subnet mask: 255.255.255.0 Default Gateway: 192.168.1.2
001 - 254	If the DIP switches are set in the range from 1 to 254, the IP address settings of the device are determined by the switches: IP address: 192.168.1.<DIP Switch Setting> Subnet mask: 255.255.255.0 Default Gateway: 192.168.1.1
255	Invalid Setting. Device will not start-up properly. PWR and GW are flashing red.

10.1.3 EtherNet/IP Electronic Data Sheet (EDS file)

Each device in an EtherNet/IP network is associated with an Electronic Data Sheet (EDS file), which describes the implementation of the product. This file is used by the network configuration tool during network configuration.

→ If necessary, the latest version of the EDS file for the PXR-ECAM-IP can be downloaded here: https://www.eaton.com/digitalnzm

10.1.4 EtherNet/IP register map

There are seven different release types in the NZM digital circuit breaker family. As a result, the devices access the registers differently, since not all versions support all functions.

The release type -AX does not support a communication connection; register access is therefore not possible.

→ The available functions overview, for each trip unit type, can be found on → chapter 3, "Protection and measurement functions", page 19.

10.1.4.1 Input status (discrete inputs)

The input status bits can be requested via object: 0xA2, with attribute: 5 and Instance: 1.

The input status answer is a 4 bytes data type. The first 16 bits (1001 to 1016) indicate the current status, while the last 16 bits (1017 to 1032) indicate whether the corresponding status is valid or supported by the release unit.

Table 47: Input status - EtherNet/IP

Input	Description or value	Input	Description or value
1001	The breaker is in the closed position	1017	The breaker is in the closed position and is valid
1002	Unacknowledged trip condition	1018	Unacknowledged trip condition is valid
1003	Active or unacknowledged alarm	1019	Active or unacknowledged alarm is valid
1004	0	1020	0
1005	Maintenance mode is active	1021	Maintenance mode is active and valid
1006	Test mode is active	1022	Test mode is active and valid
1007	0	1023	0
1008	0	1024	0
1009	0	1025	0
1010	Overload mode is active (an overload is present)	1026	Overload mode is active and valid (an overload is present)

Input	Description or value	Input	Description or value
1011	Zone selectivity (ZSI) is active	1027	Zone selectivity (ZSI) is active and valid
1012	0	1028	0
1013	0	1029	0
1014	0	1030	0
1015	0	1031	0
1016	0	1032	0

10.1.4.2 Real-time data object register

Data that is subject to real-time changes, such as current, voltage and energy, can be requested via object: 0xA2, with attribute: 5 and instances according to → table 48.

Real-time data can be obtained either in IEEE floating-point or fixed-point format. For data displayed in fixed-point format, each result is presented as a multiplication of the real-time data with a scaling factor. Energy objects can only be obtained in fixed-point format.

Registers for which the IEEE floating-point value is not specified are only supported in fixed-point format (FP).

Table 48: Real-time data register - EtherNet/IP

Instance		Object		
IEEE floating point	**Fixed point (FP)**	**Description (Values in brackets reflect the American notation.)**	**Unit**	**Scale factor (FP)**
56	182	Cause of status: High byte = primary status Low byte = secondary status	–	–
57	183	I_{L1} (IA)	A	10
58	184	I_{L2} (IB)	A	10
59	185	IL3 (IC)	A	10
60	186	I_G (IG)	A	10
61	187	I_N (IN)	A	10
62	188	U_{L1-L2} (VAB)	V	10
63	189	U_{L2-L3} (VBC)	V	10
64	190	U_{L3-L1} (VCA)	V	10
65	191	U_{L1-N} (VAN)	V	10
66	192	U_{L2-N} (VBN)	V	10
67	193	U_{L3-N} (VCN)	V	10
72	198	Active 3-phase power	W	1
73	199	Reactive 3-phase power	Var	1
74	200	Apparent 3-phase power	VA	1
75	201	Power factor	–	100
76	202	Frequency	Hz	10
81	207	Peak active power demand	W	1
82	208	Product ID	–	–
83	209	Frequency	Hz	100
–	210	Active energy (forward)	kWh	1
–	211	Active energy (reverse)	kWh	1
–	212	Active energy combined (= forward + reverse)	kWh	1
–	213	Apparent energy	kVAh	1
–	214	Active energy (forward)	Wh	1
–	215	Active energy (reverse)	Wh	1
–	216	Active energy combined (= forward + reverse)	Wh	1
–	217	Apparent energy	VAh	1
84	218	Peak reactive power demand	Var	1
85	219	Peak apparent power demand	VA	1
90	224	Active power demand	W	1
91	225	Reactive power demand	Var	1
92	226	Apparent power demand	VA	1

Instance		Object		
IEEE floating point	**Fixed point (FP)**	**Description (Values in brackets reflect the American notation.)**	**Unit**	**Scale factor (FP)**
93	227	Minimum value - I_{L1} (IA)	A	10
94	228	Maximum value - I_{L1} (IA)	A	10
95	229	Minimum value - I_{L2} (IB)	A	10
96	230	Maximum value - I_{L2} (IB)	A	10
97	231	Minimum value - I_{L3} (IC)	A	10
98	232	Maximum value - I_{L3} (IC)	A	10
99	233	Minimum value - I_G (IG)	A	10
100	234	Maximum value - I_G (IG)	A	10
101	235	Minimum value - I_N (IN)	A	10
102	236	Maximum value - I_N (IN)	A	10
103	237	Minimum value - U_{L1} (VA)	V	10
104	238	Maximum value - U_{L1} (VA)	V	10
105	239	Minimum value - U_{L2} (VB)	V	10
106	240	Maximum value - U_{L2} (VB)	V	10
107	241	Minimum value - U_{L3} (VC)	V	10
108	242	Maximum value - U_{L3} (VC)	V	10
109	243	Minimum value - U_{L1-N} (VAN)	V	10
110	244	Maximum value - U_{L1-N} (VAN)	V	10
111	245	Minimum value - U_{L2-N} (VAN)	V	10
112	246	Maximum value - U_{L2-N} (VAN)	V	10
113	247	Minimum value - U_{L3-N} (VAN)	V	10
114	248	Maximum value - U_{L3-N} (VAN)	V	10
115	249	Overload pre-warning	%	1
129	263	Counter - I_{sd}, I_i tripping	–	1
130	264	Counter - I_r, I_g tripping	–	1
131	265	Operations counter	–	1
132	266	Counter - I_{sd} tripping	–	1
133	267	Counter - I_i tripping	–	1
134	268	Counter - bypass tripping	–	1
135	269	Counter - I_r tripping	–	1
136	270	Counter - I_g tripping	–	1
137	271	Counter - trips total	–	1
138	272	Counter - test mode tripping	–	1
139	273	Counter - number of openings via the communication interface	–	1
140	274	Counter - external actuation[1)]	–	1
141	275	Time of last actuation (year, month, day, hour, minute, second)	–	–

Instance		Object		
IEEE floating point	**Fixed point (FP)**	**Description (Values in brackets reflect the American notation.)**	**Unit**	**Scale factor (FP)**
142	276	Operating time[2] in minutes	min	1
143	277	Operating time[2] in hours	h	1
144	278	Operating time[2] in days	d	1
145	279	Residual life[3]	points	–

1) An external actuation is a switching operation that is not initiated by the trip unit, such as manual switching, switching via an externally wired remote operator or the actuation of a push-to-trip button.
2) The operating time counter will start as soon as the device is energized, either autonomously or through an external power supply.
3) 0 points ≙ 100 % residual life
10.000 points ≙ 0 % residual life
Conversion formula: Residual life expressed as a percentage = 100 - (point value / 100)

10.1.4.3 Setting register

The release settings are arranged in three groups (groups 0 to 2).

Each group can be conceived as a binary array of information.

Before reading or writing the settings, the appropriate group should be selected. Access to the groups are obtained via object 0xA2, with attribute 5 and instance 3, which is a R/W register used to select the respective group (default: group 0). The high byte contains the desired group number, while the low byte must contain the value 255 (0x0FF).

Prior to writing the settings, the correct password must be entered via object 0xA2, with attribute 5 and instance 2, and the settings have to be written within 10 seconds of the password check.

For trip units that support settings, the settings of groups 0, 1 and 2 should be written one after the other.

The setting groups are assigned as follows:

- Group 0: System group
- Group 1: Protective group
- Group 2: Modbus group

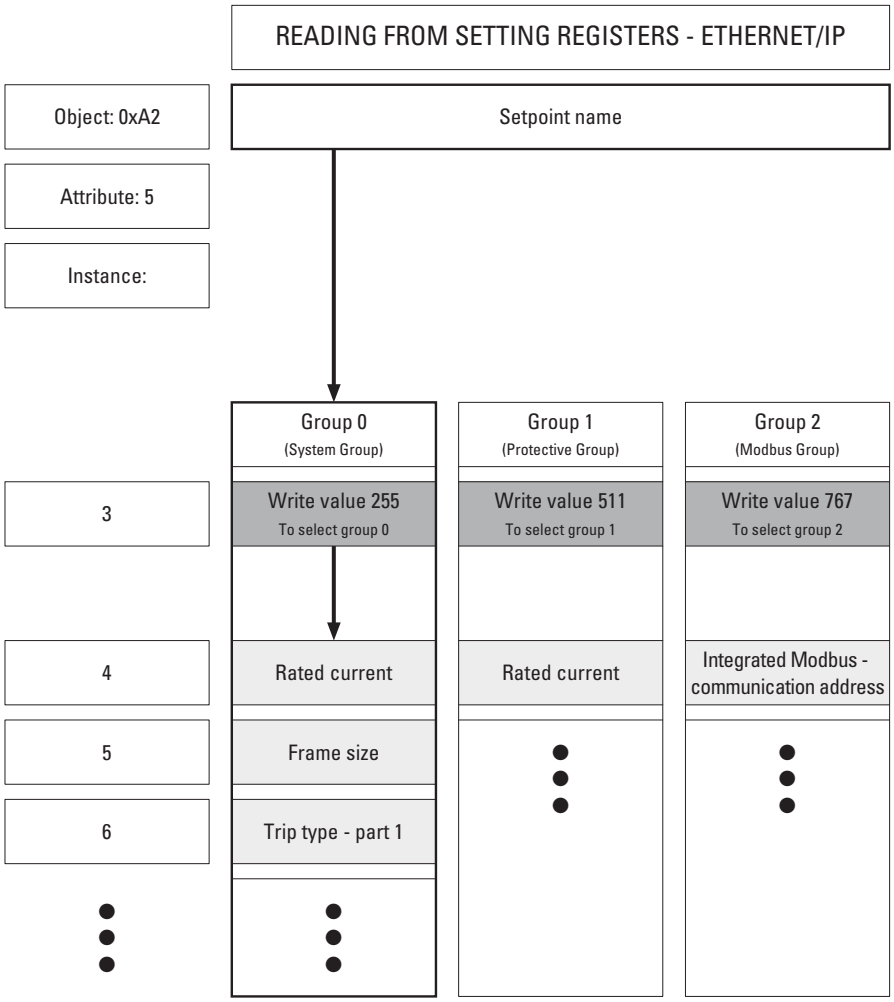


Figure 21: Reading from setting registers – EtherNet/IP

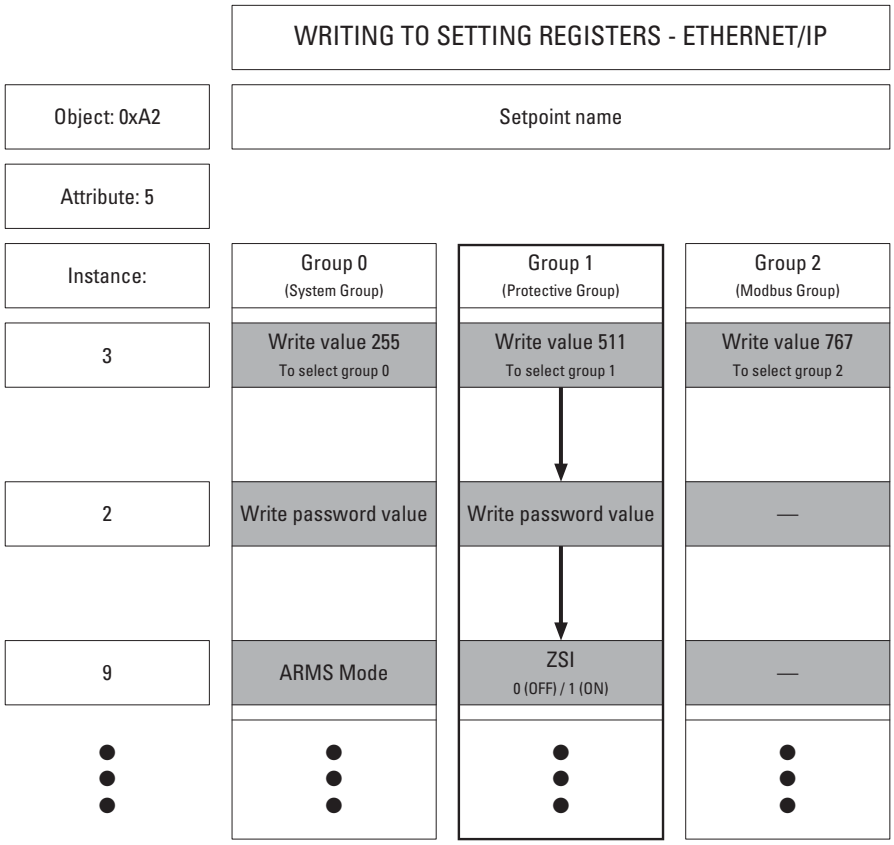


Figure 22: Writing to setting registers – EtherNet/IP

Table 49: Setting group 0: "System group" - EtherNet/IP

Instance	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
2	15 - 0		Password	W	–	0000 (default setting	–
3	15 - 0	0xFFFFFF	Group 0 = system	R/W	–	0x00FF	–
4	12 - 0	0x1FFFF	Rated current	R	Encoded	NZM2: 25, 40, 63, 90, 100, 140, 160, 200, 220, 250, 300 NZM3: 250, 350, 400, 450, 600, 630 NZM4: 550, 600, 630, 800, 875, 1000, 1200, 1250, 1400, 1600	A
5	2 - 0	0x0007	Frame size	R	Encoded	The frame size indicates the breaker type 11: NZM2 12: NZM3 13: NZM4	–
6	3 - 0	0x000F	Trip type version - part 1	R	Encoded	Bit 0: LdSel: with overload protection I_r = 1 Bit 1: SdSel: with short-time delayed short-circuit protection I_{sd} = 1 Bit 2: InstSel: with instantaneous short-circuit release I_i = 1 Bit 3: GfSel: with ground-fault protection I_g = 1 Bit 4: ARMSel: with maintenance mode = 1 Bit 5: OvrideSel: with instantaneous release function = 1 Bit 6: not used Bit 7: MotorSel: with motor-protection function = 1 Bit 8: NeuSenorSel: 0: 3-pole device 1: 4-pole device Bit 9: ThermalSel: with thermal memory = 1 Bit 12: VoltSel: with voltage meter = 1 Bit 13: 0: PXR20 1: PXR25	–
7			Trip type version - part 2	R	Encoded	Bit 0: ModbusSel: with integrated Modbus RTU = 1 Bit 1: CAMSel: with CAM RS422 = 1 Bit 2: IOModuleSel: with IO module = 1 Bit 3: RelaySel: with relay module = 1 Bit 4: ZSISel: with zone selectivity = 1 Bit 12: NZM_ACB_Sel: degree of protection 0: IZMX 1: NZM Bit 13: IECSel: 0: UL 1: Standard IEC Bit 0: ModbusSel: with integrated Modbus RTU = 1 Bit 1: CAMSel: with CAM RS422 = 1 Bit 2: IOModuleSel: with IO module = 1 Bit 3: RelaySel: with relay module = 1 Bit 4: ZSISel: with zone selectivity = 1 Bit 12: NZM_ACB_Sel: degree of protection 0: IZMX 1: NZM Bit 13: IECSel: 0: UL 1: Standard IEC	–

Instance	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
8	8	0x0100	Maintenance mode: state	R	Encoded	0: off 1: on	–
	BBE	0x0001	Maintenance mode: remote control	R/W	Encoded	0: off 1: on	–
9	2 - 0	0x0007	Maintenance mode: Trip setting	R/W	Encoded	1: 2.5 x I_n 2: 4 x I_n 3: 6 x I_n 4: 8 x I_n 5: 10 x I_n	A
11	0	0x0001	Direction of incoming supply	R/W	Encoded	0: forward 1: reverse **Note:** only available on the PXR25	–
12	0	0x0001	Sign convention	R/W	Encoded	Sign convention: 0: IEC 1: IEEE 2: IEEE old	–
13			Power demand window	R/W	Encoded	Power demand: 0: fixed 1: sliding	–
14			Power demand interval	R/W	Encoded	Power demand: 5 - 60 min (1 min increments)	–
17			Configuration of relay 1	R/W	Encoded	Configuration of relay 1 and relay 2: → table 21, page 44	–
18			Configuration of relay 2	R/W	Encoded		–
20			Phase sequence – phase L1 (A)	R/W	Encoded	Phase L1 (A) 0: counterclockwise 1: clockwise	–
23		0xBCC	Alarm - Residual Life	R/W	Encoded	Range: 50 - 100, step size 1, default value: 75 Alarm level value 100 ≙ 0 % residual life Alarm level value 75 ≙ 25 % residual life Formula for conversion: Alarm level expressed as a percentage = 100 - point value	–

In setting group 0, the maintenance mode setting (instance 8) can be divided into two parts. The high byte is read only and is used for the status indication of the maintenance mode, the comprehensive results of the maintenance mode rotary switch, the secondary terminal and the communication settings. The low byte can be configured and is used to indicate the maintenance mode settings via the communication port.

The respective protection settings may vary according to the size, type and rated operational current of the release.

Table 50: Setting group 1: "Protection group" - EtherNet/IP

Instance	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
2	15 - 0	0xFFFFFF	Password	W	Encoded	0000 (default setting)	–
3	15 - 0	0xFFFFFF	Group 1 = protection	R/W			–
4	12 - 0	0x1FFFF	Rated current	R	Encoded	NZM2: 25, 40, 63, 90, 100, 140, 160,200, 220, 250, 300 NZM3: 250, 350, 400, 450, 600, 630 NZM4: 550, 600, 630, 800, 875,1000, 1200, 1250, 1400, 1600	A
5	2 - 0	0x0007	Frame size	R	Encoded	The frame size indicates the breaker type. 11: NZM2 12: NZM3 13: NZM4	–
6	3 - 0	0x000F	Trip type version - part 1	R	Encoded	Bit 0: LdSel: with overload protection I_r = 1 Bit 1: SdSel: with short-time delayed short-circuit protection I_{sd} = 1 Bit 2: InstSel: with instantaneous short circuit release I_i = 1 Bit 3: GfSel: with ground-fault protection I_g = 1 Bit 4: ARMSel: with maintenance mode = 1 Bit 5: OvrideSel: with instantaneous release function = 1 Bit 6: not used Bit 7: MotorSel: with motor-protection function = 1 Bit 8: NeuSenorSel: 0: 3-pole device 1: 4-pole device Bit 9: ThermalSel: with thermal memory = 1 Bit 12: VoltSel: with voltage meter = 1 Bit 13: 0: PXR20 1: PXR25	–
7			Trip type version - part 2	R	Encoded	Bit 0: ModbusSel: with integrated Modbus RTU = 1 Bit 1: CAMSel: with CAM RS422 = 1 Bit 2: IOModuleSel: with IO module = 1 Bit 3: RelaySel: with relay module = 1 Bit 4: ZSISel: with zone selectivity = 1 Bit 12: NZM_ACB_Sel: degree of protection 0: IZMX 1: NZM Bit 13: IECSel: 0: UL 1: Standard IEC	
8	0	0x0001	Thermal memory (overload protection)	R/W	Encoded	Activates/deactivates the thermal memory of the overload protection. Recommended for repetitive testing only. Among other things, the thermal memory protects the switch against overheating during repeated overloads. Reactivate the thermal memory after testing: 0: switched off 1: switched on	

Instance	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
9	0	0x0001	ZSI	R/W	Encoded	ZSI, zone-selectivity: If enabled for releases with ground-fault protection, ZSI is implemented for both the short-time delayed short-circuit release and for ground-fault protection. If enabled for releases without groundfault protection, ZSI is only implemented for the short-time delayed short-circuit release. 0: switched off 1: switched on	–
10	0 - 1	0x0003	Overload release - waveform	R/W	Encoded	Waveform of the overload release 2 = I^2t (default setting)	–
11			Settings -release (I_r)	R/W	Unsigned	Settings – overload (I_r = x * I_n): NZM PXR20: R NZM PXR25: R/W NZM PXR20: 40: 0.4 45: 0.4 50: 0.5 55: 0.5 00: 0.6 05: 0.6 10: 0.7 15: 0.8 20: 0.8 25: 0.8 30: 0.9 35: 1.0 40: 1.0 The following applies to the NZM PXR25: General value range: 20 - 1600 (in increments of 1 (1 A)) **Caution:** The value range depends on the type: (e.g. a 250-A switch can be set in the range from 40 % to 100 % of In (value range: 100 - 250)	–
12			Settings -overload delay time (t_r)	R/W	Unsigned	Settings - overload delay time (t_r = x [s]) NZM PXR20: R NZM PXR25: R/W NZM PXR20: 20: 2 40: 4 50: 5 60: 6 70: 7 80: 8 100: 10 120: 12 140: 14 160: 16 180: 18 200: 20 32767: ∞ (overload protection deactivated)	s
13			Load alarm 1	R/W	Unsigned	Load alarm 1 level (AL1 = n % x I_r): 50 - 120 (in increments of 1)	%

Instance	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
14	0	0x0001	Short-time delayed short circuit release - waveform	R/W	Encoded	Waveform of the short-time delayed short-circuit release 0: flat (default setting) 1: I^2t	–
15			Settings - short-time delayed short-circuit release (I_{sd})	R/W	Unsigned	Settings - short-time delayed short circuit release (I_{sd} = n x I_r): NZM PXR20: R NZM PXR25: R/W NZM PXR20: 20: 2.0 30: 3.0 40: 4.0 50: 5.0 60: 6.0 65: 6.5 70: 7.0 75: 7.5 80: 8.0 85: 8.5 90: 9.0 95: 9.5 100: 10.0 The following applies to the NZM PXR25: The value range [20 - 100] corresponds to 2 to 10, in increments of 0.1 (1 for values)	A
16			Settings - delay time of the short-time delayed short-circuit release (t_{sd})	R/W	Unsigned	Settings - delay time of the short-time delayed short-circuit release (t_{sd} = x [ms]) NZM PXR20: R NZM PXR25: R/W NZM PXR20: 0: 0 (no delay) 2: 20 10: 100 30: 300 50: 500 75: 750 100: 1000 The following applies to the NZM PXR25: The value range [0 - 100] corresponds to 0 to 1,000 ms, respectively, in increments of 0.1 (10 for values)	ms

Instance	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
17			Settings - instantaneous short-circuit release (I_i)	R/W	Unsigned	Settings - instantaneous short-circuit release ($I_i = n \times I_n$) NZM PXR20: R NZM PXR25: R/W NZM PXR20: 20: 2 30: 3 40: 4 50: 5 60: 6 70: 7 80: 8 90: 9 100: 10 110: 11 120: 12 140: 14 160: 16 180: 18 The following applies to the NZM PXR25: The value range [20 - 180] corresponds to 2 to 18, in increments of 0.1 (1 for values)	A
18	0	0x0001	Type of ground-fault detection	R	Unsigned	Type of ground-fault detection: 0: differential current detection	–
19	0 - 1	0x0003	Settings - functioning of the ground-fault protection	R/W	Encoded	Type of ground-fault protection 0: trip 1: alarm 2: OFF	–
20	0	0x0001	ground-fault release - waveform	R/W	Encoded	ground-fault release - waveform: 0: flat 1: I^2t	–
21			Settings - ground-fault release (I_g)	R/W	Unsigned	Settings - ground-fault release ($I_g = n \times I_n$) NZM PXR20: R NZM PXR25: R/W NZM PXR20: 20: 0.2 30: 0.3 40: 0.4 60: 0.6 80: 0.8 100: 1.0 The following applies to the NZM PXR25: The value range [20 - 100] corresponds to 0.2 to 1.0, in increments of 0.1 (10 for values)	A

Instance	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
22			Settings - delay time of the ground-fault release (t_g)	R/W	Unsigned	Settings - delay time of the ground-fault release (t_g = x [ms]) NZM PXR20: R NZM PXR25: R/W NZM PXR20: 0: 0 (no delay) 2: 20 10: 100 30: 300 50: 500 75: 750 100: 1000 The following applies to the NZM PXR25: The value range [0 - 100] corresponds to 0 to 1,000 ms, respectively, in increments of 10 ms (10 for values)	ms
23			Thermal memory (ground fault protection)	R/W	Encoded	Activates/deactivates the thermal memory of the ground-fault protection. Recommended for repetitive testing only. Among other things, the thermal memory protects the switch against overheating during repeated overloads. **Note:** Must be reactivated after testing! 0: switched off 1: switched on	–
24			Settings - neutral protection	R/W	Unsigned	Adjusts the neutral protection of an NZM PXR25 breaker with a "/VAR" variably adjustable neutral conductor 0 ≙ 0 % 60 ≙ 60 % 100 ≙ 100 % (default setting) The lower setting affects the LSI protection functions of the switch, but not the ground-fault protection function ("G"). **Note:** L = long delay (= overload protection I_r) S = short delay (= short-time delayed short-circuit protection I_{sd}) I = instantaneous (= instantaneous shortcircuit protection I_i) G = ground fault (= ground fault protection I_g)	%
25			Load alarm 2	R/W	Unsigned	Load alarm 2 level (AL2 = x % x I_r): 50 - 120 (in increments of 1)	%
26			Pre-alarm of the groundfault release	R/W		If the ground-fault protection function is set to "trip" (see register 403017), a pre-alarm can also be set. ($GF_{pre\text{-}alarm}$ = x % x I_g) 50 - 100 (in increments of 5 %)	%

Table 51: Setting group 2: "Modbus" group - EtherNet/IP

Instance	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
2	15 - 0	0xFFFFFF	Password	W	Encoded	0000 (default setting)	–
3	15 - 0	0xFFFFFF	Group 2 = on-board Modbus	R/W	Encoded	0x02FF	–
4	15 - 0		Integrated Modbus -communication address	R/W	Encoded	001 - 247 002: default setting	–
5	15 - 0		Integrated Modbus - baud rate	R/W	Encoded	00: 9,600 bit/s 01: 19,200 bit/s (default setting) 02: 38,400 bit/s 02: 57,600 bit/s	–
6	15 - 0		Integrated Modbus - parity	R/W	Encoded	00: none 01: odd 02: even (default setting)	–
7	15 - 0		Integrated Modbus - stop bit	R/W	Encoded	00: 1 bit 01: 2 bits (default setting)	–

10.1.4.4 Event logs

A trip event provides historical values for the data objects at the time the event has occurred. The trip unit classifies the event information in order to be able to provide a different quantity for each type.
The EtherNet/IP communication can only access the historical summary, as well as the trip and event data.

Table 52: Event classification - EtherNet/IP

Event type	Quantity of numbers stored	Description of the event log
Summary	200	→ table 53
Tripping	10	→ table 54
Alarms	10	→ table 54 and → table 55

A single trip may be registered under multiple event types. For example, a protective trip may be recorded in the summary log (→ table 53) as well as in the trip log (→ table 54).

Event logs information is accessed via object: 0xA2, with attribute: 5 and instances according to tables 53, 54 and 55.

If the event type selection is written to instance 316, the first and last event ID can be retrieved from instances 317 and 318, respectively, in order to determine the range of events that have been stored for the selected event type. Instance 319 is a R/W register for selecting the ID of the event in question. If the requested event has been recorded by the device, instances 320 and 321 will supply both the ID of the previous event and that of the next event.

If the device has not recorded the event in question, the exception code can be queried by requesting the Modbus communication status of the ECAM from the controller via a dedicated industrial protocol object (via object: 0xA2, with attribute: 5 and instance: 410).

For more information on the exception codes, see → section 10.1.4.11, “Exception codes”, page 107.

The date and time at which the requested event occurred are read in log 322, with the same date and time description as in → table 57, page 104.
This value corresponds to the time at which the historical event occurred.

Log 323 indicates the data content of the selected event type. This is a constant value for the three event types supported by the module.

The event data also provide a valid bit for each data object, starting with instance 324. If bit 0 is set to 1, the initial data will be valid for the current trip type, bit 1 for the second data object, bit 2 for the third data object, and so forth.

The number of valid bit registers is calculated as:
(number of data objects - 1)/16

The following instances are assigned to the data objects.

Table 53: Event summary - EtherNet/IP

Instance	Format	R/W	Description (historical event overview)
316	Encoded	R/W	Event type: summary = 0x8EFF
317	Unsigned 32	R	Earliest event ID
318	Unsigned 32	R	Latest event ID
319	Unsigned 32	R/W	Requested event ID
320	Unsigned 32	R	Previous event ID
321	Unsigned 32	R	Next event ID
322	Date/time	R	Date/time
323	Encoded	R	Data format: 0x0000, 0x0001, 0x0004, 0x0005, 0x0005, 0x0006
324	B0	R	Valid bit of the object
325	Encoded	R	Cause of event: 00: boot process - time OK 01: download of the setpoint values 02: time has been adjusted 03: trip 04: alarm 05: test mode has been selected 06: exiting the test mode 08: boot process - no time 09: test completed 10: maintenance mode activated 11: maintenance mode deactivated 12: opened via the communication interface 13: closed via the communication interface

Table 54: Historical trip / major alarm event - EtherNet/IP

Instance	Format	R/W	Description (historical event overview)	Unit
316	Encoded	R/W	Event type: Trip: 0x80FF Alarm: 0x81FF	–
317	Unsigned 32	R	Earliest event ID	–
318	Unsigned 32	R	Latest event ID	–
319	Unsigned 32	R/W	Requested event ID	–
320	Unsigned 32	R	Previous event ID	–
321	Unsigned 32	R	Next event ID	–
322	Date/time	R	Date/time	–
323	Encoded	R	Data format: Trip: 0x0004 Main alarm: 0x0005	–
324	Bit 15 - Bit 0	R	Valid bits of the object	–
325	Bit 31 - Bit 16	R	Valid bits of the object	–
326	Encoded	R	Status reason (primary, secondary, reason)	–
327	Unsigned 32	R	I_{L1} (IA)	A

Instance	Format	R/W	Description (historical event overview)	Unit
328	Unsigned 32	R	I_{L2} (IB)	A
329	Unsigned 32	R	I_{L3} (IC)	A
330	Unsigned 32	R	I_N (IN)	A
332	Unsigned 32	R	I_G (IG residual)	A
333	Unsigned 16	R	U_{L1-L2} (VAB)	V
334	Unsigned 16	R	U_{L2-L3} (VBC)	V
335	Unsigned 16	R	U_{L3-L1} (VCA)	V
336	Unsigned 16	R	U_{L1-N} (VAN)	V
337	Unsigned 16	R	U_{L2-N} (VBN)	V
338	Unsigned 16	R	U_{L3-N} (VCN)	V
339	Signed 32	R	Active 3-phase power	W
340	Signed 32	R	Reactive 3-phase power	VAR
341	Unsigned 32	R	Apparent 3-phase power	VA
342	Signed 32	R	Active power demand	W
343	Signed 32	R	Reactive power demand	VAR
344	Unsigned 32	R	Apparent power demand	VA
346	Unsigned 32	R	Frequency	1/10 Hz
348	Unsigned 32	R	Number of operations	–
349	Bit 31 - Bit 0	R	Binary status with valid bits	–

Table 55: Minor alarm event - EtherNet/IP

Instance	Format	R/W	Description (historical event overview)
316	Encoded	R/W	Event type: Summary = 0x81FF
317	Signed 32	R	Earliest event ID
318	Signed 32	R	Latest event ID
319	Signed 32	R/W	Requested event ID
320	Signed 32	R	Previous event ID
321	Signed 32	R	Next event ID
322	Date/time	R	Date/time
323	Encoded	R	Data format: Small alarm: 0x0006
324	Bit 0	R	Valid bits of the object
325	Encoded	R	Status reason (primary, secondary, reason code)

10.1.4.5 Remote control

One instance with 3 elements of 16 bits is reserved for remote control of the release, accessed via object: 0xA2, with attribute: 5 and Instance: 358. These three elements should be written together with a "slave action code" and the corresponding ones' complement.

The data format registers, which is an array of 16 bits, are shown below.

Data format for remote control

Instance 358 - Element 1

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Byte 1 (slave action)								Byte 0 (slave action)							

Instance 358 - Element 2

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Ones' complement of byte 0 (slave action)								Byte 2 (slave action)							

Instance 358 - Element 3

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Ones' complement of byte 2 (slave action)								Ones' complement of byte 1 (slave action)							

The "slave action code" and its functioning are listed in → table 56, and whether it is supported depends on the specific product.

If the "slave action code" and the associated ones' complement command are valid, the release will perform the action in question. If the "slave action code" and the associated ones' complement command are invalid, the exception code can be queried by requesting the Modbus communication status of the ECAM from the controller via a dedicated industrial protocol object (via object: 0xA2, with attribute: 5 and instance: 410).

→ For more information on the exception codes, see → section 10.1.4.11, "Exception codes", page 107.

Table 56: Remote control - EtherNet/IP

Command group	Definition	Bit		
		Byte 2	Byte 1	Byte 0
Reset	Reset the trip	0	0	2
	Reset the min./max. values of the L-N voltages[1)]	0	1	15
	Reset the min./max. values of the L-L voltages[1)]	0	1	14
	Reset the peak power requirement[1)]	0	0	4
	Reset all min./max. values	0	1	4
	Reset the energy[1)]	0	0	8
	Reset the power-up display	0	0	3
Maintenance mode	Activate the maintenance mode	1	0	8
	Deactivate the maintenance mode	1	0	9

1) PXR25 only!

10.1.4.6 Date and time

The release supports the reading and writing of real-time clock information by the Ethernet communication adapter module EtherNet/IP.

Eight registers, starting with instance number 350, are reserved for this purpose.

Table 57: Real-time clock - EtherNet/IP

Instance	Definition	Data range
350	Month	01. Dez
351	Day	Jan 31
352	Year	2000 - 2099
353	Day of the week	1 = Sunday … 7 = Saturday
354	Hour	0 - 23
355	Minute	0 - 59
356	Seconds	0 - 59
357	1/100 of a second	0 - 99

10.1.4.7 Primary status codes

Table 58: Primary status codes (High Byte) - EtherNet/IP

Code	Meaning
0x01	open
0x02	closed
0x03	tripped
0x04	Alarm active
0x0D	Threshold value active

10.1.4.8 Secondary status codes

Table 59: Secondary status codes (Low Byte) - EtherNet/IP

Code	Meaning
0x01	not applicable
0x03	Test mode
0x07	has been switched on since last trip / triggered alarm
0x08	alarm

10.1.4.9 Reason codes

Table 60: Reason codes - EtherNet/IP

Code	Meaning
0x0000	unknown
0x0001	normal
0x0003	Instantaneous short circuit
0x000E	Auxiliary power supply too low
0x0011	Current imbalance
0x0021	Control via the communication interface
0x0025	Coil monitoring
0x002B	Diagnostic warning #2 (configuration read error)
0x003D	Overload
0x003E	Short-time delay
0x0049	Phase currents are close to the threshold value, load alarm
0x004C	Override
0x004D	Setpoint error
0x004E	Overtemperature
0x0050	Overload (neutral conductor)
0x0054	Ground fault
0x0071	Calibration

Code	Meaning
0x0088	Real-time clock
0x0099	Maintenance mode
0x009A	Fault in the breaker mechanism
0x07FC	Digital bypass
0x07FD	Non-volatile memory failure
0x07FE	Watchdog fault
0x07FF	Motor alarm or motor tripping

10.1.4.10 Device information

The device information (fixed data range) includes, for example, the device name, model name, catalogue number, version number, serial number, date code, firmware version 1 and 2, USB version, and product ID.

Table 61: Reason code definitions - EtherNet/IP

Instance	Description	Format	Range	Register	Comment
42	Device name	ASCII	16 characters	8	EATON PXR20 EATON PXR25
43	Model name	ASCII	16 characters	8	PXR 20/PX25 MCCB
44	Catalogue number	ASCII	32 characters	16	internal catalogue number (max. 20 characters)
45	Style number	ASCII	32 characters	16	internal version number (max. 20 characters)
46	Serial number	ASCII	32 characters	16	if supported
47	Date code	ASCII	12 characters	6	yy.mm.dd
48	Firmware version 1	ASCII	16 characters	8	Sample version 01.02.0033
49	Firmware version 2	ASCII	16 characters	8	Sample version 01.02.0033
50	USB version	ASCII	16 characters	8	Sample version 01.02.0033
51	Release family	U16	16-bit	1	PXR10: 0x02 PXR20: 0x01 PXR25: 0x01
52	Standard	U16	16-bit	1	IEC only: 0x01 UL only: 0x02 UL / IEC: 0x03
53	Poles	U16	16-bit	1	3-pole / 4-pole
55	Product ID	Bitmap	32-bit	2	ppppppvvvvdddddd Division code (dddddd) 06 (0x06) Product code (pppppp): 2: NZM2 PXR 3: NZM3 PXR 4: NZM4 PXR Comm version (vvvv) 0

10.1.4.11 Exception codes

If there is an error in the request or the response, the release will return an exception code via instance 410.

Table 62: Exception codes - EtherNet/IP

Modbus returned exception code values	Meaning
0	No error
8	Timeout error occurred
10	Illegal function exception
11	Illegal data address
12	Illegal data value
13	Slave device failure
14	Slave acknowledge
15	Slave device busy
16	Memory parity error
17	ECAM path unavailable
18	ECAM target device failed to respond

10.2 EtherCAT

The PXR-ECAM-ECT is designed to connect with an electronic trip unit's internal communication module (PXR-RCAM-MRTU-I) Modbus-RTU link and expand the communication capabilities into EtherCAT. The PXR-ECAM-ECT is intended for use with PXR20 or PXR25 moulded case circuit breakers (MCCB).

This section details the data and functions available for the Digital NZM with PXR20 or PXR25 trip units via the PXR-ECAM-ECT register map.

Depending upon trip unit capabilities, a large number of features are accessible through the registers as following described.

10.2.1 Configuration of the Modbus parameters

In order to synchronize the communication between the breaker Modbus RTU (slave device) and the ECAM (which acts as the Modbus RTU master device), the slave ID (Modbus RTU slave), baud rate and parity bit settings of both devices must be configured with the same values.

The ECAM's Modbus RTU slave ID (which the master device addresses to), baud rate and parity bit settings can be configured via SDOs 0x21F4 - 0x21F6.

Both, Modbus Slave (PXR-RCAM-MRTU-I) and Modbus Master (PXR-ECAM-ECT) have the same default parameters. In case the Modbus RTU slave parameters are not changed from the default values, the values of this communication module do not need to be changed as well. The SDOs 0x21F4 - 0x21F6 only provide the possibility to do so, if desired by the user.

The stop bit is automatically set up and the value is 1.

The default settings of the Modbus Slave and Modbus Master are as follows:

Table 63: EtherCAT settings

Setting value	SDO Number [Hex]	Data range	Default value
Slave ID	0x21F4	1 - 247	2
Baud rate	0x21F5	00: 9,600 bit/s 01: 19,200 bit/s 02: 38,400 bit/s 03: 57,600 bit/s	01
Parity	0x21F6	00: none 01: odd 02: even	02

The valid parameter values will be applied instantly. Writing parameter values outside valid ranges has no effect.

After a power-cycle, meaning the switch off the trip unit, the PXR-ECAM-ECT does not save configured values but returns them to default values.

The Modbus communication parameters of the NZM breaker (Modbus RTU slave) cannot be configured via Ethernet communication adapter module (ECAM).

10.2.2 EtherCAT Slave Information file (ESI file)

Each device in an EtherCAT network is associated with an EtherCAT Slave Information file (an ESI file), which describes the implementation of the product. This file is used by the network configuration tool during network configuration.

If necessary, the latest version of the ESI file for the PXR-ECAM-ECT can be downloaded here:
https://www.eaton.com/digitalnzm

10.2.3 EtherCAT register map

There are seven different release types in the NZM digital circuit breaker family. As a result, the devices access the registers differently, since not all versions support all functions.

The release type -AX does not support a communication connection; register access is therefore not possible.

→ The available functions overview, for each trip unit type, can be found on → chapter 3, "Protection and measurement functions", page 19.

10.2.3.1 Input status (discrete inputs)

The input status bits can be requested via sub index: 0 and index 2001 (Hex). The input status answer is a 4 bytes data type. The first 16 bits (1001 - 1016) indicate the current status, while the last 16 bits (1017 - 1032) indicate whether the corresponding status is valid or supported by the release unit.

Table 64: Input status - EtherCAT

Input	Description or value	Input	Description or value
1001	The breaker is in the closed position	1017	The breaker is in the closed position and is valid
1002	Unacknowledged trip condition	1018	Unacknowledged trip condition is valid
1003	Active or unacknowledged alarm	1019	Active or unacknowledged alarm is valid
1004	0	1020	0
1005	Maintenance mode is active	1021	Maintenance mode is active and valid
1006	Test mode is active	1022	Test mode is active and valid
1007	0	1023	0
1008	0	1024	0
1009	0	1025	0
1010	Overload mode is active (an overload is present)	1026	Overload mode is active and valid (an overload is present)
1011	Zone selectivity (ZSI) is active	1027	Zone selectivity (ZSI) is active and valid
1012	0	1028	0
1013	0	1029	0
1014	0	1030	0
1015	0	1031	0
1016	0	1032	0

10.2.3.2 Real-time data object register

Data that is subject to real-time changes, such as current, voltage and energy, can be requested via sub index: 0 and indexes according to → table 65.

Real-time data can be obtained either in IEEE floating-point or fixed-point format. For data displayed in fixed-point format, each result is presented as a multiplication of the real-time data with a scaling factor. Energy objects can only be obtained in fixed-point format.

Registers for which the IEEE floating-point value is not specified are only supported in fixed-point format (FP).

Table 65: Real-time data register - EtherCAT

Index (Hex)		**Object**		
IEEE floating point	**Fixed point (FP)**	**Description (Values in brackets reflect the American notation.)**	**Unit**	**Scale factor (FP)**
2038	20B6	Cause of status: High byte = primary status Low byte = secondary status	–	–
2039	20B7	I_{L1} (IA)	A	10
203A	20B8	I_{L2} (IB)	A	10
203B	20B9	IL3 (IC)	A	10
203C	20BA	I_G (IG)	A	10
203D	20BB	I_N (IN)	A	10
203E	20BC	U_{L1-L2} (VAB)	V	10
203F	20BD	U_{L2-L3} (VBC)	V	10
2040	20BE	U_{L3-L1} (VCA)	V	10
2041	20BF	U_{L1-N} (VAN)	V	10
2042	20C0	U_{L2-N} (VBN)	V	10
2043	20C1	U_{L3-N} (VCN)	V	10
2048	20C6	Active 3-phase power	W	1
2049	20C7	Reactive 3-phase power	Var	1
204A	20C8	Apparent 3-phase power	VA	1
204B	20C9	Power factor	–	100
204C	20CA	Frequency	Hz	10
2051	20CF	Peak active power demand	W	1
2052	20D0	Product ID	–	–
2053	20D1	Frequency	Hz	100
–	20D2	Active energy (forward)	kWh	1
–	20D3	Active energy (reverse)	kWh	1
–	20D4	Active energy combined (= forward + reverse)	kWh	1
–	20D5	Apparent energy	kVAh	1
–	20D6	Active energy (forward)	Wh	1

Index (Hex)		Object		
IEEE floating point	**Fixed point (FP)**	**Description (Values in brackets reflect the American notation.)**	**Unit**	**Scale factor (FP)**
–	20D7	Active energy (reverse)	Wh	1
–	20D8	Active energy combined (= forward + reverse)	Wh	1
–	20D9	Apparent energy	VAh	1
2054	20DA	Peak reactive power demand	Var	1
2055	20DB	Peak apparent power demand	VA	1
205A	20E0	Active power demand	W	1
205B	20E1	Reactive power demand	Var	1
205C	20E2	Apparent power demand	VA	1
205D	20E3	Minimum value - I_{L1} (IA)	A	10
205E	20E4	Maximum value - I_{L1} (IA)	A	10
205F	20E5	Minimum value - I_{L2} (IB)	A	10
2060	20E6	Maximum value - I_{L2} (IB)	A	10
2061	20E7	Minimum value - I_{L3} (IC)	A	10
2062	20E8	Maximum value - I_{L3} (IC)	A	10
2063	20E9	Minimum value - I_G (IG)	A	10
2064	20EA	Maximum value - I_G (IG)	A	10
2065	20EB	Minimum value - I_N (IN)	A	10
2066	20EC	Maximum value - I_N (IN)	A	10
2067	20ED	Minimum value - U_{L1} (VA)	V	10
2068	20EE	Maximum value - U_{L1} (VA)	V	10
2069	20EF	Minimum value - U_{L2} (VB)	V	10
206A	20F0	Maximum value - U_{L2} (VB)	V	10
206B	20F1	Minimum value - U_{L3} (VC)	V	10
206C	20F2	Maximum value - U_{L3} (VC)	V	10
206D	20F3	Minimum value - U_{L1-N} (VAN)	V	10
206E	20F4	Maximum value - U_{L1-N} (VAN)	V	10
206F	20F5	Minimum value - U_{L2-N} (VAN)	V	10
2070	20F6	Maximum value - U_{L2-N} (VAN)	V	10
2071	20F7	Minimum value - U_{L3-N} (VAN)	V	10
2072	20F8	Maximum value - U_{L3-N} (VAN)	V	10
2073	20F9	Overload pre-warning	%	1
2081	2107	Counter - I_{sd}, I_i tripping	–	1
2082	2108	Counter - I_r, I_g tripping	–	1
2083	2109	Operations counter	–	1
2084	210A	Counter - I_{sd} tripping	–	1
2085	210B	Counter - I_i tripping	–	1
2086	210C	Counter - bypass tripping	–	1

Index (Hex)		Object		
IEEE floating point	**Fixed point (FP)**	**Description (Values in brackets reflect the American notation.)**	**Unit**	**Scale factor (FP)**
2087	210D	Counter - I_r tripping	–	1
2088	210E	Counter - I_g tripping	–	1
2089	210F	Counter - trips total	–	1
208A	2110	Counter - test mode tripping	–	1
208B	2111	Counter - number of openings via the communication interface	–	1
208C	2112	Counter - external actuation[1)]	–	1
208D	2113	Time of last actuation (year, month, day, hour, minute, second)	–	–
208E	2114	Operating time[2)] in minutes	min	1
208F	2115	Operating time[2)] in hours	h	1
2090	2116	Operating time[2)] in days	d	1
2091	2117	Residual life[3)]	points	–

1) An external actuation is a switching operation that is not initiated by the trip unit, such as manual switching, switching via an externally wired remote operator or the actuation of a push-to-trip button.

2) The operating time counter will start as soon as the device is energized, either autonomously or through an external power supply.

3) 0 points ≙ 100 % residual life
10.000 points ≙ 0 % residual life
Conversion formula: Residual life expressed as a percentage = 100 - (point value / 100)

10.2.3.3 Setting register

The release settings are arranged in three groups (groups 0 to 2).

Each group can be conceived as a binary array of information.

Before reading or writing the settings, the appropriate group should be selected. Access to the groups are obtained via sub index 0 and index 2003 (hex), which is a R/W register used to select the respective group (default: group 0). The high byte contains the desired group number, while the low byte must contain the value 255 (0x0FF).

Prior to writing the settings, the correct password must be entered via sub index 0 and index 2002 (hex), and the settings have to be written within 10 seconds of the password check.

For trip units that support settings, the settings of groups 0, 1 and 2 should be written one after the other.

The setting groups are assigned as follows:

- Group 0: System group
- Group 1: Protective group
- Group 2: Modbus group

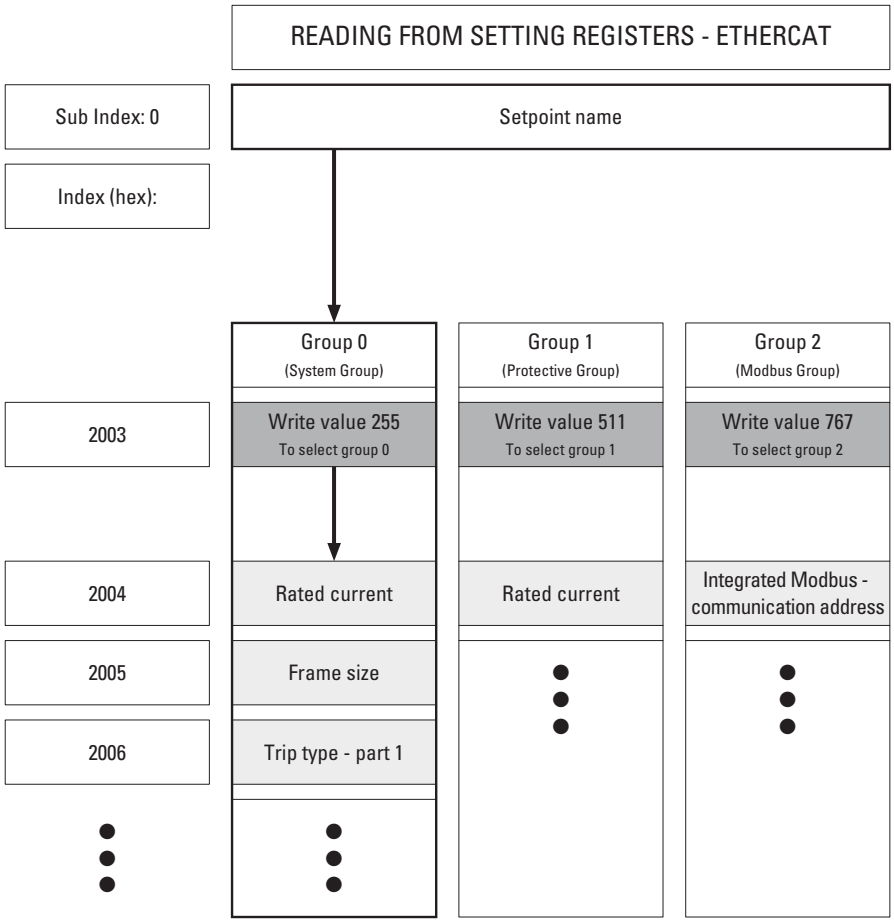


Figure 23: Reading from setting registers - EtherCAT

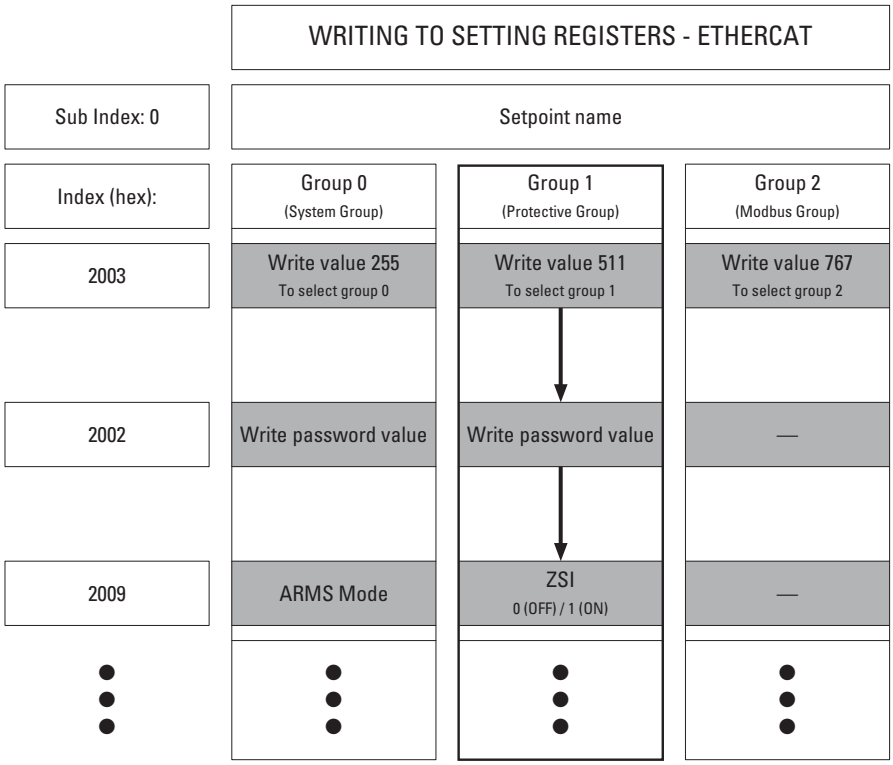


Figure 24: Writing to setting registers - EtherCAT

Table 66: Setting group 0: "System group" - EtherCAT

Index (Hex)	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
2002	15 - 0		Password	W	–	0000 (default setting	–
2003	15 - 0	0xFFFFFF	Group 0 = system	R/W		0x00FF	–
2004	12 - 0	0x1FFFF	Rated current	R	Encoded	NZM2: 25, 40, 63, 90, 100, 140, 160, 200, 220, 250, 300 NZM3: 250, 350, 400, 450, 600, 630 NZM4: 550, 600, 630, 800, 875, 1000, 1200, 1250, 1400, 1600	A
2005	2 - 0	0x0007	Frame size	R	Encoded	The frame size indicates the breaker type. 11: NZM2 12: NZM3 13: NZM4	–
2006	3 - 0	0x000F	Trip type version - part 1	R	Encoded	Bit 0: LdSel: with overload protection I_r = 1 Bit 1: SdSel: with short-time delayed short-circuit protection I_{sd} = 1 Bit 2: InstSel: with instantaneous short-circuit release I_i = 1 Bit 3: GfSel: with ground-fault protection I_g = 1 Bit 4: ARMSel: with maintenance mode = 1 Bit 5: OvrideSel: with instantaneous release function = 1 Bit 6: not used Bit 7: MotorSel: with motor-protection function = 1 Bit 8: NeuSenorSel: 0: 3-pole device 1: 4-pole device Bit 9: ThermalSel: with thermal memory = 1 Bit 12: VoltSel: with voltage meter = 1 Bit 13: 0: PXR20 1: PXR25	–
2007			Trip type version - part 2	R	Encoded	Bit 0: ModbusSel: with integrated Modbus RTU = 1 Bit 1: CAMSel: with CAM RS422 = 1 Bit 2: IOModuleSel: with IO module = 1 Bit 3: RelaySel: with relay module = 1 Bit 4: ZSISel: with zone selectivity = 1 Bit 12: NZM_ACB_Sel: degree of protection 0: IZMX 1: NZM Bit 13: IECSel: 0: UL 1: Standard IEC	–
2008	8	0x0100	Maintenance mode: state	R	Encoded	0: off 1: on	–
	BBE	0x0001	Maintenance mode: remote control	R/W	Encoded	0: off 1: on	–
2009	2 - 0	0x0007	Maintenance mode: Trip setting	R/W	Encoded	1: 2.5 x I_n 2: 4 x I_n 3: 6 x I_n 4: 8 x I_n 5: 10 x I_n	A

Index (Hex)	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
200B	0	0x0001	Direction of incoming supply	R/W	Encoded	0: forward 1: reverse Note: only available on the PXR25	–
200C	0	0x0001	Sign convention	R/W	Encoded	Sign convention: 0: IEC 1: IEEE 2: IEEE old	–
200D			Power demand window	R/W	Encoded	Power demand: 0: fixed 1: sliding	–
200E			Power demand interval	R/W	Encoded	Power demand: 5 - 60 min (1 min increments)	–
2011			Configuration of relay 1	R/W	Encoded	Configuration of relay 1 and relay 2: → table 21, page 44	–
2012			Configuration of relay 2	R/W	Encoded		–
2014			Phase sequence - phase L1 (A)	R/W	Encoded	Phase L1 (A) 0: counterclockwise 1: clockwise	–
2017		0xBCC	Alarm - Residual Life	R/W	Encoded	Range: 50 - 100, step size 1, default value: 75 Alarm level value 100 ≙ 0 % residual life Alarm level value 75 ≙ 25 % residual life Formula for conversion: Alarm level expressed as a percentage = 100 - point value	–

In setting group 0, the maintenance mode setting (index 2008) can be divided into two parts. The high byte is read only and is used for the status indication of the maintenance mode, the comprehensive results of the maintenance mode rotary switch, the secondary terminal and the communication settings. The low byte can be configured and is used to indicate the maintenance mode settings via the communication port.

The respective protection settings may vary according to the size, type and rated operational current of the release.

Table 67: Setting group 1: "Protection group" - EtherCAT

Index [Hex]	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
2002	15 - 0	0xFFFFFF	Password	W	Encoded	0000 (default setting)	–
2003	15 - 0	0xFFFFFF	Group 1 = protection	R/W			–
2004	12 - 0	0x1FFFF	Rated current	R	Encoded	NZM2: 25, 40, 63, 90, 100, 140, 160, 200, 220, 250, 300 NZM3: 250, 350, 400, 450, 600, 630 NZM4: 550, 600, 630, 800, 875, 1000, 1200, 1250, 1400, 1600	A
2005	2 - 0	0x0007	Frame size	R	Encoded	The frame size indicates the breaker type. 11: NZM2 12: NZM3 13: NZM4	–
2006	3 - 0	0x000F	Trip type version - part 1	R	Encoded	Bit 0: LdSel: with overload protection I_r = 1 Bit 1: SdSel: with short-time delayed short-circuit protection I_{sd} = 1 Bit 2: InstSel: with instantaneous short circuit release I_i = 1 Bit 3: GfSel: with ground-fault protection I_g = 1 Bit 4: ARMSel: with maintenance mode = 1 Bit 5: OvrideSel: with instantaneous release function = 1 Bit 6: not used Bit 7: MotorSel: with motor-protection function = 1 Bit 8: NeuSenorSel: 0: 3-pole device 1: 4-pole device Bit 9: ThermalSel: with thermal memory = 1 Bit 12: VoltSel: with voltage meter = 1 Bit 13: 0: PXR20 1: PXR25	–
2007			Trip type version - part 2	R	Encoded	Bit 0: ModbusSel: with integrated Modbus RTU = 1 Bit 1: CAMSel: with CAM RS422 = 1 Bit 2: IOModuleSel: with IO module = 1 Bit 3: RelaySel: with relay module = 1 Bit 4: ZSISel: with zone selectivity = 1 Bit 12: NZM_ACB_Sel: degree of protection 0: IZMX 1: NZM Bit 13: IECSel: 0: UL 1: Standard IEC	–
2008	0	0x0001	Thermal memory (overload protection)	R/W	Encoded	Activates/deactivates the thermal memory of the overload protection. Recommended for repetitive testing only. Among other things, the thermal memory protects the switch against overheating during repeated overloads. Reactivate the thermal memory after testing: 0: switched off 1: switched on	–

Index [Hex]	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
2009	0	0x0001	ZSI	R/W	Encoded	ZSI, zone-selectivity: If enabled for releases with ground-fault protection, ZSI is implemented for both the short-time delayed short-circuit release and for ground-fault protection. If enabled for releases without groundfault protection, ZSI is only implemented for the short-time delayed short-circuit release. 0: switched off 1: switched on	–
200A	0 - 1	0x0003	Overload release - waveform	R/W	Encoded	Waveform of the overload release 2: I^2t (default setting)	–
200B			Settings - release (I_r)	R/W	Unsigned	Settings – overload (I_r = x * I_n): NZM PXR20: R NZM PXR25: R/W NZM PXR20: 40: 0.4 45: 0.45 50: 0.5 55: 0.55 60: 0.6 65: 0.65 70: 0.7 75: 0.75 80: 0.8 85: 0.85 90: 0.9 95: 0.95 100: 1.0 The following applies to the NZM PXR25: General value range: 20 - 1600 (in increments of 1 (1 A)) **Caution:** The value range depends on the type: (e.g. a 250-A switch can be set in the range from 40 % to 100 % of I_n (value range: 100 - 250)	–
200C			Settings - overload delay time (t_r)	R/W	Unsigned	Settings - overload delay time (t_r = x [s]) NZM PXR20: R NZM PXR25: R/W NZM PXR20: 20: 2 40: 4 50: 5 60: 6 70: 7 80: 8 100: 10 120: 12 140: 14 160: 16 180: 18 200: 20 32767: ∞ (overload protection deactivated)	s
200D			Load alarm 1	R/W	Unsigned	Load alarm 1 level (AL1 = n % x I_r): 50 - 120 (in increments of 1)	%

Index [Hex]	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
200E	0	0x0001	Short-time delayed short circuit release - waveform	R/W	Encoded	Waveform of the short-time delayed short-circuit release 0: flat (default setting) 1: I^2t	–
200F			Settings - short-time delayed short-circuit release (I_{sd})	R/W	Unsigned	Settings - short-time delayed short circuit release (I_{sd} = n x I_r): NZM PXR20: R NZM PXR25: R/W NZM PXR20: 20: 2.0 30: 3.0 40: 4.0 50: 5.0 60: 6.0 65: 6.5 70: 7.0 75: 7.5 80: 8.0 85: 8.5 90: 9.0 95: 9.5 100: 10.0 The following applies to the NZM PXR25: The value range [20 - 100] corresponds to 2 to 10, in increments of 0.1 (1 for values)	A
2010			Settings - delay time of the short-time delayed short-circuit release (t_{sd})	R/W	Unsigned	Settings - delay time of the short-time delayed short-circuit release (t_{sd} = x [ms]) NZM PXR20: R NZM PXR25: R/W NZM PXR20: 0: 0 (no delay) 2: 20 10: 100 30: 300 50: 500 75: 750 100: 1000 The following applies to the NZM PXR25: The value range [0 - 100] corresponds to 0 to 1,000 ms, respectively, in increments of 0.1 (10 for values)	ms

Index [Hex]	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
2011			Settings - instantaneous short-circuit release (I_i)	R/W	Unsigned	Settings - instantaneous short-circuit release ($I_i = n \times I_n$) NZM PXR20: R NZM PXR25: R/W NZM PXR20: 20: 2 30: 3 40: 4 50: 5 60: 6 70: 7 80: 8 90: 9 100: 10 110: 11 120: 12 140: 14 160: 16 180: 18 The following applies to the NZM PXR25: The value range [20 - 180] corresponds to 2 to 18, in increments of 0.1 (1 for values)	A
2012	0	0x0001	Type of ground-fault detection	R	Unsigned	Type of ground-fault detection: 0 = differential current detection	–
2013	0 - 1	0x0003	Settings - functioning of the ground-fault protection	R/W	Encoded	Type of ground-fault protection 0: trip 1: alarm 2: OFF	–
2014	0	0x0001	ground-fault release - waveform	R/W	Encoded	ground-fault release - waveform: 0: flat 1: I^2t	–
2015			Settings - ground-fault release (Ig)	R/W	Unsigned	Settings - ground-fault release ($I_g = n \times I_n$) NZM PXR20: R NZM PXR25: R/W NZM PXR20: 20: 0.2 30: 0.3 40: 0.4 60: 0.6 80: 0.8 100: 1.0 100: 1000 The value range [20 - 100] corresponds to 0.2 to 1.0, in increments of 0.1 (10 for values)	A

Index [Hex]	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
2016			Settings - delay time of the ground-fault release (t_g)	R/W	Unsigned	Settings - delay time of the ground-fault release (t_g = x [ms]) NZM PXR20: R NZM PXR25: R/W NZM PXR20: 0: 0 (no delay) 2: 20 10: 100 30: 300 50: 500 75: 750 100: 1000 The following applies to the NZM PXR25: The value range [0 - 100] corresponds to 0 to 1,000 ms, respectively, in increments of 10 ms (10 for values)	ms
2017			Thermal memory (ground fault protection)	R/W	Encoded	Activates/deactivates the thermal memory of the ground-fault protection. Recommended for repetitive testing only. Among other things, the thermal memory protects the switch against overheating during repeated overloads. **Note:** Must be reactivated after testing! 0: switched off 1: switched on	–
2018			Settings - neutral protection	R/W	Unsigned	Adjusts the neutral protection of an NZM PXR25 breaker with a "/VAR" variably adjustable neutral conductor 0 = 0 % 60 = 60 % 100 = 100 % (default setting) The lower setting affects the LSI protection functions of the switch, but not the ground-fault protection function ("G"). **Note:** L = long delay (= overload protection I_r) S = short delay (= short-time delayed short-circuit protection I_{sd}) I = instantaneous (= instantaneous shortcircuit protection I_i) G = ground fault (= ground fault protection I_g)	%
2019			Load alarm 2	R/W	Unsigned	Load alarm 2 level (AL2 = x % x I_r): 50 - 120 (in increments of 1)	%
201A			Pre-alarm of the groundfault release	R/W		If the ground-fault protection function is set to "trip" (see register 403017), a pre-alarm can also be set. ($GF_{pre\text{-}alarm}$ = x % x I_g) 50 - 100 (in increments of 5 %)	%

Table 68: Setting group 2: "Modbus" group - EtherCAT

Index [Hex]	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
2002	15 - 0	0xFFFFFF	Password	W	Encoded	0000 (default setting)	–
2003	15 - 0	0xFFFFFF	Group 2 = on-board Modbus	R/W	Encoded	0x02FF	–
2004	15 - 0		Integrated Modbus - communication address	R/W	Encoded	001 - 247 (default setting 002)	–
2005	15 - 0		Integrated Modbus - baud rate	R/W	Encoded	00: 9,600 bit/s 01: 19,200 bit/s (default setting) 02: 38,400 bit/s 02: 57,600 bit/s	–
2006	15 - 0		Integrated Modbus - parity	R/W	Encoded	00: none 01: odd 02: even (default setting)	–
2007	15 - 0		Integrated Modbus - stop bit	R/W	Encoded	00: 1 bit 01: 2 bits (default setting)	–

10.2.3.4 Event logs

A trip event provides historical values for the data objects at the time the event has occurred. The trip unit classifies the event information in order to be able to provide a different quantity for each type. The EtherCAT communication can only access the historical summary, as well as the trip and event data.

Table 69: Event classification - EtherCAT

Event type	Quantity of numbers stored	Description of the event log
Summary	200	→ table 70
Tripping	10	→ table 71
Alarms	10	→ table 71 and → table 72

A single trip may be registered under multiple event types. For example, a protective trip may be recorded in the summary log (→ table 70) as well as in the trip log (→ table 71).

Event logs information is accessed via sub index: 0 and indexes according to → tables 70, 71 and 72.

If the event type selection is written to index 213C, the first and last event ID can be retrieved from instances 213D and 213E, respectively, in order to determine the range of events that have been stored for the selected event type. Index 213F is a R/W register for selecting the ID of the event in question. If the requested event has been recorded by the device, instances 2140 and 2141 will supply both the ID of the previous event and that of the next event.

If the device has not recorded the event in question, the exception code can be queried by requesting the Modbus communication status of the ECAM from the controller via a dedicated industrial protocol object (sub index: 0 and index 2167).

→ For more information on the exception codes, see → section 10.2.3.11, “Exception codes”, page 132.

The date and time at which the requested event occurred are read in log 2142, with the same date and time description as in → table 74, page 129. This value corresponds to the time at which the historical event occurred.

Log 2143 indicates the data content of the selected event type. This is a constant value for the three event types supported by the module.

The event data also provide a valid bit for each data object, starting with index 2144. If bit 0 is set to 1, the initial data will be valid for the current trip type, bit 1 for the second data object, bit 2 for the third data object, and so forth.

The number of valid bit registers is calculated as:
(number of data objects - 1)/16.

The following indexes are assigned to the data objects.

Table 70: Event summary - EtherCAT

Index [Hex]	Format	R/W	Description (historical event overview)
213C	Encoded	R/W	Event type: summary = 0x8EFF
213D	Unsigned 32	R	Earliest event ID
213E	Unsigned 32	R	Latest event ID
213F	Unsigned 32	R/W	Requested event ID
2140	Unsigned 32	R	Previous event ID
2141	Unsigned 32	R	Next event ID
2142	Date/time	R	Date/time
2143	Encoded	R	Data format: 0x0000, 0x0001, 0x0004, 0x0005, 0x0005, 0x0006
2144	B0	R	Valid bit of the object
2145	Encoded	R	Cause of event: 00: boot process - time OK 01: download of the setpoint values 02: time has been adjusted 03: trip 04: alarm 05: test mode has been selected 06: exiting the test mode 08: boot process - no time 09: test completed 10: maintenance mode activated 11: maintenance mode deactivated 12: opened via the communication interface 13: closed via the communication interface

Table 71: Historical trip / major alarm event - EtherCAT

Index [Hex]	Format	R/W	Description (historical event overview)	Unit
213C	Encoded	R/W	Event type: trip: 0x80FF alarm: 0x81FF	–
213D	Unsigned 32	R	Earliest event ID	–
213E	Unsigned 32	R	Latest event ID	–
213F	Unsigned 32	R/W	Requested event ID	–
2140	Unsigned 32	R	Previous event ID	–
2141	Unsigned 32	R	Next event ID	–
2142	Date/time	R	Date/time	–
2143	Encoded	R	Data format: trip: 0x0004 main alarm: 0x0005	–
2144	Bit 15 – Bit 0	R	Valid bits of the object	–
2145	Bit 31 – Bit 16	R	Valid bits of the object	–
2146	Encoded	R	Status reason (primary, secondary, reason)	–

Index [Hex]	Format	R/W	Description (historical event overview)	Unit
2147	Unsigned 32	R	I_{L1} (IA)	A
2148	Unsigned 32	R	I_{L2} (IB)	A
2149	Unsigned 32	R	I_{L3} (IC)	A
214A	Unsigned 32	R	I_N (IN)	A
214C	Unsigned 32	R	I_G (IG residual)	A
214D	Unsigned 16	R	U_{L1-L2} (VAB)	V
214E	Unsigned 16	R	U_{L2-L3} (VBC)	V
214F	Unsigned 16	R	U_{L3-L1} (VCA)	V
2150	Unsigned 16	R	U_{L1-N} (VAN)	V
2151	Unsigned 16	R	U_{L2-N} (VBN)	V
2152	Unsigned 16	R	U_{L3-N} (VCN)	V
2153	Signed 32	R	Active 3-phase power	W
2154	Signed 32	R	Reactive 3-phase power	VAR
2155	Unsigned 32	R	Apparent 3-phase power	VA
2156	Signed 32	R	Active power demand	W
2157	Signed 32	R	Reactive power demand	VAR
2158	Unsigned 32	R	Apparent power demand	VA
215A	Unsigned 32	R	Frequency	1/10 Hz
215C	Unsigned 32	R	Number of operations	–
215D	Bit 31 – Bit 0	R	Binary status with valid bits	–

Table 72: Minor alarm event - EtherCAT

Index [Hex]	Format	R/W	Description (historical event overview)
213C	Encoded	R/W	Event type: summary = 0x81FF
213D	Signed 32	R	Earliest event ID
213E	Signed 32	R	Latest event ID
213F	Signed 32	R/W	Requested event ID
2140	Signed 32	R	Previous event ID
2141	Signed 32	R	Next event ID
2142	Date/time	R	Date/time
2143	Encoded	R	Data format: Small alarm: 0x0006
2144	Bit 0	R	Valid bits of the object
2145	Encoded	R	Status reason (primary, secondary, reason code)

10.2.3.5 Remote control

One index with 3 elements of 16 bits is reserved for remote control of the release, accessed via sub index: 0 and index 2166. These three elements should be written together with a "slave action code" and the corresponding ones' complement.

The data format registers, which is an array of 16 bits, are shown below.

Data format for remote control

Index 2166 - Element 1

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Byte 1 (slave action)								Byte 0 (slave action)							

Index 2166 - Element 2

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Ones' complement of byte 0 (slave action)								Byte 2 (slave action)							

Index 2166 - Element 3

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Ones' complement of byte 2 (slave action)								Ones' complement of byte 1 (slave action)							

The "slave action code" and its functioning are listed in → table 73, and whether it is supported depends on the specific product.

If the "slave action code" and the associated ones' complement command are valid, the release will perform the action in question. If the "slave action code" and the associated ones' complement command are valid, the release will perform the action in question. If the "slave action code" and the associated ones' complement command are invalid, the exception code can be queried by requesting the Modbus communication status of the ECAM from the controller via a dedicated industrial protocol object (via sub index: 0 and index 2167).

→ For more information on the exception codes, see → section 10.2.3.11, "Exception codes", page 132.

Table 73: Remote control - EtherCAT

Command group	Definition	Bit		
		Byte 2	Byte 1	Byte 0
Reset	Reset the trip	0	0	2
	Reset the min./max. values of the L-N voltages1)	0	1	15
	Reset the min./max. values of the L-L voltages1)	0	1	14
	Reset the peak power requirement1)	0	0	4
	Reset all min./max. values	0	1	4
	Reset the energy1)	0	0	8
	Reset the power-up display	0	0	3
Maintenance mode	Activate the maintenance mode	1	0	8
	Deactivate the maintenance mode	1	0	9

10.2.3.6 Date and time

The release supports the reading and writing of real-time clock information by the external communication module EtherCAT.

Eight registers, starting with index number 215E, are reserved for this purpose.

Table 74: Real-time clock - EtherCAT

Index [Hex]	Definition	Data range
215E	Month	1 - 12
215F	Day	1 - 31
2160	Year	2000 - 2099
2161	Day of the week	1 = Sunday … 7 = Saturday
2162	Hour	0 - 23
2163	Minute	0 - 59
2164	Seconds	0 - 59
2165	1/100 of a second	0 - 99

10.2.3.7 Primary status codes

Table 75: Primary status codes - EtherCAT

Code	Meaning
0x01	open
0x02	closed
0x03	tripped
0x04	Alarm active
0x0D	Threshold value active

10.2.3.8 Secondary status codes

Table 76: Secondary status codes - EtherCAT

Code	Meaning
0x01	not applicable
0x03	Test mode
0x07	has been switched on since last trip / triggered alarm
0x08	Alarm

10.2.3.9 Reason codes

Table 77: Reason codes - EtherCAT

Code	Meaning
0x0000	unknown
0x0001	normal
0x0003	Instantaneous short circuit
0x000E	Auxiliary power supply too low
0x0011	Current imbalance
0x0021	Control via the communication interface
0x0025	Coil monitoring
0x002B	Diagnostic warning #2 (configuration read error)
0x003D	Overload
0x003E	Short-time delay
0x0049	Phase currents are close to the threshold value, load alarm
0x004C	Override
0x004D	Setpoint error
0x004E	Overtemperature
0x0050	Overload (neutral conductor)
0x0054	Ground fault
0x0071	Calibration
0x0088	Real-time clock
0x0099	Maintenance mode
0x009A	Fault in the breaker mechanism
0x07FC	Digital bypass
0x07FD	Non-volatile memory failure
0x07FE	Watchdog fault
0x07FF	Motor alarm or motor tripping

10.2.3.10 Device information

The device information (fixed data range) includes, for example, the device name, model name, catalogue number, version number, serial number, date code, firmware version 1 and 2, USB version, and product ID.

Table 78: Reason code definitions - EtherCAT

Index (Hex)	Description	Format	Range	Register	Comment
202A	Device name	ASCII	16 characters	8	EATON PXR20 EATON PXR25
202B	Model name	ASCII	16 characters	8	PXR 20/25 MCCB
202C	Catalogue number	ASCII	32 characters	16	internal catalogue number (max. 20 characters)
202D	Style number	ASCII	32 characters	16	internal version number (max. 20 characters)
202E	Serial number	ASCII	32 characters	16	if supported
202F	Date code	ASCII	12 characters	6	yy.mm.dd
2030	Firmware version 1	ASCII	16 characters	8	Sample version 01.02.0033
2031	Firmware version 2	ASCII	16 characters	8	Sample version 01.02.0033
2032	USB version	ASCII	16 characters	8	Sample version 01.02.0033
2033	Release family	U16	16-bit	1	PXR10: 0x02 PXR20: 0x01 PXR25: 0x01
2034	Standard	U16	16-bit	1	IEC only: 0x01 UL only: 0x02 UL / IEC: 0x03
2035	Poles	U16	16-bit	1	3-pole / 4-pole
2037	Product ID	Bitmap	32-bit	2	ppppppvvvvdddddd Division code (dddddd) 06 (0x06) Product code (pppppp): 2: NZM2 PXR 3: NZM3 PXR 4: NZM4 PXR Comm version (vvvv) 0

10.2.3.11 Exception codes

If there is an error in the request or the response, the release will return an exception code, via index 2167.

Table 79: Exception codes - EtherCAT

Modbus returned exception code values	Meaning
0	No error
8	Timeout error occurred
10	Illegal function exception
11	Illegal data address
12	Illegal data value
13	Slave device failure
14	Slave acknowledge
15	Slave device busy
16	Memory parity error
17	ECAM path unavailable
18	ECAM target device failed to respond

10.3 Profinet

The PXR-ECAM-PNET is designed to connect with an electronic trip unit's internal communication module (PXR-RCAM-MRTU-I) Modbus-RTU link and expand the communication capabilities into Profinet.

The PXR-ECAM-PNET is intended for use with PXR20 or PXR25 moulded case circuit breakers (MCCB).

This section details the data and functions available for the Digital NZM with PXR20 or PXR25 trip units via the PXR-ECAM-PNET register map. Depending upon trip unit capabilities, a large number of features are accessible through the registers as following described.

10.3.1 Configuration of the Modbus parameters

In order to synchronize the communication between the breaker Modbus RTU (slave device) and the ECAM (which acts as the Modbus RTU master device), the slave ID (Modbus RTU slave), baud rate and parity bit settings of both devices must be configured with the same values.

The ECAM's Modbus RTU slave ID (which the master device addresses to), baud rate and parity bit settings can be configured via API 0, indexes 0x1F4m 0x1F5 and 0x1F6.

Both, Modbus Slave (PXR-RCAM-MRTU-I) and Modbus Master (PXR-ECAM-PNET) have the same default parameters. In case the Modbus RTU slave parameters are not changed from the default values, the values of this communication module do not need to be changed as well. The API 0, indexes 0x1F4, 0x1F5 and 0x1F6, only provide the possibility to do so, if desired by the user.

The stop bit is automatically set up and the value is 1.

The default settings of the Modbus Slave and Modbus Master are as follows:

Table 80: Profinet settings - Profinet

Setting value	Index Number [Hex]	Data range	Default value
Slave ID	0x1F4	1 - 247	2
Baud rate	0x1F5	00: 9,600 bit/s 01: 19,200 bit/s 02: 38,400 bit/s 03: 57,600 bit/s	01
Parity	0x1F6	00: none 01: odd 02: even	02

The valid parameter values will be applied instantly. Writing parameter values outside valid ranges has no effect.

After a power-cycle, meaning the switch off the trip unit, the PXR-ECAM-PNET does not save configured values but returns them to default values.

The Modbus communication parameters of the NZM breaker (Modbus RTU slave) cannot be configured via Ethernet communication adapter module (ECAM).

10.3.2 IP configuration/DIP Switch Settings

The DIP switches are used to configure the device's fieldbus addresses. Flipping a single switch adds the switch specific value to the total address value. As a result, values in a range from 0 to 255 can be configured that way.

Table 81: Fieldbus address configuration via DIP switch

Switch	1	2	3	4	5	6	7	8
Value	1	2	4	8	16	32	64	128

For example, flipping switches 4 and 6 results in the address 40.

Figure 25: DIP switches flipping example

Table 82: Fieldbus address configuration via DIP switch

Switches Setting Value	**Remarks**
000	If the DIP switches are set to 0, the IP address settings stored in the NV-memory of the device are used. The factory default behaviour is DHCP. The IP address settings can be configured by the IPconfig tool. The tool can be downloaded here: https://www.eaton.com/digitalnzm
001	If the DIP switches are set to 1, the address settings of the device are as follows: IP address: 192.168.1.1 Subnet mask: 255.255.255.0 Default Gateway: 192.168.1.2
001 - 254	If the DIP switches are set in the range from 1 to 254, the IP address settings of the device are determined by the switches: IP address: 192.168.1.<DIP Switch Setting> Subnet mask: 255.255.255.0 Default Gateway: 192.168.1.1
255	Invalid Setting. Device will not start-up properly. PWR and GW are flashing red.

10.3.3 Profinet (GSDML file)

Each device in a Profinet network is associated with a Profinet GSDML file, which describes the implementation of the product. This file is used by the network configuration tool during network configuration.

→ If necessary, the latest version of the GSDML file for the PXR-ECAM-PNET can be downloaded here:
https://www.eaton.com/digitalnzm

10.3.4 Profinet register map

There are seven different release types in the NZM digital circuit breaker family. As a result, the devices access the registers differently, since not all versions support all functions.

The release type -AX does not support a communication connection; register access is therefore not possible.

→ The available functions overview, for each trip unit type, can be found on → chapter 3, "Protection and measurement functions", page 19.

10.3.4.1 Input status (discrete inputs)

The input status bits can be requested via API: 0, index 1.

The input status answer is a 4 bytes data type. The first 16 bits (1001 - 1016) indicate the current status, while the last 16 bits (1017 - 1032) indicate whether the corresponding status is valid or supported by the release unit.

Table 83: Input status - Profinet

Input	Description or value	Input	Description or value
1001	The breaker is in the closed position	1017	The breaker is in the closed position and is valid
1002	Unacknowledged trip condition	1018	Unacknowledged trip condition is valid
1003	Active or unacknowledged alarm	1019	Active or unacknowledged alarm is valid
1004	0	1020	0
1005	Maintenance mode is active	1021	Maintenance mode is active and valid
1006	Test mode is active	1022	Test mode is active and valid
1007	0	1023	0
1008	0	1024	0
1009	0	1025	0
1010	Overload mode is active (an overload is present)	1026	Overload mode is active and valid (an overload is present)
1011	Zone selectivity (ZSI) is active	1027	Zone selectivity (ZSI) is active and valid
1012	0	1028	0

Input	Description or value	Input	Description or value
1013	Ground-fault protection type is “source ground”	1029	Ground-fault protection type is “source ground”
1014	0	1030	0
1015	0	1031	0
1016	0	1032	0

10.3.4.2 Real-time data object register

Data that is subject to real-time changes, such as current, voltage and energy, can be requested via API: 0 and indexes according to → table 84.

Real-time data can be obtained either in IEEE floating-point or fixed-point format. For data displayed in fixed-point format, each result is presented as a multiplication of the real-time data with a scaling factor.
Energy objects can only be obtained in fixed-point format.

Registers for which the IEEE floating-point value is not specified are only supported in fixed-point format (FP).

Table 84: Real-time data register - Profinet

Index (Hex)		Object	
IEEE floating point	Fixed point (FP)	Description (Values in brackets reflect the American notation.)	Scale factor (FP)
38	B6	Cause of status: High byte = primary status Low byte = secondary status	–
39	B7	I_{L1} (IA)	10
3A	B8	I_{L2} (IB)	10
3B	B9	IL3 (IC)	10
3C	BA	I_G (IG)	10
3D	BB	I_N (IN)	10
3E	BC	U_{L1-L2} (VAB)	10
3F	BD	U_{L2-L3} (VBC)	10
40	BE	U_{L3-L1} (VCA)	10
41	BF	U_{L1-N} (VAN)	10
42	C0	U_{L2-N} (VBN)	10
43	C1	U_{L3-N} (VCN)	10
48	C6	Active 3-phase power	1
49	C7	Reactive 3-phase power	1
4A	C8	Apparent 3-phase power	1
4B	C9	Power factor	100
4C	CA	Frequency	10
51	CF	Peak active power demand	1

Index (Hex) IEEE floating point	Fixed point (FP)	Object Description (Values in brackets reflect the American notation.)	Scale factor (FP)
52	D0	Product ID	–
53	D1	Frequency	100
–	D2	Active energy (forward)	1
–	D3	Active energy (reverse)	1
–	D4	Active energy combined (= forward + reverse)	1
–	D5	Apparent energy	1
–	D6	Active energy (forward)	1
–	D7	Active energy (reverse)	1
–	D8	Active energy combined (= forward + reverse)	1
–	D9	Apparent energy	1
54	DA	Peak reactive power demand	1
55	DB	Peak apparent power demand	1
5A	E0	Active power demand	1
5B	E1	Reactive power demand	1
5C	E2	Apparent power demand	1
5D	E3	Minimum value - I_{L1} (IA)	10
5E	E4	Maximum value - I_{L1} (IA)	10
5F	E5	Minimum value - I_{L2} (IB)	10
60	E6	Maximum value - I_{L2} (IB)	10
61	E7	Minimum value - I_{L3} (IC)	10
62	E8	Maximum value - I_{L3} (IC)	10
63	E9	Minimum value - I_G (IG)	10
64	EA	Maximum value - I_G (IG)	10
65	EB	Minimum value - I_N (IN)	10
66	EC	Maximum value - I_N (IN)	10
67	ED	Minimum value - U_{L1} (VA)	10
68	EE	Maximum value - U_{L1} (VA)	10
69	EF	Minimum value - U_{L2} (VB)	10
6A	F0	Maximum value - U_{L2} (VB)	10
6B	F1	Minimum value - U_{L3} (VC)	10
6C	F2	Maximum value - U_{L3} (VC)	10
6D	F3	Minimum value - U_{L1-N} (VAN)	10
6E	F4	Maximum value - U_{L1-N} (VAN)	10
6F	F5	Minimum value - U_{L2-N} (VAN)	10
70	F6	Maximum value - U_{L2-N} (VAN)	10
71	F7	Minimum value - U_{L3-N} (VAN)	10
72	F8	Maximum value - U_{L3-N} (VAN)	10

Index (Hex) IEEE floating point	Fixed point (FP)	Object Description (Values in brackets reflect the American notation.)	Scale factor (FP)
73	F9	Overload pre-warning	1
81	107	Counter - I_{sd}, I_i tripping	1
82	108	Counter - I_r, I_g tripping	1
83	109	Operations counter	1
84	10A	Counter - I_{sd} tripping	1
85	10B	Counter - I_i tripping	1
86	10C	Counter - bypass tripping	1
87	10D	Counter - I_r tripping	1
88	10E	Counter - I_g tripping	1
89	10F	Counter - trips total	1
8A	110	Counter - test mode tripping	1
8B	111	Counter - number of openings via the communication interface	1
8C	112	Counter - external actuation[1)]	1
8D	113	Time of last actuation (year, month, day, hour, minute, second)	–
8E	114	Operating time[2)] in minutes	1
8F	115	Operating time[2)] in hours	1
90	116	Operating time[2)] in days	1
91	117	Residual life[3)]	–

1) An external actuation is a switching operation that is not initiated by the trip unit, such as manual switching, switching via an externally wired remote operator or the actuation of a push-to-trip button.
2) The operating time counter will start as soon as the device is energized, either autonomously or through an external power supply.
3) 0 points ≙ 100 % residual life
10.000 points ≙ 0 % residual life
Conversion formula: Residual life expressed as a percentage = 100 - (point value / 100)

10.3.4.3 Setting register

The release settings are arranged in three groups (groups 0 to 2).

Before reading or writing the settings, the appropriate group should be selected. Access to the groups are obtained via API 0 and index 3, which is a R/W register used to select the respective group (default: group 0).
The high byte contains the desired group number, while the low byte must contain the value 255 (0x0FF).

Prior to writing the settings, the correct password must be entered via API 0 and index 2, and the settings have to be written within 10 seconds of the password check.

For trip units that support settings, the settings of groups 0, 1 and 2 should be written one after the other.

The setting groups are assigned as follows:

- Group 0: System group
- Group 1: Protective group
- Group 2: Modbus group

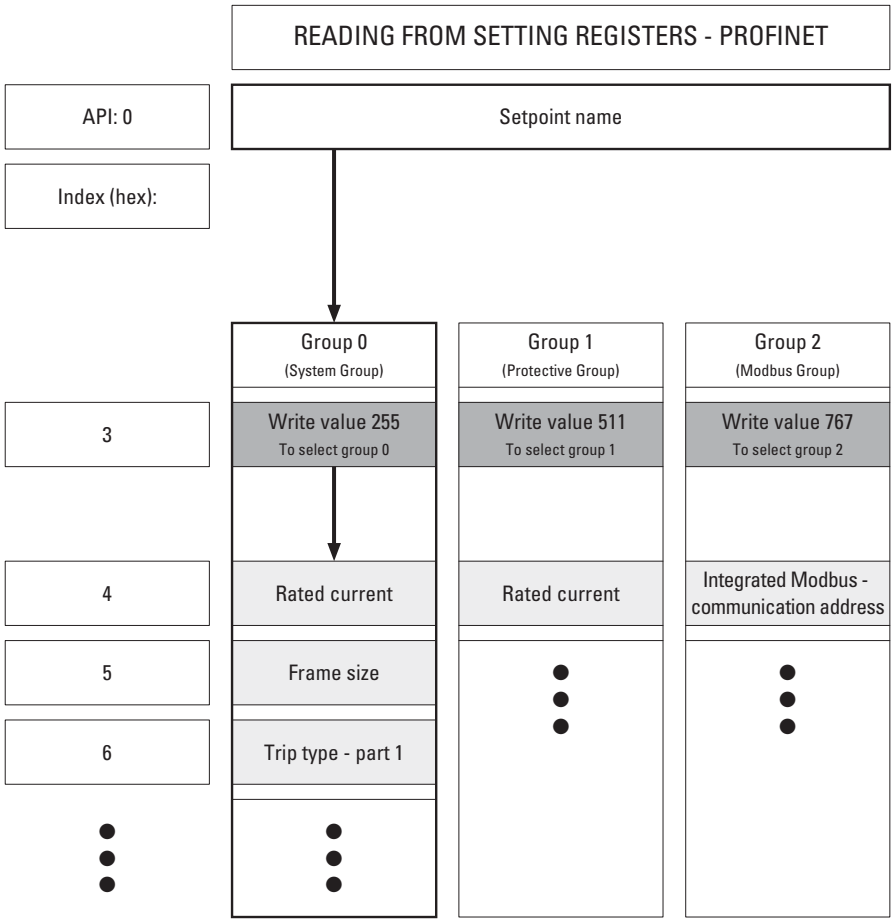


Figure 26: Reading from setting registers - Profinet

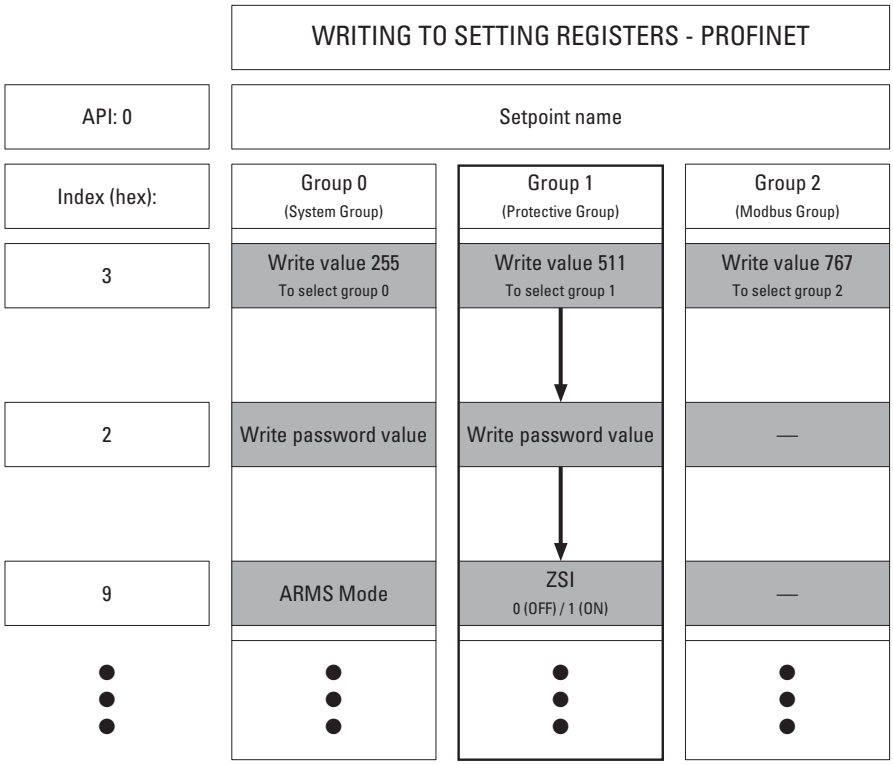


Figure 27: Writing to setting registers - Profinet

Table 85: Setting group 0: "System group" - Profinet

Index [Hex]	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
2	15 - 0		Password	W	–	0000 (default setting	–
3	15 - 0	0xFFFFFF	Group 0 = system	R/W		0x00FF	–
4	12 - 0	0x1FFFF	Rated current	R	Encoded	NZM2: 25, 40, 63, 90, 100, 140, 160, 200, 220, 250, 300 NZM3: 250, 350, 400, 450, 600, 630 NZM4: 550, 600, 630, 800, 875, 1000, 1200, 1250, 1400, 1600	A
5	2 - 0	0x0007	Frame size	R	Encoded	The frame size indicates the breaker type. 11: NZM2 12: NZM3 13: NZM4	–
6	3 - 0	0x000F	Trip type version - part 1	R	Encoded	Bit 0: LdSel: with overload protection I_r = 1 Bit 1: SdSel: with short-time delayed short-circuit protection I_{sd} = 1 Bit 2: InstSel: with instantaneous short-circuit release I_i = 1 Bit 3: GfSel: with ground-fault protection I_g = 1 Bit 4: ARMSel: with maintenance mode = 1 Bit 5: OvrideSel: with instantaneous release function = 1 Bit 6: not used Bit 7: MotorSel: with motor-protection function = 1 Bit 8: NeuSenorSel: 0: 3-pole device 1: 4-pole device Bit 9: ThermalSel: with thermal memory = 1 Bit 12: VoltSel: with voltage meter = 1 Bit 13: 0: PXR20 1: PXR25	–
7			Trip type version - part 2	R	Encoded	Bit 0: ModbusSel: with integrated Modbus RTU = 1 Bit 1: CAMSel: with CAM RS422 = 1 Bit 2: IOModuleSel: with IO module = 1 Bit 3: RelaySel: with relay module = 1 Bit 4: ZSISel: with zone selectivity = 1 Bit 12: NZM_ACB_Sel: degree of protection 0: IZMX 1: NZM Bit 13: IECSel: 0: UL 1: Standard IEC	–
8	8	0x0100	Maintenance mode: state	R	Encoded	0: off 1: on	–
	BBE	0x0001	Maintenance mode: remote control	R/W	Encoded	0: off 1: on	–
9	2 - 0	0x0007	Maintenance mode: Trip setting	R/W	Encoded	1: 2.5 x I_n 2: 4 x I_n 3: 6 xI_n 4: 8 x I_n 5: 10 x I_n	A

Index [Hex]	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
B	0	0x0001	Direction of incoming supply	R/W	Encoded	0: forward 1: reverse **Note:** only available on the PXR25	–
C	0	0x0001	Sign convention	R/W	Encoded	Sign convention: 0: IEC 1: IEEE 2: IEEE old	–
D			Power demand window	R/W	Encoded	Power demand: 0: fixed 1: sliding	–
E			Power demand interval	R/W	Encoded	Power demand: 5 - 60 min (1 min increments)	–
11			Configuration of relay 1	R/W	Encoded	Configuration of relay 1 and relay 2: → table 21, page 44	–
12			Configuration of relay 2	R/W	Encoded		–
14			Phase sequence - phase L1 (A)	R/W	Encoded	Phase L1 (A) 0: counterclockwise 1: clockwise	–
17		0xBCC	Alarm - Residual Life	R/W	Encoded	Range: 50 - 100, step size 1, default value: 75 Alarm level value 100 ≙ 0 % residual life Alarm level value 75 ≙ 25 % residual life Formula for conversion: Alarm level expressed as a percentage = 100 - point value	–

In setting group 0, the maintenance mode setting (index 8) can be divided into two parts. The high byte is read only and is used for the status indication of the maintenance mode, the comprehensive results of the maintenance mode rotary switch, the secondary terminal and the communication settings. The low byte can be configured and is used to indicate the maintenance mode settings via the communication port.

The respective protection settings may vary according to the size, type and rated operational current of the release.

Table 86: Setting group 1: "Protection group" - Profinet

Index (Hex)	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
2	15 – 0	0xFFFFFF	Password	W	Encoded	0000 (default setting)	–
3	15 – 0	0xFFFFFF	Group 1 = protection	R/W			–
4	12 – 0	0x1FFFF	Rated current	R	Encoded	NZM2: 25, 40, 63, 90, 100, 140, 160, 200, 220, 250, 300 NZM3: 250, 350, 400, 450, 600, 630 NZM4: 550, 600, 630, 800, 875, 1000, 1200, 1250, 1400, 1600	A
5	2 – 0	0x0007	Frame size	R	Encoded	The frame size indicates the breaker type. 11: NZM2 12: NZM3 13: NZM4	–
6	3 - 0	0x000F	Trip type version - part 1	R	Encoded	Bit 0: LdSel: with overload protection I_r = 1 Bit 1: SdSel: with short-time delayed short-circuit protection I_{sd} = 1 Bit 2: InstSel: with instantaneous short circuit release I_i = 1 Bit 3: GfSel: with ground-fault protection I_g = 1 Bit 4: ARMSel: with maintenance mode = 1 Bit 5: OvrideSel: with instantaneous release function = 1 Bit 6: not used Bit 7: MotorSel: with motor-protection function = 1 Bit 8: NeuSenorSel: 0: 3-pole device 1: 4-pole device Bit 9: ThermalSel: with thermal memory = 1 Bit 12: VoltSel: with voltage meter = 1 Bit 13: 0: PXR20 1: PXR25	–
7			Trip type version - part 2	R	Encoded	Bit 0: ModbusSel: with integrated Modbus RTU = 1 Bit 1: CAMSel: with CAM RS422 = 1 Bit 2: IOModuleSel: with IO module = 1 Bit 3: RelaySel: with relay module = 1 Bit 4: ZSISel: with zone selectivity = 1 Bit 12: NZM_ACB_Sel: degree of protection 0: IZMX 1: NZM Bit 13: IECSel: 0: UL 1: Standard IEC	–
8	0	0x0001	Thermal memory (overload protection)	R/W	Encoded	Activates/deactivates the thermal memory of the overload protection. Recommended for repetitive testing only. Among other things, the thermal memory protects the switch against overheating during repeated overloads. Reactivate the thermal memory after testing: 0: switched off 1: switched on	–

Index (Hex)	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
9	0	0x0001	ZSI	R/W	Encoded	ZSI, zone-selectivity: If enabled for releases with ground-fault protection, ZSI is implemented for both the short-time delayed short-circuit release and for ground-fault protection. If enabled for releases without groundfault protection, ZSI is only implemented for the short-time delayed short-circuit release. 0: switched off 1: switched on	–
A	0 - 1	0x0003	Overload release - waveform	R/W	Encoded	Waveform of the overload release 2: I^2t (default setting)	–
B			Settings - release (I_r)	R/W	Unsigned	Settings - overload ($I_r = x * I_n$): NZM PXR20: R NZM PXR25: R/W NZM PXR20: 40: 0.4 45: 0.4 50: 0.5 55: 0.5 00: 0.6 05: 0.6 10: 0.7 15: 0.8 20: 0.8 25: 0.8 30: 0.9 35: 1.0 40: 1.0 The following applies to the NZM PXR25: General value range: 20 - 1600 (in increments of 1 (1 A)) **Caution:** The value range depends on the type: (e.g. a 250-A switch can be set in the range from 40 % to 100 % of I_n (value range: 100 - 250)	–
C			Settings - overload delay time (t_r)	R/W	Unsigned	Settings - overload delay time ($t_r = x$ [s]) NZM PXR20: R NZM PXR25: R/W NZM PXR20: 20: 2 40: 4 50: 5 60: 6 70: 7 80: 8 100: 10 120: 12 140: 14 160: 16 180: 18 200: 20 32767: ∞ (overload protection deactivated)	s
D			Load alarm 1	R/W	Unsigned	Load alarm 1 level (AL1 = n % x I_r): 50 - 120 (in increments of 1)	%

Index (Hex)	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
E	0	0x0001	Short-time delayed short circuit release - waveform	R/W	Encoded	Waveform of the short-time delayed short-circuit release 0: flat (default setting) 1: I^2t	–
F			Settings - short-time delayed short-circuit release (I_{sd})	R/W	Unsigned	Settings - short-time delayed short circuit release (I_{sd} = n x I_r): NZM PXR20: R NZM PXR25: R/W NZM PXR20: 20: 2.0 30: 3.0 40: 4.0 50: 5.0 60: 6.0 65: 6.5 70: 7.0 75: 7.5 80: 8.0 85: 8.5 90: 9.0 95: 9.5 100: 10.0 The following applies to the NZM PXR25: The value range [20 - 100] corresponds to 2 to 10, in increments of 0.1 (1 for values)	A
10			Settings - delay time of the short-time delayed short-circuit release (t_{sd})	R/W	Unsigned	Settings – delay time of the short-time delayed short-circuit release (t_{sd} = x [ms]) NZM PXR20: R NZM PXR25: R/W NZM PXR20: 0: 0 (no delay) 2: 20 10: 100 30: 300 50: 500 75: 750 100: 1000 The following applies to the NZM PXR25: The value range [0 - 100] corresponds to 0 to 1,000 ms, respectively, in increments of 0.1 (10 for values)	ms

Index (Hex)	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
11			Settings - instantaneous short-circuit release (I_i)	R/W	Unsigned	Settings - instantaneous short-circuit release ($I_i = n \times I_n$) NZM PXR20: R NZM PXR25: R/W NZM PXR20: 20: 2 30: 3 40: 4 50: 5 60: 6 70: 7 80: 8 90: 9 100: 10 110: 11 120: 12 140: 14 160: 16 180: 18 The following applies to the NZM PXR25: The value range [20 - 180] corresponds to 2 to 18, in increments of 0.1 (1 for values)	A
12	0	0x0001	Type of ground-fault detection	R	Unsigned	Type of ground-fault detection: 0 = differential current detection	–
13	0 - 1	0x0003	Settings - functioning of the ground-fault protection	R/W	Encoded	Type of ground-fault protection 0: trip 1: alarm 2: OFF	–
14	0	0x0001	ground-fault release - waveform	R/W	Encoded	Ground-fault release - waveform: 0: flat 1: I^2t	–
15			Settings - ground-fault release (I_g)	R/W	Unsigned	Settings - ground-fault release ($I_g = n \times I_n$) NZM PXR20: R NZM PXR25: R/W NZM PXR20: 20: 0.2 30: 0.3 40: 0.4 60: 0.6 80: 0.8 100: 1.0 The value range [20 - 100] corresponds to 0.2 to 1.0, in increments of 0.1 (10 for values)	A

Index (Hex)	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
16			Settings - delay time of the ground-fault release (t_g)	R/W	Unsigned	Settings - delay time of the ground-fault release (t_g = x [ms]) NZM PXR20: R NZM PXR25: R/W NZM PXR20: 0: 0 (no delay) 2: 20 10: 100 30: 300 50: 500 75: 750 100: 1000 The following applies to the NZM PXR25: The value range [0 - 100] corresponds to 0 to 1,000 ms, respectively, in increments of 10 ms (10 for values)	ms
17			Thermal memory (ground fault protection)	R/W	Encoded	Activates/deactivates the thermal memory of the ground-fault protection. Recommended for repetitive testing only. Among other things, the thermal memory protects the switch against overheating during repeated overloads. **Note:** Must be reactivated after testing! 0: switched off 1: switched on	–
18			Settings - neutral protection	R/W	Unsigned	Adjusts the neutral protection of an NZM PXR25 breaker with a "/VAR" variably adjustable neutral conductor 0 ≙ 0 % 60 ≙ 60 % 100 ≙ 100 % (default setting) The lower setting affects the LSI protection functions of the switch, but not the ground-fault protection function ("G"). **Note:** L = long delay (= overload protection I_r) S = short delay (= short-time delayed short-circuit protection I_{sd}) I = instantaneous (= instantaneous shortcircuit protection I_i) G = ground fault (= ground fault protection I_g)	%
19			Load alarm 2	R/W	Unsigned	Load alarm 2 level (AL2 = x % x I_r): 50 - 120 (in increments of 1)	%
1A			Pre-alarm of the groundfault release	R/W		If the ground-fault protection function is set to "trip" (see register 403017), a pre-alarm can also be set. ($GF_{pre\text{-}alarm}$ = x % x I_g) 50 - 100 (in increments of 5 %)	%

Table 87: Setting group 2: "Modbus" group - Profinet

Index [Hex]	Bit field	Mask field	Setpoint name	R/W	Format	Description or value	Unit
2	15 - 0	0xFFFFFF	Password	W	Encoded	0000 (default setting)	–
3	15 - 0	0xFFFFFF	Group 2 = on-board Modbus	R/W	Encoded	0x02FF	–
4	15 - 0		Integrated Modbus - communica-tion address	R/W	Encoded	001 - 247 (default setting 002)	–
5	15 - 0		Integrated Modbus - baud rate	R/W	Encoded	00: 9,600 bit/s 01: 19,200 bit/s (default setting) 02: 38,400 bit/s 02: 57,600 bit/s	–
6	15 - 0		Integrated Modbus - parity	R/W	Encoded	00: none 01: odd 02: even (default setting)	–
7	15 - 0		Integrated Modbus - stop bit	R/W	Encoded	00: 1 bit 01: 2 bits (default setting)	–

10.3.4.4 Event logs

A trip event provides historical values for the data objects at the time the event has occurred. The trip unit classifies the event information in order to be able to provide a different quantity for each type. The Profinet communication can only access the historical summary, as well as the trip and event data.

Table 88: Event classification - Profinet

Event type	Quantity of numbers stored	Description of the event log
Summary	200	→ table 89
Tripping	10	→ table 90
Alarms	10	→ table 90 and → table 91

A single trip may be registered under multiple event types. For example, a protective trip may be recorded in the summary log (→ table 89) as well as in the trip log (→ table 90).

Event logs information is accessed via API: 0 and indexes according to → tables 89, 90 and 91.

If the event type selection is written to index 13C, the first and last event ID can be retrieved from indexes 13D and 13E, respectively, in order to determine the range of events that have been stored for the selected event type. Index 13F is a R/W register for selecting the ID of the event in question. If the requested event has been recorded by the device, indexes 140 and 141 will supply both the ID of the previous event and that of the next event.

If the device has not recorded the event in question, the exception code can be queried by requesting the Modbus communication status of the ECAM from the controller via a dedicated industrial protocol object (via API: 0 and index 167).

→ For more information on the exception codes, see → section 10.3.4.11, “Exception codes”, page 159.

The date and time at which the requested event occurred are read in log 2142, with the same date and time description as in → table 93, page 155.
This value corresponds to the time at which the historical event occurred.

Log 143 indicates the data content of the selected event type. This is a constant value for the three event types supported by the module.

The event data also provide a valid bit for each data object, starting with index 144. If bit 0 is set to 1, the initial data will be valid for the current trip type, bit 1 for the second data object, bit 2 for the third data object, and so forth.

The number of valid bit registers is calculated as.
(number of data objects - 1)/16

The following indexes are assigned to the data objects.

Table 89: Event summary - Profinet

Index [Hex]	Format	R/W	Description (historical event overview)
13C	Encoded	R/W	Event type: summary = 0x8EFF
13D	Unsigned 32	R	Earliest event ID
13E	Unsigned 32	R	Latest event ID
13F	Unsigned 32	R/W	Requested event ID
140	Unsigned 32	R	Previous event ID
141	Unsigned 32	R	Next event ID
142	Date/time	R	Date/time
143	Encoded	R	Data format 0x0000, 0x0001, 0x0004, 0x0005, 0x0005, 0x0006
144	B0	R	Valid bit of the object
145	Encoded	R	Cause of event: 00: boot process - time OK 01: download of the setpoint values 02: time has been adjusted 03: trip 04: alarm 05: test mode has been selected 06: exiting the test mode 08: boot process - no time 09: test completed 10: maintenance mode activated 11: maintenance mode deactivated 12: opened via the communication interface 13: closed via the communication interface

Table 90: Historical trip / major alarm event - Profinet

Index [Hex]	Format	R/W	Description (historical event overview)	Unit
13C	Encoded	R/W	Event type: Trip: 0x80FF Alarm: 0x81FF	–
13D	Unsigned 32	R	Earliest event ID	–
13E	Unsigned 32	R	Latest event ID	–
13F	Unsigned 32	R/W	Requested event ID	–
140	Unsigned 32	R	Previous event ID	–
141	Unsigned 32	R	Next event ID	–
142	Date/time	R	Date/time	–
143	Encoded	R	Data format: Trip: 0x0004 Main alarm: 0x0005	–
144	Bit 15 - Bit 0	R	Valid bits of the object	–
145	Bit 31 - Bit 16	R	Valid bits of the object	–
146	Encoded	R	Status reason (primary, secondary, reason)	–

Index [Hex]	Format	R/W	Description (historical event overview)	Unit
147	Unsigned 32	R	I_{L1} (IA)	A
148	Unsigned 32	R	I_{L2} (IB)	A
149	Unsigned 32	R	I_{L3} (IC)	A
14A	Unsigned 32	R	I_N (IN)	A
14C	Unsigned 32	R	I_G (IG residual)	A
14D	Unsigned 16	R	U_{L1-L2} (VAB)	V
14E	Unsigned 16	R	U_{L2-L3} (VBC)	V
14F	Unsigned 16	R	U_{L3-L1} (VCA)	V
150	Unsigned 16	R	U_{L1-N} (VAN)	V
151	Unsigned 16	R	U_{L2-N} (VBN)	V
152	Unsigned 16	R	U_{L3-N} (VCN)	V
153	Signed 32	R	Active 3-phase power	W
154	Signed 32	R	Reactive 3-phase power	VAR
155	Unsigned 32	R	Apparent 3-phase power	VA
156	Signed 32	R	Active power demand	W
157	Signed 32	R	Reactive power demand	VAR
158	Unsigned 32	R	Apparent power demand	VA
15A	Unsigned 32	R	Frequency	1/10 Hz
15C	Unsigned 32	R	Number of operations	–
15D	Bit 31 - Bit 0	R	Binary status with valid bits	–

Table 91: Minor alarm event - Profinet

Index [Hex]	Format	R/W	Description (historical event overview)
13C	Encoded	R/W	Event type: Summary = 0x81FF
13D	Signed 32	R	Earliest event ID
13E	Signed 32	R	Latest event ID
13F	Signed 32	R/W	Requested event ID
140	Signed 32	R	Previous event ID
141	Signed 32	R	Next event ID
142	Date/time	R	Date/time
143	Encoded	R	Data format: Small alarm: 0x0006
144	Bit 0	R	Valid bits of the object
145	Encoded	R	Status reason (primary, secondary, reason code)

10.3.4.5 Remote control

One index with 3 elements of 16 bits is reserved for remote control of the release, accessed via API: 0 and index 166. These three elements should be written together with a "slave action code" and the corresponding ones' complement. The data format registers, which is an array of 16 bits, are shown below.

Data format for remote control

Index 166 - Element 1

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Byte 1 (slave action)								Byte 0 (slave action)							

Index 166 - Element 2

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Ones' complement of byte 0 (slave action)								Byte 2 (slave action)							

Index 166 - Element 3

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Ones' complement of byte 2 (slave action)								Ones' complement of byte 1 (slave action)							

The "slave action code" and its functioning are listed in → table 92, and whether it is supported depends on the specific product.

If the "slave action code" and the associated ones' complement command are valid, the release will perform the action in question. If the "slave action code" and the associated ones' complement command are valid, the release will perform the action in question. If the "slave action code" and the associated ones' complement command are invalid, the exception code can be queried by requesting the Modbus communication status of the ECAM from the controller via a dedicated industrial protocol object (via API 0 and index 167).

→ For more information on the exception codes, see → section 10.3.4.11, "Exception codes", page 159.

Table 92: Remote control - Profinet

Command group	Definition	Bit		
		Byte 2	Byte 1	Byte 0
Reset	Reset the trip	0	0	2
	Reset the min./max. values of the L-N voltages[1)]	0	1	15
	Reset the min./max. values of the L-L voltages[1)]	0	1	14
	Reset the peak power requirement[1)]	0	0	4
	Reset all min./max. values	0	1	4
	Reset the energy[1)]	0	0	8
	Reset the power-up display	0	0	3
Maintenance mode	Activate the maintenance mode	1	0	8
	Deactivate the maintenance mode	1	0	9

1) PXR25 only!

10.3.4.6 Date and time

The release supports the reading and writing of real-time clock information by the external communication module Profinet.
Eight registers, starting with index number 15E, are reserved for this purpose.

Table 93: Real-time clock - Profinet

Index [Hex]	Definition	Data range
15E	Month	1 - 12
15F	Day	1 - 31
160	Year	2000 - 2099
161	Day of the week	1 = Sunday … 7 = Saturday
162	Hour	0 - 23
163	Minute	0 - 59
164	Seconds	0 - 59
165	1/100 of a second	0 - 99

10.3.4.7 Primary status codes

Table 94: Primary status codes - Profinet

Code	Meaning
0x01	open
0x02	closed
0x03	tripped
0x04	Alarm active
0x0D	Threshold value active

10.3.4.8 Secondary status codes

Table 95: Secondary status codes - Profinet

Code	Meaning
0x01	not applicable
0x03	Test mode
0x07	has been switched on since last trip / triggered alarm
0x08	alarm

10.3.4.9 Reason codes

Table 96: Reason codes - Profinet

Code	Meaning
0x0000	unknown
0x0001	normal
0x0003	Instantaneous short circuit
0x000E	Auxiliary power supply too low
0x0011	Current imbalance
0x0021	Control via the communication interface
0x0025	Coil monitoring
0x002B	Diagnostic warning #2 (configuration read error)
0x003D	Overload
0x003E	Short-time delay
0x0049	Phase currents are close to the threshold value, load alarm
0x004C	Override
0x004D	Setpoint error
0x004E	Overtemperature
0x0050	Overload (neutral conductor)
0x0054	Ground fault
0x0071	Calibration

Code	Meaning
0x0088	Real-time clock
0x0099	Maintenance mode
0x009A	Fault in the breaker mechanism
0x07FC	Digital bypass
0x07FD	Non-volatile memory failure
0x07FE	Watchdog fault
0x07FF	Motor alarm or motor tripping

10.3.4.10 Device information

The device information (fixed data range) includes, for example, the device name, model name, catalogue number, version number, serial number, date code, firmware version 1 and 2, USB version, and product ID.

Table 97: Reason code definitions - Profinet

Index [Hex]	Description	Format	Range	Register	Comment
2A	Device name	ASCII	16 characters	8	EATON PXR20 EATON PXR25
2B	Model name	ASCII	16 characters	8	PXR 20/25 MCCB
2C	Catalogue number	ASCII	32 characters	16	internal catalogue number (max. 20 characters)
2D	Style number	ASCII	32 characters	16	internal version number (max. 20 characters)
2E	Serial number	ASCII	32 characters	16	if supported
2F	Date code	ASCII	12 characters	6	yy.mm.dd
30	Firmware version 1	ASCII	16 characters	8	Sample version 01.02.0033
31	Firmware version 2	ASCII	16 characters	8	Sample version 01.02.0033
32	USB version	ASCII	16 characters	8	Sample version 01.02.0033
33	Release family	U16	16-bit	1	PXR10: 0x02 PXR20: 0x01 PXR25: 0x01

Index [Hex]	Description	Format	Range	Register	Comment
34	Standard	U16	16-bit	1	IEC only: 0x01 UL only: 0x02 UL / IEC: 0x03
35	Poles	U16	16-bit	1	3-pole / 4-pole
37	Product ID	Bitmap	32-bit	2	ppppppvvvvdddddd Division code (dddddd) 06 (0x06) Product code (pppppp): 2: NZM2 PXR 3: NZM3 PXR 4: NZM4 PXR Comm version (vvvv) 0

10.3.4.11 Exception codes

If there is an error in the request or the response, the release will return an exception code, via index 167.

Table 98: Exception codes - Profinet

Modbus returned exception code values	Meaning
0	No error
8	Timeout error occurred
10	Illegal function exception
11	Illegal data address
12	Illegal data value
13	Slave device failure
14	Slave acknowledge
15	Slave device busy
16	Memory parity error
17	ECAM path unavailable
18	ECAM target device failed to respond

11 Troubleshooting

The following table provides helpful information in the event of a fault.

Table 99: Possible faults, causes and solutions

Fault	Probable cause	Possible solution
The status LED of the trip unit is not flashing.	No current is flowing through the current transformers of the circuit breaker to the trip unit.	Connect the +24 V DC supply for auxiliary power and monitor the status LED.
The circuit breaker will trip in the event of a ground fault.	A ground fault is actually present.	Determine the location of the fault.
	When using a 3-pole circuit breaker with ground-fault protection in a four-wire system, the neutral current will not be detected.	A 4-pole circuit breaker should therefore be used.
	High inrush phase currents may cause the device to temporarily detect a ground fault.	If zone selective interlocking is used, Z_{out} to Z_{in} should be connected by means of a jumper to obtain a short delay. → section 4.10, "Zone selective interlocking (ZSI)", page 31
	The trip unit is malfunctioning.	Replace the trip unit.
The breaker trips too quickly in the event of a ground fault or a short-time delay (zone selective interlocking is not used).	The ZSI function is active.	Make sure that the ZSI function in the settings menu is turned off. → section 4.10, "Zone selective interlocking (ZSI)", page 31
	The trip unit settings are incorrect. Is the I^2t slope or the "flat" option selected?	Change the ground fault or short-time delay settings.
	The trip unit is malfunctioning.	Replace the trip unit.
The breaker trips too rapidly on long delay.	The thermal memory is active.	In the event of repeated tripping, the thermal memory protects the switch and any downstream system components against overheating.
	The trip unit settings are incorrect.	Change the long-delay settings.
The primary source of injection current is not supplying the correct current.	The testing of the primary injection and the trip times yields incorrect results.	Use an oscilloscope with a current probe to determine the exact current value and times, and to ensure that no inrush current peaks will occur.
	Single-phase testing.	When testing a single phase, the current may "bleed" into other de-energized phases and thereby reduce the testing phase current itself.
	During testing with high current pulses, an overload trip may occur due to the cumulative effect of the short-current pulses.	Deactivate the thermal memory for the duration of the test. Reactivate the memory again once the test has been completed!
	The precise input levels are difficult to control and reproduce when testing the primary injection at high current levels.	Use functional current testing (remote) via USB/PXPM.
The LCD display is not connected to the power supply.	No auxiliary power (24 V DC) will be available if the current flowing through the circuit breaker is less than the minimum current required for the operation of the LCD display.	Connect the auxiliary power supply.
The status LED is permanently red or flashes red.	The circuit breaker locking mechanism is not closing properly.	Contact your Eaton representative for manufacturer support.
	Internal memory issue.	Contact your Eaton representative for manufacturer support.
The maintenance mode fails to deactivate.	Faulty remote or local switch.	Make sure that the local or remote switch is not turned on.
	The maintenance mode was originally activated via the communication interface, which is currently not available.	If possible, restore the communication link and check for possible wiring errors.

11 Troubleshooting

12 PXR25 Navigation menu

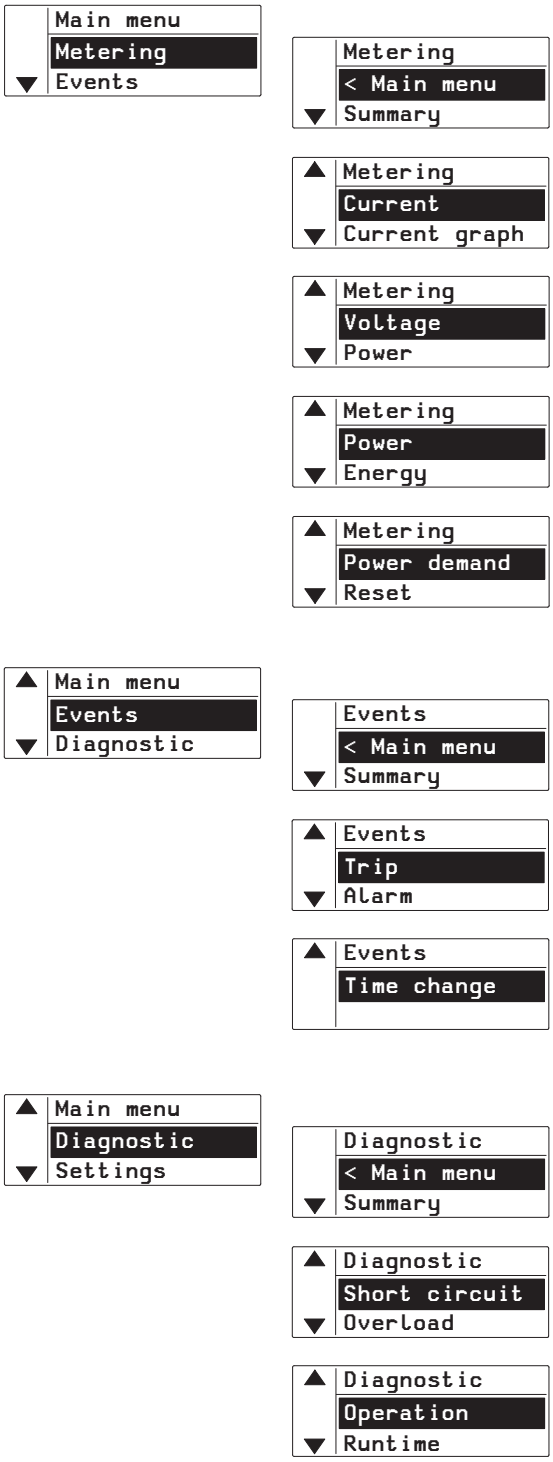


Figure 28: Menu items “measurement data”, “events” and “diagnostics”.

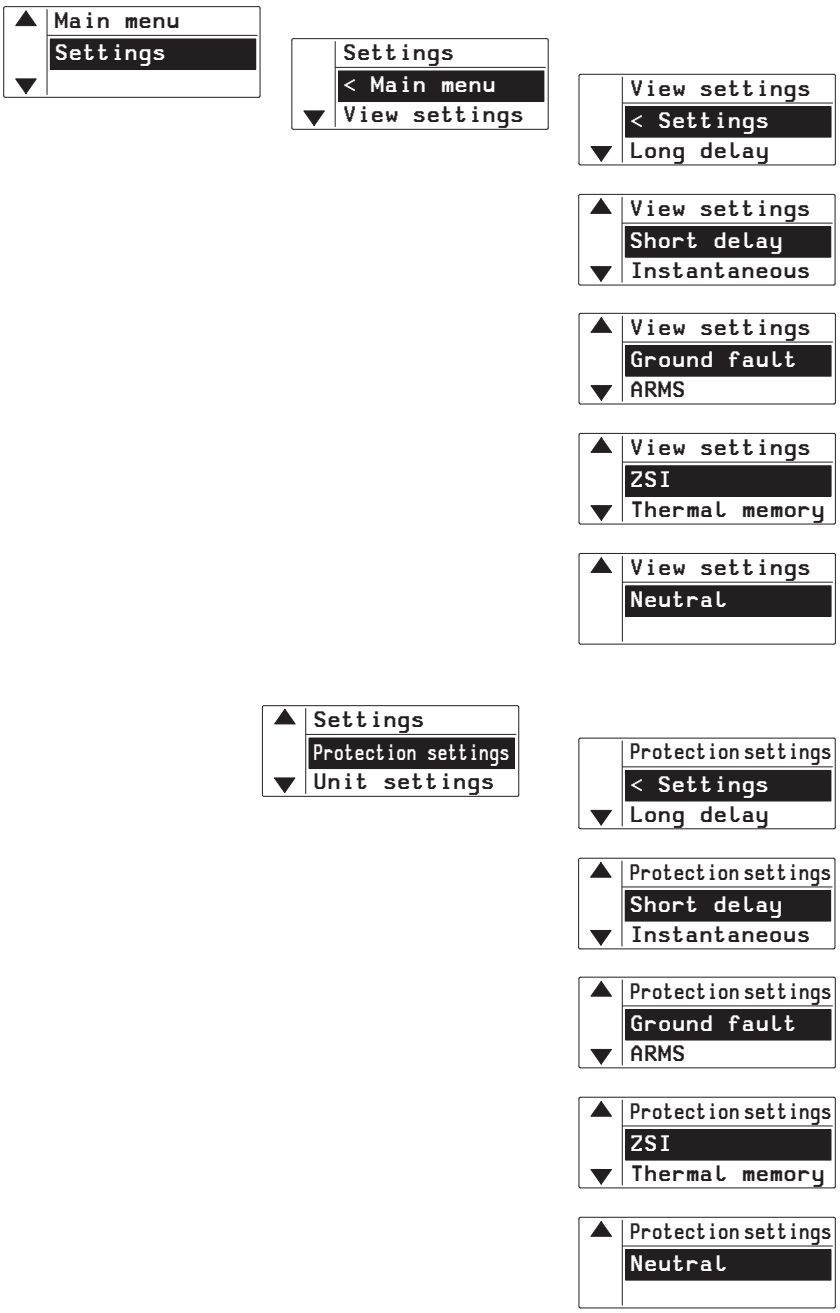


Figure 29: Menu item "settings"

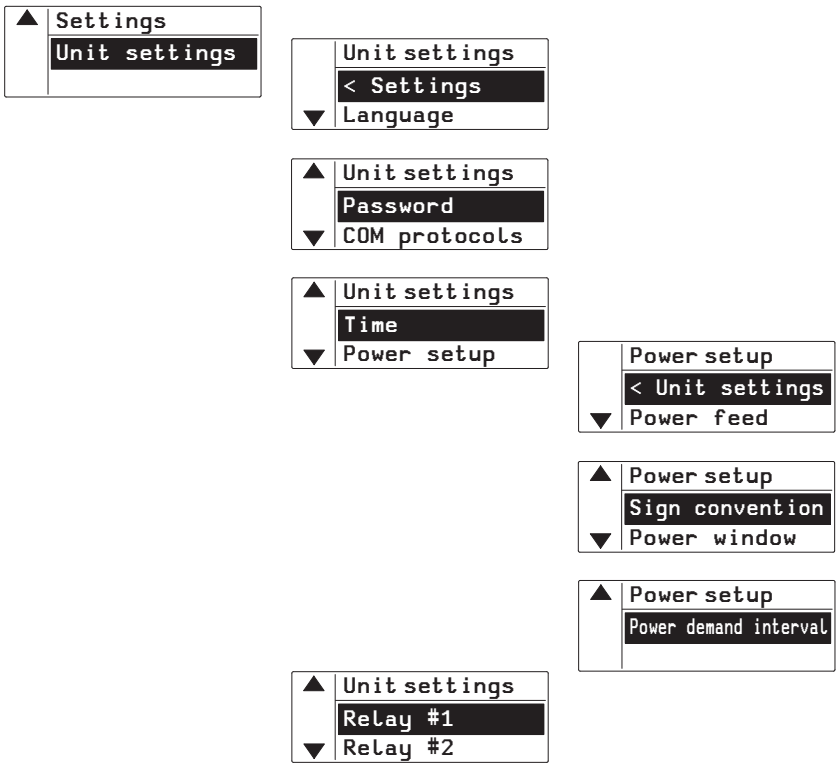


Figure 30: Menu item “device settings”

Alphabetical index