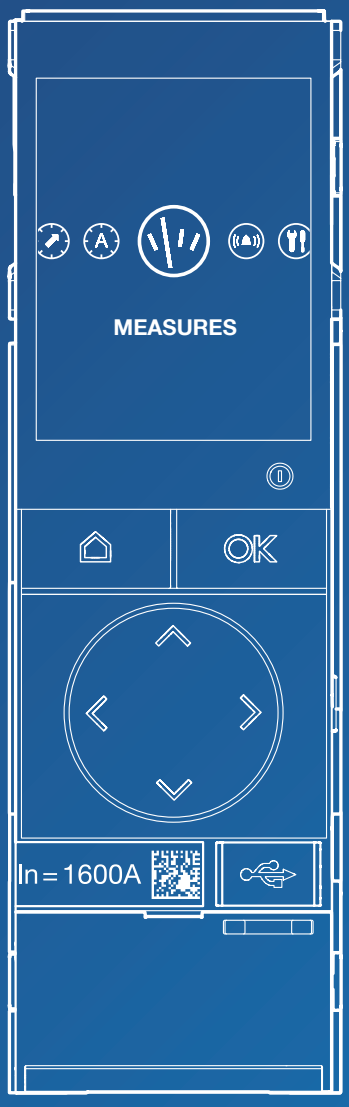
User manual

hw+

sentinel Energy
electronic trip units



hager

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Warnings and instructions

This documentation contains safety advice which must be respected for your own safety and to prevent property damage.
Safety advice relating to your own safety is identified by a safety warning symbol in the documentation. Safety advice relating to damage to property is identified by "ATTENTION".
The safety warning symbols and the wording below are classified according to the risk level.

DANGER
DANGER indicates an imminent dangerous situation which, if not avoided, will result in death or serious injuries.

WARNING
WARNING indicates a potentially dangerous situation which, if not avoided, may result in serious injuries or even death.

CAUTION
CAUTION indicates a potentially dangerous situation which, if not avoided, may result in minor or moderate injuries.

ATTENTION
ATTENTION indicates a warning message relating to equipment damage. **ATTENTION** also indicates important instructions for use and particularly relevant information regarding the product, which must be respected to ensure effective and safe use.

Qualified personnel

The product or the system described in this documentation must be installed, operated and maintained by qualified personnel only. Hager Electro accepts no responsibility regarding the consequences of this equipment being used by unqualified personnel.
Qualified personnel are those people who have the necessary skills and knowledge for building, operating and installing electrical equipment, and who have received training enabling them to identify and avoid the risks incurred.

Appropriate use of Hager products

Hager products are designed to be used only for the applications described in the catalogues and in the technical documentation relating to them. If products and components from other manufacturers are used, they must be recommended or approved by Hager.
Appropriate use of Hager products during transport, storage, installation, assembly, commissioning, operation and maintenance is required to guarantee problem-free operation in complete safety.
The permissible ambient conditions must be respected. The information contained in the technical documentation must be respected.

Publication liability

The contents of this documentation have been reviewed in order to ensure that the information is correct at the time of publication.
Hager cannot, however, guarantee the accuracy of all the information contained in this documentation. Hager assumes no responsibility for printing errors and any damage they may cause.
Hager reserves the right to make the necessary corrections and modifications to subsequent versions.

Cybersecurity and wireless connection

The product or the system described in this documentation requires protective measures to be set up against the risks intrinsic to any wireless connection and transmission and the risks intrinsic to any cable-based connection and transmission.

WARNING

Risks of remote hacking through a wireless connection
- Keep the Bluetooth Low Energy connection deactivated if you do not use the Hager Power touch application.
- Do not activate the Bluetooth Low Energy connection if you are unable to prevent unauthorised access to the installed devices.

Failure to follow these instructions may result in death, serious injury or material damage.

WARNING

Risks that could affect the availability, integrity and confidentiality of the sentinel Energy system
- Change the default passwords during first use to prevent any unauthorised access to the device settings, controls and information.
- Disable unused ports and services, as well as default accounts, to reduce the risk of malicious attacks.
- Protect the devices in the network with several levels of cyberdefence (firewall, network segmentation, intrusion detection and network protection).
- Respect good cybersecurity practices (for example: least privilege principle, separation of tasks) to reduce the risks of intrusion, the loss or alteration of data and logs, or the interruption of services.

Failure to follow these instructions may result in death, serious injury or material damage.

Purpose of the document

This manual is designed to provide users, electrical installers, panel builders, system builders and maintenance personnel with the technical information required for the commissioning and operation of circuit breakers with hw+ sentinel Energy trip units.

Field of application

This document applies to hw+ circuit breakers with sentinel Energy trip units.

Revisions

Version	Date
6LE008147Ac	October 2024

Documents to consult

Document	Reference
HW1 installation manual	6LE007893A
HW2 / HW4 / HW6 installation manual	6LE009206A
hw+ user maintenance guide	6LE007897A
sentinel Energy Modbus communication user guide	6LE007964A
HTD210H panel display user manual	6LE002999A

You can download these publications and other technical information from our website: www.hager.com

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hw+ circuit breakers equipped with the sentinel Energy electronic trip unit provide protection, alarm, measurement, communication and remote control functions.
There are two versions of the sentinel Energy trip unit:
- Energy LSI,
- Energy LSIG.

In addition to the standard functions, offers optional functions for advance use tailored to the needs of the electrical installation.
The availability of the optional functions depends on the type of rating plug installed.

The standard functions (grey rating plugs) are indicated in the following table.

Standard functions	**Energy LSI**	**Energy LSIG**
Long Time Delay protection against overcurrent (L)	■	■
Long Time Delay protection against overcurrent IEC 60255-151	■	■
Short Time Delay protection against overcurrent (S)	■	■
Instantaneous protection against overcurrent (I)	■	■
Earth fault protection (G)	-	■
Neutral protection	■	■
Dual settings (profile A - profile B)	■	■
Zone Selective Interlocking (ZSI)	■	■
Trip and overload alarms	■	■
Optional alarms	■	■
Protection against electronic malfunctions (HWF)	■	■
Trip Test	■	■
Trip history	■	■
History of status and parameter changes	■	■
Class 1 embedded energy meter	■	■
Measurement of current, voltage and power	■	■
Measurement of frequency, phase sequence and power factors	■	■
Maintenance alarm	■	■

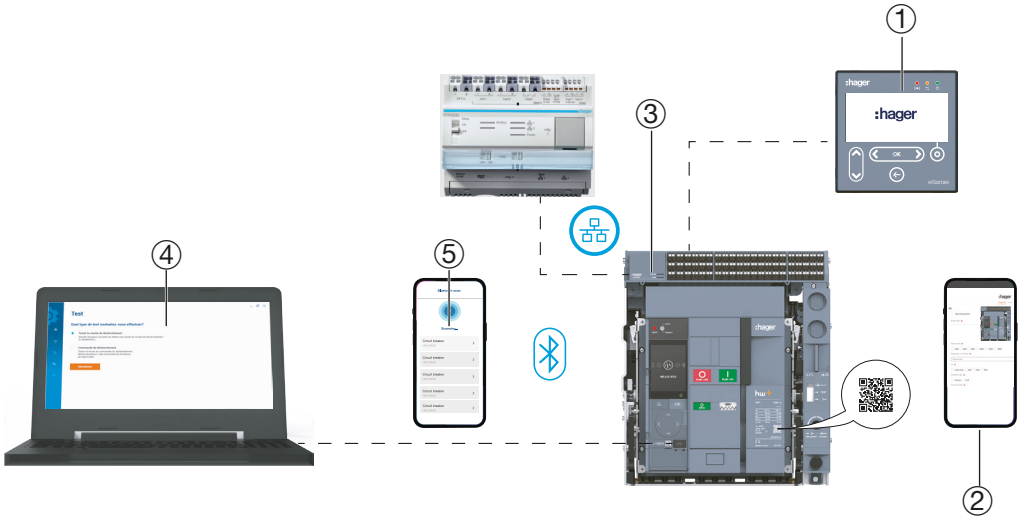
The optional functions (black rating plugs) are indicated in the following table.

Optional functions	**Meter Plus**	**Harmonic**	**Advanced**	**Ultimate**
Measurement of total harmonic distortion THDV and THDV	■	■	■	■
Analysis of individual harmonics	-	■	-	■
Measurement of voltage unbalances	-	■	■	■
Alarm for voltage dips and swells	-	■	■	■
Multi-tariff energy meters	■	■	-	■
Undervoltage protection - ANSI 27	-	-	■	■
Overvoltage protection - ANSI 29	-	-	■	■
Underfrequency protection - ANSI 81L		-	■	■
Overfrequency protection - ANSI 81H	-	-	■	■
Reverse active power protection - ANSI 32R	-	-	■	■
Phase unbalance protection - ANSI 46	-	-	■	■
Voltage unbalance protection - ANSI 47	-	-	■	■

The sentinel Energy trip unit is compatible with the following types of cable-based and wireless communication.

In local communication:
Bluetooth Low Energy connection to a smartphone running the Hager Power touch application.

Through a network cable connection:
Ethernet communication network with the Modbus-TCP protocol.
Serial link communication network with the Modbus-RTU protocol.
The following diagram shows how the sentinel Energy trip unit communicates with external media.



hw+ communication system

① HTD210H panel display (for a single circuit breaker)

② Web page to access the product documentation

③ Modbus-RTU or Modbus-TCP communication module

④ Hager Power setup application via USB connection

⑤ Hager Power touch application via Bluetooth connection

The sentinel Energy electronic trip unit includes:
- A graphical colour display and a keyboard with six keys allowing interaction with the trip unit,
- A ReadyToProtect indicator that displays when the trip unit is operational and ready to protect.

① Graphical colour display

② ReadyToProtect LED

③ Home button

④ Acknowledgement and confirmation OK button

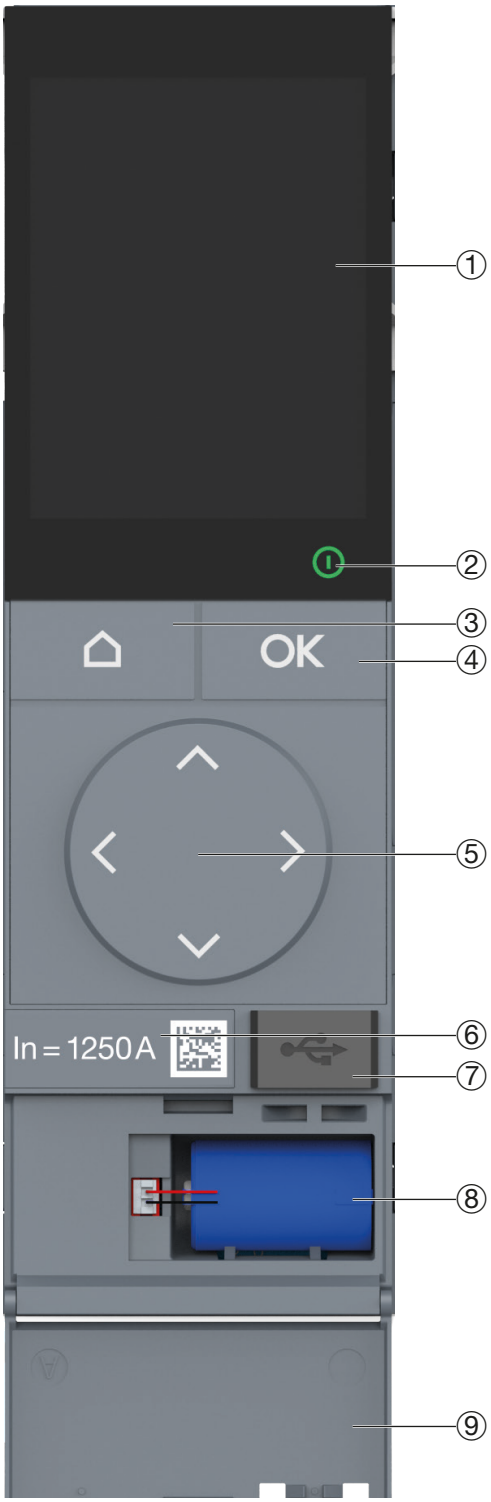
⑤ Navigation buttons

⑥ Rated current value In and indication of optional functions. This value is shown on the rating plug fitted on the trip unit.

⑦ USB-C port to connect an external battery or a computer equipped with the Hager Power setup software

⑧ The backup battery powers the display after a tripping in order to indicate the cause of the fault that was stored.

⑨ Backup battery housing cover.



ATTENTION
The electronic trip unit must be powered in order for it to perform its protection functions. It is powered on condition that a minimum current of 120 A on one phase or 80 A per phase passes through the circuit breaker. Nevertheless, it is strongly recommended that a 24V DC SELV external power supply be connected (recommended product reference Hager HTG911H) on the TU terminal to guarantee optimal operation of the trip unit and prevent malfunctions in the electrical installation associated with a breach in the trip unit's continuity of operation.

The date and time of the sentinel Energy trip unit are used to timestamp events so they can be identified in time.

They can be adjusted manually:
- On the trip unit display, on the Home screen ⇨ CONFIGURATION ⇨ DATE AND TIME. The date format can be DD/MM/YYYY or YYYY/MM/DD. The time format can be based on the 24-hour clock or 12-hour clock.
- From the Hager Power setup application, via manual entry or synchronisation with the clock of the computer on which the application is installed.
- From the HTD210H panel display
- From a web browser connected to the embedded server in the Modbus-TCP communication module.

They can be updated automatically:
- With the Modbus-RTU communication module.
- With the Modbus-TCP communication module receiving a request to update the date and time of an SNTP server.

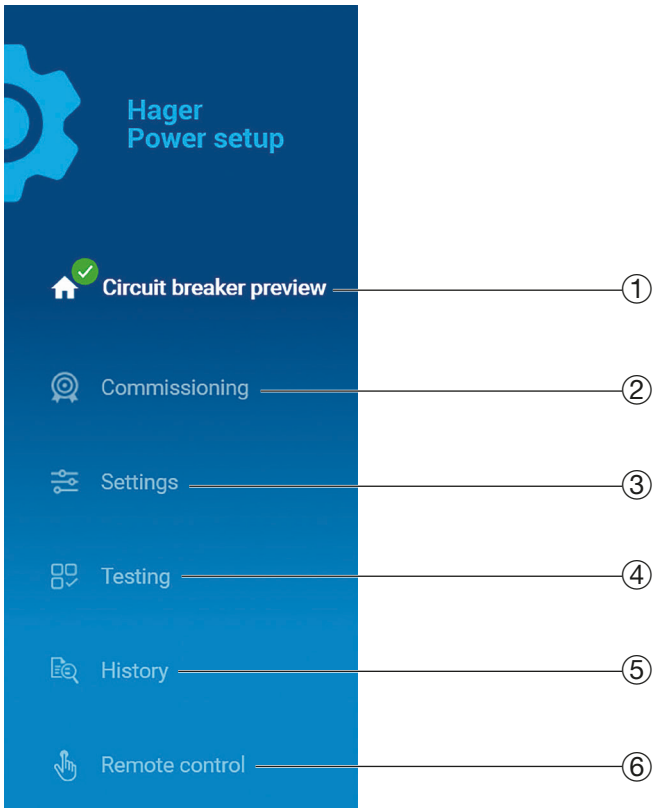
ATTENTION
It is recommended that the date and time be set when the Energy trip unit is commissioned. The default date is 01 January 2000.

The Hager Power setup software has been designed for testing and commissioning hw+ and h3+ circuit breakers.
Thanks to the commissioning menu, it is possible to specifically generate a commissioning report proving that the protection settings comply with the short-circuit and selectivity calculations. This requires the settings to be imported from the Hagercad software.
It offers a smart way of creating the protection settings. It also allows all the trip unit parameter settings to be displayed and modified.

It is possible to perform a test of the hw+ circuit breakers tripping curve.
It also allows a forced electro-mechanical tripping of the circuit breakers to be performed.

It is very useful during the test phase when wiring the output contacts. It makes it possible to force the opening or closing of the OAC, PTA and ZSI output contacts.
The result of the different tests can be entered into a test report that can be generated at any time whether in the wiring workshop or during acceptance tests on site.

The functions of the Hager Power setup software can be accessed through six menus:



① Functional state of the circuit breaker, maintenance information and principal technical characteristics.

② Three-stage procedure: 1. Setting the protection with verification, 2. Test of the tripping curve, 3. Electromechnical tripping.
Allows a commissioning report to be generated.

③ Access to all the parameter settings of the trip unit.

④ Access to the tripping curve of the manual test, the forced electro-mechanical tripping and activation of the output contacts available on the circuit breaker. Allows a test report to be generated.

⑤ Access to events history, displays of active alarms, operating counters dashboard.

⑥ Access to remote controls available on the circuit breaker: remote opening and closing, switching between protection profiles, inhibition of advanced protections.

Principal functions

Display the functional state of the circuit breaker, maintenance information and principal technical characteristics.

Perform a commissioning by importing settings from Hagercad.

Generate and export a PDF of the test reports and commissioning reports.

Perform a test of the trip curve resulting from the protection parameter settings of the hw+ circuit breakers.
Perform a forced electro-mechanical tripping of the circuit breakers.

Display and modify all the electronic trip unit parameter settings.
Display alarms in progress.

Download and export the electronic trip unit settings in a file in CSV format.
Save the settings of a circuit breaker from within the Energy family to load them into one or more similar circuit breakers.
Force the opening or closing of the OAC, PTA and ZSI output contacts.

Display the active alarms.
View the event logs and export them in a file in CSV format.

Display the status of the operating counters available (handling cycles, tripping operations...).

Perform the remote control actions (opening, closing, switching of protection profiles, inhibition of advanced protections) in a safe way.

Manage the passwords of the Energy trip unit, the communication modules and the panel display.

The Hager Power setup software is available on the Hager website for your country.

IT configuration required.

	Minimal	Recommended
Operating system	Windows 10 x32 bits	Windows 10 x64 bits
Memory	4 Gb RAM	8 Gb RAM
Disk space	50 Mb	50 Mb
Components	Microsoft .NET Framework 4.7.2 .NET Core Runtime 3.1.13 .NET Desktop Runtime 3.1.13 Microsoft web view 2 v1.0.818.14	Microsoft .NET Framework 4.7.2 or higher .NET Core Runtime 3.1.13 or higher .NET Desktop Runtime 3.1.13 or higher Microsoft web view 2 v1.0.818.14 or higher
Resolution	1024x768 pixels	1280x1024 pixels

The Hager Power touch mobile application displays status, measurement and settings information, and allows the circuit breaker to be remotely controlled in order to perform an opening or closing command.

It is compatible with the hw+ circuit breakers with the sentinel Energy trip unit.

This application is particularly useful for day-to-day operation and maintenance.

The Energy trip unit must be powered for it to establish the Bluetooth connection. Only one smartphone can be connected to a circuit breaker at a time.

The Hager Power touch mobile application allows access to a Home page showing the circuit breaker's principal characteristics, its operating state and maintenance information.

The other information and functions are described in the sections below:

Remote com-mand Close/open	allows the circuit breaker's opening or closing functions to be carried out.
Voltage and current ...	displays real-time voltage and current values.
Quality of l... Frequency, power fac...	displays frequency, power factor, harmonic distortion rate and individual harmonic values.
Demand Current and power	displays the current demand and power demand values.
Power... +Quadrant, phase rotation...	display the power and real-time energy measurement values as well as the power quadrant and phase sequence.
Parameters Overview of...	gives a read-only view of the values of the protection setting, advanced protections, alarms, electrical grid and the date and time of the circuit breaker.
History Overview of all events	display the events history by section.

The application can be installed on a smartphone and downloaded from:
- Google Play Store for Android smartphones,
- App Store for iOS smartphones.

Compatibility

The application is only available for Apple and Android smartphones.
The dedicated page on the App Store indicates the compatibility of the application with the various versions of iOS.
The dedicated page on the Google Play Store indicates the compatibility of the application with the various versions of Android.

The Modbus-RTU communication module or the Modbus-TCP communication module enable communication with the hw+ sentinel Energy circuit breaker.

The Modbus-RTU communication module connects to an RS485 serial communication network.

Modbus RTU module

The Modbus-TCP communication module connects to an Ethernet network.

Modbus TCP module

These communication modules are compatible and specially indicated to interface with the agardio.manager HTG411H data server.

They enable the following principal functions:
- Reading of state and measurement data,
- Transfer of event history,
- Display and modification of the protection and measurement settings,
- Reading of identification data of the circuit breakers,
- Access to remote controls available on the circuit breaker (opening or closing, switching of the protection profiles, inhibition of advanced protections),
- Setting the clock and synchronising it.

For more information on the use of these communication modules, refer to the sentinel Energy Modbus communication user manual.

Electrical characteristics

Rated DC supply voltage	24 V (+/- 30 %) SELV
Modbus RTU module power consumption	14 mA
Modbus TCP module power consumption	38 mA

The HTD210H panel display allows the state, measurement and setting information on a cover of the electrical assembly to be displayed.
It also allows the main protection and alarm settings to be changed.
The HWY210H adapter is necessary to connect the CIP cable pair from the circuit breaker to supply 24 V DC power to the HTD210H panel display. The same 24 V DC external power supply must be used to supply power to the 24 V TU terminal block on the circuit breaker.

HTD210H panel display

HWY210H adapter

The HTD210H display shows the following:
- the protection parameters
- the measured values
- the alarm management parameters
- the optional alarm and trip histories
- the circuit breaker's status and identification information.

It allows the following to be changed:
- the circuit breaker protection parameters
- the measurement parameters
- the date and time
- the optional alarms and overload prealarms.

It also allows the minimum/maximum measurement counters to be reset and the optional alarm and trip logs to be erased.

For more information on use of the panel display
HTD210H, refer to the HTD210H panel display user manual 6LE002999A.

Electrical characteristics

Rated DC supply voltage	24 V (+/- 30 %) SELV
Current consumption	85 mA

Environmental and mechanical characteristics

Operating temperature range	-10 °C…+55 °C
Storage temperature	-20 °C…+70 °C
Pollution degree	2
Installation category	III
IP class of front side	IP65
IP class of back side	IP20
Mechanical protection (front face)	IK07

Physical characteristics

Dimensions L x H x D	97 x 97 x 46 mm
Panel/door cut-out dimensions	92 x 92 mm
Weight	165 g
Display dimensions	37 x 78 mm
Type of connector	RJ9
Cable length max.	10 m

DANGER

Risk of serious injury or danger of death.
Ensure that the power supply inlet upstream of the circuit breaker is cut off and isolated before connecting the accessories and devices for the communication system.

ATTENTION

Please respect the recommendations and instructions for installing the sentinel Energy trip unit. To do this, please refer to the technical documentation for the range of hw+ circuit breakers as well as the installation manual supplied with the circuit breaker.

Choosing the external 24 V DC supply
An external 24 V DC supply is required to supply the communication accessories and to guarantee that the measurement, alarm and configuration functions of the Energy trip unit always function correctly. It is recommended to use a 24 V DC SELV supply (Safety Extra Low Voltage).

This external supply must be dimensioned adequately to meet the needs of the accessories connected.

Power consumption of various accessories

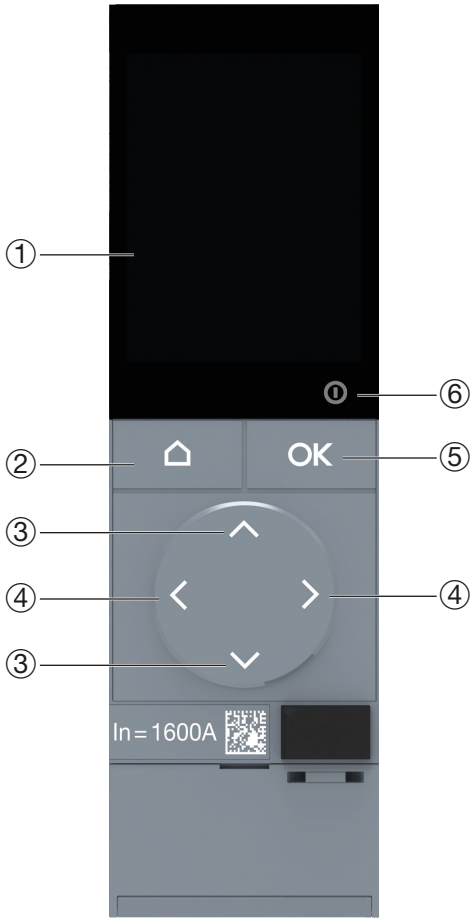
sentinel Energy trip unit	60 mA
HTD210H panel display	85 mA
Modbus RTU communication module	14 mA
Modbus TCP communication module	38 mA
OAC alarm output contacts module	34 mA

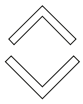
The HTG911H 24 V power supply fully meets these needs as it is SELV and provides an output current up to 2.5 A.

N.B.
In addition, it is recommended to use a secure 24 V DC supply to guarantee complete continuity of service and correct operation even in the event of a failure in the electrical distribution network.

Reminder:
Minimum circuit breaker conditions for which the measurement, alarm and configuration functions are available without an external power supply: 3 x 80 A.

The sentinel Energy trip unit user interface consists of a display panel, 6 navigation buttons and a ReadyToProtect LED.



	Button	Description
①	-	Display panel
②		The Home button: • takes you back to the Home screen and the main menu screen • cancels the change to a parameter.
③		Arrows to navigate in a submenu and select a parameter value
④		Arrows to navigate between the main menus and submenus
⑤		The OK button: - confirms a parameter change, - moves in the sequence of views available on the Home display, - displays and acknowledges an alarm.
⑥	-	ReadyToProtect LED

Navigation is performed from two display types:
- Operation: from the Home screen to display the sequence of predefined views in Live mode or to display only the indications and alarm warnings.
- Tree: from the main menus screen to navigate in the submenus.

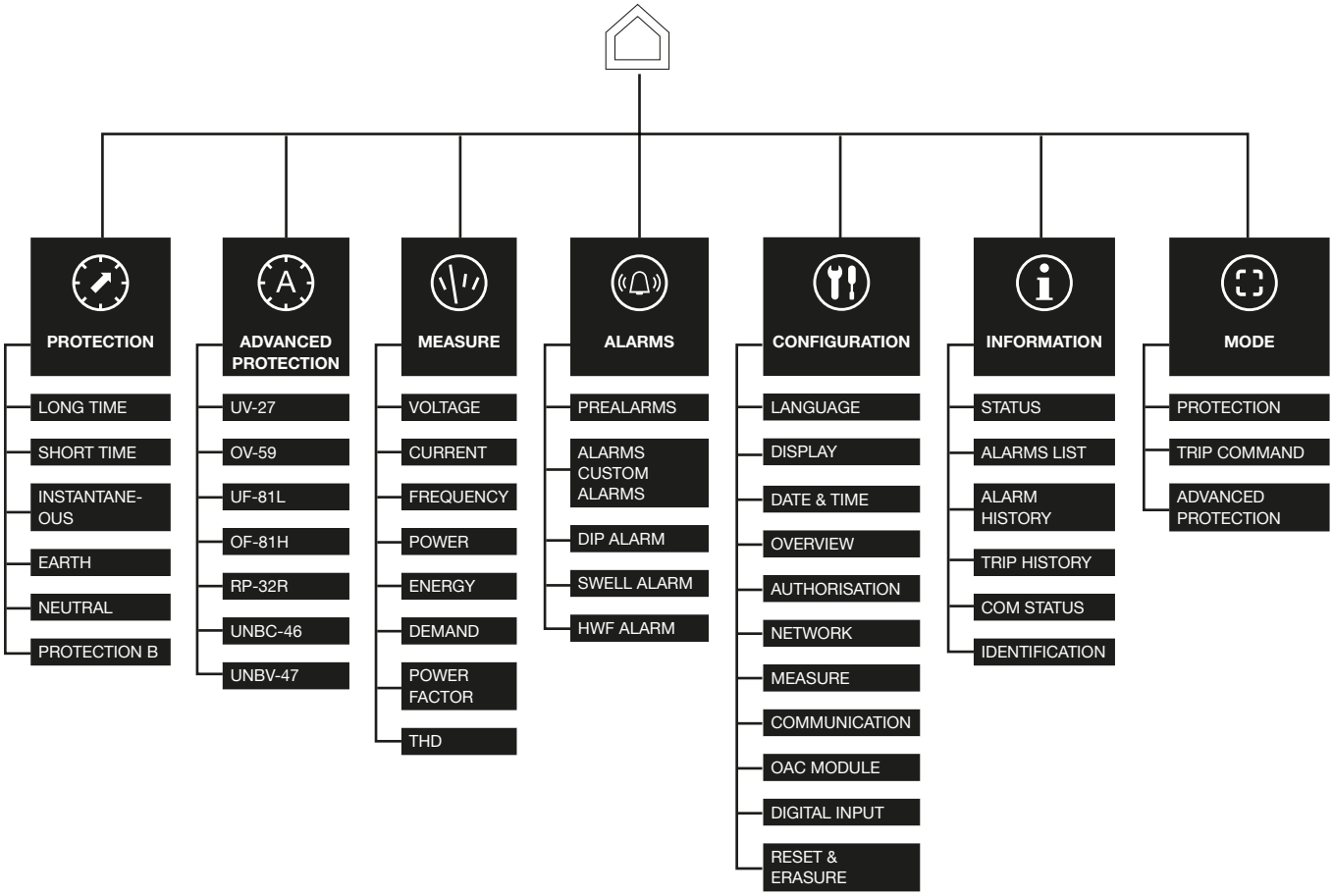
Navigation in the tree is done from the main menus screen.

When navigating through the tree structure, the following actions can be performed:
- Display and modification of the standard protection settings
- Display and modification of the advanced protection settings
- Display of measured values
- Display and modification of the alarm settings
- Display and modification of the configuration settings
- Display of information
- Access the control functions of the MODE menu.

Navigation between submenus

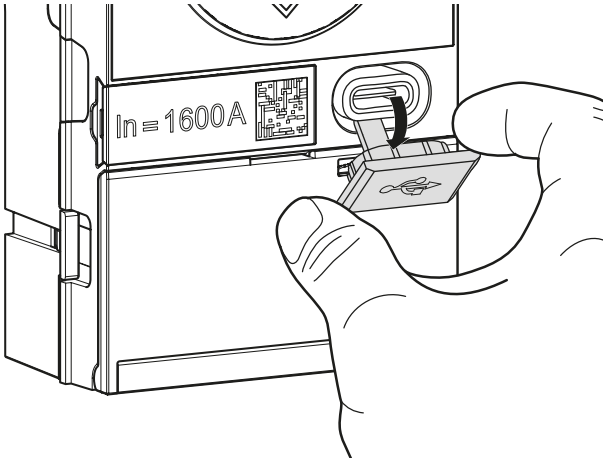
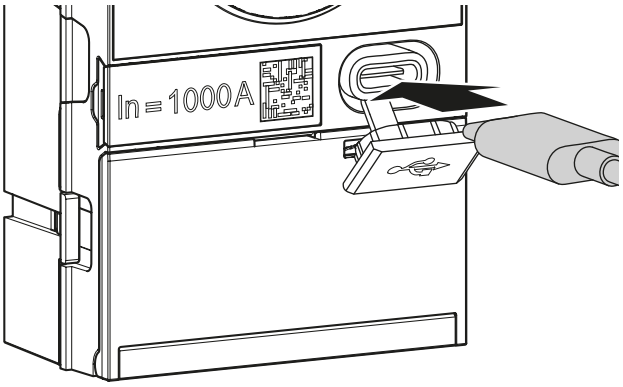
Button	Description
	Returns you to the main menu
	Enters the tree of the main menu selected.
	Navigates between submenus
	Moves through the content of the submenu

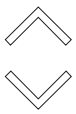
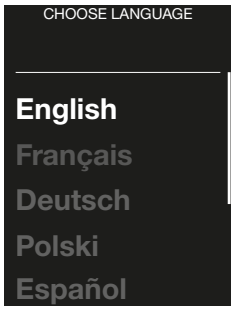
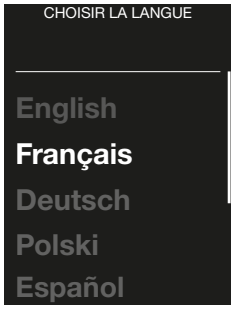
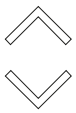
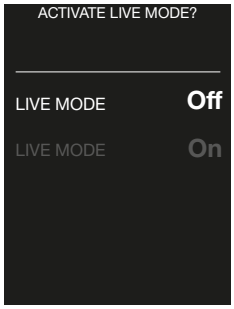
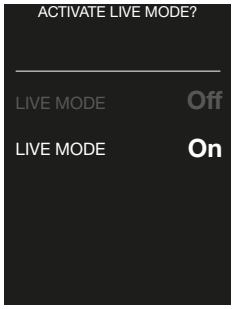
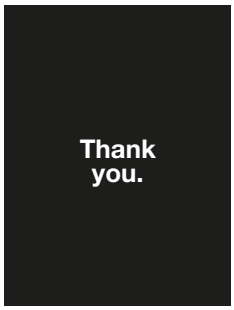
Tree structure:



ATTENTION
The protection, alarm and configuration parameters can be protected from change by the trip unit's password. Changing the language and setting brightness remain available without a password.

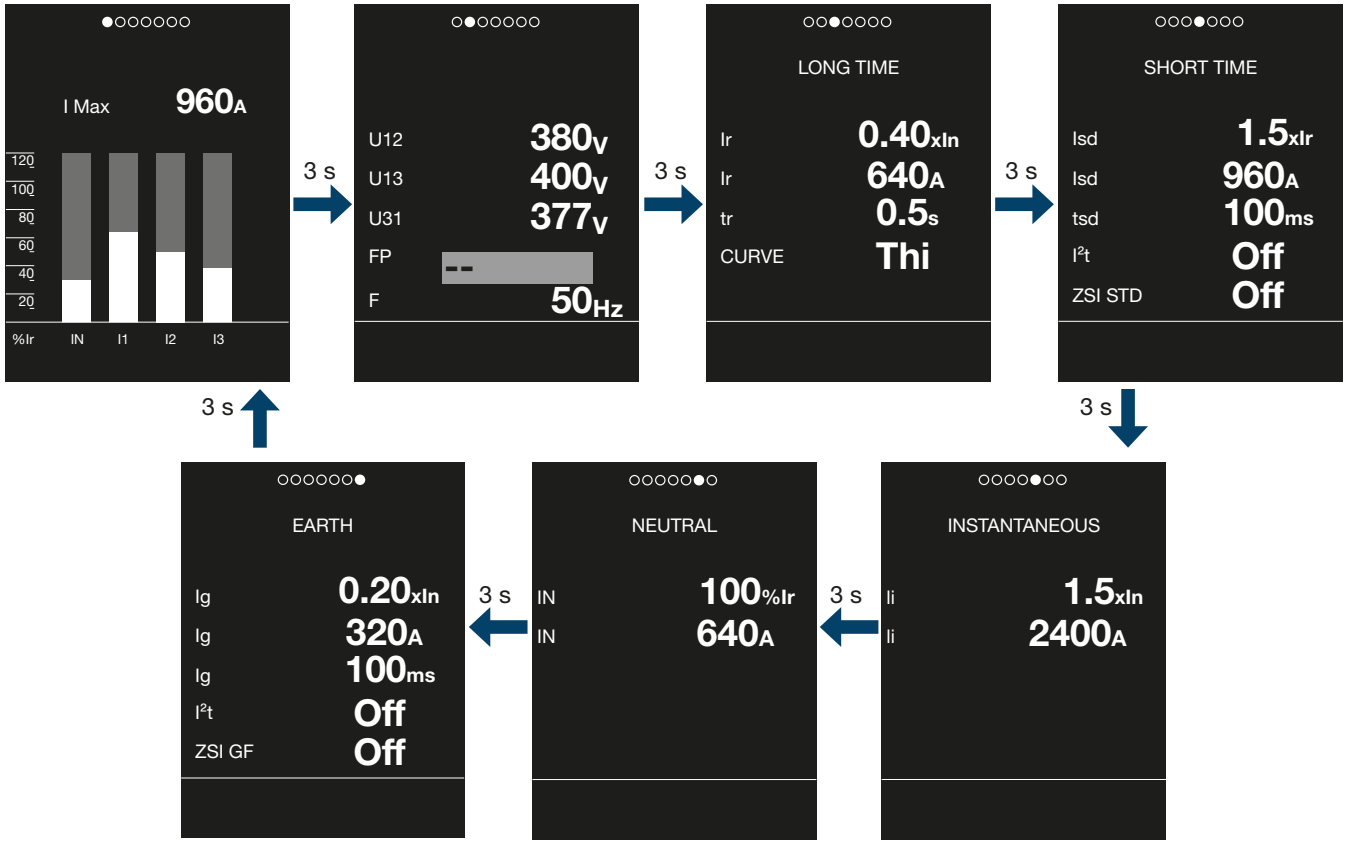
The first time the system is powered up, the start-up assistant allows the display language to be defined and Live mode to be activated.

	Action	Illustration
1	Remove the USB-C port cover.	
2	Connect the external battery to the trip unit's USB-C port.	
3	The trip unit display switches on.	

	Step/Action	Button	Display
4	Select the display language of the sentinel Energy trip unit.		
5	Confirm the preferred language. The language can also be changed within the CONFIGURATION menu.		
6	Select Live mode. The choice of Live mode can be changed at any time in the CONFIGURATION menu.		
7	Confirm the Live mode desired.		
8	The start-up assistant is complete.		

Live mode continuously displays a sequence of predefined views of measurements or protection settings.
Three parameters allow adjustments to be made to Live mode:
- choice of views to display
- display time of a view
- display mode of a Measurement view (graphical or numeric).

Once activated, up to 15 views can be selected from a list of 27 views.
The Live mode parameters can be accessed in the CONFIGURATION menu.
It starts automatically after 30 seconds of inactivity on the navigation buttons. By default the views below cannot be deselected from Live mode.



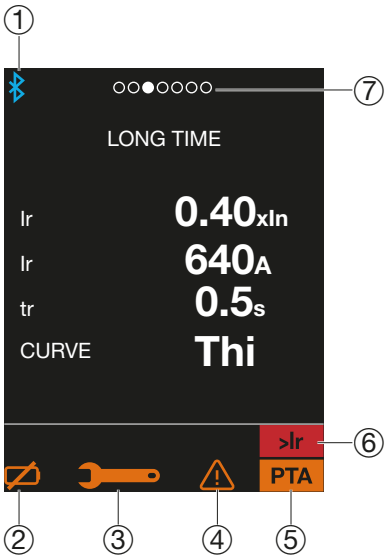
Navigation in Live mode

Button	Description
	Returns to the Home screen that displays the sequence of Live views.
	Pauses Live mode and moves to the next view.
	Moves from one view to another.

ATTENTION
See the chapter Live mode setting for information on the activation and selection of Live mode views.

Indications and notification in Live mode

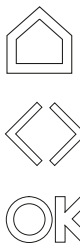
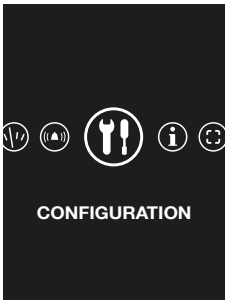
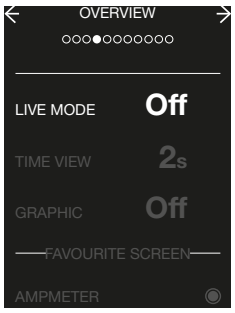
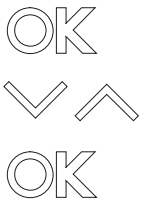
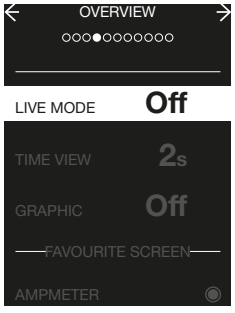
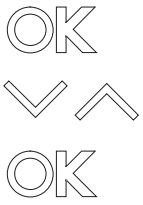
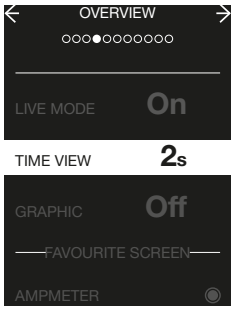
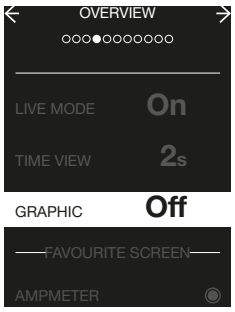
The top and bottom of the views selected in Live mode are reserved for display of a position marker in the scrolling sequence, Bluetooth activation and alarm notifications.

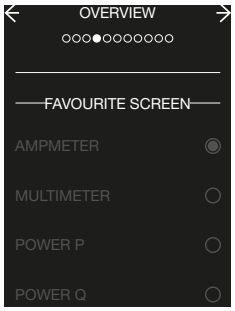


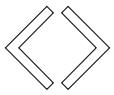
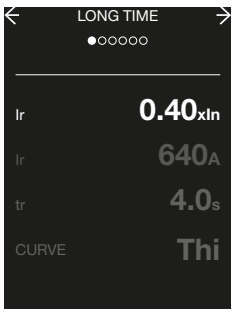
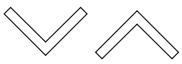
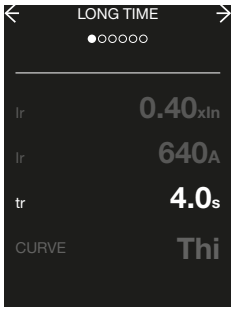
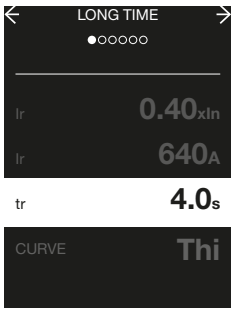
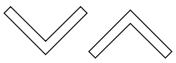
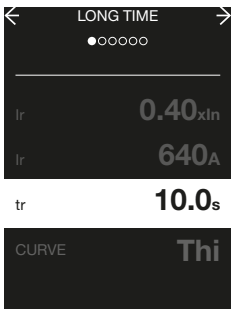
①	Bluetooth	appears as soon as the Bluetooth connection is activated.
②	Low or missing battery indicator alarm	displayed if the sentinel Energy trip unit backup battery needs to be changed or is not connected.
③	Maintenance alarm indicator	displayed when maintenance is required.
④	System alarm indicator	appears when a system alarm is present and the INFORMATION ⇨ ALARM HISTORY menu has not been viewed yet.
⑤	Overload prealarm alarm indicator	appears when the current crosses the PTA 1 threshold. Allows warnings about a risk of imminent overload.
⑥	Overload alarm indicator	flashes when the current exceeds 105 % of Ir and is constant when above 112.5 % of Ir. Allows you to be alerted to an imminent risk of tripping.
⑦	View marker	indicates the positioning order of the screen in the view sequence.

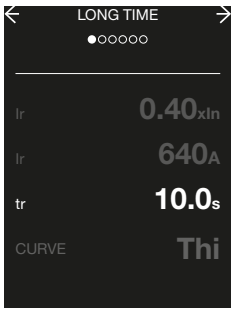
Live mode setting

To adjust Live mode settings:

	Step/Action	Button	Display
1	Open the CONFIGURATION menu.		
2	Select the **OVERVIEW** submenu.		
3	Activate Live mode.		
4	Define the rate at which views are displayed.		
5	Set the graphical or numeric display mode of the measurement views.		

	Step/Action	Button	Display
6	Select the predefined views (up to 8 views in addition to the default views).		

	Action	Button	Display
1	Open the PROTECTION menu.		
2	Select the submenu desired.		
3	Select a parameter.		
4	Activate parameter change mode.		
5	Set the value desired.		

	Action	Button	Display
6	Confirm the change.	OK	

Content of the PROTECTION menu

Submenus	Parameter	Unit	Description
LONG TIME	Ir	x In	0.40xIn to 1.00xIn, in increments of 0.01; default value 0.40xIn
	tr	s	0.5 to 25s in increments of 0.5 s; default value 0.5s
	Curve	-	Thi/HVF I4t/EI I2t/VI It/SI I0.02t; default value Thi
SHORT TIME	Activation	-	On/Off; default value On.
	Isd	x Ir	1.0 to 10xIr in increments of 0.5; default value 1.5xIr
	tsd	ms	50 to 600 ms in increments of 50; default value 100ms
	I^2t	-	On/Off; default value Off
	ZSI STD	-	On/Off; default value Off
INSTANTA-NEOUS	Activation	-	On/Off; default value On
	Ii	x In	1.5xIn to 15xIn, in increments of 0.5; default value 1.5xIn
EARTH	Activation	-	On/Off; default value Off for 3-pole, On for 4-pole
	Ig	x In	0.1 to 1.0xIn in increments of 0.1; default value 0.2xIn
	tg	ms	50 to 600 with steps of 50
	I^2t	-	On/Off; default value Off
	ZSI GF	-	On/Off; default value Off
NEUTRAL	Activation	-	On/Off; default value Off for 3-pole and On for 4-pole
	IN/Ir (%)	% Ir	50 to 200 %Ir, in increments of 50; default value 100 %Ir for a 4-pole circuit breaker

Content of the ADVANCED PROTECTION menu

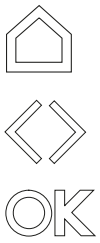
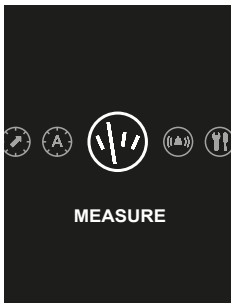
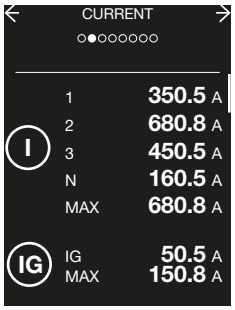
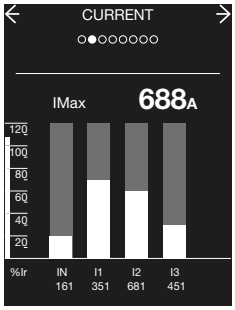
Submenus	Text	Unit	Description
UV-27	CONFIG	-	Off, Trip, Alarm
	INHIBIT	-	Off or On
	U-V TYPE	-	L-L or L-N
	THRESHOLD	V	100 to 1000 V in increments of 5 V
	TIME	s	0.1 to 300 with steps of 0.1
OV-59	CONFIG	-	Off, Trip, Alarm
	INHIBIT	-	Off or On
	U-V TYPE	-	L-L or L-N
	THRESHOLD	V	100 to 1000 V in increments of 5
	TIME	s	0.1 to 300 with steps of 0.1
UF-81L	CONFIG	-	Off, Trip, Alarm
	INHIBIT	-	Off or On
	THRESHOLD	Hz	45 to Fn with steps of 0.1
	TIME	s	0.1 to 300 with steps of 0.1
OF-81H	CONFIG	-	Off, Trip, Alarm
	INHIBIT	-	Off or On
	THRESHOLD	Hz	Fn to 65 with steps of 0.1
	TIME	s	0.1 to 300 with steps of 0.1
RP-32R	CONFIG	-	Off, Trip, Alarm
	INHIBIT	-	Off or On
	THRESHOLD	%Pn	4.0 to 15.0 with steps of 0.5
	TIME	s	0.1 to 300 with steps of 0.1
UNBC-46	CONFIG	-	Off, Trip, Alarm
	INHIBIT	-	Off or On
	THRESHOLD	%	2 to 90 with steps of 1
	TIME	s	0.5 to 60 with steps of 0.1
UNBV-47	CONFIG	-	Off, Trip, Alarm
	INHIBIT	-	Off or On
	THRESHOLD	%	2 to 90 with steps of 1
	TIME	s	0.5 to 60 with steps of 0.1

N.B.
Advanced protections are deactivated by default.

Choice of display mode on the measurement screens

The measurement views (except the voltage, energy, power factor and THD views) can be displayed in numerical mode or in graphical mode.

To change display mode:

	Action	Button	Display
1	Open the MEASURE menu.		
2	Select a measurement.		
3	Switch to graphical mode.		

Content of the MEASURE menu
Content of the VOLTAGE submenu

Text		Unit	Description
U	12	V	RMS voltage between phases L1 and L2
	23	V	RMS voltage between phases L2 and L3
	31	V	RMS voltage between phases L3 and L1
V	1N	V	RMS voltage between phase L1 and neutral
	2N	V	RMS voltage between phase L2 and neutral
	3N	V	RMS voltage between phase L3 and neutral
U max	12	V	Maximum RMS voltage between phases L1 and L2
	23	V	Maximum RMS voltage between phases L2 and L3
	31	V	Maximum RMS voltage between phases L3 and L1
V max	1N	V	Maximum RMS voltage between phase L1 and neutral
	2N	V	Maximum RMS voltage between phase L2 and neutral
	3N	V	Maximum RMS voltage between phase L3 and neutral
U min	12	V	Minimum RMS voltage between phases L1 and L2
	23	V	Minimum RMS voltage between phases L2 and L3
	31	V	Minimum RMS voltage between phases L3 and L1
V min	1N	V	Minimum RMS voltage between phase L1 and neutral
	2N	V	Minimum RMS voltage between phase L2 and neutral
	3N	V	Minimum RMS voltage between phase L3 and neutral
U avg	LL	V	Arithmetic mean of phase-to-phase voltages
	LN	V	Arithmetic mean of phase-to-neutral voltage measurements
max u avg	LL	V	Maximum arithmetic mean of phase-to-phase voltages
	LN	V	Maximum arithmetic mean of voltages between phase and neutral
* min u avg	LL	V	Minimum arithmetic mean of phase-to-phase voltages
	LN	V	Minimum arithmetic mean of voltages between phase and neutral
U unb	12	%	Voltage unbalance between U12 and the mean of phase-to-phase voltages
	23	%	Voltage unbalance between U23 and the mean of phase-to-phase voltages
	31	%	Voltage unbalance between U31 and the mean of phase-to-phase voltages
V unb	1N	%	Voltage unbalance between V1N and the mean of phase-to-neutral voltages
	2N	%	Voltage unbalance between V2N and the mean of phase-to-neutral voltages
	3N	%	Voltage unbalance between V3N and the mean of phase-to-neutral voltages

* The following measurements are available only with the Harmonic, Advanced and Ultimate rating plugs.

Content of the CURRENT submenu

Text		Unit	Description
I	1	A	RMS current I1 on L1
	2	A	RMS current I2 on L2
	3	A	RMS current I3 on L3
	N	A	RMS current IN on neutral
	MAX	A	Maximum current between I1, I2, I3 and IN
IG	IG	A	RMS current calculated at earth
	MAX	A	Last maximum RMS current value calculated at earth
I max	1	A	Maximum RMS current I1 on L1
	2	A	Maximum RMS current I2 on L2
	3	A	Maximum RMS current I3 on L3
	N	A	Maximum RMS current on neutral
I min	1	A	Minimum RMS current I1 on L1
	2	A	Minimum RMS current I2 on L2
	3	A	Minimum RMS current I3 on L3
	N	A	Minimum RMS current on neutral IN
I avg	I	A	Arithmetic mean current of I1, I2 and I3
	MAX	A	Last maximum of arithmetic mean current
	MIN	A	Last minimum of arithmetic mean current
I unb	1	%	current unbalance between I1 and the arithmetic mean
	2	%	current unbalance between I2 and the arithmetic mean
	3	%	current unbalance between I3 and the arithmetic mean
	MAX	%	maximum unbalance between Inba1, Inba2 and Inba3
max unb	I	%	Last maximum of unbalanced current

Content of the FREQUENCY submenu

Text		Unit	Description
FREQUENCY		Hz	
QUADRANT		-	power quadrant
PHASE SEQ.	1, 2, 3	-	Direct
	1, 3, 2	-	Reverse

Content of the POWER submenu

Text		Unit	Description
P	1	kW	Active power on phase L1
	2	kW	Active power on phase L2
	3	kW	Active power on phase L3
	tot	kW	Total active power
Q	1	kvar	Reactive power on phase L1
	2	kvar	Reactive power on phase L2
	3	kvar	Reactive power on phase L3
	tot	kvar	Total reactive power
S	1	kVA	Apparent power on phase L1
	2	kVA	Apparent power on phase L2
	3	kVA	Apparent power on phase L3
	tot	kVA	Total apparent power
P max	1	kW	Last maximum active power on phase L1
	2	kW	Last maximum active power on phase L2
	3	kW	Last maximum active power on phase L3
	tot	kW	Total maximum active power
Q max	1	kvar	Last maximum reactive power on phase L1
	2	kvar	Last maximum reactive power on phase L2
	3	kvar	Last maximum reactive power on phase L3
	tot	kvar	Total maximum reactive power
S max	1	kVA	maximum apparent power on phase L1
	2	kVA	maximum apparent power on phase L2
	3	kVA	maximum apparent power on phase L3
	tot	kVA	maximum total apparent power

Content of the ENERGY submenu

Text		Unit	Description
Ea tot	IN	kWh	total active energy imported (consumed)
	OUT	kWh	total active energy exported (produced)
Er tot	IN	kvarh	total reactive energy imported (consumed)
	OUT	kvarh	total reactive energy exported (produced)
Ea part	IN	kWh	total active energy exported (consumed) (partial meter)
	OUT	kWh	total active energy exported (produced) (partial meter)
Es		kVAh	Apparent energy

Content of the DEMAND submenu

Text		Unit	Description
I	1	A	current demand on phase L1
	2	A	current demand on phase L2
	3	A	current demand on phase L3
	N	A	neutral current demand
I avg	I	A	average current demand
I peak	1	A	peak current demand on phase 1
	2	A	peak current demand on phase 2
	3	A	peak current demand on phase 3
	N	A	peak current demand on neutral N
AVG peak	I	A	Average peak current demand
PQS	P	kW	total active power demand
	Q	kvar	total reactive power demand
	S	kVA	total apparent power demand
PQS peak	P	kW	total peak active power demand
	Q	kvar	total peak reactive power demand
	S	kVA	total peak apparent power demand

Content of the POWER FACTOR submenu

Text		Unit	Description
PF	1	-	Power factor on phase 1
	2	-	Power factor on phase 2
	3	-	Power factor on phase 3
	tot	-	Total power factor
Cos	ϕ 1	-	Fundamental power factor on phase 1
	ϕ 2	-	Fundamental power factor on phase 2
	ϕ 3	-	Fundamental power factor on phase 3
	ϕ tot	-	Total fundamental power factor

Content of the THD* submenu

Text		Unit	Description
U	12	%	THD of U12
	23	%	THD of U23
	31	%	THD of U31
V	1N	%	THD of V1N
	2N	%	THD of V2N
	3N	%	THD of V3N
I	1	%	THD of I1
	2	%	THD of I2
	3	%	THD of I3
	N	%	THD of IN
max I	IN	%	Last maximum of THD of IN

* The following measurements are available only with the Meter Plus, Harmonic, Advanced and Ultimate rating plugs.

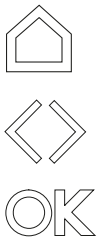
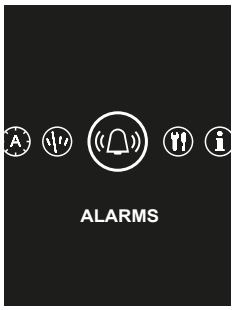
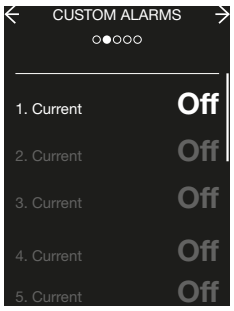
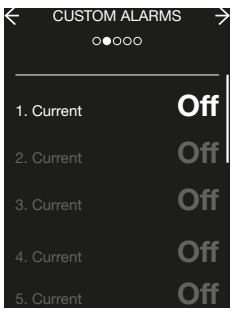
Content of the PREALARM submenu

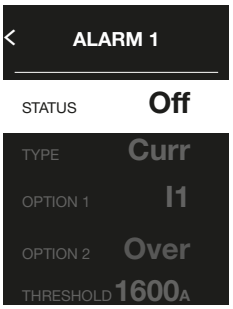
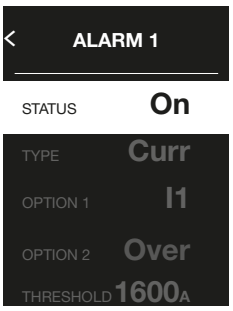
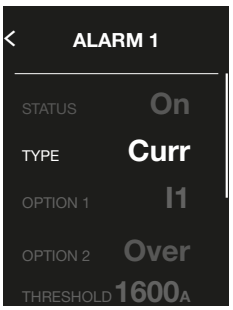
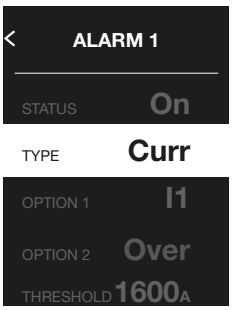
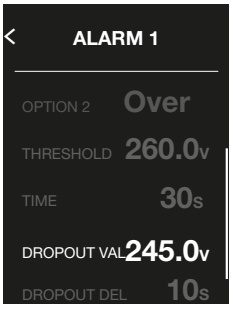
Text	Parameter		Unit	Description	Default setting
PTA 1	Threshold Ir	PTA prealarm threshold (% Ir)	%	60 to 95 (increments of 5 %)	90
	Delay tr	PTA prealarm time delay (% tr)	%	5 to 80 (increments of 5 %)	50
PTA 2	Activation		-	On or Off	Off
	Threshold Ir	PTA prealarm threshold (% Ir)	%	60 to 95 (increments of 5 %)	90
	Delay tr	PTA prealarm time delay (% tr)	%	5 to 80 (increments of 5 %)	50

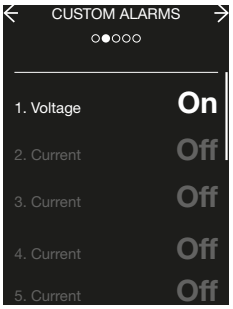
Details of the CUSTOM ALARMS submenu

Up to 12 custom alarms can be customised.

The procedure to configure a custom alarm is as follows.

	Step/Action	Button	Display
1	Open the ALARMS menu.		
2	Select the CUSTOM ALARMS submenu.		
3	Select and confirm an alarm.		

	Step/Action	Button	Display
4	Activate the change of the STATUS parameter.		
5	Change the STATUS parameter to On and confirm.		
6	Choose the type of measurement to monitor and confirm the change (same procedure as stages 4 and 5). The parameters OPTION 1 and OPTION 2 change automatically according to the parameter TYPE chosen.		
7	Move on to the next parameter and adjust all of the alarm parameters in the same way.		
8	When all the parameters have been defined, press the left button.		

	Step/Action	Button	Display
9	Confirm the new parameterisation.	OK	
10	Alarm 1 is configured to monitor a voltage.		

Content of the CUSTOM ALARMS submenu

Type	Text	Description
Current	STATUS	Off, On
	OPTION 1	I1, I2, I3, IN, IMax, I1Unb, I2 Unb, I3 Unb, I Max Unb, I Avg
	OPTION 2	Under or over (alarm activation condition on Option 1)
	THRESHOLD	in A for I1, I2, I3, IN, IMax,I Avg in % for I1Unb, I2 Unb, I3 Unb, I Max Unb
	TIME	1 to 3000 s in increments of 1 s
	DROPOUT VAL	in A for I1, I2, I3, IN, IMax,I Avg in % for I1Unb, I2 Unb, I3 Unb, I Max Unb
	DROPOUT DEL	1 to 3000 s in increments of 1 s
Earth	STATUS	Off, On
	OPTION 1	% IG
	OPTION 2	Over
	THRESHOLD	30 to 100% in increments of 1%
	TIME	1 to 3000 s in increments of 1 s
	DROPOUT VAL	10 to 30% in increments of 1%
	DROPOUT DEL	1 to 3000 s in increments of 1 s
Voltage	STATUS	Off, On
	OPTION 1	V1N, V2N, V3N, VMax, VMin, V1N Unb, V2N Unb, V3N Unb, MaxUnbV, VAvg, U12, U23, U31, UMax, UMin, U12 Unb, U23, Unb, U31 Unb, MaxUnbU
	OPTION 2	Under or over
	THRESHOLD	80 to 850 V in increments of 0.5 V
	TIME	1 to 3000 s in increments of 1 s
	DROPOUT VAL	80 to 850 V in increments of 0.5 V
	DROPOUT DEL	1 to 3000 s in increments of 1 s

Type	Text	Description
Power	STATUS	Off, On
	OPTION 1	Pd1, Pd2, Pd3, Pdtot, Pr1, Pr2, Pr3, Prtot, Qd1, Qd2, Qd3, Qdtot, Qr1, Qr2, Qr3, Qrtot, S1, S2, S3, Stot
	OPTION 2	Under or over
	THRESHOLD	depending on the type of power
	TIME	1 to 3000 s in increments of 1 s
	DROPOUT VAL	depending on the type of power
	DROPOUT DEL	1 to 3000 s in increments of 1 s
Power Factor	STATUS	Off, On
	OPTION 1	PF1, PF2, PF3, PFtot, Cosϕ1, Cosϕ2, Cosϕ3, Cosϕtot
	OPTION 2	Inductive or capacitive
	THRESHOLD	0.00 to 0.99 with steps of 0.01
	TIME	1 to 3000 s in increments of 1 s
	DROPOUT VAL	0.00 to 0.99 with steps of 0.01
	DROPOUT DEL	1 to 3000 s in increments of 1 s
THD	STATUS	Off, On
	OPTION 1	I1,I2, I3,IN, V1N, V2N, V3N, U12, U23, U31
	OPTION 2	Under or over
	THRESHOLD	0 to 1000% in increments of 0.1%
	TIME	1 to 3000 s in increments of 1 s
	DROPOUT VAL	0 to 1000% in increments of 0.1%
	DROPOUT DEL	1 to 3000 s in increments of 1 s
Frequency	STATUS	Off, On
	OPTION 1	F
	OPTION 2	Under or over
	THRESHOLD	45.0 to 65.0 Hz with steps of 0.01
	TIME	1 to 3000 s in increments of 1 s
	DROPOUT VAL	45.0 to 65.0 Hz with steps of 0.01
	DROPOUT DEL	1 to 3000 s in increments of 1 s
Demand	STATUS	Off, On
	OPTION 1	I1, I2, I3, IN, IAvg, P, Q, S
	OPTION 2	Under or over
	THRESHOLD	depending on the type of value
	TIME	1 to 3000 s in increments of 1 s
	DROPOUT VAL	depending on the type of value
	DROPOUT DEL	1 to 3000 s in increments of 1 s
Quadrant	STATUS	Off, On
	OPTION 1	Quadrant 1 to 4
	TIME	1 to 3000 s in increments of 1 s
	DROPOUT DEL	1 to 3000 s in increments of 1 s
Phase Seq.	STATUS	Off, On
	OPTION 1	1,2,3 or 1,3,2
	TIME	1 to 3000 s in increments of 1 s
	DROPOUT DEL	1 to 3000 s in increments of 1 s
Capa. / Induc.	STATUS	Off, On
	OPTION 1	Capa. or induc.
	TIME	1 to 3000 s in increments of 1 s
	DROPOUT DEL	1 to 3000 s in increments of 1 s

Content of the DIP ALARM submenu

Submenus	Text	Unit	Description
DIP ALARM	ACTIVATION	-	Off, On
	UDIP	%	75 to 95 % in increments of 1

Content of the SWELL ALARM submenu

Submenus	Text	Unit	Description
SWELL ALARM	ACTIVATION	-	Off, On
	USWELL	%	105 to 125 % in increments of 1

Content of the HWF ALARM submenu

Submenus	Text	Unit	Description
HWF ALARM	ACTIVATION	-	Alarm or Trip

Content of the CONFIGURATION menu

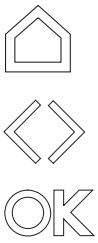
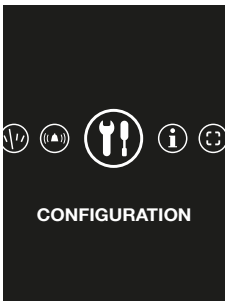
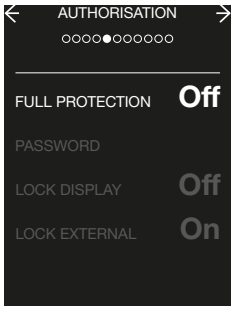
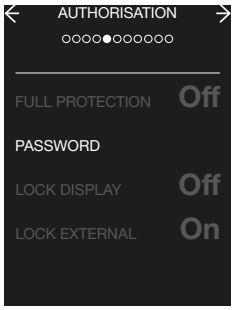
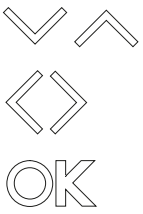
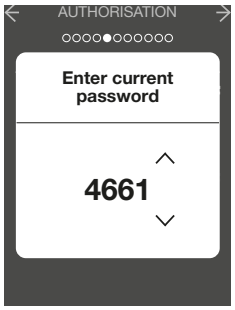
Submenus	Text	Unit	Description
LANGUAGE	-	-	English, Français, Deutsch, Polski, Espanol, Portugues, Chinese, Italiano
DISPLAY	BRIGHTNESS	%	25, 50, 75.100
DATE AND TIME	DATE FORMAT	-	DD/MM/YYYY or YYYY/MM/DD
	TIME FORMAT	-	12H or 24H
	DATE	-	Setting the date.
	TIME	-	Time setting.
OVERVIEW	LIVE MODE	-	Off or On
	TIME VIEW	s	1 to 30 s
	GRAPHIC	-	Off or On
	FAVOURITE SCREEN	-	Ampmeter, Multimeter, Power P, Power Q, Power S, Power factor, Long time , Short time , Instantaneous, Neutral, Earth, Voltage U, Voltage V, Current, Other, Active tariff, Energy, Max U, Max V, Max I, Frequency, THDI, THDV, THDU, Cos Phi, I demand, P demand
AUTHORISATION	FULL PROTECTION	-	Off or On
	PASSWORD	-	Off or On
	LOCK DISPLAY	-	Off or On
	LOCK EXTERNAL	-	Off or On
NETWORK	Un	V	208 to 690 V
	Pn	kW	50 to 9995 kW in increments of 5
	Fn	Hz	50 or 60 Hz
	P Sign	-	Negative or positive
MEASURES	ENVA	-	On or Off
	ENCT	-	On or Off
	PHASE SEQ.	-	Defining the sequence of the connected electrical phases 1, 2, 3 or 1, 3, 2
	CALCULATION	-	Defining the calculation convention of Qtot, Stot, Eap, ErOut, ErIn and PF. Arithmetic or Vector
	INTERVAL	-	1 to 60 min in increments of 1 min
	DEM. MODE	-	Definition of the type of integration of averaged values. Sliding, Sync. Bus or Fixed
	PF SIGN	-	Defining the sign convention of the power factor. IEEE or IEC
	TARIFF	-	Off or On

Submenus	Text	Unit	Description
	BLUETOOTH		
	ACTIVATION	-	On, Off
	TIMER	-	On, Off
	TIMER VAL	-	1 to 30 min
	MODBUS RTU		
	ADDRESS	-	1 to 247
COMMUNICATION	BAUD	-	4800; 9600; 19200; 38400
	PARITY	-	Odd, Even, None
	STOP BIT	-	1 or 2
	MODBUS TCP		
	DHCP	-	Off (static) or On (DHCP)
	IP ADDRESS	-	IP address in static mode
	SUBNET MASK	-	Subnet mask
	GATEWAY	-	Address of the gateway
	DO1 to DO5		
OAC MODULE	SOURCE		see list in Chapter 7.10 Programming the OAC module
	CONTACT		Autoreset - Latching - Pulse
	PULSE		0.1 to 30 s increments of 0.1 s
DIGITAL INPUT	INPUT		Remote reset, Tariff, Inhibit, Profile B
	RESET MIN/MAX		All, current, voltage, power, frequency, THD, power factor, I demand, P demand
RESET & ERASE	COUNTERS		Min/Max, Energies, Custom alarms, OAC contacts
	HISTORY		All, Trip, Alarm
	FACTORY RESET		ALL

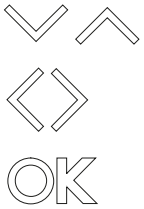
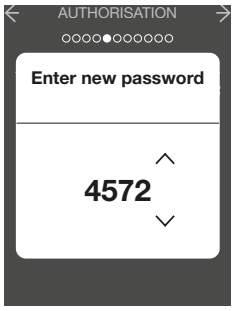
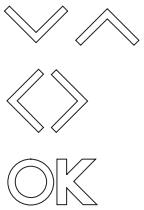
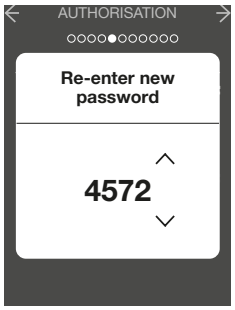
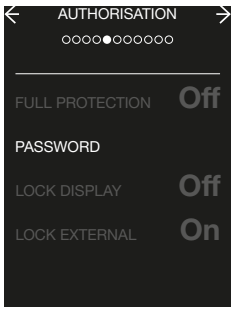
N.B.
Reset the protection, advanced protection, electrical network and display parameters to their factory default value.

Buttons	Function when entering password
	Move the cursor left or right
	Change the value of the figure

Password change procedure

	Step/Action	Button	Display
1	Open the Configuration menu.		
2	Select the **Authorisation** submenu.		
3	Select and confirm **Password**.		
4	Enter the current password. By default: 4661		

N.B.
The passwords 1234, 4321, 1111, 2222, 3333, 4444, 5555, 6666, 7777, 8888, 9999 are not accepted.

	Step/Action	Button	Display
5	Enter the desired new password then confirm.		
6	Re-enter the new password then confirm.		
7	The **PASSWORD** has been changed.		

Content of the INFORMATION menu

Submenus	Text	Unit	Description
STATUS	PROT. PROFILE	-	A or B
	FS CONTACT	-	Off or On
	ON/OFF COUNTER	-	Number of openings/closures
	TRIP NUMBER	-	Number of trips
	OPERAT. TIME	h	Cumulative operating time (hours).
	SETTINGS	-	Date last settings saved
	LAST MAINT.	-	Date of the last maintenance
	MAINT. TYPE	-	Maintenance type
	NEXT MAINT.	-	Date of the next maintenance
ALARM LIST	-	-	-
ALARM HISTORY	-	-	-
TRIP HISTORY	-	-	-
COM STATUS	BLUETOOTH	-	On or Off
	MODBUS RTU	-	On or Off
	MODBUS TCP	-	On or Off
IDENTIFICATION	RANGE NAME	-	hw+
	FRAME	-	HW1
	In	A	400 to 1600 A
	Icu	kA	2 kA, 55 kA, 66 kA
	FRAME	-	HW2
	In	A	630 to 2500 A
	Icu	kA	55 kA, 66 kA, 100 kA
	FRAME	-	HW4
	In	A	1000 to 4000 A
	Icu	kA	66 kA, 85 kA, 120 kA
	FRAME	-	HW6
	In	A	3200 to 6300 A
	Icu	kA	100 kA
	SERIAL NUMBER	-	Serial number
	PRODUCT CODE	-	Product code
	DESCRIPTION	-	-
	TU TYPE	-	LSI / LSIG
	OPTION		Basic, Meter Plus, Harmonic, Advanced, Ultimate
	TU SN	-	Trip unit serial number

Access to the content of the MODE menu requires the trip unit password to be entered (by default 4661).

WARNING

Risks that could affect the availability, integrity and confidentiality of the sentinel Energy system
It is strongly recommended that a new password be set when the trip unit is first started up.

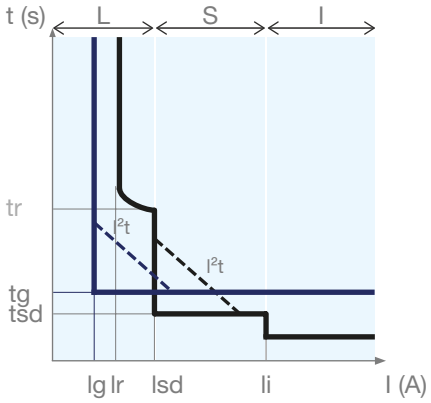
Content of the MODE menu

Submenus	Text	Unit	Description
PROTECTION	PROFILE	-	A or B
TRIP COMMAND	MODE	-	Trip unit, no trip unit
	START	-	
ADVANCED PROTECTION	INHIBIT	-	Off or On

The sentinel Energy electronic trip unit protects against overcurrent and earth faults for all types of electrical distribution in accordance with the requirements of standards IEC 60947-1 and 60947-2.

Protection system

- Long delay against overcurrent - **L**: Overload protection
- Short delay against overcurrent - **S**: Protection against low current short circuits
- Instantaneous against overcurrent - **I**: Protection against high current short circuits
- Earth fault - **G**: Earth fault protection
- Neutral - **N**: Protection against overloads and short circuits which may flow through and damage the neutral conductors.



L	Ir	Long time delay protection threshold against overcurrent
	tr	Long time delay against overcurrent
S	Isd	Short time delay protection threshold against overcurrent
	tsd	Short time delay value
	I^2t ON/OFF	Short time delay protection I^2t curve against overcurrent (activated/deactivated)
I	Ii	Instantaneous protection threshold against overcurrent
G	Ig	Earth protection threshold
	tg	Earth protection time delay
	I^2t ON/OFF	Earth protection I^2t curve (activated/deactivated)
N	N	Threshold as % of the value of the neutral protection setting (adjustment of the Ir and Isd thresholds)

Protection according to IEC	**Protection according to ANSI**
L	ANSI 49
S	ANSI 50TD/51
I	ANSI 50
G	ANSI 50N TD/51N

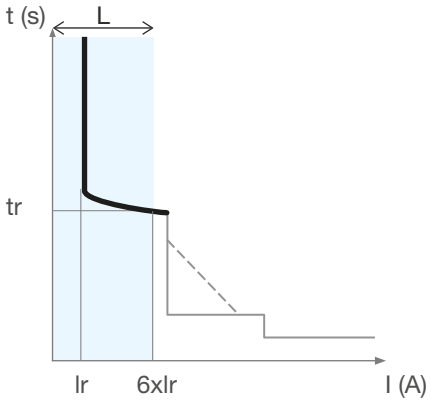
In addition to Instantaneous overcurrent protection, the Energy trip units include MCR protection (Making Current Release). This guarantees immediate tripping of the hw+ circuit breakers in cases of closing operation on a short-circuit.

Protection setting adjustment device

The protection settings are adjustable from the PROTECTION menu of the sentinel Energy display or the panel display or the Hager Power setup software. All protection functions are based on the root-mean-square value (RMS) of the current to take into account the presence of current harmonics. The expanded range of protection curve settings facilitates coordination in terms of selectivity.

The Long time delay protection is designed to protect the cables, the busbars and the busbar trunking from current overloads. It includes a thermal memory function that temporarily stores the calculated thermal values so that the thermal effect of the cable heating remains available. The phases and the neutral pole benefit independently from the Long time delay protection. It can also be used to protect transformers or generators.

Long time delay protection curve



Long time delay protection

Parameters

L	Ir= 0.40 to 1.00 x In (A)	Long time delay protection threshold against overcurrent
	tr (s) = 0.5 to 25 in increments of 0.5	Long time delay
	Curve	Tripping curve. Thi by default, to be used for Long time delay protection in accordance with IEC 60974-2.

The Long time delay protection is adjusted from the PROTECTION ⇨ LONG TIME menu of the sentinel Energy display, the panel display or the Hager Power setup software.

Adjusting the Ir threshold

Rating (In)	Threshold adjustment range Ir = 0.40 to 1.00 x In (A)	Rating (In)	Threshold adjustment range Ir = 0.40 to 1.00 x In (A)
400 A	160 - 400 A	**2000 A**	728 - 2000 A
630 A	252 - 630 A	**2500 A**	910 - 2500 A
800 A	320 - 800 A	**3200 A**	1164.8 - 3200 A
1000 A	400 - 1000 A	**4000 A**	1456 - 4000 A
1250 A	500 - 1250 A	**5000 A**	1820 - 5000 A
1600 A	640 - 1600 A	**6300 A**	2300 - 6300 A

The Long time delay protection triggers between 1.05 and 1.20 x Ir.

Adjusting the tr time delay

The tr time delay defines the tripping time of the Long time delay overcurrent protection for a current of 6 x Ir.

tr adjustment range

tr (s) = 0.5 to 25 s in increments of 0.5

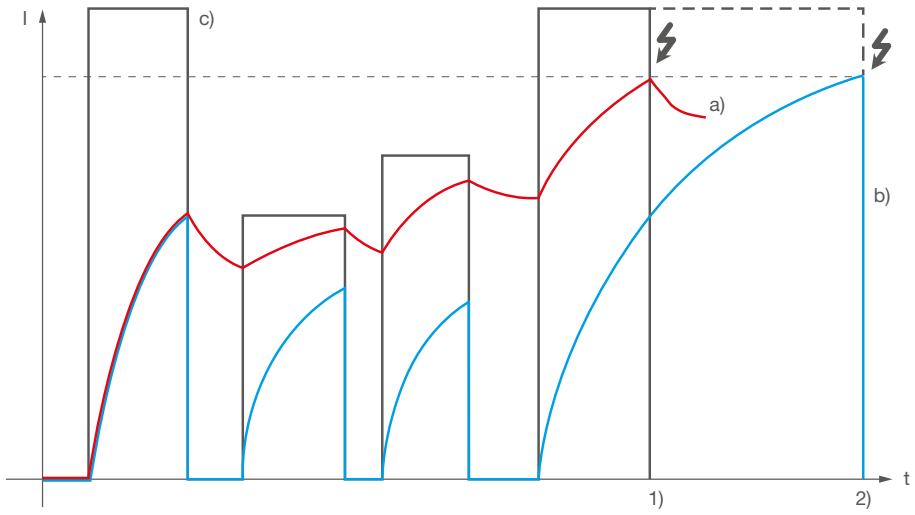
The tripping time tolerance for the long time delay overcurrent protection is from 0 % to -20 %.

Example:
For tr = 5 s and I = 6 x Ir, the tripping time for long time delay overcurrent protection will be between 3.98 s and 5.03 s.

Thermal image

Closure resulting from an overload, successive motor starts or a fluctuating load cause significant current swells that can potentially damage conductors (heating up, premature ageing).
Traditional Long time delay protection is not able to protect the conductors against repetitive faults of this kind because the duration of each detected overload is too short to cause effective tripping.
Thanks to its thermal memory and imaging function, the sentinel Energy trip unit memorizes and integrates the thermal effects of the detected overloads whatever the current value. These functions are guaranteed even if the trip unit is not powered by an external power supply. This reduces the associated Long time delay time to cause effective tripping before the conductors overheat.
The thermal memory and image function of the sentinel Energy trip unit provides optimal protection of the cables and busbars against overheating.

Tripping threshold



Tripping with and without thermal image

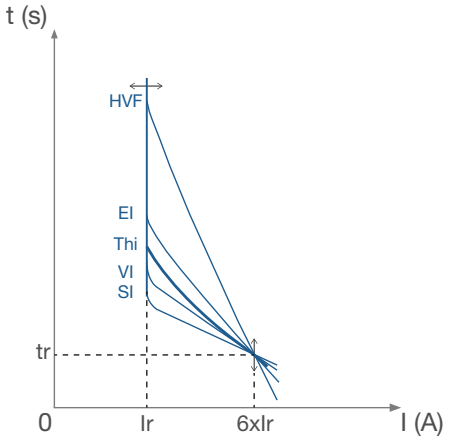
Key:
a) Calculation with thermal memory
b) Calculation without thermal memory
c) Instantaneous current in the load
1) Tripping case a)
2) Tripping case b)

The example above clearly shows that the trip unit a) with thermal memory trips earlier and thus protects the conductors better than trip unit b) without thermal memory.

N.B.
The thermal imaging function of the sentinel Energy trip units cannot be deactivated.

It is possible to configure the calculation of the sentinel Energy Long Time Delay protection in accordance with the requirements of the IEC 60255-151 standard.
The Long time delay overcurrent protection in accordance with the IEC 60255-151 standard is designed to protect the cables, the busbars and the busbar trunking from current overloads. It also allows selectivity to be improved with an upstream protection device.
One of the following four trip curves can be chosen, based on a calculation in accordance with the requirements of the IEC 60255-151 standard.

- SI $I^{0.02t}$: Standard Inverse Time curve
- VI It: Very Inverse Time curve
- EI I^{2t}: Extremely Inverse Time curve
- HVF I^{4t}: High Voltage Fuse curve
- The chosen curve is added to the existing Long time delay protection (default setting **Thi**, thermal image).



The parameters of the four curves depend on Ir and tr.
Long time delay overcurrent protection in accordance with IEC 60255-151 is available in profiles A and B of the dual settings. It is adjusted independently for profiles A and B.

Tripping time calculation

The tripping time depends on the current I compared to the threshold Ir and the time delay tr. The tripping time is calculated using the following equation, in accordance with the IEC 60255-151 standard Appendix A:

$$ts = \left(\frac{t_r}{\frac{k}{\left(\left(\frac{6}{1.125}\right)^{\alpha} - 1\right) \cdot 0.9}} \right) \cdot \left[\frac{k}{\left(\frac{I}{1.125 \cdot Ir}\right)^{\alpha} - 1} + c \right]$$

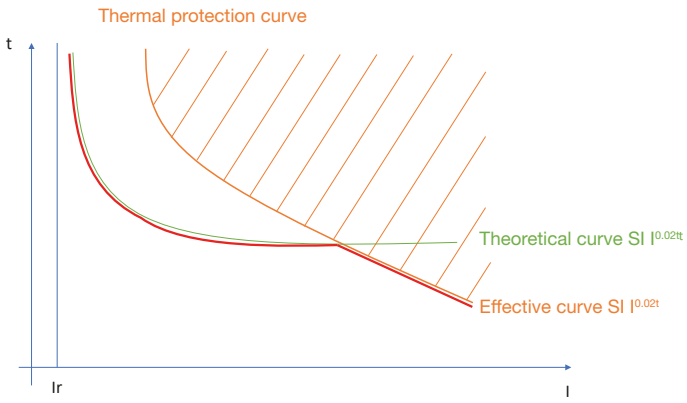
The value of the coefficients k, c and α for each tripping curve is indicated in the table below:

Trip curve	k	c	α
SI $I^{0.02t}$	0.14	0	0.02
VI It	13.5	0	1
EI I^{2t}	80	0	2
HVF I^{4t}	80	0	4

Tripping time reduction

The tripping time is limited by a thermal protection curve of the circuit breaker that reduces the tripping time to prevent excessive overheating of the circuit breaker when the Long time delay protection setting leads to a trigger time that is too long.

The following graphic illustrates the principle of tripping time reduction:



Reset time
The reset time works in the same way as the thermal memory. It allows the thermal effects of overloads to be taken into account and allows the cables and power busbars to be protected against overheating.
It is the time between the end of the detection of the overcurrent and the reset of the protection time delay.

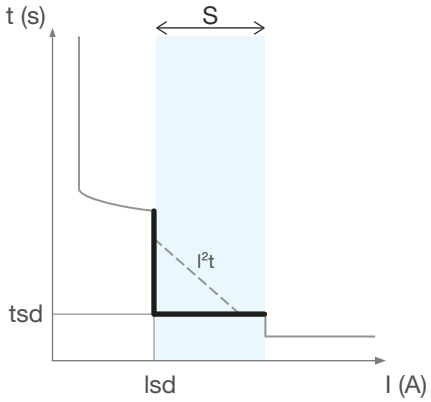
The reset time is dependent at times, meaning that the reset time depends on the value of the current after the overload. This is the time required to reset the effect of the previous overload. If a new overload appears before the end of the reset, the tripping time will be shortened.
The reset time factor is fixed. It is 40 % x tr.

The reset time is calculated with the following equation:

$$Treset\ (Reset\ Time) = \frac{0.4 \cdot 0.9 \cdot t_r}{1 - \left(\frac{I}{1.125 \cdot Ir}\right)^{\alpha}}$$

Short time delay protection is designed to protect against low current short circuits.

Short time delay protection curve



Short time delay protection

Parameters

S	Activation	Activation of the short time delay overcurrent protection
	Isd (x Ir)	Short Time Delay protection threshold
	tsd (ms)	Short time delay value
	I^2t (On/Off)	Short time delay protection curve I^2t

The Short time delay protection is adjusted from the PROTECTION ⇨ SHORT TIME menu of the sentinel Energy display, the panel display or the Hager Power setup software.

Adjusting the Isd pick-up setting

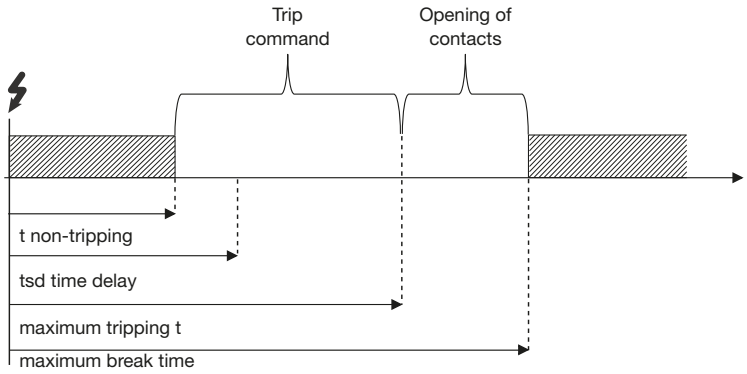
Isd pick-up adjustment range (x Ir)
1.0 to 10.0 x Ir in increments of 0.5.

The Isd tripping tolerance threshold for short time delay protection is ±10%.

Adjusting the tsd time delay

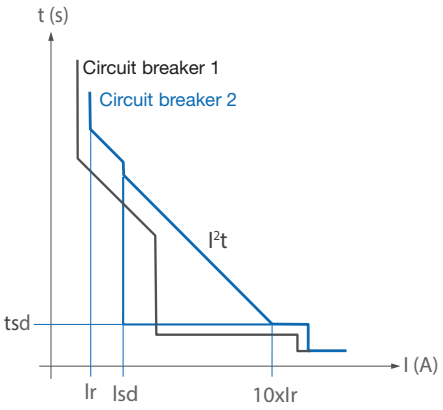
Adjustment of the tsd time delay is done from the SHORT TIME DELAY ⇨ PROTECTION menu.

tsd adjustment range (ms)	50	100	150	200	250	300	350	400	450	500	550	600
Non-tripping time (ms)	25	75	125	175	225	275	325	375	425	475	525	575
Maximum tripping time (ms)	100	150	200	250	300	350	400	450	500	550	600	650
Maximum break time (ms)	120	170	220	270	320	370	420	470	520	570	620	670



An inverse time function $I^2t=K$ can be activated or deactivated when adjusting the short time delay.
This I^2t function makes it possible to improve selectivity with downstream devices. It activates at the Isd threshold and works up to 10 x Ir.

Example use of the I^2t function



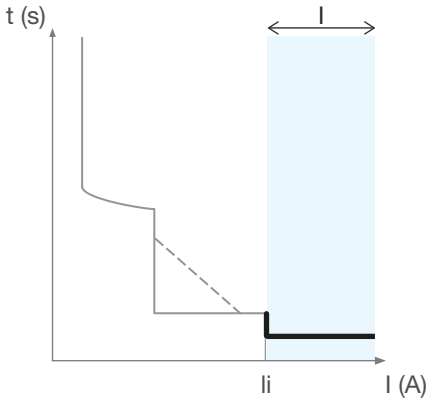
Circuit breaker 1: h3+
Circuit breaker 2: hw+

Activating the I^2t function on circuit breaker 1 achieves total selectivity, otherwise selectivity remains partial.

ATTENTION
The I^2t function is deactivated by default. Activate it if selectivity needs to be improved.

Instantaneous protection is designed to protect against high short circuit currents. This protection is time-independent.

Instantaneous protection curve



Instantaneous protection

Parameters

I	Activation	Activation of the Ii protection
	Ii (x In)	Instantaneous protection threshold against overcurrent

The Instantaneous protection is adjusted from the PROTECTION ⇨ INSTANTANEOUS menu of the sentinel Energy display, the panel display or the Hager Power setup software.

Instantaneous protection setting against overcurrent

When the Activation parameter is Off, the Instantaneous protection against overcurrents is deactivated.

Adjusting the Ii pick-up setting

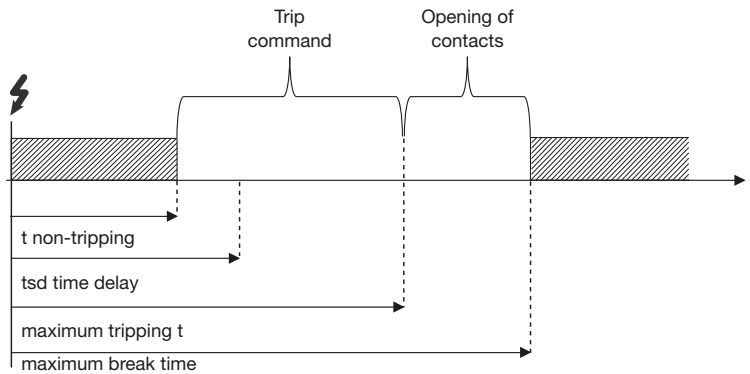
Ii pick-up adjustment range (x In)

1.5 to 15.0 x In in increments of 0.5.

The Ii threshold tolerance for Instantaneous overcurrent protection is ±15%.

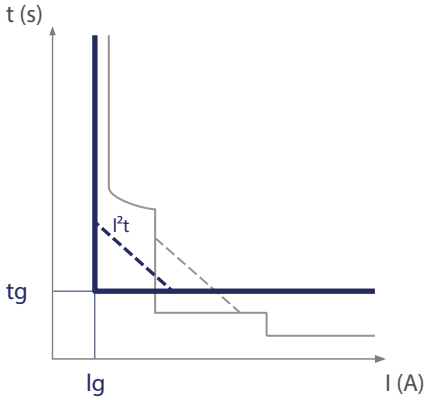
Tripping time

Instantaneous overcurrent protection has no adjustable time delay.
The non-tripping time is 20 ms.
The maximum tripping time is 80 ms.
The maximum break time is 100 ms.



The earth protection is used against phase-to-earth faults. The earth fault currents can reach a high enough amplitude that they are similar to a short circuit.
It is based on the calculation of the sum of the phase and neutral currents.

Earth protection curve



Earth protection

Parameters

G	Activation	Activation of the GF earth fault protection
	Ig (xIn)	Earth protection threshold
	tg (s)	Earth protection time delay
	I^2tg (On/Off)	Earth I^2t protection curve

The Earth fault protection is adjusted from the PROTECTION ⇨ EARTH menu of the sentinel Energy display or from the Hager Power setup software.

Adjusting the Ig pick-up setting

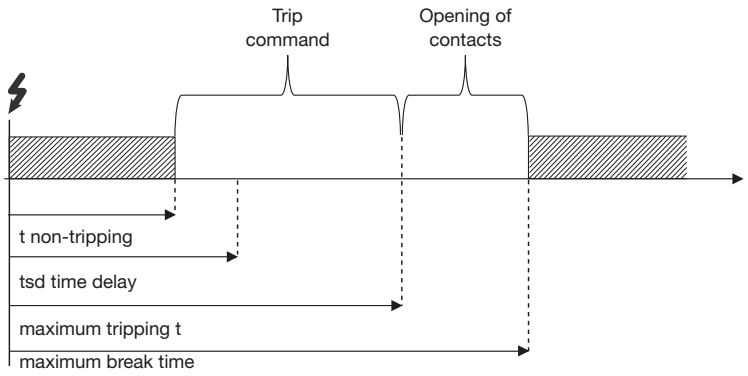
0.10 to 1.00 x In in increments of 0.10.

When the Activation parameter is set to OFF, earth fault protection is deactivated.

Adjusting the tg time delay

tsd adjustment range (ms)	50	100	150	200	250	300	350	400	450	500	550	600
Non-tripping time (ms)	25	75	125	175	225	275	325	375	425	475	525	575
Maximum tripping time (ms)	100	150	200	250	300	350	400	450	500	550	600	650
Maximum break time (ms)	120	170	220	270	320	370	420	470	520	570	620	670

The I^2t earth protection curve improves the selectivity of the earth faults with circuit breakers

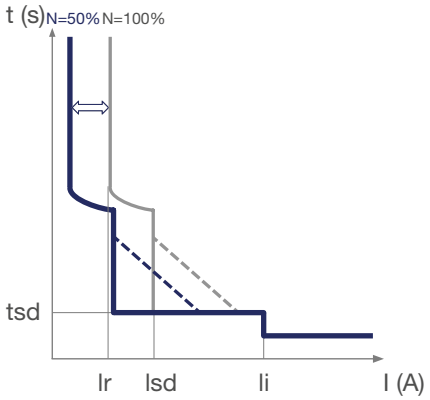


located upstream. This protection functions from the value of the Ig setting to the nominal value In.

ATTENTION
If an ENCT external neutral sensor is used, it is necessary to activate the neutral protection to take into account the sum of the phase and neutral currents.

Neutral protection is built into the 4-pole circuit breakers and available as an option with the addition of the ENCT external neutral sensor on 3-pole versions. It is particularly useful if the neutral conductor section is less than that of the phases, or if the neutral conductor is heavily loaded (for example, in office buildings).
It uses similar tripping curve characteristics as the Long time delay, Short time delay and instantaneous protection parameters.

Neutral protection curve



Neutral protection

The neutral protection is adjusted from the PROTECTION ⇨ NEUTRAL menu of the sentinel Energy display, the panel display or the Hager Power setup software.

Adjusting the Ir and Isd neutral protection thresholds

N coefficient adjustment range (%)	Parameters impacted
Activation	Neutral protection time delay
50 - 100 - 150 - 200	The coefficient is applied to the adjustment value of the Ir and Isd thresholds for the phases.

For a setting at 150 or 200 %, the maximum value of the neutral protection setting is limited by the rating plug of the circuit breaker.

For example for an HW1 circuit breaker (maximum rating 1600 A) with an Ir setting at 1000 A and a neutral protection setting at 200 %, the Ir neutral threshold value will be limited to 1600 A and not 2000 A.

The Ii protection (Instantaneous protection) remains identical to that of the phases.

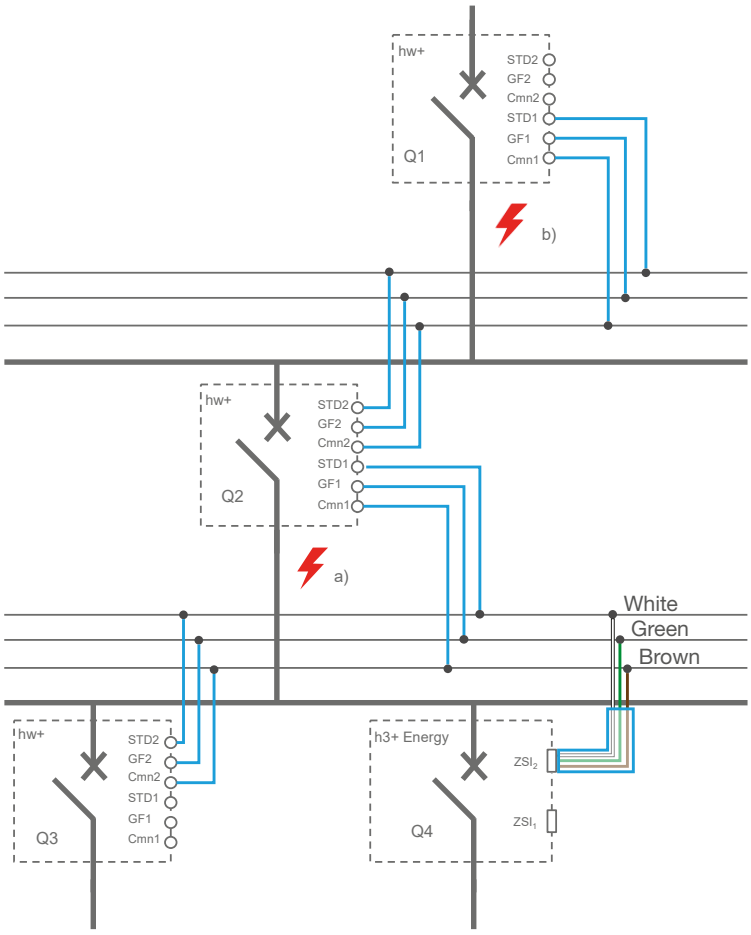
On a 3-pole product and in the absence of an ENCT external neutral current sensor, the factory setting must be kept at Off.

Neutral protection time delay

The time delays for neutral protection remain identical to the phase time delay adjustment values.

The Zone Selective Interlocking (ZSI) function is designed to limit the electro-dynamic constraints on the installation in case of a short circuit fault or earth fault.
The devices, conductors, bar sheathing and busbars can thus benefit from this limitation.
It reduces the time taken to clear the electrical fault while maintaining the selectivity and coordination provided by the protection settings.
The installed circuit breakers are linked together by cable to determine which circuit breaker should trip first. If an electrical fault appears between two linked circuit breakers connected together by the ZSI function, the downstream circuit breaker is unable to clear it. Thanks to zone selectivity, the circuit breaker upstream of the fault trips without waiting till the end of its time delay.
For zone selectivity to work correctly, the ZSI terminals of all circuit breakers must be connected together among themselves. The tripping time delay of each circuit breaker must be adjusted according to the chronometric sensitivity desired and the ZSI function must be activated (only on circuit breakers linked to their downstream circuit breakers).
The ZSI function applies to the Short Time Delay protection (ZSI STD) and the Earth Fault protection (ZSI GF).

Here are two examples to explain the functioning.



Zone selectivity: Example

First, circuit breakers Q1, Q2, Q3, Q4 are set to their respective thresholds enabling the expected time selectivity to be activated. The ZSI function must be activated only on the Q1 and Q2 circuit breakers.

Fault example a):
- If a fault occurs at point a), the Q1 and Q2 circuit breakers detect the electrical fault. Thanks to the ZSI cabling (in blue), the Q1 circuit breaker receives a signal from Q2 and remains closed to allow the Q2 circuit breaker to eliminate the fault. The Q2 circuit breaker does not receive a signal either from Q3 or Q4. It opens immediately, despite the previously set tripping time delay.

Fault example b):
- If a fault occurs at point b), only the Q1 circuit breaker detects the electrical fault.
  The Q1 circuit breaker does not receive a signal from Q2, it opens immediately, despite the previously set tripping time delay.

Adjusting the ZSI protection setting

ZSI protection can be activated on hw+ circuit breakers from the SHORT TIME DELAY ⇨ PROTECTION or EARTH ⇨ PROTECTION menu of the sentinel Energy display or the Hager Power setup software.

ZSI STD	On or Off (Off by default)
ZSI GF	On or Off (Off by default)

N.B.
It is important to keep the ZSI protection deactivated on an hw+ circuit breaker not connected to its downstream circuit breakers (ZSI STD1, GF1, Cmn1 terminals not used). If it is activated, the circuit breaker will trip immediately during an electrical fault without waiting for the end of the Short time
delay and the earth fault protection time delay.

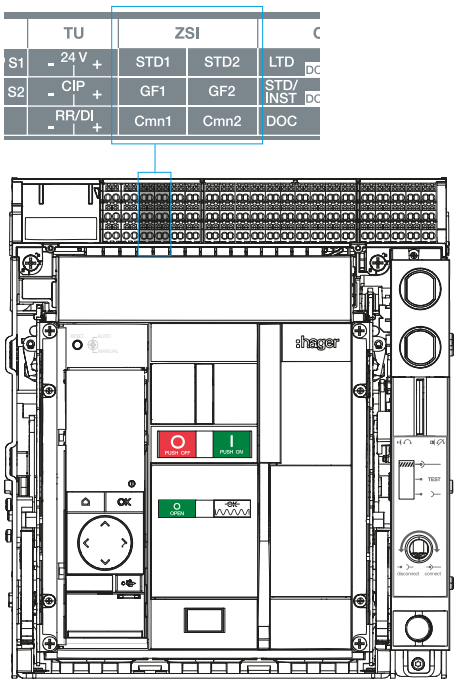
Connection of ZSI protection

hw+ air circuit breakers have 6 ZSI terminal blocks enabling the upstream or downstream circuit breakers to be connected to deploy zone selectivity (ZSI).

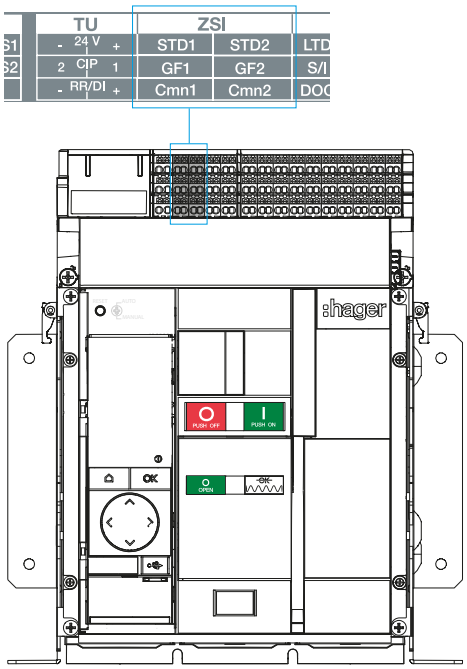
Type of connection	**Total number of circuit breakers**	**Max. distance between 2 circuit breakers**
Upstream	3	300 m
Downstream	7	300 m

Recommended connection cable: 3 x 1 to 1.5 mm² shielded twisted pair.

Drawout circuit breaker



Fixed circuit breaker



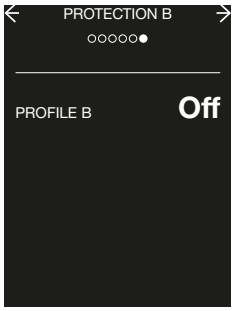
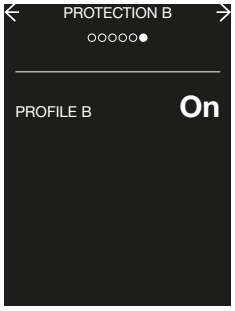
Dual settings protection (A + B) is particularly appropriate when the circuit breaker can be powered by two sources with very different short circuit currents
For example, source 1 is the power network, source 2 is a backup power supply (generator).

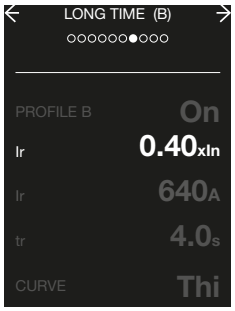
Dual settings allow the following parameters to be set separately for protection profile A and protection profile B:
- Long time delay protection against overcurrent
- Short time delay protection against overcurrent
- Instantaneous protection against overcurrent
- Earth protection

The neutral protection parameter cannot be set separately for protection profile B.

You can switch from one profile to another in certain operating conditions.

Dual settings are deactivated by default.
On the sentinel Energy display they can be activated from the HOME ⇨ PROTECTION ⇨ PROTECTION B menu.
Dual settings can also be activated using the Hager Power setup software.

	Step/Action	Button	Display
1	Open the Protection menu.		
2	Select the PROTECTION B submenu.		
3	Activate PROFILE B.		

	Step/Action	Button	Display
4	Dual settings are activated.		

Once the profile B is activated, the settings parameters are displayed. The protection parameters of profile A are then copied automatically to profile B.
The profile B parameters can now be changed from the LONG TIME (B), SHORT TIME(B), INSTANTANEOUS (B), EARTH (B) submenus in the sentinel Energy display. See chapter 3.5 Protection setting principle for setting the parameters.

When dual settings are activated and configured, switching between protection profile A and protection profile B can be controlled in one of the following ways:
- sentinel Energy display (MODE menu, protected by a password),
- Hager Power setup software (Commands menu),
- digital input (DI): the digital input must first have been assigned to the dual settings function,
- communication Modbus (protection configuration command, protected by password).

The sentinel Energy trip unit can accommodate seven optional advanced protection functions. They enable monitoring and protection of the installation against undervoltage and overvoltage, underfrequency and overfrequency, excessing reverse active power and voltage and current unbalances.
The additional protection functions improve installation availability and protect against harmful disruptions that can inhibit optimal operation of the installation.

Advanced protections

Description	ANSI code
Undervoltage protection (UV-27)	27
Overvoltage protection (OV-59)	59
Underfrequency protection (UF-81L)	81L
Overfrequency protection (OF-81H)	81H
Reverse active power protection (RP-32R)	32R
Current unbalance protection (UNBC-46)	46
Voltage unbalance protection (UNBV-47)	47

Advanced protection settings

The advanced protection is adjusted from the ADVANCED PROTECTION menu of the sentinel Energy display or from the Hager Power setup software.

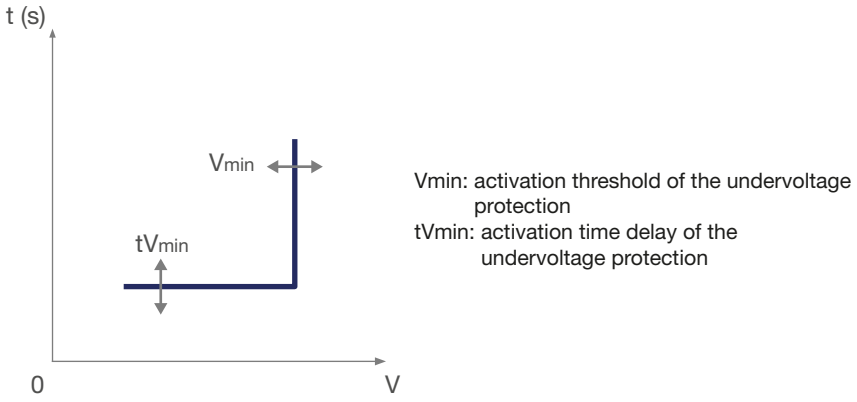
CAUTION

To use the advanced protections an external 24V DC SELV power supply must be connected to the circuit breaker.
The advanced protection cannot work without an external power supply.

The undervoltage protection (UV-27), ANSI 27 permanently monitors the installation voltage. When the voltage exceeds acceptable limits, either the circuit breaker trips and a trip alarm is generated, or only an advanced protection alarm is generated.
In addition, continuous monitoring of phase-phase or phase-neutral voltages allows the appropriate action to be performed to secure the electrical installation such as load-shedding, switch of power source, start of a backup generator.

Operating principle

These undervoltage protections allow the three phase-phase voltages to be monitored or the three phase-neutral voltages.
It launches at the end of the activation time delay when one of the three voltages reaches the activation threshold.



Adjustment parameters

UV-27 ANSI 27	Config.	Configuration of the protection
	Inhibit	Inhibition of the protection
	Type U/V	Choice U: L-L = phase-phase voltage, V: L-N = phase-neutral voltage
	Threshold	Activation threshold Vmin
	Time	Activation time delay tVmin

Configuration

The Configuration parameter defines the protection behaviour when the activation threshold and the time delay are reached.

Trip	Circuit breaker tripping
Alarm	Alarm without tripping the circuit breaker
Off	Protection deactivated (default setting)

Inhibition

The protection is only deactivated if its inhibition parameter is set to On.
This parameter allows the protection action to be inhibited temporarily based on a command sent in one of the following ways:
- sentinel Energy display from the MODE menu
- Hager Power setup software (Commands menu)
- Digital input (DI): assignment of the digital input to the inhibition required
- Modbus communication.

On	The protection is inhibited while the inhibition command is at On
Off	The protection is fully operational while the inhibition command is at Off

Type U/V of measurement to monitor

L-L	Monitoring of compound voltages U12, U13 or U23
L-N	Monitoring of single voltages V1N, V2N or V3N

Activation threshold

ATTENTION
The U/V type parameter is valid for the undervoltage protection and overvoltage protection. The U or V setting used for the OV-59 protection is also applicable to the UV-27 protection.

The activation threshold is expressed in volts.
Adjustment range: 100 to 1000 V in increments of 5 V.
Precision of the activation threshold: +/- 1 %.

Activation time delay

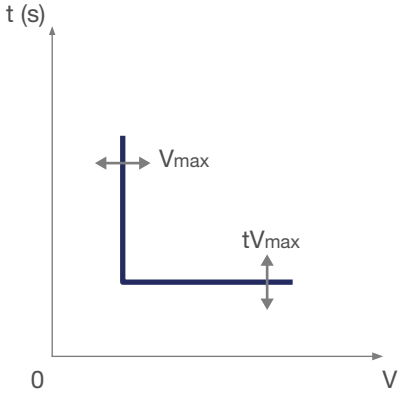
Adjustment range: 0.1 to 300.0 s in increments of 0.1.
Precision of the activation time: +/- 40 ms from 0.1 to 2 s +/-2 % above 2 s.
Hysteresis: 102%.

Minimum tripping time: 60 ms.
Maximum tripping time: 140 ms with time delay set to 0.1 s.

The overvoltage protection (OV-59), ANSI 59 permanently monitors the installation voltage. When the voltage exceeds the acceptable limits, either the air circuit breaker trips and a trip alarm is generated, or only an advanced protection alarm is generated. In addition, continuous monitoring of phase-phase or phase-neutral voltages enables the appropriate action to be taken to secure the electrical installation, such as load shedding, switching the power source or starting an emergency generator.

Operating principle

These overvoltage protections allow the three phase-phase voltages to be monitored or the three phase-neutral voltages.
It launches at the end of the activation time delay when one of the three voltages reaches the activation threshold.



Vmax: activation threshold of the overvoltage protection
tVmax: activation time delay of the overvoltage protection

Adjustment parameters

OV-59 ANSI 59	Config.	Configuration of the protection
	Inhibit	Inhibition of the protection
	Type U/V	Choice of the voltage to monitor: L-L = phase-phase voltage, L-N = phase-neutral voltage
	Threshold	Activation threshold Vmax
	Time	Activation time delay tVmax

Configuration

The parameter configuration defines the protection behaviour when the activation threshold and the time delay are reached.

Trip	Circuit breaker tripping
Alarm	Alarm without tripping the circuit breaker
Off	Protection deactivated (default setting)

Inhibition

This parameter allows the protection action to be inhibited temporarily based on a command sent in one of the following ways:
- sentinel Energy display from the MODE menu
- Hager Power setup software (Commands menu)
- Digital input (DI): assignment of the digital input to the inhibition required
- Modbus communication.

On	The protection is inhibited while the inhibition command is at On
Off	The protection is fully operational while the inhibition command is at Off

Type U/V of measurement to monitor

L-L	Monitoring of compound voltages U12, U13 or U23
L-N	Monitoring of single voltages V1N, V2N or V3N

Activation threshold

ATTENTION
The U/V type parameter is valid for the undervoltage protection and overvoltage protection. The U or V setting used for the UV-27 protection is also applicable to the OV-59 protection.

The activation threshold is expressed in volts.
Adjustment range: 100 to 1000 V in increments of 5 V.
Precision of the activation threshold: +/- 1 %.

Activation time delay

Adjustment range: 0.1 to 300 s in increments of 0.1.
Precision of the activation time: +/- 40 ms from 0.1 to 2 s +/-2 % above 2 s.
Hysteresis: 98%.

Minimum tripping time: 60 ms.
Maximum tripping time: 140 ms with time delay set to 0.1 s.

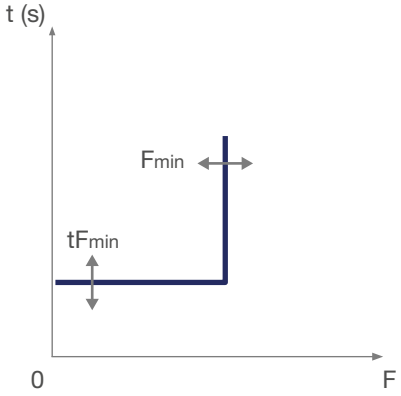
The underfrequency protection (UF-81L), ANSI 81L permanently monitors the installation frequency. When the frequency exceeds acceptable limits, either the circuit breaker trips and a trip alarm is generated, or only an advanced protection alarm is generated.

The frequency of an electrical installation must be maintained within a strict operating range to limit the risk of damaged caused to the motor loads or sensitive electronic equipment and to maintain a good performance level of the loads.

Underfrequency protection may be used in an energy production installation (generator, photovoltaic, etc.).
In addition, continuous monitoring of the frequency allows the appropriate action to be performed to secure the electrical installation, for example load-shedding, switching the power source, starting a backup generator.

Operating principle

Underfrequency protection allows the frequency to be monitored.
It launches at the end of the activation time delay when the measured frequency reaches the activation threshold.



Fmin: activation threshold of the underfrequency protection
tFmin: activation time delay of the underfrequency protection

Adjustment parameters

UF-81L ANSI 81L	Config.	Configuration of the protection
	Inhibit	Inhibition of the protection
	Threshold	Activation threshold Fmin
	Time	Activation time delay tFmin

Configuration

The configuration defines the protection behaviour when the activation threshold and the time delay are reached.

Trip	Circuit breaker tripping
Alarm	Alarm without tripping the circuit breaker
Off	Protection deactivated (default setting)

Inhibition

This parameter allows the protection action to be inhibited temporarily based on a command sent in one of the following ways:
- sentinel Energy display from the MODE menu
- Hager Power setup software (Commands menu)
- Digital input (DI): assignment of the digital input to the inhibition required
- Modbus communication.

On	The protection is inhibited while the inhibition command is at On
Off	The protection is fully operational while the inhibition command is at Off

Activation threshold

Adjustment range: 45.0 to Fn in steps of 0.1.
Precision of the activation threshold: +/-0.1 Hz.

Activation time delay

Adjustment range: 0.1 to 300 s in increments of 0.1.
Precision of the activation time: +/- 40 ms from 0.1 to 2 s +/-2 % above 2 s.
Hysteresis: 102%.

Total minimum break time: 60 ms.
Maximum break time: 140 ms with time delay set to 0.1 s.

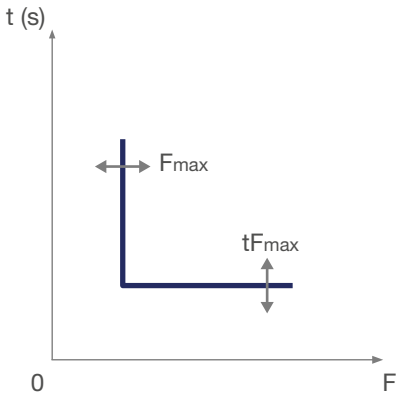
The overfrequency protection (OF-81H), ANSI 81H permanently monitors the installation frequency. When the frequency exceeds acceptable limits, either the circuit breaker trips and a trip alarm is generated, or only an advanced protection alarm is generated.

The frequency of an electrical installation must be maintained within a strict operating range to limit the risk of damaged caused to the motor loads and sensitive electronic equipment and to maintain a good performance level of the loads.

Overfrequency protection can be used with generators.
In addition, continuous monitoring of the frequency allows the appropriate action to be performed to secure the electrical installation, for example load-shedding, switching the power source, starting a backup generator.

Operating principle

Underfrequency protection allows the frequency to be monitored.
It launches at the end of the activation time delay when the measured frequency reaches the activation threshold.



Fmax: activation threshold of the overfrequency protection
tFmax: activation time delay of the overfrequency protection

Adjustment parameters

OF-81H ANSI 81H	Config.	Configuration of the protection
	Inhibit	Inhibition of the protection
	Threshold	Activation threshold Fmax
	Time	Activation time delay tFmax

Configuration

The configuration defines the protection behaviour when the activation threshold and the time delay are reached.

Trip	Circuit breaker tripping
Alarm	Alarm without tripping the circuit breaker
Off	Protection deactivated (default setting)

Inhibition

This parameter allows the protection action to be inhibited temporarily based on a command

sent in one of the following ways:
- sentinel Energy display from the MODE menu
- Hager Power setup software (Commands menu)
- Digital input (DI): assignment of the digital input to the inhibition required
- Modbus communication.

On	The protection is inhibited while the inhibition command is at On
Off	The protection is fully operational while the inhibition command is at Off

Activation threshold

Adjustment range: Fn to 65.0 Hz with steps of 0.1.
Precision of the activation threshold: +/-0.1 Hz.

Activation time delay

Adjustment range: 0.1 to 300 s in increments of 0.1.
Accuracy of the activation time: +/- 40 ms from 0.1 to 2 s +/-2 % above 2 s.
Hysteresis: 98%.

Minimum tripping time: 60 ms.
Maximum tripping time: 140 ms with time delay set to 0.1 s.

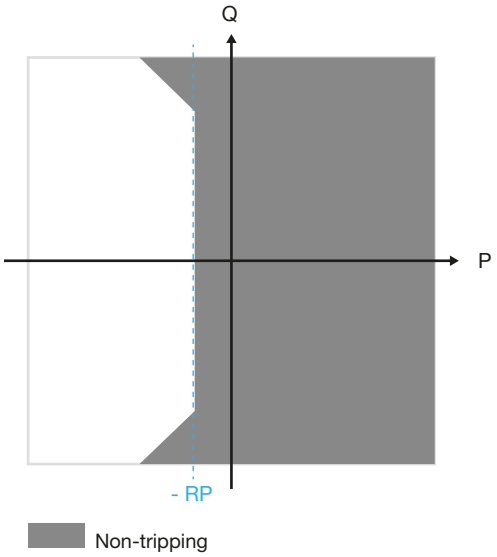
The reverse active power protection (RP-32R), ANSI 32R detects when a synchronous power generator connected in parallel to other sources is functioning as a synchronous motor.

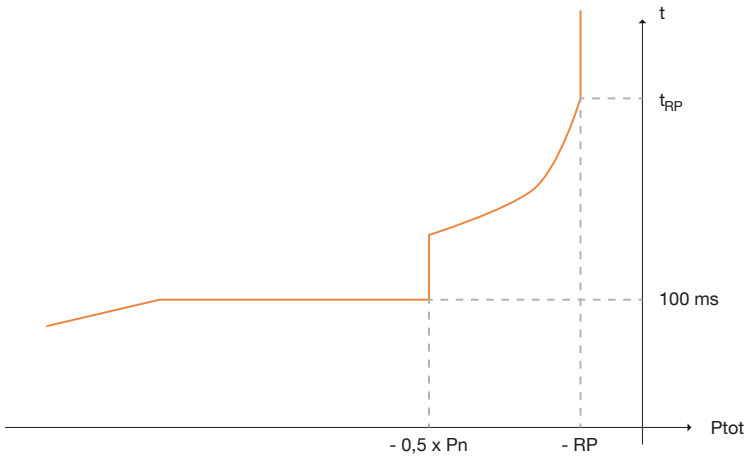
It enables the circuit breaker to be tripped to disconnect the generator from other sources or it can also be used to monitor the active power exchanged between two sources and generate an alarm to take a load-shedding measure or to trip once the flow coming back from the active power exceeds the fixed value.

Operating principle

The reverse active power protection is based on the measurement of the internal sensors of the hw+ sentinel Energy circuit breaker.
The power sign convention parameter must be set in accordance with the direction of the circuit breaker's power supply, from the top or bottom. This allows the power sign to be assigned correctly, which must be positive in the direction of the power supply towards the load. By default, the power sign convention parameter is set to positive which is valid for the power source connected from the top of the circuit breaker.
If the power source is connected from the bottom of the circuit breaker, this parameter must be set to negative.
This is necessary for the reverse active power protection to work correctly.
It starts when the total active power reaches the negative value of the activation threshold and when the activation time delay has elapsed.
In order to avoid unwanted tripping, the RP-32R protection only activates if the power factor is very weak, i.e. if:
$|Q/P| > 32$ ($88.2° < \phi < 91.8°$ or $268.2° < \phi < 271.8°$).

The diagram below illustrates the case where RP = 1000 kW.





RP: activation threshold of the reverse active power protection
t_{RP}: activation time delay for the reverse active power protection

Adjustment parameters

RP-32R ANSI 32R	Config.	Configuration of the protection
	Inhibit	Inhibition of the protection
	Threshold	RP activation threshold
	Time	Activation time delay t_{RP}

Configuration

The configuration defines the protection behaviour when the activation threshold and the time delay are reached.

Trip	Circuit breaker tripping
Alarm	Alarm without tripping the circuit breaker
Off	Protection deactivated (default setting)

Inhibition

This parameter allows the protection action to be inhibited temporarily based on a command sent in one of the following ways:
- sentinel Energy display from the MODE menu
- Hager Power setup software (Commands menu)
- Digital input (DI): assignment of the digital input to the inhibition required
- Modbus communication.

On	The protection is inhibited while the inhibition command is at On
Off	The protection is fully operational while the inhibition command is at Off

Activation threshold

The activation threshold is expressed as a percentage of Pn, configurable rated power (see chapter 6.12 Electrical grid parameters).
Adjustment range: 4.0 to 15.0 x Pn in increments of 0.5.
Precision of the activation threshold: 0 % to -20 %.

Activation time delay

Adjustment range: 0.5 to 25 s in increments of 0.5.
Precision of the activation time: - 15 % to + 15 % + 100 ms.

Minimum tripping time: 425 ms.
Maximum tripping time: 675 ms with time delay set to 0.5 s.

The current unbalance protection (UNBC-46), ANSI 46 permanently monitors the current unbalances of each phase. When the unbalance is detected on one of the phases, the UNBC-46 protection allows an alarm to be generated or the circuit breaker tripped.

The unbalances in phase currents generate significant heating and braking torques that can cause the motor to degrade prematurely.

Current unbalance protection is recommended for motor protection.

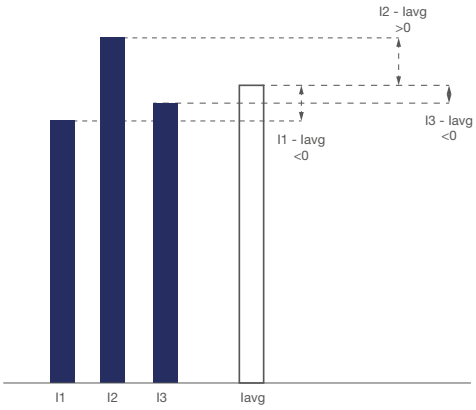
Operating principle

Current unbalance protection calculates the current unbalances for each phase, in relation to the average current, expressed as a percentage:

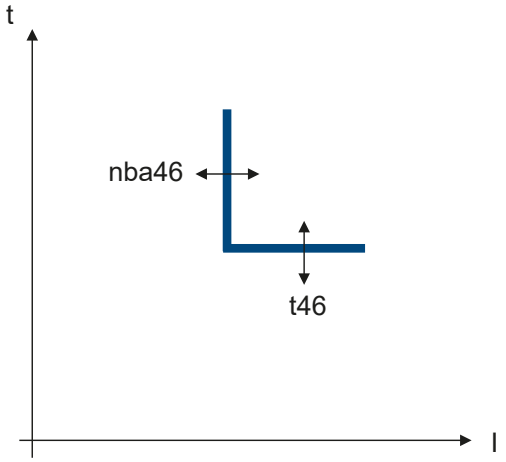
$$I_{nba}p[\%] = 100 * \frac{I_p - I_{avg}}{I_{avg}} \quad \text{avec p = 1, 2, 3}$$

$$I_{avg} = \frac{I_1 + I_2 + I_3}{3}$$

It compares the maximum current unbalance value to the activation threshold for the protection.
Example of maximum positive unbalance on phase 2:



If the maximum current unbalance is greater than the activation threshold, the protection trips at the end of the activation threshold.



nba46: activation threshold of the current unbalance protection
t46: activation time delay of the current unbalance protection

Adjustment parameters

UNBC-46 ANSI 46	Config.	Configuration of the protection
	Inhibit	Inhibition of the protection
	Threshold	Activation threshold nba46
	Time	Activation time delay t46

Configuration

The configuration defines the protection behaviour when the activation threshold and the time delay are reached.

Trip	Circuit breaker tripping
Alarm	Alarm without tripping the circuit breaker
Off	Protection deactivated (default setting)

Inhibition

This parameter allows the protection action to be inhibited temporarily based on a command sent in one of the following ways:
- sentinel Energy display from the MODE menu
- Hager Power setup software (Commands menu)
- Digital input (DI): assignment of the digital input to the inhibition required
- Modbus communication.

On	The protection is inhibited while the inhibition command is at On
Off	The protection is fully operational while the inhibition command is at Off

Activation threshold

The activation threshold is expressed as a percentage.
Adjustment range: 2 to 90% in increments of 1.
Precision of the activation threshold: +/- 5 units, for example for a 20 % threshold the accuracy will be between 15 % and 25 %.

Activation time delay

Adjustment range: 0.5 to 60.0 s with steps of 0.1.
Accuracy of the activation time: +/- 40 ms from 0.1 to 2 s +/-2 % above 2 s.
Hysteresis: 98%.

Minimum tripping time: 60 ms.
Maximum tripping time: 140 ms with time delay set to 0.5 s.

The voltage unbalance protection (UNBV-47), ANSI 47 permanently monitors the voltage unbalances of each phase. When the unbalance is detected on one of the phases, the UNBV-47 protection allows an alarm to be generated or the circuit breaker tripped.

The voltage unbalances in a 3-phase system are caused by the connection of too many 1-phase loads on a single phase. These unbalances can cause major problems for those administering the electrical grid.
Voltage unbalances also have an influence on all three-phase equipment and in particular on motors, because they then experience undesirable braking torque which then takes the form of overheating. Any voltage unbalance greater than 2% results in overheating of equipment, which makes it necessary for the latter to be overdimensioned to compensate for the overheating and prevent premature degradation.

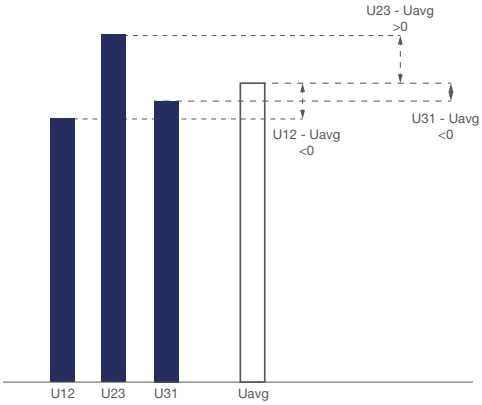
Operating principle

Current unbalance protection calculates the voltage unbalances for compound voltages, in relation to the average current, expressed as a percentage:

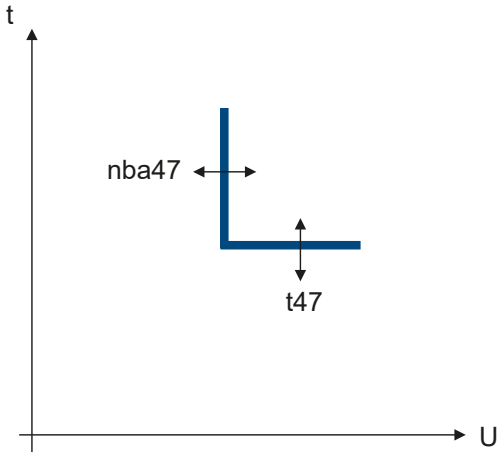
$$U_{nbal}pg[\%] = 100 * \frac{U_{pg} - U_{avg}}{U_{avg}} \text{ avec pg} = 12, 23, 31 \quad \text{et}$$

$$U_{avg} = \frac{U_{12} + U_{23} + U_{31}}{3}$$

It compares the percentage of each unbalance to the activation threshold for the protection.
Example of voltage unbalance on phase 2:



If the unbalance value of at least one of the voltages is greater than the activation threshold, the protection trips at the end of the activation time delay.



nba47: activation threshold of the voltage unbalance protection
t47: activation time delay of the voltage unbalance protection

Adjustment parameters

UNBV-47 ANSI 47	Config.	Configuration of the protection
	Inhibit	Inhibition of the protection
	Threshold	Activation threshold
	Time	Activation time delay

Configuration

The configuration defines the protection behaviour when the activation threshold and the time delay are reached.

Trip	Circuit breaker tripping
Alarm	Alarm without tripping the circuit breaker
Off	Protection deactivated (default setting)

Inhibition

This parameter allows the protection action to be inhibited temporarily based on a command sent in one of the following ways:
- sentinel Energy display from the MODE menu
- Hager Power setup software (Commands menu)
- Digital input (DI): assignment of the digital input to the inhibition required
- Modbus communication.

On	The protection is inhibited while the inhibition command is at On
Off	The protection is fully operational while the inhibition command is at Off

Activation threshold

The activation threshold is expressed as a percentage.
Adjustment range: 2 to 90% in increments of 1.
Precision of the activation threshold: +/- 2 units, for example for a 20 % threshold the accuracy will be between 18 % and 22 %.

Activation time delay

Adjustment range: 0.5 to 60.0 s with steps of 0.1.
Accuracy of the activation time: +/- 40 ms from 0.1 to 2 s +/-2 % above 2 s.
Hysteresis: 98%.

Minimum tripping time: 60 ms.
Maximum tripping time: 140 ms with time delay set to 0.5 s.

The sentinel Energy trip unit is used to measure the following types of values:

Measurements in real-time		**sentinel Energy display**	**Panel display**	**Hager Power touch**
Voltages				
phase-phase	U12, U23, U31	■	■	■
phase-neutral	V1N, V2N, V3N	■	■	■
Ph-Ph arithmetic mean	Uavg = (U12 + U21 + U23) / 3	■	■	■
Ph-N arithmetic mean	Vavg = (V1N + V2N + V3N) / 3	■	■	■
Instantaneous maximum	Voltages Ph-Ph and Ph-N	-	-	-
Instantaneous minimum	Voltages Ph-Ph and Ph-N	-	-	-
Unbalances Ph-Ph and Ph-N (1)	% Uavg and % Vavg	■	■	■
Max. instant. unbalance (1)	Unba, Vnba	-	■	-
Phase sequence	1-2-3, 1-3-2	■	■	■

(1) The availability of these measurements depends on the type of rating plug installed.

Currents				
Phase and neutral	I1, I2, I3, IN	■	■	■
Arithmetic mean	Iavg = (I1 + I2 + I3)/3	-	■	■
Instantaneous maximum	Imax of I1, I2, I3, IN	-	■	■
Instantaneous minimum	Imin of I1, I2, I3	-	■	-
Earth fault	IG	■	■	■
Unbalance per phase	Inba1, Inba2, Inba3	■	■	■
Neutral unbalance	InbaN	-	■	■
Max. instant. unbalance	Inba	■	-	-

Frequency				
Frequency	f	■	■	■
Quadrant	I, II, II, IV	■	■	■
Rotary field	direct, inverse	■	■	■

Power				
Active	P total per phase	■	■	■
Reactive	Q total per phase	■	■	■
Apparent	S total per phase	■	■	■

Energy				
Total active energy imported/ exported (consumed/produced)	EaIn / EaOut	■	■	■
Total reactive energy imported/ exported (consumed/produced)	ErIn / ErOut	■	■	■
Total active energy imported/ exported (consumed/produced) (partial counter)	EaIn part / EaOut part	■	■	■
Total apparent energy	Es	■	■	■
Total net active energy	Ea net	-	-	-
Total net reactive energy	Er net	-	-	-
Absolute value of the total net active energy	Ea	-	-	-
Absolute value of the total net reactive energy	Er	-	-	-
Maximum and minimum values since last reset				

Measurements in real-time		**sentinel Energy display**	**Panel display**	**Hager Power touch**
Max. and min. of the phase-phase, phase-neutral and arithmetic mean voltages	max U12, max U23, max U32, min U12, min U23, min U31, max V1N, max V2N, max V3N, max Uavg, min Uavg, max Vavg, min Vavg	■	■	■
Max. of currents and arithmetic mean	max I1, max I2, max I3, max Iavg,	■	■	■
Min. of currents and arithmetic mean	min I1, min I2, min I3, min Iavg	■	-	■
Max. and min. of the voltage and current unbalances	max U12nba, max U23nba, max U32nba, min U12nba, min U23nba, min U31nba, max V1Nnba, max V2Nnba, max V3Nnba…	-	-	-
Max. of powers, max IG	max P1 max P2, max P3, max Ptot,	■	■	-
Min. of powers, power factors, cos φ and min IG	min P1, min P2, min P3, min Ptot, min FP1, min FP2, min FP3, min FPtot, min cos φ1, min cos φ2, min cos φ3, min cos φtot	-	-	-
Max. of power factors, cos φ	max Ptot, max FP1, max FP2, max FP3, max FPtot, max cos φ1, max cos φ2, max cos φ3, max cos φtot,	-	-	-
Max. and min. of the THD of the voltages and currents	max THD U12, max THD U12, max THD U31, min THD U12, min THD U23, min THD U31, max THD V1N, max THD V2N, max THD V3N, min THD V1N…	-	-	-
Max. and min. of the frequency	max Freq, min Freq	-	-	■
Min. of the THD of IN	min THD IN	-	-	-
Max. of the THD of IN	max THD IN	■	■	-

Averages over interval (demand)				
Active (kW), reactive (kvar), apparent (kVA) power demand	P Dmd, Q Dmd, S Dmd Total and per phase	total only	■	■
Peak power demand since last reset.	Max P Dmd, Max Q Dmd, Max S Dmd Total and per phase	total only	■	■
Current demand	I1 Dmd, I2 Dmd, I3 Dmd; IN Dmd, Iavg Dmd	■	-	■
Peak current demand since last reset.	Max I1 Dmd, Max I2 Dmd, Max I3 Dmd; Max IN Dmd	■	-	■
Integration interval sliding, fixed or synchronised by Modbus	Adjustable from 5 to 60 minutes in increments of one minute	■	■	■

Power factor				

Measurements in real-time		**sentinel Energy display**	**Panel display**	**Hager Power touch**
Power factor and cos φ (fundamental)	Total	■	■	■
Power factor and cos φ (fundamental)	Per phase	■	■	■
Total harmonic distorsion				
Voltage THD(1)	THDU (Ph -Ph), THDV (Ph -N)	■	■	■
Current THD(1)	THDI per phase	■	■	■
THD IN	Neutral THDI	■	■	■

(1) The availability of these measurements depends on the type of rating plug installed.

N.B.
All the calculated values and measurements of the sentinel Energy trip unit are accessible through Modbus communication.
These values are updated every second according to their nature, for example minimums, maximums or the indices of energy meters when the last value is changed.

The sentinel Energy trip unit provides the following basic electrical value measurements in real-time:
- Current for each phase and neutral (on 4-pole version)
- IG Ground fault current (resulting from 3 or 4 currents from active conductors)
- Voltages between phases and between phase and neutral on 3, 4 poles or 3 poles + ENVA
- Indication of the rotary field direction
- Network frequency.

Electrical variable	Symbol used	3-pole version	3-pole version + ENVA	4-pole version
RMS current of phases or neutral	I1, I2, I3, IN	■	■	■
RMS earth current (three-phase system with neutral)	IG	-	-	■
RMS earth current (three-phase system without neutral)	IG	■	■	-
RMS voltage	V1N, V2N, V3N	-	■	■
RMS voltage	U12, U23, U31	■	■	■
Rotary field	1,2,3; 1,3,2	■	■	■
Frequency	F	■	■	■

In addition, the sentinel Energy trip unit calculates the following associated electrical values in real-time (every second):

Electrical variable	Value calculation	3-pole version	4-pole version
Average RMS current	$I_{average} = \frac{I_1 + I_2 + I_3}{3}$	■	■
Maximum instantaneous RMS current with neutral	$I_{max} = \max(I_1, I_2, I_3, I_N)$	-	■
Maximum instantaneous RMS current without neutral	$I_{max} = \max(I_1, I_2, I_3)$	■	-
Minimum instantaneous RMS current	$I_{min} = \min(I_1, I_2, I_3)$	■	■
Average Ph-N RMS voltage	$V_{average} = \frac{V_{1N} + V_{2N} + V_{3N}}{3}$	-	■
Maximum Ph-N RMS voltage	$V_{max} = \max(V_{1N}, V_{2N}, V_{3N})$	-	■
Minimum Ph-N RMS voltage	$V_{min} = \min(V_{1N}, V_{2N}, V_{3N})$	-	■
Average Ph-Ph RMS voltage	$U_{average} = \frac{U_{12} + U_{23} + U_{31}}{3}$	■	■
Maximum Ph-Ph RMS voltage	$U_{max} = \max(U_{12}, U_{23}, U_{31})$	■	■
Minimum Ph-Ph RMS voltage	$U_{min} = \min(U_{12}, U_{23}, U_{31})$	■	■

The sentinel Energy trip unit calculates the real-time maximum and minimum values reached since the last reset.
Certain values are time stamped.

All of these values take into account the positive and negative values.
For example, if the previous maximum value was 25 and a value of -30 is measured, the new maximum value becomes -30.

Monitored value			**Time stamp**	**3-pole version**	**4-pole version**
Current					
Maximum	instantaneous	- for I1, I2 and I3	-	■	-
		- for I1, I2, I3 and IN	-	-	■
	since reset	- for each phase	■	■	■
		- for IN	■	-	■
		- for current maximums - for minimum of I1, I2 and I3 - for average current - for IG	-	■	■
		- for IN unbalance	-	-	■
		- for unbalance per phase - for maximum unbalance	-	■	■
Minimum	instantaneous	- for I1, I2 and I3	-	■	■
	since reset	- for each phase	-	■	■
		- for IN	-	-	■
		- for current maximums - for minimum of I1, I2 and I3 - for average current - for IG	-	■	■
		- for IN unbalance	-	-	■
		- for unbalance per phase - for maximum unbalance	-	■	■
Voltage					
Maximum	instantaneous	- of three single voltages	-	-	■
		- of three phase voltages	-	■	■
	since reset	- of each single voltage	■	-	■
		- of each three phase voltage	■	■	■
		- for unbalance of each single voltage - for maximum single phase unbalances	-	-	■
		- for unbalance of each three phase voltage - for minimums of three phase unbalances - for average voltage	-	■	■
Minimum	instantaneous	- of three single voltages	-	-	■
		- of three phase voltages	-	■	■

Monitored value			Time stamp	3-pole version	4-pole version
Minimum	since reset	- of each single voltage	■	-	■
		- of each three phase voltage	■	■	■
		- for unbalance of each single voltage - for maximum single voltage unbalances	-	-	■
		- for unbalance of each three phase voltage - for minimums of three phase unbalances - for average voltage	-	■	■
Frequency					
Maximum frequency			■	■	■
Minimum frequency			■	■	■
Power					
Maximum	for total power	- active - reactive - apparent	-	■	■
	for power per phase	- active - reactive - apparent	-	-	■
Minimum	for total power	- active - reactive - apparent	-	■	■
	for power per phase	- active - reactive - apparent	-	-	■
Maximum for total power factor and for total φ cos			-	■	■
Minimum for total power factor and for total φ cos			-	■	■
Total harmonic distorsion current					
Maximum	for current THD	- per phase - maximum instantaneous	-	■	■
Minimum	for current THD	- per phase - maximum instantaneous	-	■	■
Voltage total harmonic distortion					
Maximum	THD of single voltages		-	-	■
	THD of compound voltages		-	■	■
Minimum	THD of single voltages		-	-	■
	THD of compound voltages		-	■	■

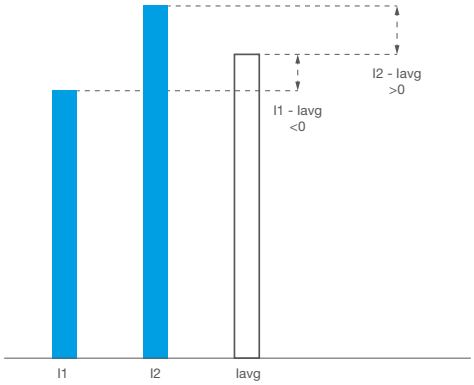
N.B.
Some or all of these min/max values as well as the partial energy meters can be reset using the reset to zero command depending on the interface used:
- sentinel Energy display,
- panel display,
- Hager Power setup.

The sentinel Energy trip unit calculates in real-time (every second) current and voltage unbalances.

Current unbalance is expressed as a % in relation to the average current.

$$I_{avg} = \frac{I1 + I2 + I3}{3}$$

$$I_p \text{ unbalance} = \frac{I_p - I_{avg}}{I_{avg}} x100 \quad \text{with P = 1, 2, 3}$$

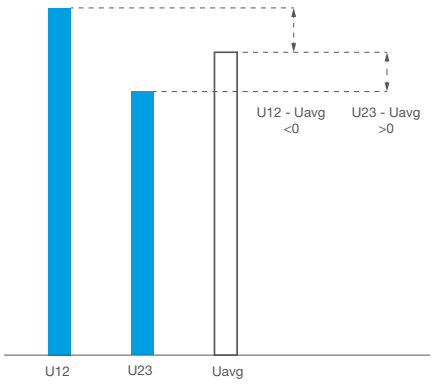


Unbalanced current principle

Voltage unbalance is expressed as a % in relation to the arithmetic mean of the corresponding voltage:

$$U_{avg} = \frac{U12 + U23 + U31}{3}$$

$$U_{pg} \text{ unbalance} = \frac{U_{pg} - U_{avg}}{U_{avg}} \times 100 \quad \text{with pg = 12, 23, 31}$$



Unbalanced current principle

List of unbalance values:

Electrical variable	**Symbol used**	**3-pole version**	**4-pole version**
Phase current unbalance	Inba1, Inba2, Inba3	■	■
Neutral current unbalance	IN Unb	-	■
Instantaneous maximum unbalanced phase current without neutral	Inba	■	-
Instantaneous maximum unbalanced phase current with neutral	Inba	-	■
Single voltage unbalance	U12 Unb, U23 Unb, U31 Unb	■	■
Maximum instantaneous compound voltage unbalance	Max Unb U	■	■
Single voltage unbalance	V1N Unb, V2N Unb, V3 Unb	-	■
Maximum instantaneous single voltage unbalance	Max Unb V	-	■

ATTENTION

Unbalanced values are indicated in the form of relative values as a %.
The calculation of these values is based on the measurement of current and voltage amplitudes.

The sentinel Energy trip unit calculates the following electrical powers in real-time (every second):
- Active power per phase
- Reactive power per phase
- Apparent power per phase
- Total active power
- Total reactive power
- Total apparent power.

The exhaustive list of variables calculated, associated with their mathematical definition and their availability according to 3-pole or 4-pole version, is given in the following table:

Electrical parameter	Symbol	Definition	3-pole version	4-pole version
Active power per phase	P1, P2, P3	$P_p = \frac{1}{N} \cdot \sum_{k=0}^{N-1} \left(v_{pN_k} \cdot i_{p_k} \right)$	-	■
Apparent power per phase	S1, S2, S3	$S_p = V_{pN} \cdot I_{p\mathrm{A}}$	-	■
Reactive power per phase	Q1, Q2, Q3	$Q_p = Signe(\varphi_p) \cdot \sqrt{{S_p}^2 - {P_p}^2}$	-	■
Total active power	Ptot	On a 4-pole product $P_{tot} = P_1 + P_2 + P_3$. The 2 wattmeter method is used on a 3-pole product	■	■
Total reactive power	Qtot	Vector or arithmetic addition depending on configuration, see § 6.13	■	■
Total apparent power	Stot	Vector or arithmetic addition depending on configuration, see § 6.13	■	■

Details about the calculations

The calculations of these powers take into account the harmonics up to rank 40.

Symbol	Definition
N	Total number of samples per network period
T	Period measured, in seconds
i_{p_k}	k sample number of phase p current
v_{pN_k}	k sample number of voltage between phase p and neutral
φ_p	Phase difference between the current and the voltage for phase p
h_i	Rank i harmonic component

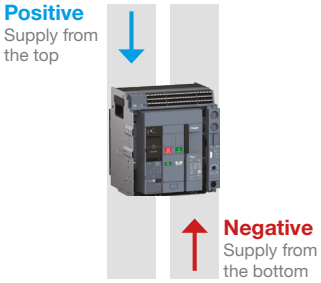
The sentinel Energy trip unit continuously calculates the power variables based on current and voltage measurement samples. The variables calculated are:
- the active powers (total Ptot and per phase)
- the reactive powers (total Qtot and per phase)
- the apparent powers (total Stot and per phase) in kVA
- the maximum and minimum values for each of these powers
- the cos φ and power factors (total values and per phase)
- the operating quadrant and the type of load (capacitive or inductive).

Power sign

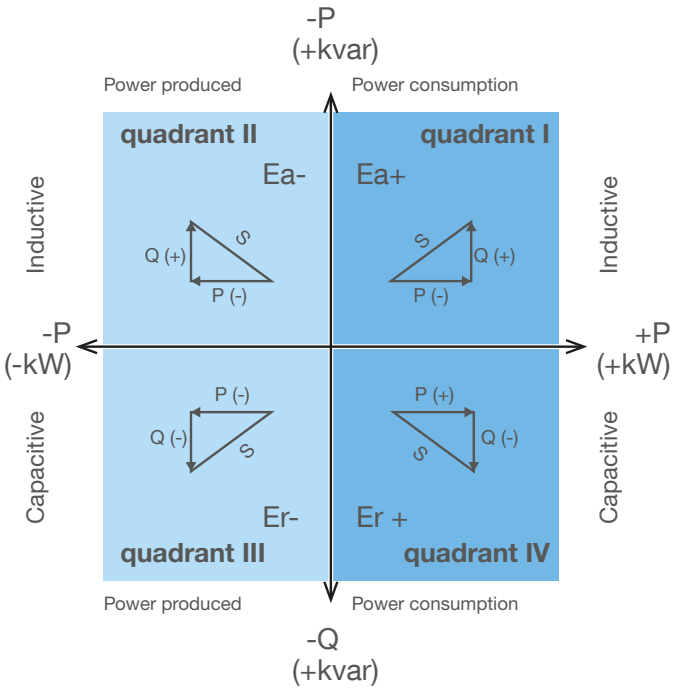
The power values are signed.
The sentinel Energy circuit breaker can be supplied both from the top and from the bottom. It is therefore important to configure the power value sign in line with the supply direction. This configuration is done from the sentinel Energy display, the panel display or the Hager Power setup software.

The active powers are given with the + sign when they are imported (consumed), i.e. when the equipment is working as a receiver.
The active powers are given with the - sign when they are exported (produced), i.e. when the equipment is working as a generator.
The reactive powers are given with the same sign as the active energies and powers, when the current lags the voltage, i.e. when the equipment is inductive.
The reactive powers are given with the opposite sign to the active energies and powers, when the current is ahead of the voltage, i.e. when the equipment is capacitive.
The operating quadrant (I, II, III, IV) is therefore given according to the power sign.

Direction of power supply



Operating quadrant



The sentinel Energy trip unit calculates the different energies by integrating the instantaneous power over a network period.

It powers several energy meters. All these meters supply absolute unsigned values except the signed meters. They count the stored energy by increasing incrementally every second.

The partial energy meters can be reset from the embedded display, the panel display and the Hager Power setup software.

Total meters

Total energy meter	Symbol	Reset to zero
Active energy imported (consumed)	Ea In,	No
Active energy exported (produced)	Ea Out	No
Reactive energy imported (consumed)	Er In	No
Reactive energy exported (produced)	Er Out	No
Absolute active energy (consumed + produced)	Ea Abs	No
Absolute reactive energy (consumed + produced)	Er Abs	No
Net active energy (consumed-produced)	Ea	No
Net reactive energy (consumed-produced)	Er	No
Apparent energy	Es	No

Partial energy meter	Electrical variable	Reset to zero
Active energy imported (consumed)	Ea In	Yes
Active energy exported (produced)	Ea Out	Yes

Multi-tariff meters

The sentinel Energy trip unit offers the possibility of adding up to 8 groups of energy meters as an option in order to use differentiated metering in accordance with the tariff order slots from T1 to T8.
Each tariff group consists of 6 energy meters:

Total energy meter	Symbol	Reset to zero
Active energy imported (consumed)	Ea In,	No
Active energy exported (produced)	Ea Out	No
Reactive energy imported (consumed)	Er In	No
Reactive energy exported (produced)	Er Out	No

Partial energy meter	Electrical variable	Reset to zero
Active energy imported (consumed)	Ea In	Yes
Active energy exported (produced)	Ea Out	Yes

The values of the active tariff meters can be viewed from the sentinel Energy display, the panel display and the Hager Power touch application.

N.B.
The Er In, Er Out, Er Abs, Er, Es values depend on the arithmetic or vector summation convention for reactive or apparent power (see configuration, see § 6.13).

The sentinel Energy trip unit calculates the average current and power values by integration over a given time interval. These are the averaged values over an interval (demand values). These values are useful in order to create a load profile for the receivers supplied by the sentinel Energy circuit breaker. They must not be confused with the instantaneous averages (Instantaneous average current, etc.).

Calculation principle
The sentinel Energy trip unit calculates a value averaged out over an interval using the electrical variable G over a time interval T divided by this same interval T.

$$G_{average} = \frac{1}{T}\int_0^T G_{.\,dt}$$

The time interval T designates the configurable integration interval.

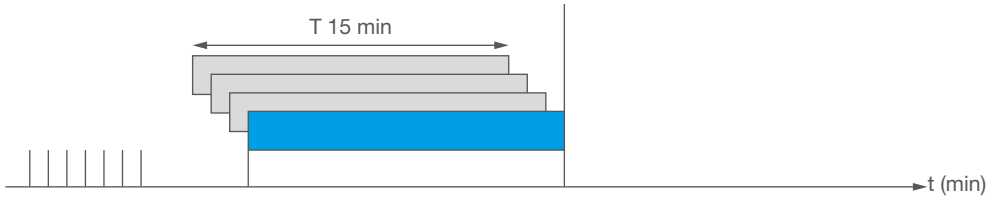
There are 3 types of integration interval:
- Fixed integration interval
- Sliding integration interval
- Synchronised integration period (Sync. Bus).

Fixed integration interval
The calculation intervals are consecutive.
A new average value is calculated at the end of the interval.

Fixed integration interval

The duration of interval T can be configured at between 1 and 60 minutes in increments of 1 minute.

Sliding integration interval
The calculation intervals are consecutive.
A new averaged value is produced every minute.

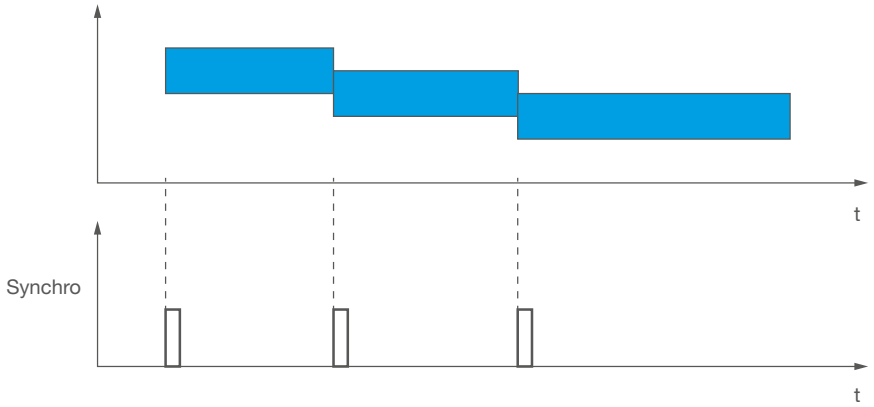


Sliding integration interval

The duration of interval T can be configured at between 1 and 60 minutes in increments of 1 minute.

Synchronised integration interval
When the first synchronisation pulse is received, a first averaged value calculation is initialised. For each new pulse, the integration in progress is stopped and the averaged value available is updated. At the same time, a new calculation is initialised.

The time interval between two synchronisation pulses must be between 1 and 60 minutes. If the interval exceeds 60 minutes, integration of the measurement stops and the measurements up to the next synchronisation pulse are not taken into account.



Synchronised integration interval

Averaged values maximum
For each averaged value period calculated, the maximum value over the time interval is stored. The maximum values can be reset to zero from the sentinel Energy display, the panel display or the Hager Power setup software.

The exhaustive list of current and power demand values calculated according to the 3-pole or 4-pole version and the visualisation interface, is given in the table below:

Electrical variable	Symbol	3-pole version	4-pole version	sentinel Energy display	Panel display	Hager Power touch
Phase current demand	I1 Dmd, I2 Dmd, I3 Dmd	■	■	■	-	■
Neutral current demand	IN Dmd	-	■	■	-	■
average current demand	Iavg Dmd	■	■	■	-	■
Active power demand per phase	P1 Dmd, P2 Dmd, P3 Dmd	-	■	-	■	■
total active power demand	Ptot Dmd	■	■	■	■	■
Reactive power demand per phase	Q1 Dmd, Q2 Dmd, Q3 Dmd	-	■	-	■	■
Total reactive power demand	Qtot Dmd	■	■	■	■	■
Apparent power demand per phase	S1 Dmd, S2 Dmd, S3 Dmd	-	■	-	■	■
Total apparent power demand	Stot DSmd	■	■	■	■	■
Peak current demand per phase	Max I1 Dmd, Max I2 Dmd, Max I3 Dmd	■	■	■	-	■
Neutral peak current demand	Max IN Dmd	-	■	■	-	■
Average peak current demand	Max Iavg Dmd	■	■	■	-	■
Active peak power demand per phase	Max P1 Dmd, Max P2 Dmd, Max P3 Dmd	-	■	-	■	■
Total active peak power demand	Max Ptot Dmd	■	■	■	■	■
Reactive peak power demand per phase	Max Q1 Dmd, Max Q2 Dmd, Max Q3 Dmd	-	■	-	■	■
Total reactive peak power demand	Max Qtot Dmd	■	■	■	■	■
Apparent peak power demand per phase	Max S1 Dmd, Max S2 Dmd, Max S3 Dmd	-	■	-	■	■
Total apparent peak power demand	Max Stot DSmd	■	■	■	■	■

The type of integration interval and the duration of the interval T are configurable on the sentinel Energy display, the panel display and the Hager Power setup software.

N.B.
The Qtot Dmd, Stot Dmd, Max Q1 Dmd, Max Q2 Dmd, Max Q3 Dmd, Max Qtot Dmd and Max Stot Dmd values depend on the arithmetic or vector summation convention for reactive and apparent power (see § 6.13 – Setting the reactive and apparent power calculation convention).

The sentinel Energy trip unit calculates the rate of harmonic distortion (Total Harmonic Distortion) every second based on real-time measurements of current and voltage.
The availability of these measurements depends on the type of rating plug installed.
These calculations are carried out up to harmonics of the 31st order with accuracy class 2 in accordance with IEC 61557-12.
The harmonic distortion rates are energy distribution quality indicators. The THDi is used to determine the current wave deformation rate. The THDU or THDV is used to determine the voltage wave deformation rate.

Harmonic distortion THD in current THDi
The current THD is the percentage of the RMS value of current harmonics of a rank above one, compared to the RMS value of the harmonic current of rank one.
As the rate is calculated in relation to the fundamental, its value can exceed 100 %.

$$THD_{Ip} = \frac{\sqrt{I_{p\,h_2}{}^2 + \cdots + I_{p\,h_{31}}{}^2}}{I_{p\,h_1}}$$

Calculation formula symbol	Definition
$I_{p\,h_n}$	Rank n root-mean-square harmonic component for the current of pole p

The THDi or, in other words, deformation rate of the current wave is caused by receiver non-linearity, which produces non-sinusoidal current waveforms. Therefore the THDi enables potential polluter receivers in energy distribution to be identified.
A THDi < 10 % shows low pollution which is generally acceptable.
A THDi up to 50 % indicates risky levels of pollution (risk of overheating, etc.).
A THDi above 50 % is a high harmonics percentage and may result in serious degradation, dangerous overheating and risk of malfunctions if the installation has not been designed correctly.

Total harmonic distortion of voltage THD, THDU, THDV
The THD of voltage is the percentage of the RMS value of harmonic voltages of a rank above one, compared to the RMS value of the harmonic voltage of rank one.
Its value can theoretically exceed 100 % but, in practice, it does not exceed 25 %.

$$THD_{Upg} = \frac{\sqrt{U_{pg\,h_2}{}^2 + \cdots + U_{pg\,h_{31}}{}^2}}{U_{pg\,h_1}}$$

Calculation formula symbol	Definition
$U_{pg\,h_n}$	Harmonic RMS component of rank n for voltage with pg = 12, 23, 31

The THD of voltage is used to assess the impact of the impedance of the line on the quality of the voltage at the level of the pollutant receivers. The higher the impedance of the lines supplying these receivers, the higher the THD of voltage.

The exhaustive list of variables calculated according to the 3-pole or 4-pole version is given in the following table:

Electrical variable	Symbol	3-pole version	4-pole version
Neutral current THD	THD IN	■	■
Phase current THD	THD I1, THD I2, THD I3	■	■
THD of single voltages	THD V1N, THD V2N, THD V3N	-	■
THD of compound voltages	THD U12, THD U23, THD U31	■	■

The sentinel Energy trip unit calculates every second in real-time the power factor PFtot from the ratio of total active power to total apparent power. It also calculates the power factors per phase from the ratios of active power per phase to apparent power per phase.

Example: Formula for the power factor per phase.

$$PF_x = {}^{P_x}/_{S_x}$$

Calculation formula symbol	Definition
x	Phase number.

The sentinel Energy trip unit also calculates in real-time (every second) the total cos φ from the ratio of total active power reduced to the harmonics of rank 1 to total apparent power reduced to the harmonics of rank 1. In addition, it calculates the cos φ per phase.

The power factors and the cos φ are energy distribution quality indicators. Improving these indicators enables the following:
- Decreasing the reactive energy consumption that may result in penalties related to electrical consumption costs
- Reducing the cross-section of the cables
- Reducing line losses
- Reducing the voltage drop
- Increasing the power available to the transformer.

The exhaustive list of variables calculated according to the 3-pole or 4-pole version is given in the following table:

Electrical variable	Symbol	3-pole version	4-pole version
Power factor per phase	PF1, PF2, PF3	-	■
Total power factor	PFtot	■	■
Cos φ per phase (fundamental power factor)	cos φ 1, cos φ 2, cos φ 3	-	■
Total cos φ (fundamental power factor)	cos φ tot	■	■

N.B.
The values PFtot and cos φ tot depend on the arithmetic or vector summation convention for reactive and apparent power (see § 6.13 - Setting the reactive and apparent power calculation convention).

PF power factor and cos sign φ
The Energy trip unit is used to configure the sign convention to be applied to the power factor and cos valuesφ.

Two options are possible:
- **IEC Convention**: The sign for the power factors and cos φ follows the active power sign,
- **IEEE convention**: The sign for the power factors and cos φ is modified to indicate whether the electrical system is capacitive (+ sign) or inductive (- sign).

IEC convention

	P < 0		P > 0	
Q > 0	**II**	Capacitive (lead) PF < 0 cos φ < 0	**I**	Inductive (lag) PF > 0 cos φ > 0
Q < 0	**III**	Inductive (lag) PF < 0 cos φ < 0	**IV**	Capacitive (lead) PF > 0 cos φ > 0

The IEC convention is indicated when the equipment downstream of the circuit breaker can operate in turn as a receiver and as a generator. It is indicated for countries using the IEC standards.

IEEE convention

	P < 0		P > 0	
Q > 0	**II**	Capacitive (lead) PF > 0 cos φ > 0	**I**	Inductive (lag) PF < 0 cos φ < 0
Q < 0	**III**	Inductive (lag) PF < 0 cos φ < 0	**IV**	Capacitive (lead) PF > 0 cos φ > 0

The IEEE convention is indicated when the equipment downstream of the circuit breaker operates exclusively as a receiver or exclusively as a generator. It is indicated for all countries using the IEEE standard.
In this case, the + sign designates the capacitive behaviour and the - sign designates the inductive behaviour.

N.B.
The configuration of the power factors and cos φ sign convention is done from the sentinel Energy display, the panel display and the Hager Power setup software.

The presence of several non-linear loads on an electrical network generates harmonic currents.
Non-linear loads distort the current and voltage waves, degrading the quality of the energy distributed.

If the distortions are large, they can result in:
- disruption to or degraded operation of powered devices,
- unwanted heating of devices and conductors,
- overconsumption.

These various effects increase the installation and operating costs of the system. It is therefore necessary to monitor the quality of the energy distributed.

The sentinel Energy trip unit allows real-time monitoring of every voltage and current harmonic up to the 40th order.

The availability of the individual harmonic voltage and current values depends on the type of optional rating plug installed (see 2.1 General description).

The values of the individual harmonics are displayed graphically in the Hager Power touch application.
They are also available on the Modbus communication.

Accuracy of measurement

Variable	Measuring range	Accuracy
Fundamental harmonic of currents on phase 1 Fundamental harmonic of currents on phase 2 Fundamental harmonic of currents on phase 3	0.2 x Ib... Imax	0.5 %
Harmonics 1 to 40 of currents on phase 1 Harmonics 1 to 40 of currents on phase 2 Harmonics 1 to 40 of currents on phase 3	0 % - 655.35 %	5 %
Fundamental harmonic of voltages between phase and neutral V1N Fundamental harmonic of voltages between phase and neutral V2N Fundamental harmonic of voltages between phase and neutral V3N	70 V - 440 V	0.5 %
Harmonics 1 to 40 of voltages between phase and neutral V1N Harmonics 1 to 40 of voltages between phase and neutral V2N Harmonics 1 to 40 of voltages between phase and neutral V3N	0 % - 655.35 %	5 %
Fundamental harmonic of voltages between phases U12 Fundamental harmonic of voltages between phases U23 Fundamental harmonic of voltages between phases U31	120 V - 690 V	0.5 %
Harmonics 1 to 40 of voltages between phases U12 Harmonics 1 to 40 of voltages between phases U23 Harmonics 1 to 40 of voltages between phases U31	0 % - 655.35 %	5 %

The hw+ circuit breaker equipped with the sentinel Energy trip unit and embedded sensors is defined as a PMD-DD measurement device of accuracy class 1 on power and energy measurements in accordance with the IEC 61557-12 version 2 standard.

This standard classifies PMD devices according to the measurements available in Table 1 below extracted from the IEC 61557-12 version 2 standard: "Functional classification of PMDs with the minimum functions required".

Table 1

Symbol of functions (a)	**Type of PMD (b)**		
	PMD-I Energy efficiency	**PMD- II Basic monitoring of the installation**	**PMD-III Advanced monitoring of the installation/network performance**
P		■	■
Q		■	■
S		■	■
E*a*	■	■	■
E*r*		■	■
E*ap*			■
f		■	■
I		■	■
I*n*			■
U and/or V		■	■
PF		■	■
THD*u* and/or THD*v* and/or THD-R*u* and/or THD-R*v*			■
THD*i* and/or THD-R*i*			■

(a) Only the total variables are mandatory.
(b) For PMDs other than PMD-I, PMD-III and those called PMP-x, other combinations of functions are authorised and must be specified by the manufacturer.

The hw+ circuit breaker with sentinel Energy trip unit is classified PMD-II or PMD-III according to the rating plug installed.

Rating plug type	**PMD- II device**	**PMD- III device**
Standard	■	
Meter Plus		■
Harmonic		■
Advanced		■
Ultimate		■

In its Chapter 4.8.2.3 the IEC 61557-12 standard defines the limits of uncertainty intrinsic to the PMD device. The uncertainty is an estimate of the error percentage between the measurement of an electrical parameter and its real value. The hw+ circuit breaker equipped with the sentinel Energy trip unit complies with these requirements. For more information, refer to the IEC 61557-12 version 2 standard.

The hw+ circuit breaker equipped with the sentinel Energy trip unit complies with the K70 class temperature requirements and the standard operating conditions in terms of humidity and altitude, according to Tables 6 and 7 of the IEC 61557-12 standard.
Here is an extract from these tables.

Table 6
Assigned operating temperatures for fixed installation equipment

	K55 temperature class of the PMDs	**K70 temperature class of the PMDs**	**Kx (b) temperature class of the PMDs**
Rated operating range (with specified uncertainty)	-5 °C to + 55 °C	-25 °C to + 70 °C	Greater than + 70 °C and/or less than - 25 °C (a)
Operating range limit (no material failure)	-5 °C to + 55 °C	-25 °C to + 70 °C	Greater than + 70 °C and/or less than - 25 °C (a)
Range limit for storage and transport	-25 °C to + 70 °C	-40 °C to + 85 °C	According to the manufacturer's specification (a)

(a) The limits must be defined by the manufacturer, in keeping with the application.
(b) Kx represents the extended conditions.
(c) The operating temperature is the highest temperature of the air in immediate proximity to the PMD.

Table 7
Operating conditions in humidity and at altitude

	Normalised conditions	**Extended conditions**
Rated operating range (with specified uncertainty)	0 % to 75 % HR (b)	0 % to more than 75 % HR (a) (b)
Operating range limit for 30 days/year	0 % to 90 % HR (b)	0 % to more than 90 % HR (a) (b)
Range limit for storage and transport	0 % to 90 % HR (b)	0 % to more than 90 % HR (a) (b)
Altitude	0 m to 2000 m	0 m to 2000 m (a)

(a) The limits must be defined by the manufacturer, in keeping with the application.
(b) The relative humidity values are specified without condensation.

The hw+ circuit breaker equipped with the sentinel Energy trip unit also complies with all the electromagnetic compatibility (EMC) immunity requirements and other influence variables defined by the IEC 61557-12 standard.

The precision of each measurement applies to a measurement range or extent in accordance with IEC 61557-12. It is defined, in accordance with IEC 61557-12, for a power supply within normal ambient temperature conditions of 23 °C ± 2 °C.
For a measurement taken at another temperature, within the temperature range of - 25 °C...+ 70 °C, the temperature accuracy derating coefficient is 0.05 % per °C.
The accuracy range is the part of the measuring range for which the defined accuracy is obtained; the definition of this range may be related to the load characteristics of the circuit breaker.

Variables	**Symbols**	**Measuring range**	**Accuracy class according to IEC 61557-12**
Currents and Max./Min. current	I1, I2, I3; IN, Iavg, Imax, Imin,…	0.2 x Ib ... Imax	0.5
Earth fault	% IG	0.2 x Ib ... Imax	0.5
Current unbalance	Inba1, Inba2, Inba3, InbaN, Inba	-	-
Phase-phase and Min/Max voltages	U12, U23, U31, Uavg	120 V - 690 V	0.5
Phase-neutral and Min/Max voltages	V1N, V2N, V3N, Vavg	70 V - 440 V	0.5
Unbalances	U12 Unb, U23 Unb, U31 Unb, V1N Unb, V2N Unb, V3N Unb, Max Unb U, Max Unb V	0.8…1.2 x Vn	-
Frequency	f	45 Hz - 65 Hz	0.02
Power	P total, P per phase, Q total, Q per phase, S total, S per phase	0.05 x Ib... Imax	1
Active energy	EaIn, EaOut, Ea Abs, Ea, EaIn EaOut	0.05 x Ib... Imax	1
Reactive energy	ErIN, ErOut, Er Abs, Er	0.05 x Ib... Imax	2
Apparent energy	Es	0.05 x Ib... Imax	1
Average power over interval	P Dmd per phase, P Dmd Total, Q Dmd per phase, Q Dmd Total, S Dmd per phase, S Dmd Total	0.05 x Ib... Imax	1
	Max P Dmd per phase, Max P Dmd Total, Max Q Dmd per phase, Max Q Dmd Total, Max S Dmd per phase, Max S Dmd Total		
Average currents over interval	I1 Dmd, I2 Dmd, I3 Dmd, IN Dmd, Iavg Dmd, Max I1 Dmd, Max I2 Dmd, Max I3 Dmd; Max IN Dmd, Max I1 Dmd, Max I2 Dmd, Max I3 Dmd; Max IN Dmd	0.2 x Ib ... Imax	0.5
Power factors	PF1, PF2, PF3, PFtot, Cos φ 1, Cos φ 2, Cos φ 3, Cos φ tot	0.5 inductive to 0.8 capacitive	1
Voltage THD	THDU (ph.-ph.), THDV (ph.-N)	0…20 %	2
Current THD	THDI per phase or per neutral pole	0…200 %	2

The sentinel Energy trip unit requires configuration of the parameters associated with the characteristics of the electrical network. The parameters of nominal voltage Un, nominal power Pn, nominal frequency Fn, and the sign convention of power polarity are used by the measurement functions of the sentinel Energy trip unit. These parameters have no effect on the protections except the reverse active power protection.

These parameters are accessible from the CONFIGURATION ⇨ NETWORK of the sentinel Energy display, the panel display or the Hager Power setup software.

Nominal voltage setting

This setting allows the nominal voltage of the electrical network to be configured.

Network	Un	V	208 to 690 V

Nominal power setting

This setting allows the nominal power of the electrical network to be configured.

Network	Pn	kW	50 to 9995 kW in increments of 5

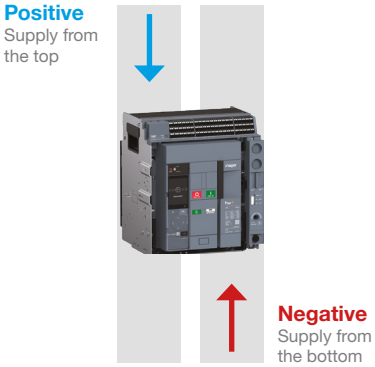
Nominal frequency setting

This setting allows the nominal frequency of the electrical network to be configured.

Network	Fn	Hz	50 or 60 Hz

Setting the power sign convention

The power sign convention parameter is used to configure the power sign according to the supply direction of the Energy circuit breaker.



Power sign

P sign convention	Default setting
Positive - negative	Positive

Configuring this convention correctly enables the 4 quadrant set-up to be respected:
- Positive active power when the downstream equipment operates as a receiver,
- Reactive power, on the one hand with the same sign as active power when the equipment downstream is inductive, on the other hand with the opposite sign when the equipment downstream is capacitive.

	P < 0		P > 0	
Q > 0	**II**	Capacitive (lead)	**I**	Inductive (lag)
Q < 0	**III**	Inductive (lag)	**IV**	Capacitive (lead)

Measurement parameters must be configured in order to obtain correct measurements that fulfil the requirements of the electrical installation.
These parameters are accessible from the CONFIGURATION ⇨ MEASURES of the sentinel Energy display, the panel display or the Hager Power setup software.

ENVA	On or Off; cannot be deactivated on 4-pole; On by default for 3-pole
ENCT	On or Off; cannot be deactivated on 4-pole; Off by default for 3-pole
Phase seq.	Defining the sequence of the connected electrical phases 1,2,3 or 1,3,2
Calculation	Defining the calculation convention of Qtot, Stot, Eap, ErOut, ErIn, PFtot and φphitot. Arithmetic or Vector
Interval	1 to 60 min in increments of 1 min
DEM. MODE	Definition of the type of integration of averaged values. Sliding, Sync. Bus or Fixed
PF sign	Defining the sign convention of the power factor. IEEE or IEC
Tariff	Off or On

ENVA setting: taking neutral potential into account
Enables measurement of voltages between phase and neutral V1N, V2N, V3N as well as the powers per phase.
On 4-pole circuit breakers this parameter is ON and cannot be changed. On 3-pole circuit breakers, this parameter must be activated to enable measurement of the voltages between phase and neutral V1N, V2N, V3N as well as the powers per phase, if the terminal vN is linked to the neutral potential.

ENVA	On or Off

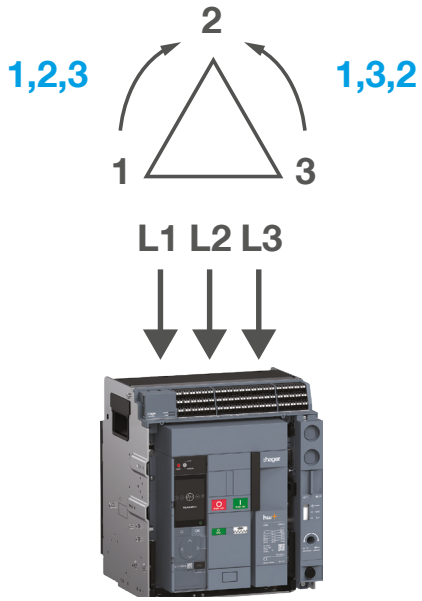
IMPORTANT
With a 3-pole circuit breaker installed in a earth fault protection system where the neutral is distributed, the vN terminal must be connected to the neutral potential and this parameter must be activated, otherwise the measurement values of the voltages between phase and neutral V1N, V2N, V3N of the powers per phase will be erroneous. Similarly, non-activation of this parameter will prevent correct operation of the reverse active power, undervoltage and overvoltage advanced protection.

ENCT setting
Allows the neutral current measurement to be taken into account.
On 4-pole circuit breakers this parameter is ON and cannot be changed. On 3-pole circuit breakers equipped with the ENCT sensor, this parameter must be activated to allow correct operation of the earth fault protection and to obtain measured values of voltages between phase and neutral V1N, V2N, V3N and current IN.

ENCT	On or Off

Adjusting the reference phase sequence

This parameter is used to configure the sequence of phases for the network supplying the sentinel Energy circuit breaker. In the case of a network with inverse phase rotation, the reference sequence is: 1, 3, 2.

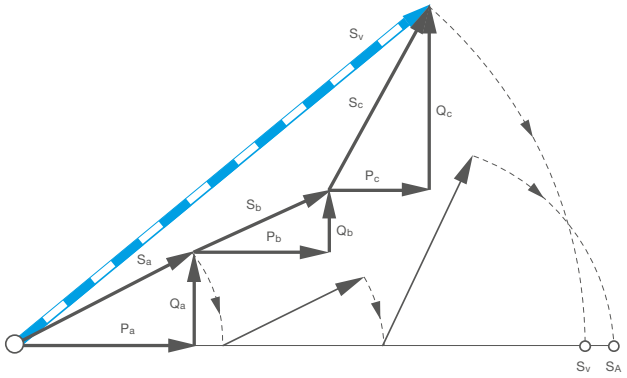


Phase sequence

Phase sequence setting	Default setting
1, 2, 3 - 1, 3, 2	1, 2, 3

Setting the reactive and apparent power calculation convention
This parameter is used to configure the convention for calculating total reactive power and total apparent power.
The calculation of these two data will not lead to the same value as it depends on whether the addition of the phase components is vectorial or arithmetic.

The following figure clearly shows the difference in the case of total apparent power:



Vector and arithmetic summing

Symbol	Definition
Pa	Active power L1
Pb	Active power L2
Pc	Active power L3
Qa	Reactive power L1
Qb	Reactive power L2
Qc	Reactive power L3
Sa	Apparent power L1
Sb	Apparent power L2
Sc	Apparent power L3
SV	Total apparent power: Vector summing
SA	Total apparent power: Arithmetic summing

On the figure above, the value of total apparent power SA by arithmetic summing is greater than the value of total apparent power SV by vector summing. The value calculated by vector summing is more precise than the value calculated by arithmetic summing.

Calculation convention setting	Default setting
Arithmetic – Vector	Vector

List of values affected by the calculation convention setting.

Value	Definition
Qtot	Total reactive power
Stot	Total apparent power
ErIn	Reactive energy consumed
ErOut	Reactive energy produced
Er Abs	Absolute reactive energy
Er	Signed reactive energy value
Es	Apparent energy
PFtot	Total power factor
cos φ tot	Cos φ total
Qtot Dmd	Averaged value (over interval) of total reactive power
Stot Dmd	Averaged value (over interval) of total apparent power
Max Qtot Dmd	Max. averaged value (over interval) of total reactive power
Max Stot Dmd	Max. averaged value (over interval) of total apparent power

Setting the averaged value over interval parameters
This parameter is used to configure the length of the integration interval and the type of integration in order to perform the averaged value calculations correctly.
Calculating the averaged values over a specific interval involves integrating the currents and powers over a time interval (see § 6.7).

Demand period	Default setting
1 – 60 min. (increments of 1 min.)	30 min

Demand mode	Default setting
Fixed – Sliding – Sync. Bus	Fixed

N.B.
The parameter "Demand Period" is not taken into account in the average value calculation if the "Demand Mode" setting (type of integration interval) is Sync. Bus (Synchronised integration interval).

Setting the power factor and cos sign convention φ

This parameter is used to configure the sign for power factors and cos φ according to the IEC convention or the IEEE convention in the four-quadrants diagram.

IEC convention

	P < 0		P > 0	
Q > 0	**II**	Capacitive (lead)	**I**	Inductive (lag)
		cos φ < 0		PF > 0 cos φ > 0
Q < 0	**III**	Inductive (lag)	**IV**	Capacitive (lead)
		cos φ < 0		PF > 0 cos φ > 0

The IEC convention is indicated when the equipment downstream of the circuit breaker may operate in turn as a receiver and as a generator. It is indicated for countries using the IEC standards.

IEEE convention

	P < 0		P > 0	
Q > 0	**II**	Capacitive (lead)	**I**	Inductive (lag)
		cos φ > 0		PF < 0 cos φ < 0
Q < 0	**III**	Inductive (lag) cos φ > 0	**IV**	Capacitive (lead) PF > 0 cos φ > 0

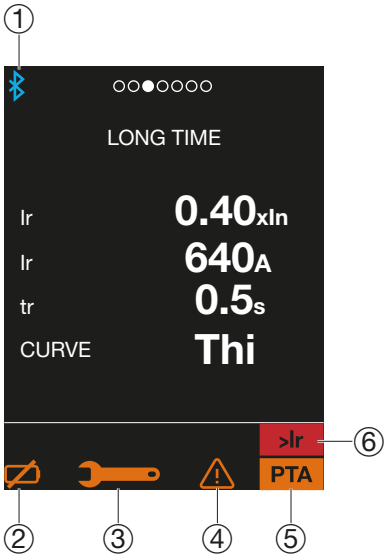
The IEEE convention is indicated for all countries using the IEEE standard.

PF sign convention	Default setting
IEC - IEEE	IEC

With the sentinel Energy trip unit, there are 9 types of alarms:
- Overload prealarm PTA
- Overload alarm > Ir
- Trip alarms
- Custom alarms (configurable)
- Advanced protection alarms
- Voltage Dip and Swell monitoring alarms
- System alarms
- Maintenance alarm
- Low or missing back-up battery alarm

The sentinel Energy alarms follow a colour code display according to their severity.
- Red: alarm associated with a potentially serious event of high severity, causing the circuit breaker to trip, before an imminent tripping or indicating a serious failure in the circuit breaker resulting in it being unable to perform its protection functions.
- Orange: alarm associated with an event of medium to low severity following an operational incident or an incident in the electrical installation not required the circuit breaker to be tripped.

The following alarms are signalled on the sentinel Energy display by an icon in the notification area:
- Overload prealarm PTA
- Overload alarm > Ir
- Maintenance alarm
- Low or missing back-up battery alarm



①	Bluetooth	appears as soon as the Bluetooth connection is activated.
②	Low or missing battery indicator alarm	displayed if the sentinel Energy trip unit backup battery needs to be changed or is not connected.
③	Maintenance alarm indicator	displayed when maintenance is required.
④	System alarm indicator	appears when a system alarm is present and the INFORMATION ⇨ ALARM HISTORY menu has not been viewed yet.
⑤	Overload prealarm alarm indicator	appears when the current crosses the PTA 1 threshold. Allows warnings about a risk of imminent overload.
⑥	Overload alarm indicator	flashes when current exceeds 105% of Ir and is fixed above 112.5 % of Ir and allows alerts about a risk of imminent tripping.

The following alarms are signalled on the sentinel Energy display by a pop-up that must be acknowledged in some cases:
- Trip alarms
- Custom alarms (configurable)
- Advanced protection alarms
- Voltage Dip and Swell monitoring alarms
- System alarms

The sentinel Energy alarms are visible in Hager Power setup and Hager Power touch in a list of active alarms.

They are signalled on the panel display in the form of a message window (see HTD210H panel display user manual).

They are recorded and timestamped in the events history (see Chapter Event management).

The PTA overload prealarms provide a warning when the situation is close to overload after a load current greater than the PTA threshold. Preventive measures (load-shedding, maintenance, etc.) can then be taken before the circuit breaker trips, avoiding a powerblackout.

The sentinel Energy trip unit offers the possibility of generating 2 overload prealarms PTA 1 and PTA 2. Only the PTA 1 prealarm is shown in the form of a message window or notification icon on the sentinel Energy display and panel display.
But the 2 prealarms PTA 1 and PTA 2 appear in the lists of active alarms and are recorded in the events history. They are also available on the Modbus communication.

Adjustment parameters

PTA 1	Threshold Ir	PTA tripping threshold of the overload prealarm
	Delay tr	PTA overload prealarm time delay
PTA 2	Activation	Activation of the PTA 2 overload prealarm
	Threshold Ir	PTA tripping threshold of the overload prealarm
	Delay tr	PTA overload prealarm time delay

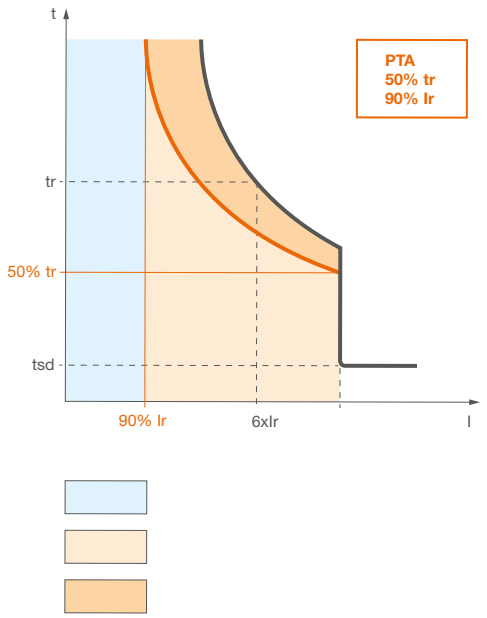
The PTA prealarms are adjusted from the ALARMS ⇨ PREALARMS menu of the sentinel Energy display, the HTD210H panel display or the Hager Power setup software.

PTA threshold adjustment range (in %Ir)
From 60 to 95% in increments of 5.

Time delay PTA adjustment range (in %tr)
From 5 to 80% in increments of 5.

The PTA prealarm is deactivated by default.

The overload prealarms trip for any current (gradual rise or current peak) reaching the **surveillance zone**.

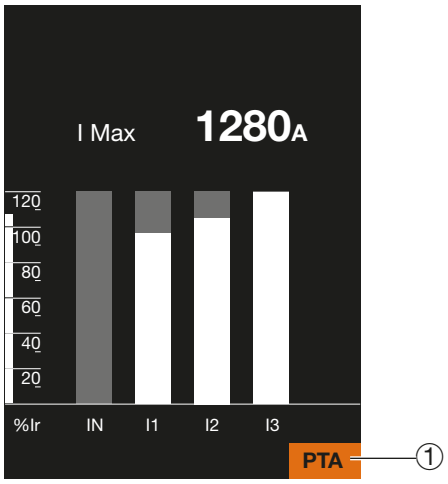


Overload prealarm zones

This **alert zone** is bounded on one hand by the threshold and time delay of the PTA overload prealarm and on the other hand by the Ir threshold and tr time delay.

The surveillance zone starts from the PTA threshold.

Display of the PTA prealarm 1:



① Overload prealarm icon (PTA 1 only)

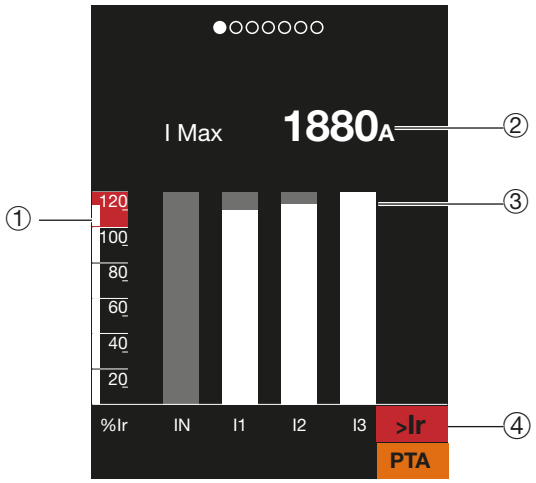
Normal load zone	Surveillance zone	Alert zone
off	flashing	fixed

The overload alarm provides an alert about a risk of imminent tripping due to a current overload.

It activates as soon as the current ≥ 105 % of the Ir value.

In the event of an overload alarm, a screen of this type is displayed with the >Ir icon flashing and the indicator lit and steady.

Above 112.5 % of Ir, the icon >Ir remains steady.



① Overload indicator

② Maximum current value reached

③ Diagram indicating the maximum instantaneous current per pole

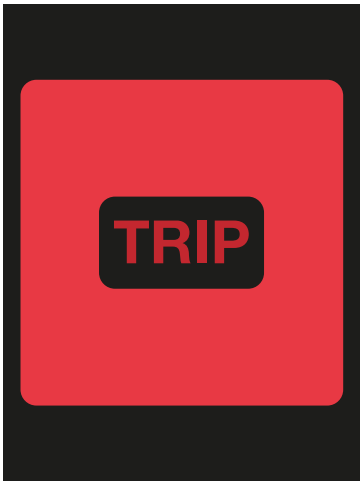
④ Overload alarm icon

Following a circuit breaker tripping, the trip alarms display a message window on the sentinel Energy display and the panel display.

They indicate the type of trip as well as useful information related to the cause of tripping

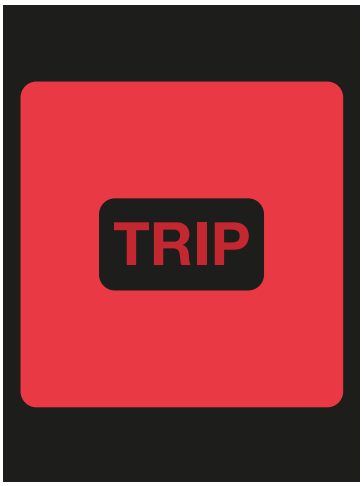
The message window must be acknowledged after handling the tripping fault and before restarting the circuit breaker.

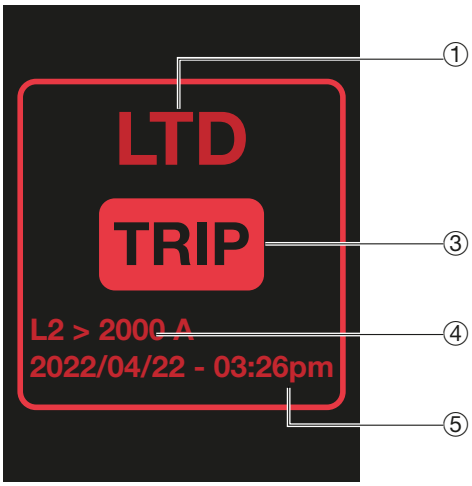
The pop-up flashes.



Briefly press the trip unit's OK button to hold the window and display the tripping type as well as additional information about what caused it.

Do a long press for more than 3 seconds to acknowledge and close the message.





①

Message	Tripping type
LTD	Long time delay protection
STD	Short time delay protection
INST	Instantaneous protection
GF	GF earth fault
MCR	Autoprotection on short circuit fault closure (Making Current Release)
UV-27	Undervoltage protection
OV-59	Overvoltage protection
UF-81L	Underfrequency protection
OF-81H	Overfrequency protection
RP-32R	Reverse active power protection
UNBC-46	Current unbalance protection
UNBV-47	Voltage unbalance protection
TEST	Trip Test
HWF	Electronic trip unit failure protection

② Trip indicator

③ Information about the cause of the tripping.
Example: tripping on overload 2000 A on phase L2

④ Date and time of tripping

ATTENTION

If the Energy trip unit is not connected to an external 24 V DC power supply, the backup battery handles the display of the alarm after the tripping. In these conditions, the trip alarm will remain visible on the sentinel Energy display up to 6 hours after it appears.

Optional alarms make it possible to monitor any measuring event detected by the sentinel Energy trip unit.
It is possible to define up to 12 alarms for a single trip unit. Each alarm is dedicated to monitoring a single measurement.

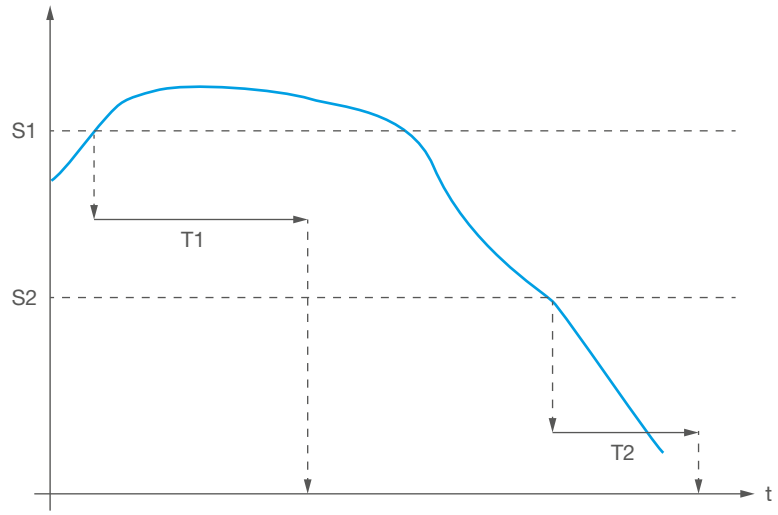
An optional alarm is defined through the following parameters:
- Measurement monitored,
- Activation threshold,
- Deactivation threshold,
- Activation time delay,
- Deactivation time delay,
- Priority level.

Activation condition for custom alarms

Activation of a custom alarm results from one of the following conditions:
- Positive crossing of a threshold condition,
- Negative crossing of a threshold condition,
- Equal to a measured value.

Activation by positive crossing

In the case of a positive crossing of a threshold, activation of the alarm is dependent on the activation threshold being positively crossed.



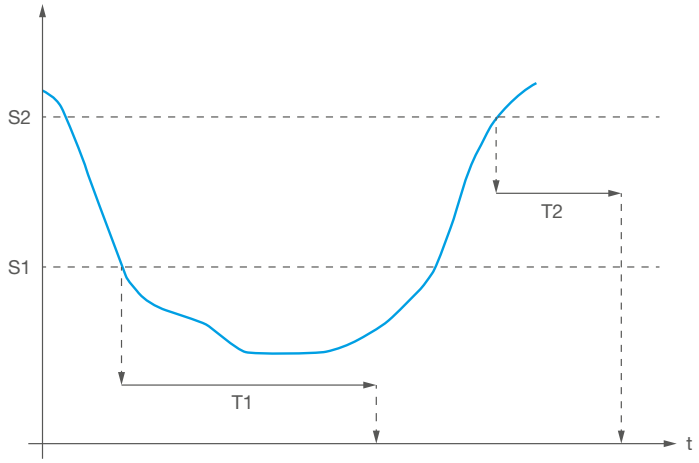
Alarm function

Upper crossing

Symbol	Meaning
s1	Activation threshold
s2	Deactivation threshold
T1	Activation time delay
T2	Deactivation time delay

Activation by negative crossing

In the case of a negative crossing of a threshold, activation of the alarm is dependent on the activation threshold being negatively crossed.



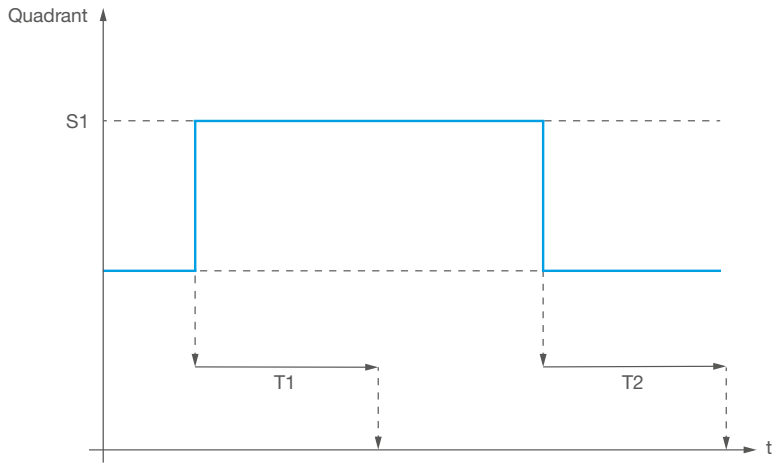
Alarm function

Upper crossing

Symbol	Meaning
s1	Activation threshold
s2	Deactivation threshold
T1	Activation time delay
T2	Deactivation time delay

Activation due to equal levels

For the equal value condition, the alarm is activated when the value measured is the same as the activation value. The activation threshold is the same as the activation value.



Alarm function

Upper crossing

Symbol	Meaning
s1	Activation value
T1	Activation time delay
T2	Deactivation time delay

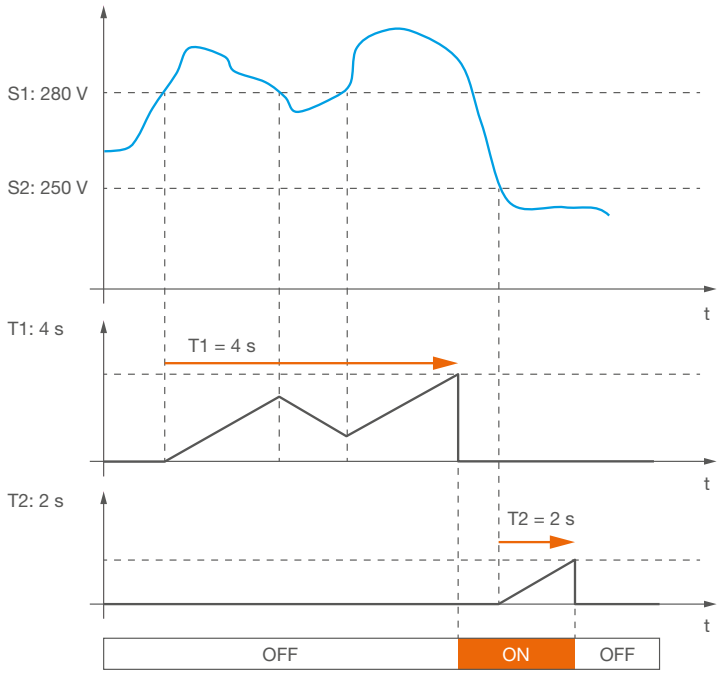
Managing time delays

The time delays of optional alarms are managed by 2 counters which are normally at 0
For the activation time delay, the counter:
- Is increased when the activation condition is met,
- Is decreased if the activation condition is not met and if the time delay T1 is not reached,
- Is reset when the time delay is reached.

For the deactivation time delay, the counter:
- Is increased when the deactivation condition is met,
- Is decreased if the deactivation condition is no longer met and if the time delay T2 is not reached,
- Is reset when the time delay is reached.

When the activation time delay is reached, the alarm is activated.
When an alarm is reconfigured, the counters are also reset.

Example:
In this example, the alarm is set to a positive crossing of the activation threshold of 280 V when measuring the voltage V1N. The activation time delay is set at 4 seconds. The deactivation threshold is set at 250 V and the deactivation time delay at 2 seconds.



Custom alarms: time delays

Symbol	Meaning
s1	Activation threshold
s2	Deactivation threshold
T1	Activation time delay
T2	Deactivation time delay

Configuring custom alarms

A custom alarm has 8 parameters.

Status	Alarm starting or stopping
Type	Type of measurement to monitor
Option 1	Additional attribute of the measurement type
Option 2	Threshold crossing option
Threshold	Activation threshold
Time	Activation time delay
Deact. threshold	Deactivation threshold
Deact. time	Deactivation time delay

The parameters Option 1 and Option 2 depend on the type of measurement chosen.
For example, for a Voltage type, option 1 is used to determine what voltage V1N or another; for the Phase Sequence type there is no option 2.

List of measurement types

Type of measurement	**Option 1 (measurement attribute)**	**Option 2 (alarm activation condition on option 1)**
Current	I1, I2, I3, IN, IMax, Inba1, Inba2, Inba3, Inba, Iavg	Over Under
Earth	-	Over
Voltage	V1, V2, V3, VN, VMax, VMin, V1Unb, V2Unb, V3Unb, VMaxUnb, Vavg, U12, U23, U31, UMax, UMin, U12Unb, U23Unb, U31Unb, UMaxUnb	Over Under
Power	Pd1, Pd2, Pd3, PdTot, Pr1, Pr2, Pr3, PrTot, Qd1, Qd2, Qd3, QdTot, Qr1, Qr2, Qr3, QrTot, S1, S2, S3, Tot	Over Under
Pow. Fact.	PF1, PF2, PF3, PF tot, cosφ1, cosφ2, cosφ3, cosφTot	Lag (inductive, quadrant I and III) Lead (capacitive, quadrant II and IV)
THD	I1, I2, I3, V1, V2, V3, U12, U23, U31	Over
Frequency	-	Over Under
Demand	I1, I2, I3, IN, Iavg, P, Q, S	Over Under
Quadrant	I, II, II, IV	-
Phase sequence	1, 2, 3: 1, 3, 2	-
Lead or lag	Lead (capacitive, quadrant II and IV), Lag (inductive, quadrant I and III)	-

N.B.
The availability of the measurement type attributes depends on the activation of the ENVA and ENCT parameters.
The custom alarms are set from the ALARMS ⇨ OPTIONAL ALARMS menu of the sentinel Energy display or the panel display or the Hager Power setup software.
The range of settings for the activation and deactivation time delays is from 1 to 3000 seconds in increments of 1 s.

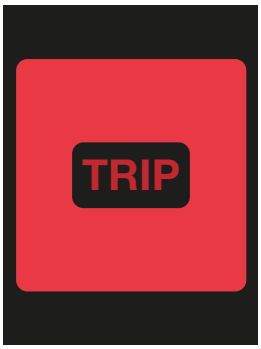
The custom alarms display a pop-up on the sentinel Energy display and the panel display as shown below.
The pop-up must be acknowledged.

Message windows on the sentinel Energy display

	Step/Action	Button	Display
1	If the custom alarm is configured, it will display the following flashing pop-up.		
2	Briefly press the trip unit's OK button to hold the pop-up and display the message.	OK	
3	Do a long press on the OK button for more than 3 seconds to acknowledge and close the pop-up after having resolved the trip fault.		

The advanced protection alarms display a message pop-up on the sentinel Energy display and the panel display.
The pop-up must be acknowledged.

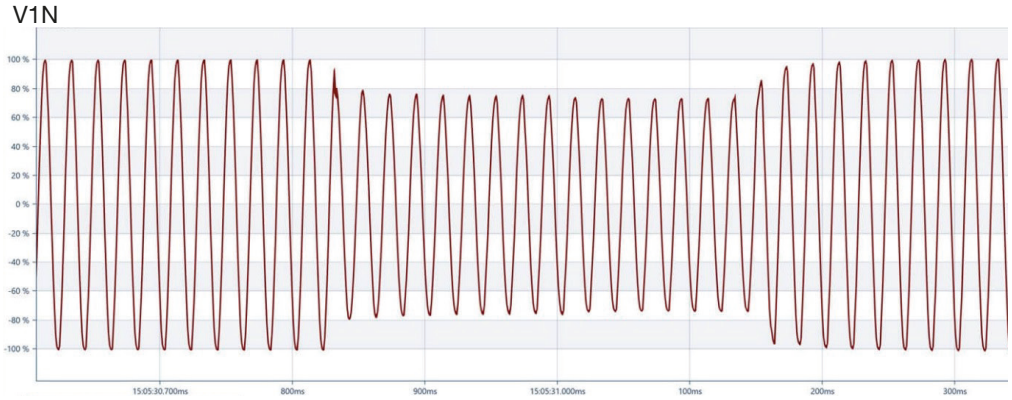
Message windows on the sentinel Energy display

	Step/Action	Button	Display
1	If the alarm is configured to “Trip” it will display the following flashing message pop-up.		
2	Briefly press the trip unit's OK button to hold the pop-up and display the message.	OK	
3	Do a long press on the OK button for more than 3 seconds to acknowledge and close the pop-up after having resolved the trip fault.		
4	If the alarm is configured to "Alarm" it will display the following flashing message pop-up.		
5	Briefly press the trip unit's OK button to hold the pop-up and display the message.	OK	
6	Do a long press on the OK button for more than 3 seconds to acknowledge and close the message.		

The voltage monitoring alarms signal an alert is there is a brief variation in the voltage of the electrical network.
In accordance with the IEC 61000-4-30 standard, when the network voltage falls or increases by 5% or more of the nominal voltage during at least one period of the electrical network. A voltage monitoring alarm is generated.

Falls or dips may be caused by a rapid change in load, such as the start of a motor, the switching of heavy loads or a short-circuit.
They can result in an increase in current consumption, which represents an additional load for all electrical equipment and, if prolonged, an increase in operating temperature and, ultimately, a build-up of heat. In the worst-case scenario, this could cause fluctuations in the electrical grid or even a general outage in the electrical grid.

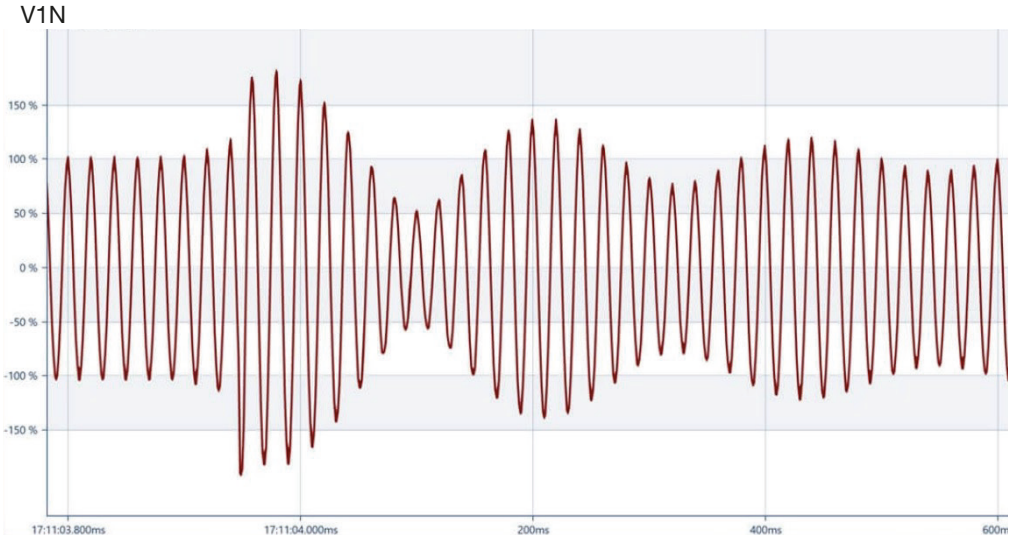
The graphic below shows the typical wave shape of a phase-neutral voltage dip.



Voltage peaks are less common than voltage dips. They can be caused by a ground fault on a single line, which briefly increases the voltage level of the other phases. They can also occur when a heavy load ceases.

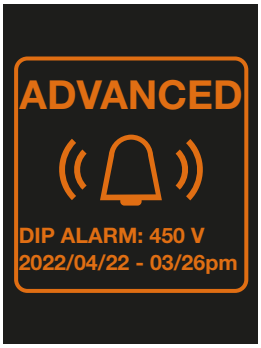
This can cause overheating and result in the stoppage of some equipment. It may also damage electronic devices and other sensitive equipment.

This illustrates the wave shape typical of several phase-neutral voltage peaks also called "voltage swells".

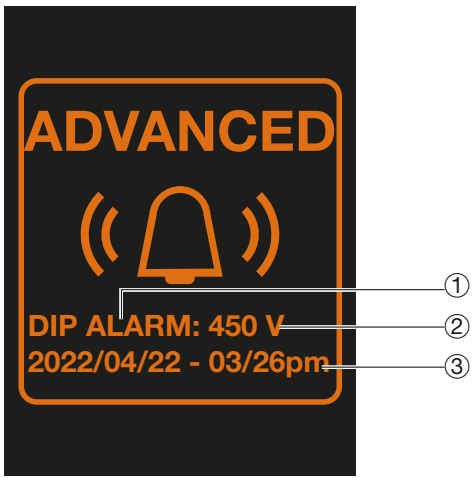


Voltage dip and swell alarms require the message pop-up to be acknowledged.

Message windows on the sentinel Energy display

	Step/Action	Button	Display
1	When voltage dip and swell alarms occur, the following flashing message window is displayed.		
2	Briefly press the trip unit's OK button to hold the pop-up and display the message.	OK	
3	Do a long press for more than 3 seconds to acknowledge and close the message.	OK	

Message meaning



① Alarm type

② tripping threshold value

③ date and time the alarm appeared

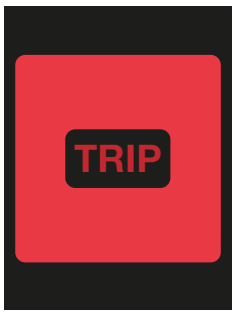
Following a malfunction, the system alarms display a message pop-up on the sentinel Energy display and the panel display as shown below.

They indicate operating faults in the trip unit.
They can be of two types:
- critical: this is a serious malfunction. The trip unit is no longer capable of performing its protection function,
- non-critical: the incident has no effect on the protection function.

Critical system alarms require acknowledgement of the corresponding HWF protection alarm message window according to the setting of the HWF alarm parameter.

Critical system alarms on the sentinel Energy display

Case of HWF alarm set to "Trip"

	Step/Action	Button	Display
1	When the HWF alarm is set to trip, the following flashing message pop-up appears.		
2	Briefly press the trip unit's OK button to hold the pop-up and display the system alarm code generated by the malfunction.	OK	
3	Do a long press on the OK button for more than 3 seconds to acknowledge and close the message after having resolved the trip fault.	OK	

In this example the error E003 is caused by the current sensor L3 being out of service.

Case of HWF alarm set to "Alarm"

	Step/Action	Button	Display
1	When the HWF alarm is set to alarm, the following flashing message pop-up appears.		
2	Briefly press the trip unit's OK button to hold the pop-up and display the system alarm code generated by the malfunction.	OK	
3	Do a long press on the OK button for more than 3 seconds to acknowledge and close the message after having resolved the trip fault.	OK	

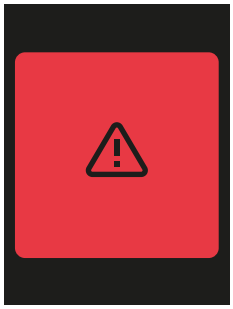
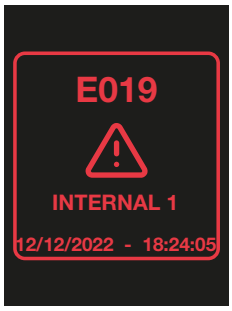
For the meanings of the different critical system alarms, refer to the table below:

Error code	Severity	Meaning	Recommended action
E001	High	L1 current sensor damaged	Contact your Hager representative or local Hager technical support (contact details on the Hager website for your country).
E002	High	L2 current sensor damaged	
E003	High	L3 current sensor damaged	
E004	High	N current sensor damaged	
E005	High	MHT actuator damaged	
E006	High	Critical error 4: faulty hardware board	
E007	High	Critical error 3: faulty hardware board	
E008	High	Critical error 2: corrupted memory	
E009	High	Rating plug damaged	Replace the rating plug.
E010	High	Critical error 5: software error	Contact your Hager representative or local Hager technical support (contact details on the Hager website for your country).
E011	High	Critical error 1: faulty hardware board	
E012	High	Trip unit overheat	Check that the temperature inside the electrical distribution board is not abnormal.

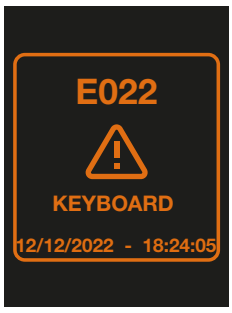
Non-critical system alarms do not require acknowledgement of the message pop-up.

Non-critical system alarms on the sentinel Energy display

Example of an alarm of high severity

	Step/Action	Button	Display
1	Non-critical system alarms of high severity are indicated by the following flashing message pop-up.		
2	Briefly press the trip unit's OK button to hold the pop-up and display the system alarm code generated by the malfunction.	OK	

Example of an alarm of medium severity

	Step/Action	Button	Display
1	Non-critical system alarms of medium severity are indicated by the following flashing message pop-up.		
2	Briefly press the trip unit's OK button to hold the pop-up and display the system alarm code generated by the malfunction.	OK	

In this example, one or more buttons on the keyboard are faulty.

For the meanings of the different non-critical system alarms, refer to the table below:

Error code	Severity	Meaning	Recommended action
E019	High	Internal error 1: microcontroller error	For more information, see the maintenance guide.
E021	Average	Trip unit temperature	Check that the temperature inside the electrical distribution board is not abnormal.
E022	Average	Trip unit key or button faulty	For more information, see the maintenance guide.
E023	Average	Digital Input faulty	Check if the digital input has a fault (cut wire, no power, etc.)
E024	Average	Broken Neutral Pole	Check if a wire in the neutral distribution is broken.
E025	Average	Internal error 2: software error	For more information, see the maintenance guide.
E027	Average	Internal error 3: software error	
E028	Average	Internal error 4: error detecting the open/closed status	
E029	Average	Internal error 5: ENCT sensor error	
E032	Average	Internal error 6: electronic link to the MHT actuator error	
E033	Average	24V DC external power supply lost	Verify the 24V DC external power supply.
E034	Average	Rating plug fault	Replace the rating plug
E035	Average	Internal error 7: circuit breaker configuration error	For more information, see the maintenance guide.
E036	Average	Internal error 8: Bluetooth error	
E040	Average	ZSI input activated	Appears when the trip unit receives the ZSI signal from the downstream circuit breaker.
E042	Average	Internal error 9: circuit breaker/ trip unit compatibility error	For more information, see the maintenance guide.
E100 to E200	Average	Manufacturing fault	Contact your Hager representative or local Hager technical support (contact details on the Hager website for your country).

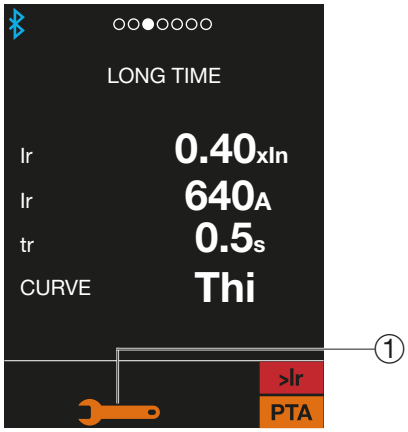
N.B.
Note: the sentinel Energy trip units have a temperature sensor that can protect them from malfunction following overheating of the sensitive internal components. The E021 non-critical system alarm issues an initial alert level when the internal temperature reaches 75°C. Reaching a temperature of 85°C will cause the display to switch off but the trip unit will remain operational until the temperature reaches 90°C which will activate the E012 critical system alarm and will cause the circuit breaker to trip.

ATTENTION
For further information about the meaning of the system alarms, please refer to the Maintenance guides 6LE007897A and 6LE007971A.

Maintenance alarm

The sentinel Energy trip unit has a function for monitoring the operation of the circuit breaker that can provide alerts when a deadline is reached or a trip event occurs requiring a maintenance intervention.

The maintenance alarm indicates the need to perform maintenance operations.
It appears on the sentinel Energy display in the form of an icon in the notification area.



① Maintenance alarm icon

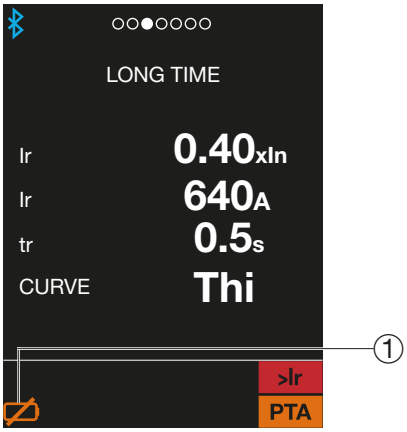
ATTENTION
If the maintenance alarm indicator appears, contact your maintenance manager, Hager Technical Support or refer to the 6LE007897A maintenance guide.

Low or absent back-up battery alarm

The backup battery powers the trip unit's internal clock and the display of the trip alarms after a tripping (if an external 24 V DC power supply is connected the backup battery will not be engaged).

The sentinel Energy trip unit monitors the presence of the backup battery and provides an alert if it detects it is lost due to being missing or having a charge level that is too low.

The low or missing back-up battery alarm appears on the sentinel Energy display in the form of an icon in the notification area.



1 Low or missing battery alarm icon.

ATTENTION
If a low or missing battery alarm appears, check that the backup battery is present and refer to the maintenance guide 6LE007897A.

The OAC output contacts module can be used to signal an event locally.
The OAC contacts are assigned by default to the following events.

Contact	Event
DO1	Long time delay trip
DO2	Grouped alarm (configured in Short time delay, Instantaneous or MCR)
DO3	Tripping of the earth fault protection
DO4	PTA1 overload pre-alarm
DO5	HWF protection tripping (electronic trip unit failure)

Programming the OAC output contacts module allows each of the 5 output contacts to be reassigned to an alarm, trip or operational event.
Here is the list of events available for assignment.

The OAC output contacts module is programmed from the sentinel Energy display or the Hager Power setup software.

⚠ CAUTION

Successive restarts of the sentinel Energy trip unit may cause the output contacts' assignments to be lost.
Check the assignment of the output contacts after the sentinel Energy trip unit is restarted.

Event	Section	Output contact mode
Long time delay trip	Trip	Manual
Short time delay trip	Trip	Manual
Instantaneous trip	Trip	Manual
Tripping of the earth fault protection	Trip	Manual
Tripping of the HWF protection	Trip	Manual
Tripping of the MCR - auto-protection	Trip	Manual
Trip Test	Trip	Manual
UV-27 undervoltage tripping	Trip	Manual
OV-59 overvoltage tripping	Trip	Manual
OF-81H overfrequency tripping	Trip	Manual
UF-81L underfrequency tripping	Trip	Manual
Reverse active power trip RP-32R	Trip	Manual
UNBV-46 current unbalance tripping	Trip	Manual
UNBV-47 voltage unbalance tripping	Trip	Manual
PTA1 overload prealarm	Alarm	Manual/Autoreset/Pulse
PTA2 overload prealarm	Alarm	Manual/Autoreset/Pulse
Overload alarm >Ir	Alarm	Manual/Autoreset/Pulse
HWF alarm (electronic trip unit failure)	Alarm	Manual/Autoreset/Pulse
Maintenance alarm	Alarm	Manual/Autoreset/Pulse
Trip unit temperature alarm	Alarm	Manual/Autoreset/Pulse
Low or missing battery alarm	Alarm	Manual/Autoreset/Pulse
UV-27 undervoltage alarm	Alarm	Manual/Autoreset/Pulse
OV-59 overvoltage alarm	Alarm	Manual/Autoreset/Pulse
UF-81L underfrequency alarm	Alarm	Manual/Autoreset/Pulse
OF-81H overfrequency alarm	Alarm	Manual/Autoreset/Pulse
Reverse active power alarm RP-32R	Alarm	Manual/Autoreset/Pulse
Current unbalance UNBV-46 alarm	Alarm	Manual/Autoreset/Pulse
Voltage unbalance UNBV-47 alarm	Alarm	Manual/Autoreset/Pulse
Custom alarm 1	Alarm	Manual/Autoreset/Pulse
Custom alarm 2	Alarm	Manual/Autoreset/Pulse
Custom alarm 3	Alarm	Manual/Autoreset/Pulse
Custom alarm 4	Alarm	Manual/Autoreset/Pulse
Custom alarm 5	Alarm	Manual/Autoreset/Pulse
Custom alarm 6	Alarm	Manual/Autoreset/Pulse
Custom alarm 7	Alarm	Manual/Autoreset/Pulse
Custom alarm 8	Alarm	Manual/Autoreset/Pulse
Custom alarm 9	Alarm	Manual/Autoreset/Pulse
Custom alarm 10	Alarm	Manual/Autoreset/Pulse
Custom alarm 11	Alarm	Manual/Autoreset/Pulse
Custom alarm 12	Alarm	Manual/Autoreset/Pulse
Broken Neutral Pole	Alarm	Manual/Autoreset/Pulse
Grouped alarm	Alarm	Manual/Autoreset/Pulse
Circuit breaker closing operation	Operation	Manual/Autoreset/Pulse
Circuit breaker opening operation	Operation	Manual/Autoreset/Pulse
Protection profile B in operation	Operation	Manual/Autoreset/Pulse
Advanced protections inhibited	Operation	Manual/Autoreset/Pulse

N.B.
The list of events available depends on the optional functions installed on the rating plug and

on the circuit breaker's configuration. When programming the OAC module only the events for installed functions and the parameters for activated alarms are available.

Grouped Alarm

The Grouped Alarm event allows several events from the list above to be brought together on a single output contact. The contact will switch when at least one grouped alarm event occurs.
The grouped alarm can only be set from the Hager Power setup software.

By default, the grouped alarm brings together the following events.

Event	Type
Short time delay trip	Trip
Instantaneous trip	Trip
Tripping of the MCR - auto-protection	Trip

Adjustment parameters

Source	Source event of the contact signal
Contact	Contact behaviour
Pulse	Pulse duration

Output contacts behaviour

The operating mode of the contacts can be set in one of the following ways.
Manual mode: the return of the contact to the stable state (open contact) requires the corresponding alarm to be acknowledged on the trip unit.
Autoreset mode: The contact returns to its stable state (open contact) when the associated event disappears.
Pulse **mode**: The contact returns to its stable state (open contact) after the pulse time regardless of when the associated event disappears.
Adjustment range for the pulse time: 0.1 to 5 seconds with steps of 0.1.

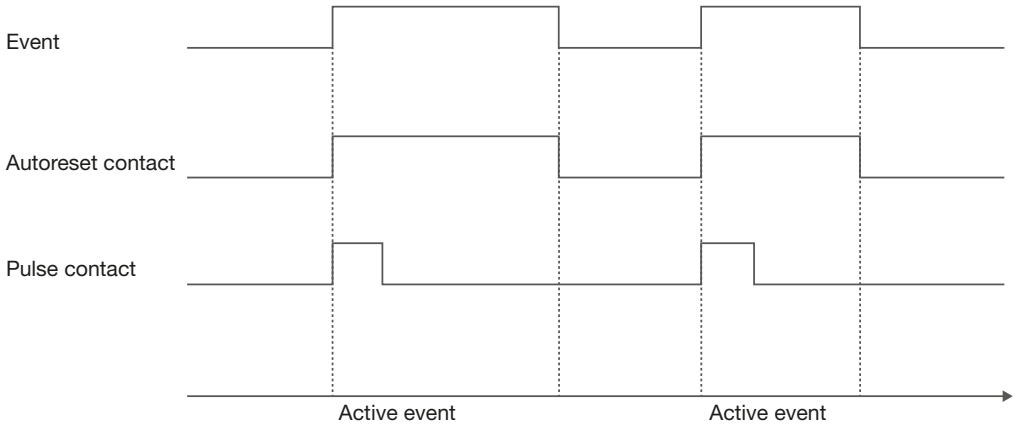
N.B.
The Autoreset or Pulse modes can only be used for events in the Alarm or Operation sections. The Trip section events impose Manual mode on the output contacts, which cannot be changed.

By default the output contacts of the OAC module are configured to the following operating modes.

Contact	Event	Default mode
DO1	Long time delay trip	Manual
DO2	Grouped alarm (configured to Short time delay or Instantaneous trip)	Manual
DO3	Tripping of the earth fault protection	Manual
DO4	PTA1 overload pre-alarm	Autoreset
DO5	HWF protection tripping (electronic trip unit failure)	Manual

Operation of the output contacts in Autoreset or Pulse mode

The following diagram shows the behaviour of a contact in Autoreset or Pulse mode.



Reset of the contacts in Manual mode

The contacts can be reset in Manual mode from the digital input configured to Remote reset.
When an event in the Trip section occurs, the contacts can also be reset by acknowledging the alarm message on the sentinel Energy display.
For an Alarm or Operational event, however, this will be possible only from the digital input.

The Remote reset of the trip unit and output contacts control function allows the alarm pop-up on the trip unit and output contacts to be acknowledged following an event from the Trip, Alarm or Operation section.

The reset command is given from the digital input.

Digital input settings

The digital input settings (RR/DI terminal) are accessible from the CONFIGURATION ⇨ DIGITAL INPUT menu of the sentinel Energy display or from the Hager Power setup software.

It can be set for one of the following control functions:

Remote reset (by default)
If there is a pulse on the RR/DI input, the reset to zero enables the trip alarm pop-up window of the sentinel Energy trip unit to be remotely acknowledged and also allows the D0x contact corresponding to the OAC alarm output contacts module to be reset.

Switching between profile A and profile B
If there is a state change on the RR/DI digital input, the protection profile switches from profile A to B and vice versa.

Switching between tariff meters T1 and T2
If there is a state change on the RR/DI input, the energy tariff metering switches from the T1 meters to the T2 meters.

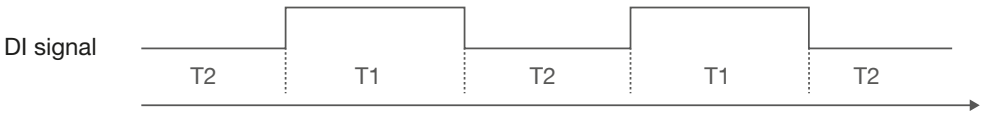
Inhibition of advanced protections
If there is a state transition on the RR/DI input to the high signal,, the inhibition command is applied to the advanced protections configured for the inhibition.

For reset of the output contacts, refer to Chapter 7.10 Programming the OAC module.

The Switch between tariff meters control function allows the metering slot of the multi-tariff energy meters to be switched. It is available after the TARIFF parameter has been activated from the CONFIGURATION ⇨ MEASURES menu of the sentinel Energy display, the panel display or the Hager Power setup software.
The sentinel Energy trip unit offers the possibility of metering the consumption of electrical energy across up to 8 tariff ranges.
See Chapter 6.6 Energy measurement for more information on multi-tariff energy meters.

The switching order between meters can be controlled in two ways:
- from the digital input configured to Tariff for energy meters T1 and T2,
- through Modbus communication for meters T1 to T8.

The following graphic illustrates the switch of tariff range on the digital input.



For information on setting the digital input see Chapter 8.1 Remote reset of the trip unit and output contacts.

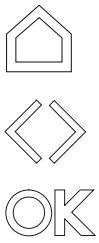
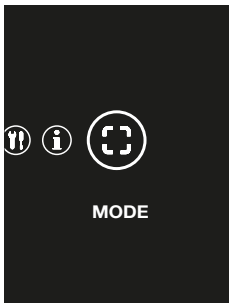
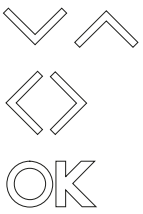
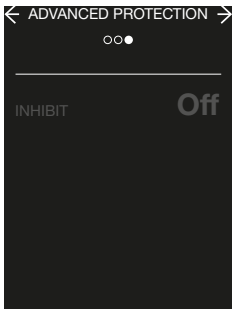
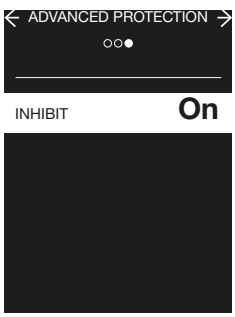
Refer to the sentinel Energy Modbus Communication user manual for management of meters T1 to T8.

The Inhibition control function momentarily deactivates the effect of advanced protection. Only advanced protections with the INHIBIT parameter enabled will receive the inhibition command.

The inhibition can be controlled in three different ways:
- from the digital input configured to Inhibit,
- directly on the sentinel Energy display,
- using the Hager Power setup software,
- via Modbus communication.

For information on setting the digital input see Chapter 8.1 Remote reset of the trip unit and output contacts.

Here is the procedure for using the Inhibition control function on the sentinel Energy display.

	Step/Action	Button	Display
1	Open the Mode menu.		
2	Enter the password.		
3	Select the **ADVANCED PROTECTION** submenu.		
4	Activate the Inhibition function.		

	Step/Action	Button	Display
5	Press OK to confirm the inhibition action.	OK V ^ OK	

The Switch control functions enables the trip unit's operation to be switched between protection profile A and protection profile B. It is available after dual settings are activated and set

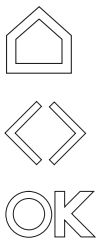
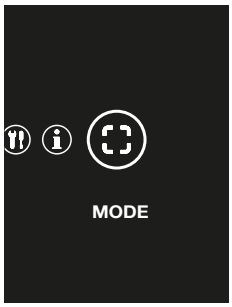
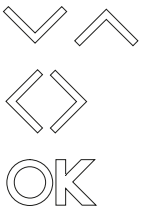
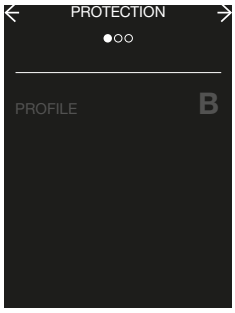
The switching order can be sent remotely via Modbus communication (see sentinel Energy Modbus communication manual).

Switching can also be controlled locally in three different ways:
- from the digital input configured to Profile B,
- directly on the sentinel Energy display,
- using the Hager Power setup software.

For information on setting the digital input see Chapter 8.1 Remote reset of the trip unit and output contacts.

N.B.
An order sent via digital input takes priority over one sent via Modbus communication.

Here is the procedure for controlling switching on the sentinel Energy display.

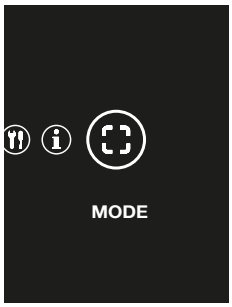
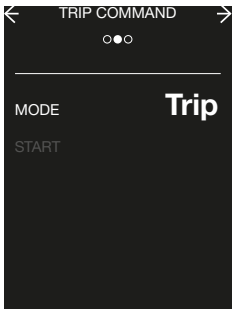
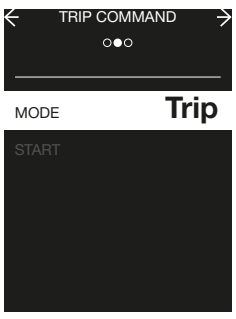
	Step/Action	Button	Display
1	Open the Mode menu.		
2	Enter the password.		
3	Select the PROTECTION submenu. The working profile is displayed.		

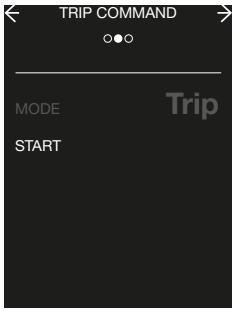
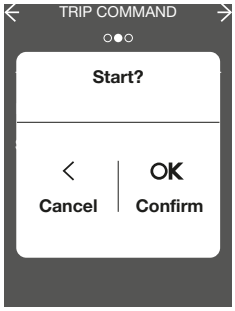
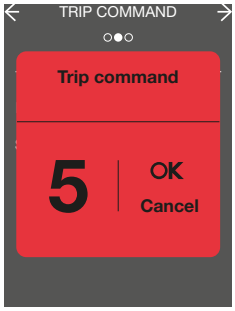
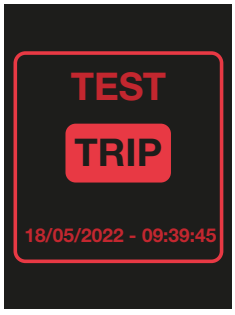
	Step/Action	Button	Display
4	Press OK to change profile. Confirm with OK.	OK OK	

The Forced Tripping control function allows an electromechanical tripping test to be carried out on the circuit breaker.
It is programmed for one of the following two modes:
• Tripping: trip to test the entire electromechanical chain of the tripping of the circuit breaker,
• Without tripping: trip the trip unit only to test the electronic part only.

This function is available directly on the sentinel Energy display or using the Hager Power setup software.

Here is the procedure to carry out a forced tripping on the sentinel Energy display.

	Step/Action	Button	Display
1	Open the Mode menu.		
2	Enter the password.		
3	Select the **TRIP COMMAND submenu.**		
4	Select and validate the mode desired. Trip: electromechanical tripping. No trip: tripping of the trip unit only.		

	Step/Action	Button	Display
5	Start the test.		
6	Confirm with OK.		
7	A 5 s countdown makes it possible to prepare for the tripping. It can be cancelled by pressing OK.		
8	Press and hold the OK button for more than 3 s to acknowledge the message.		

Bluetooth Low Energy communication allows access to the sentinel Energy trip unit from a smartphone running the Hager Power touch application (see Chapter 2.3 Hager Power touch application).
The Bluetooth Low Energy connection is only possible between one sentinel Energy trip unit and a smartphone at the same time.

During the connection, the trip unit is identified by the letters "HG" followed by its serial number.

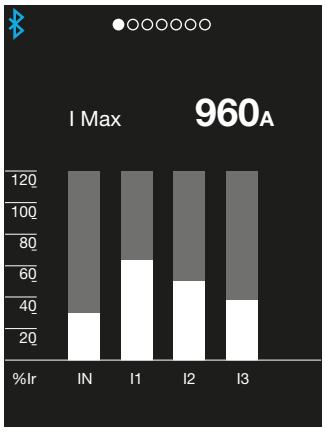
To establish a Bluetooth Low Energy connection, the following conditions must be met:
- the sentinel Energy trip unit must be powered,
- Bluetooth Low Energy communication must be activated on the trip unit,
- you must have a smartphone running the Hager Power touch application,
- you must have access to the trip unit and must be no more than 10 metres away for an optimal connection.

N.B.
The smartphone must be running IOS 13 or Android 7 (or higher).

Activation of the Bluetooth Low Energy communication

Bluetooth Low Energy communication is deactivated by default.
Bluetooth communication can be activated permanently or for a predefined period. In the latter case after there has been no activity for a certain amount of time, the connection will be ended automatically once this period has elapsed and the trip unit's Bluetooth setting is deactivated. The automatic disconnection period is 30 minutes by default and it can be adjusted.

Bluetooth Low Energy communication is shown on the sentinel Energy display by a blue icon.



Bluetooth settings

The protection parameter settings are adjustable from the CONFIGURATION → COMMUNICATION menu on the sentinel Energy display or the Hager Power setup software.

Activation	Activation or deactivation of the Bluetooth Low Energy communication
Timer	Activation or deactivation of the automatic disconnection timer
Time delay	Automatic disconnection period

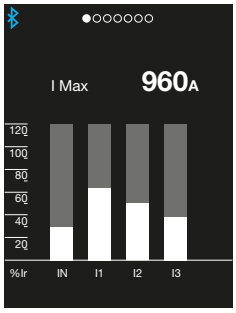
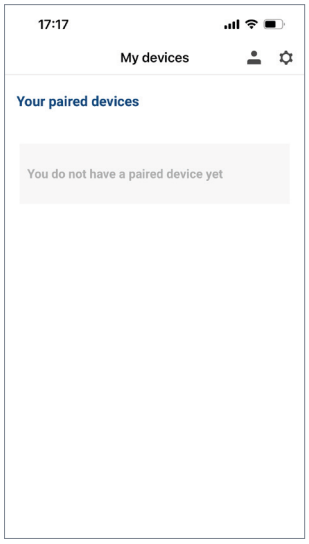
If the timer function is deactivated, Bluetooth communication will be established permanently. To use the automatic disconnection period, activate the Timer and set the time period.

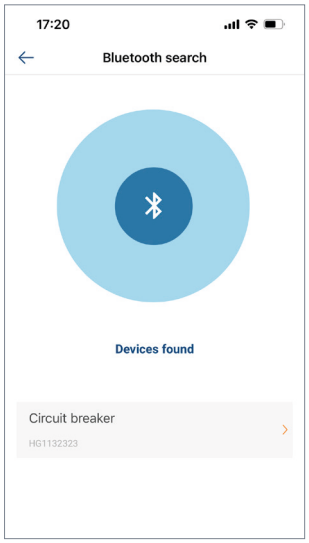
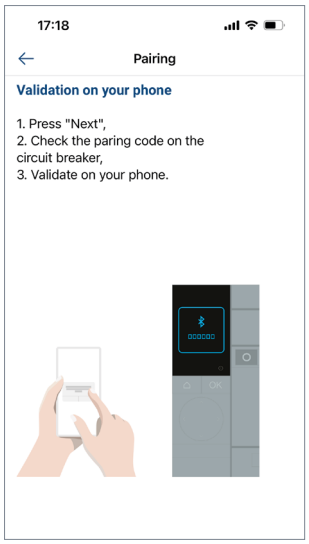
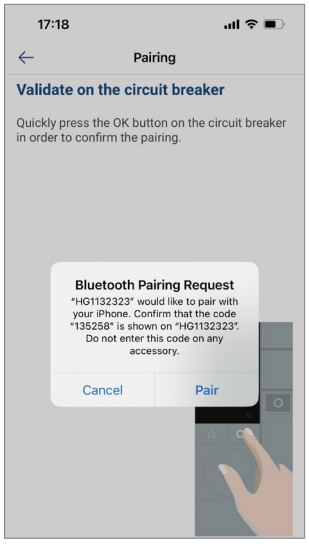
Automatic disconnection period settings page: 1 to 30 minutes in increments of 1.

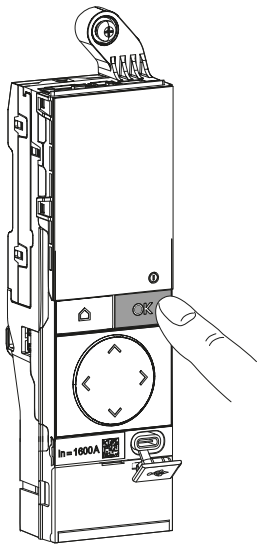
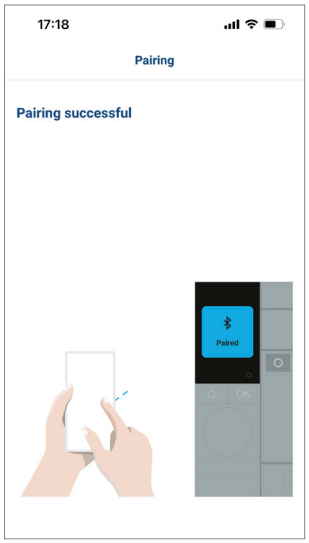
First Bluetooth pairing

You must have access to the OK button on the trip unit during the first Bluetooth pairing. This will not be necessary for subsequent connections.

Establish the first Bluetooth pairing as follows:

	Action	Illustration
1	Verify that the icon occurs on the sentinel Energy display.	
2	Open the Hager Power touch application on the smartphone.	
3	Press the + icon to begin the search for Bluetooth devices from the application.	

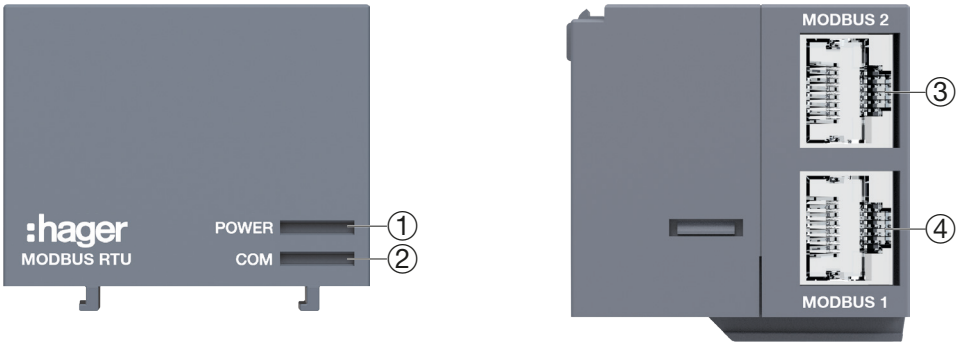
	Action	Illustration
4	Choose the device that corresponds to the circuit breaker desired (example Circuit breaker 1).	
5	Follow the instructions on the smartphone.	
6	Validate the pairing on the smartphone.	

	Action	Illustration
7	Validate the pairing on the trip unit.	
8	End of pairing.	

Modbus-RTU or Modbus-TCP communication enables the following principal functions:
- Reading of status and measurement data,
- Transfer of event history,
- Display and modification of the protection and measurement settings,
- Reading of identification data of the circuit breaker.
- Access to remote controls available on the circuit breaker (opening or closing operation, switching of the protection profiles, inhibition of advanced protections),
- Setting the clock and synchronising it.

For more information on the use of these communication modules, refer to the sentinel Energy Modbus communication user manual.

The Modbus RTU communication module has two RJ45 sockets on the left side. They are used to relay the serial link to other Modbus participants in accordance with the Daisy Chain principle.
The MODBUS 1 and MODBUS 2 plugs can be used in an inlet/outlet direction as well as an incoming/outgoing direction.

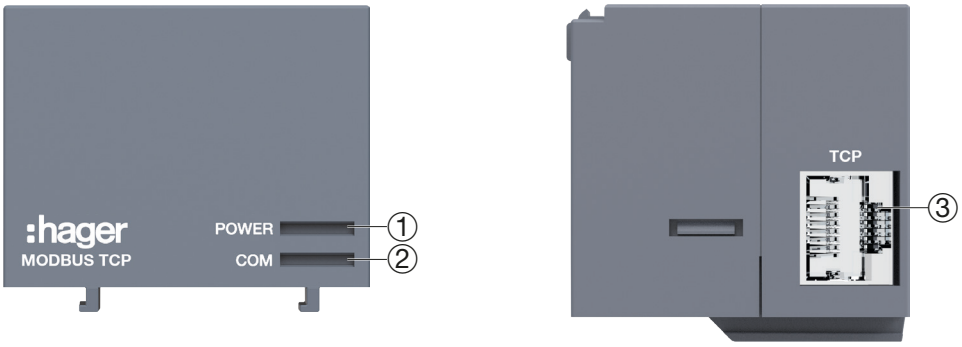


①	Power	Permanent green	Communication module powered and functional
		Flashing green	Synchronisation with the trip unit data
		Flashing red	Internal fault
②	COM	Flashing green	Modbus data transmission
		Flashing red	Modbus transmission failure
③	RTU port	Modbus 1	
④	RTU port	Modbus 2	

N.B.
If an installation includes several Modbus RTU communications modules, it is essential that the last module is connected with a resistor of 120 Ω (reference item HTG467H) to integrate a terminal resistor.

MODBUS RTU	Value	Description
ADDRESS	1 to 247	Modbus address setting
BAUD	4800; 9600; 19200; 38400	BAUD rate setting
PARITY	Odd	1 stop bit
	Even	1 stop bit
	no parity	2 stop bits
STOP BIT	1 or 2	Setting the parity includes automatically managing the automatic adjustment of the number of Stop bits.

The Modbus TCP communication module has one RJ45 socket on the left product side.



①	Power	Permanent green	Communication module powered and functional
		Flashing green	Synchronisation with the trip unit data
		Permanent red	Internal fault
②	COM	Flashing green	Modbus data transmission
		Flashing red	Modbus transmission failure
③	Ethernet port	Modbus 1	

MODBUS TCP	Default value	Description
DHCP	Off	Off: the IP address must be configured manually (static). On: the IP address is assigned automatically by the internet network (dynamic).
IP ADDRESS	172.16.1.1	Enter the unique and fixed IP address corresponding to the network parameter.
SUBNET MASK	255.255.255.0	Enter the subnet mask.
GATEWAY	0.0.0.0	Enter the network gateway.

The Modbus-TCP communication module includes a secure web server (HTTPS) enabling configuration of the IP parameters (static or dynamic configuration), time synchronisation mode and TLS security for the web servers and Modbus TCP/IP servers.

The Modbus TCP/IP protocol can be configured to function without security (default mode) or secured via Modbus TLS.
TLS security allows a Modbus communication tunnel to be established, significantly reducing the risks of intrusion in the context of cybersecurity measures.

The events are categorised by memory section, each of which accepts a maximum event number.
When a section is full (for example Alarm) each new event in the section erases the oldest event in the section.

Memory section	Maximum event number
Trip	50
Alarm	75
Custom alarm	75
Error	30
Diagnostic	20
Operation	75
Protection settings	50
Measurements setting	10
Test	10

Event type

There are two types of event.
- Appearance/end:
  Events with a well-defined start and end, representing the start or end of the status. The appearance and end of the state are each timestamped and recorded in the corresponding section. For example the start and end of an custom alarm are timestamped.
- Instantaneous:
  Events without duration. Only the appearance of the event is timestamped and recorded in the corresponding section. For example, trips are instantaneous events.

Unlocking property

An unlocking property is associated with each event.
- Manual Unlocking:
  The event signalling remains active even if its cause has disappeared until the message has been acknowledged on the sentinel Energy display and the panel display.
- Autoreset Unlocking:
  The event signalling is active while its cause is present. It automatically becomes inactive when its cause disappears.

Severity levels

A severity level is assigned to each event:
- High: corrective action must be implemented immediately,
- Medium: corrective action must be planned,
- Low: for information only.

Only Trip, Alarm, Optional alarm and Error events generate a red or orange alarm pop-up on the sentinel Energy display.

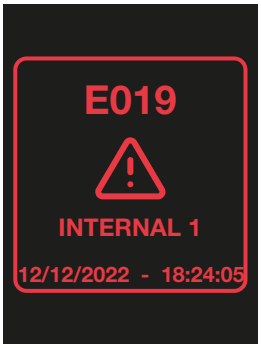
Trip events

Advanced protection alarm events

System alarm events

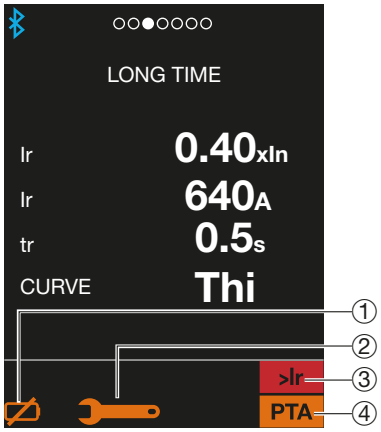
Example system alarm of medium or low severity.

Example system alarm of high severity.



Custom alarm events

Other alarm events



① Low or absent back-up battery alarm

② Maintenance alarm

③ Overload alarm >Ir

④ PTA overload prealarm

All history events can be viewed in the Hager Power setup software.
The Hager Power touch application gives limited access to history events.

Trip and Alarm events can be viewed in the INFORMATION menu of the sentinel Energy display.

All log events are available via Modbus communication (see the sentinel Energy Modbus communication manual).

List of events in the Trip section

No.	Text	Section	Type	Unlock	Severity	Indicated on the display
1	Protection LTD L1	Trip	Instantaneous	Manual	High	Yes
2	Protection LTD L2	Trip	Instantaneous	Manual	High	Yes
3	Protection LTD L3	Trip	Instantaneous	Manual	High	Yes
4	Protection LTD N	Trip	Instantaneous	Manual	High	Yes
5	Protection STD L1	Trip	Instantaneous	Manual	High	Yes
6	Protection STD L2	Trip	Instantaneous	Manual	High	Yes
7	Protection STD L3	Trip	Instantaneous	Manual	High	Yes
8	Protection STD N	Trip	Instantaneous	Manual	High	Yes
10	Protection INST L1	Trip	Instantaneous	Manual	High	Yes
11	Protection INST L2	Trip	Instantaneous	Manual	High	Yes
12	Protection INST L3	Trip	Instantaneous	Manual	High	Yes
13	Protection INST N	Trip	Instantaneous	Manual	High	Yes
9	GF earth fault	Trip	Instantaneous	Manual	High	Yes
20	MCR autoprotection at closing on short circuit fault	Trip	Instantaneous	Manual	High	Yes
23	Undervoltage protection on U12	Trip	Instantaneous	Manual	High	Yes
24	Undervoltage protection on U23	Trip	Instantaneous	Manual	High	Yes
25	Undervoltage protection on U31	Trip	Instantaneous	Manual	High	Yes
26	Undervoltage protection on V1N	Trip	Instantaneous	Manual	High	Yes
27	Undervoltage protection on V2N	Trip	Instantaneous	Manual	High	Yes
28	Undervoltage protection on V3N	Trip	Instantaneous	Manual	High	Yes
29	Overvoltage protection on U12	Trip	Instantaneous	Manual	High	Yes
30	Overvoltage protection on U23	Trip	Instantaneous	Manual	High	Yes
31	Overvoltage protection on U31	Trip	Instantaneous	Manual	High	Yes
32	Overvoltage protection on V1N	Trip	Instantaneous	Manual	High	Yes
33	Overvoltage protection on V2N	Trip	Instantaneous	Manual	High	Yes
34	Overvoltage protection on V3N	Trip	Instantaneous	Manual	High	Yes
35	Underfrequency protection	Trip	Instantaneous	Manual	High	Yes
36	Overfrequency protection	Trip	Instantaneous	Manual	High	Yes
22	Reverse active power protection	Trip	Instantaneous	Manual	High	Yes
37	Current unbalance protection on L1	Trip	Instantaneous	Manual	High	Yes
38	Current unbalance protection on L2	Trip	Instantaneous	Manual	High	Yes
39	Current unbalance protection on L3	Trip	Instantaneous	Manual	High	Yes
40	Voltage unbalance protection on L1	Trip	Instantaneous	Manual	High	Yes
41	Voltage unbalance protection on L2	Trip	Instantaneous	Manual	High	Yes
42	Voltage unbalance protection on L3	Trip	Instantaneous	Manual	High	Yes
15	Forced electromechanical trip test	Trip	Instantaneous	Manual	High	Yes
14	Electronic trip unit HWF failure protection	Trip	Instantaneous	Manual	High	Yes

List of events in Alarm and Optional alarm sections

No.	Text	Section	Type	Unlock	Severity	Indicated on the display
12	PTA1 overload pre-alarm	Alarm	Instantaneous	Autoreset	Average	Yes
13	PTA2 overload pre-alarm	Alarm	Instantaneous	Autoreset	Average	Yes
24	Overload alarm	Alarm	Instantaneous	Autoreset	High	Yes
1	Undervoltage protection alarm	Alarm	Appearance/end	Manual	High	Yes
2	Overvoltage protection alarm	Alarm	Appearance/end	Manual	High	Yes
3	Underfrequency protection alarm	Alarm	Appearance/end	Manual	High	Yes
4	Overfrequency protection alarm	Alarm	Appearance/end	Manual	High	Yes
5	Reverse active power protection alarm	Alarm	Appearance/end	Manual	High	Yes
6	Current unbalance protection alarm	Alarm	Appearance/end	Manual	High	Yes
7	Voltage unbalance protection alarm	Alarm	Appearance/end	Manual	High	Yes
26	Voltage dip alarm	Alarm	Appearance/end	Manual	Average	Yes
27	Voltage swell alarm	Alarm	Appearance/end	Manual	Average	Yes
9	Electronic trip unit HWF failure alarm	Alarm	Appearance/end	Manual	High	Yes
21	Grouped alarm	Alarm	Appearance/end	Autoreset	Average	No
23	Low or missing battery alarm	Alarm	Appearance/end	Autoreset	Average	Yes
25	Maintenance alarm	Alarm	Appearance/end	Manual	Average	Yes
-	Optional alarm (1 to 12)	Custom alarm	Appearance/end	Manual	Average	Yes

List of events in the Error section

No.	Text	Section	Type	Unlock	Severity	Indicated on the display
1	E001: L1 current sensor out of service	Error	Instantaneous	Manual	High	yes*
2	E002: L2 current sensor out of service	Error	Instantaneous	Manual	High	yes*
3	E003: L3 current sensor out of service	Error	Instantaneous	Manual	High	yes*
4	E004: N current sensor out of service	Error	Appearance/end	Manual	High	yes*
5	E005: MHT actuator out of service	Error	Appearance/end	Manual	High	yes*
6	E006: Critical error 4	Error	Appearance/end	Manual	High	yes*
7	E007: Critical error 3	Error	Appearance/end	Manual	High	yes*
8	E008: Critical error 2	Error	Appearance/end	Manual	High	yes*
9	E009: Rating plug damaged	Error	Appearance/end	Manual	High	yes*
10	E010: Critical error 5	Error	Appearance/end	Manual	High	yes*
11	E011: Critical error 1	Error	Appearance/end	Manual	High	yes*
12	E012: Trip unit overheat	Error	Appearance/end	Manual	High	yes*
19	E019: Level 1 internal error	Error	Appearance/end	Autoreset	High	Yes
21	E021: Trip unit temperature	Error	Appearance/end	Autoreset	Average	Yes
22	E022: Trip unit key or button faulty	Error	Appearance/end	Autoreset	Average	Yes
23	E023: Digital Input faulty	Error	Appearance/end	Autoreset	Average	Yes
24	E024: Broken Neutral Pole	Error	Appearance/end	Autoreset	Average	Yes
25	E025: Level 2 internal error	Error	Appearance/end	Autoreset	Average	Yes
27	E027: Level 3 internal error	Error	Appearance/end	Autoreset	Average	Yes
28	E028: Level 4 internal error	Error	Appearance/end	Autoreset	Average	Yes
29	E029: Level 5 internal error	Error	Appearance/end	Autoreset	Average	Yes
32	E032: Level 6 internal error	Error	Appearance/end	Autoreset	Average	Yes
33	E033: 24V external power supply lost	Error	Appearance/end	Autoreset	Average	Yes
34	E034: Rating plug fault	Error	Appearance/end	Autoreset	Average	Yes
35	E035: Level 7 internal error	Error	Appearance/end	Autoreset	Average	Yes
36	E036: Level 8 internal error	Error	Appearance/end	Autoreset	Average	Yes
40	E040: ZSI input activated	Error	Appearance/end	Autoreset	Low	Yes
42	E042: Level 9 internal error	Error	Appearance/end	Autoreset	Low	Yes
100 -	E100 to E200: Manufacturing fault	Error	Appearance/end	Autoreset	Low	Yes

(*) The corresponding error code is notified in the electronic trip unit HWF failure alarm message.

List of events in the Diagnostic section

No.	Text	Section	Type	Unlock	Severity	Indicated on the display
1	Bluetooth communication error	Diagnostic	Instantaneous	Autoreset	Low	No
10	Date and time reset	Diagnostic	Instantaneous	Autoreset	Low	No
9	Trip unit powered by USB-C	Diagnostic	Appearance/end	Autoreset	Low	No
8	Trip unit powered by external 24V power supply	Diagnostic	Appearance/end	Autoreset	Low	No
7	No backup battery detected	Diagnostic	Appearance/end	Autoreset	Low	No
6	History section(s) erased	Alarm	Instantaneous	Manual	High	No
4	Connection to Bluetooth port	Diagnostic	Instantaneous	Autoreset	Low	No
3	Bluetooth communication established	Diagnostic	Instantaneous	Autoreset	Low	No
2	Connection to USB port	Diagnostic	Instantaneous	Autoreset	Low	No
13	Loss of communication with the OAC alarm output contacts module	Diagnostic	Appearance/end	Autoreset	Low	No

List of events in the Operation section

No.	Text	Section	Type	Unlock	Severity	Indicated on the display
59	HWF protection operation	Operation	Instantaneous	Autoreset	Low	No
57	HWF protection start	Operation	Instantaneous	Autoreset	Low	No
58	HWF protection end	Operation	Instantaneous	Autoreset	Low	No
62	Swell detection start	Operation	Instantaneous	Autoreset	Low	No
63	Swell detection end	Operation	Instantaneous	Autoreset	Low	No
60	Dip detection start	Operation	Instantaneous	Autoreset	Low	No
61	Dip detection end	Operation	Instantaneous	Autoreset	Low	No
45	Circuit breaker in Test position	Operation	Instantaneous	Autoreset	Low	No
44	Circuit breaker in Connected position	Operation	Instantaneous	Autoreset	Low	No
43	ZSI output contact GF closed	Operation	Appearance/end	Autoreset	Low	No
42	ZSI output contact STD closed	Operation	Appearance/end	Autoreset	Low	No
41	ZSI input GF activated	Operation	Appearance/end	Autoreset	Low	No
40	ZSI input STD activated	Operation	Appearance/end	Autoreset	Low	No
38	Circuit breaker closed by remote control	Operation	Instantaneous	Autoreset	Low	No
37	Circuit breaker opened by remote control	Operation	Instantaneous	Autoreset	Low	No
32	OAC DO1 contact closed	Operation	Appearance/end	Autoreset	Low	No
33	OAC DO2 contact closed	Operation	Appearance/end	Autoreset	Low	No
34	OAC DO3 contact closed	Operation	Appearance/end	Autoreset	Low	No
35	OAC DO4 contact closed	Operation	Appearance/end	Autoreset	Low	No
36	OAC DO5 contact closed	Operation	Appearance/end	Autoreset	Low	No
31	Trip unit acknowledgement	Operation	Instantaneous	Autoreset	Low	No
30	Circuit breaker closed	Operation	Instantaneous	Autoreset	Low	No
29	Air circuit breaker	Operation	Instantaneous	Autoreset	Low	No
28	Advanced protections inhibition command	Operation	Appearance/end	Autoreset	Low	No
27	Operation on profile B	Operation	Appearance/end	Autoreset	Low	No
26	Forced electromechanical tripping	Operation	Instantaneous	Autoreset	Low	No
20	Reverse active power protection operation	Operation	Instantaneous	Autoreset	Low	No

No.	Text	Section	Type	Unlock	Severity	Indicated on the display
19	Reverse active power protection start	Operation	Instantaneous	Autoreset	Low	No
50	Reverse active power protection end	Operation	Instantaneous	Autoreset	Low	No
18	Overfrequency protection operation	Operation	Instantaneous	Autoreset	Low	No
17	Overfrequency protection start	Operation	Instantaneous	Autoreset	Low	No
49	Overfrequency protection end	Operation	Instantaneous	Autoreset	Low	No
16	Underfrequency protection operation	Operation	Instantaneous	Autoreset	Low	No
15	Underfrequency protection start	Operation	Instantaneous	Autoreset	Low	No
48	Underfrequency protection end	Operation	Instantaneous	Autoreset	Low	No
12	Undervoltage protection operation	Operation	Instantaneous	Autoreset	Low	No
11	Undervoltage protection operation	Operation	Instantaneous	Autoreset	Low	No
46	Undervoltage protection end	Operation	Instantaneous	Autoreset	Low	No
14	Overvoltage protection operation	Operation	Instantaneous	Autoreset	Low	No
13	Overvoltage protection start	Operation	Instantaneous	Autoreset	Low	No
47	Overvoltage protection end	Operation	Instantaneous	Autoreset	Low	No
24	Voltage unbalance protection operation	Operation	Instantaneous	Autoreset	Low	No
23	Voltage unbalance protection start	Operation	Instantaneous	Autoreset	Low	No
54	Voltage unbalance protection end	Operation	Instantaneous	Autoreset	Low	No
22	Current unbalance protection operation	Operation	Instantaneous	Autoreset	Low	No
21	Current unbalance protection start	Operation	Instantaneous	Autoreset	Low	No
53	Current unbalance protection end	Operation	Instantaneous	Autoreset	Low	No
10	Earth fault operation	Operation	Instantaneous	Autoreset	Low	No
9	Earth fault protection start	Operation	Instantaneous	Autoreset	Low	No
56	Earth fault protection end	Operation	Instantaneous	Autoreset	Low	No
7	STD protection operation	Operation	Instantaneous	Autoreset	Low	No
6	STD protection start	Operation	Instantaneous	Autoreset	Low	No
55	STD protection end	Operation	Instantaneous	Autoreset	Low	No
8	INST protection operation	Operation	Instantaneous	Autoreset	Low	No
4	LTD protection operation	Operation	Instantaneous	Autoreset	Low	No
3	LTD protection start (I>112.5% x Ir)	Operation	Instantaneous	Autoreset	Low	No
5	LTD protection end	Operation	Instantaneous	Autoreset	Low	No
64	Erroneous measurement acquisition	Operation	Appearance/end	Autoreset	Low	No

List of events in the Protection setting section

No.	Text	Section	Type	Unlock	Severity	Indicated on the display
2	Ir coefficient setting changed	Protection settings	Instantaneous	Autoreset	Low	No
3	tr setting changed	Protection settings	Instantaneous	Autoreset	Low	No
4	LTD curve type setting changed	Protection settings	Instantaneous	Autoreset	Low	No
5	Isd setting changed	Protection settings	Instantaneous	Autoreset	Low	No
6	tsd setting changed	Protection settings	Instantaneous	Autoreset	Low	No
8	STD i^2t setting changed	Protection settings	Instantaneous	Autoreset	Low	No
9	STD ZSI setting changed	Protection settings	Instantaneous	Autoreset	Low	No
11	INST protection activation changed	Protection settings	Instantaneous	Autoreset	Low	No
10	Ii coefficient setting changed	Protection settings	Instantaneous	Autoreset	Low	No
12	IN protection activation changed	Protection settings	Instantaneous	Autoreset	Low	No
13	IN coefficient setting changed	Protection settings	Instantaneous	Autoreset	Low	No
15	Earth fault protection status changed	Protection settings	Instantaneous	Autoreset	Low	No
16	Ig coefficient setting changed	Protection settings	Instantaneous	Autoreset	Low	No
17	tg setting changed	Protection settings	Instantaneous	Autoreset	Low	No
18	GF i^2t setting changed	Protection settings	Instantaneous	Autoreset	Low	No
19	GF ZSI setting changed	Protection settings	Instantaneous	Autoreset	Low	No
20	Ir PTA 1 coefficient setting changed	Protection settings	Instantaneous	Autoreset	Low	No
21	tr PTA 1 coefficient setting changed	Protection settings	Instantaneous	Autoreset	Low	No
22	Ir PTA 1 coefficient setting changed	Protection settings	Instantaneous	Autoreset	Low	No
23	tr PTA 1 coefficient setting changed	Protection settings	Instantaneous	Autoreset	Low	No
28	Overvoltage protection activation changed	Protection settings	Instantaneous	Autoreset	Low	No
27	Undervoltage protection activation changed	Protection settings	Instantaneous	Autoreset	Low	No
30	Overfrequency protection activation changed	Protection settings	Instantaneous	Autoreset	Low	No
29	Underfrequency protection activation changed	Protection settings	Instantaneous	Autoreset	Low	No
32	Current unbalance protection activation changed	Protection settings	Instantaneous	Autoreset	Low	No
33	Voltage unbalance protection activation changed	Protection settings	Instantaneous	Autoreset	Low	No
31	Reverse active power protection activation changed	Protection settings	Instantaneous	Autoreset	Low	No
24	Remote write access authorised	Protection settings	Instantaneous	Autoreset	Low	No
26	Reset to factory settings	Protection settings	Instantaneous	Autoreset	Low	No
35	Dual settings protection authorised	Protection settings	Instantaneous	Autoreset	Low	No
39	Digital input setting changed	Protection settings	Instantaneous	Autoreset	Low	No
42	HWF setting changed	Protection settings	Instantaneous	Autoreset	Low	No

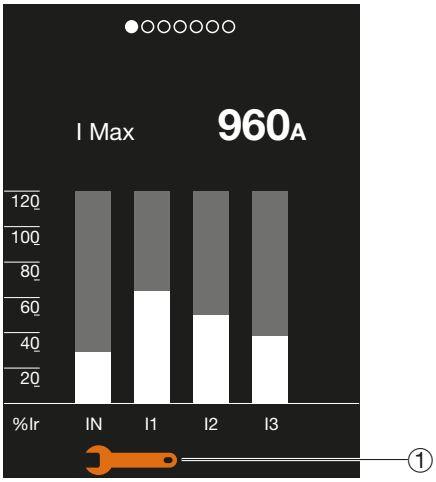
List of events in the Measurements setting section

No.	Text	Section	Type	Unlock	Severity	Indicated on the display
1	Change of optional rating plug	Measurements setting	Instantaneous	Autoreset	Low	No
2	Power sign setting changed	Measurements setting	Instantaneous	Autoreset	Low	No
3	Power factor sign convention setting changed	Measurements setting	Instantaneous	Autoreset	Low	No
4	Phase sequence setting changed	Measurements setting	Instantaneous	Autoreset	Low	No
5	Calculation convention setting changed	Measurements setting	Instantaneous	Autoreset	Low	No
6	Demand mode setting changed	Measurements setting	Instantaneous	Autoreset	Low	No
7	Demand period setting changed	Measurements setting	Instantaneous	Autoreset	Low	No
8	Rated voltage Un setting changed	Measurements setting	Instantaneous	Autoreset	Low	No
9	Rated frequency Fn setting changed	Measurements setting	Instantaneous	Autoreset	Low	No
10	Dip alarm activation authorised	Measurements setting	Instantaneous	Autoreset	Low	No
11	Swell alarm activation authorised	Measurements setting	Instantaneous	Autoreset	Low	No

List of events in the Test section

No.	Text	Section	Type	Unlock	Severity	Indicated on the display
1	ZSI test underway		Appearance/ end	Autoreset	Low	No
2	OAC D01 contact test		Instantaneous	Autoreset	Low	No
3	OAC D02 contact test		Instantaneous	Autoreset	Low	No
4	OAC D03 contact test		Instantaneous	Autoreset	Low	No
5	OAC D04 contact test		Instantaneous	Autoreset	Low	No
6	OAC D05 contact test		Instantaneous	Autoreset	Low	No
7	Trip unit test of the trip curve		Instantaneous	Autoreset	Low	No

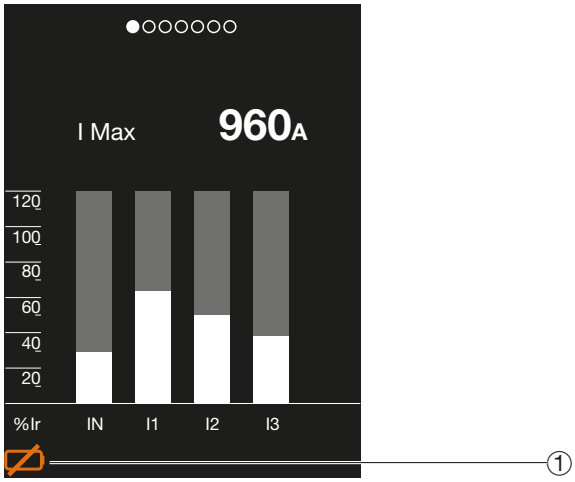
When the maintenance indicator is displayed, maintenance operations are required on the circuit breaker.



① Maintenance indicator

ATTENTION
If the maintenance indicator appears, contact your Hager Technical Support or refer to the maintenance guides 6LE007897A and 6LE007971A.

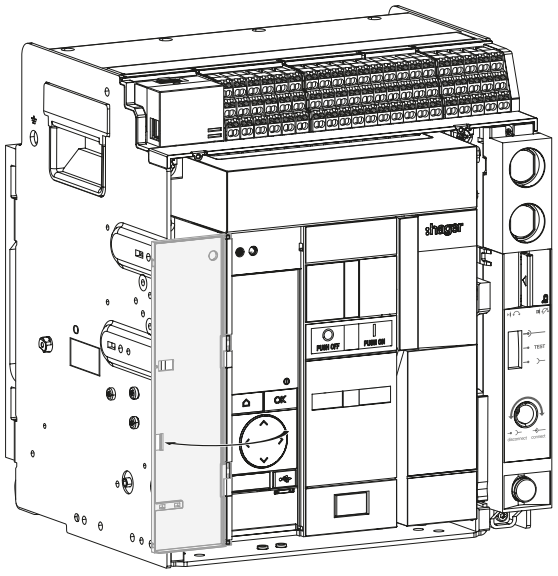
When the low or missing battery icon appears, the sentinel Energy trip unit backup battery must be replaced.

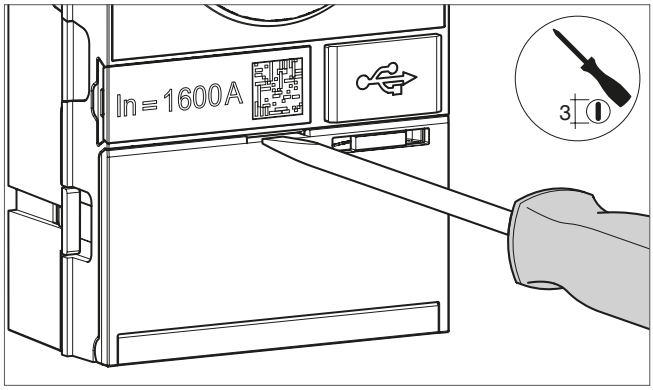
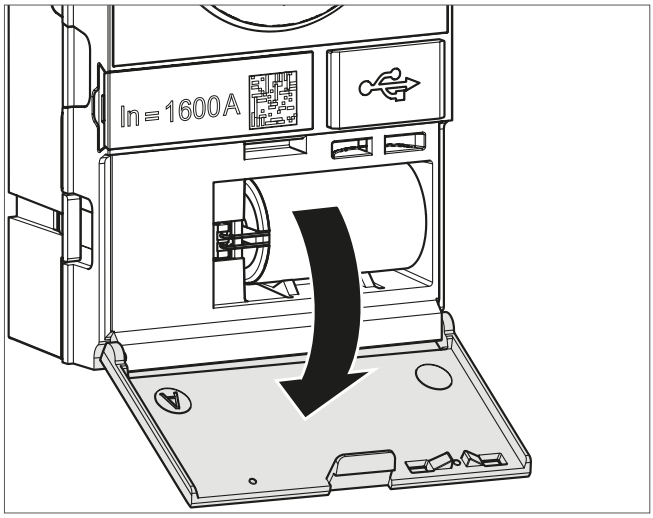
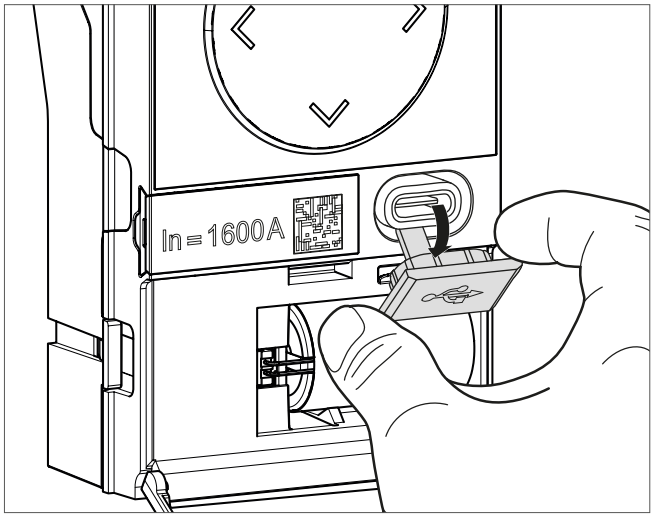


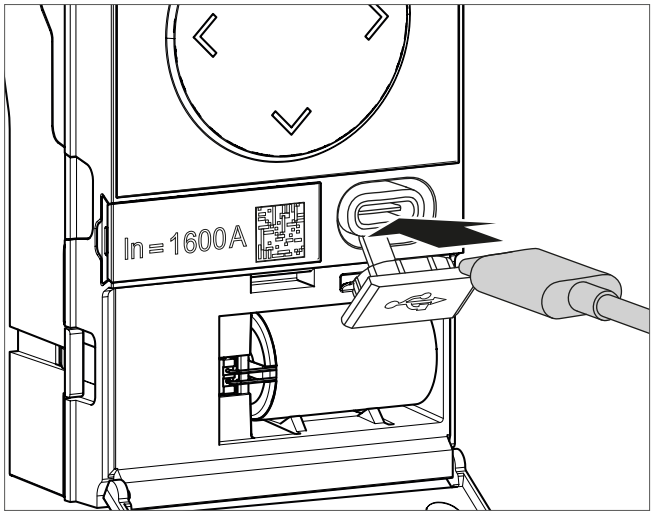
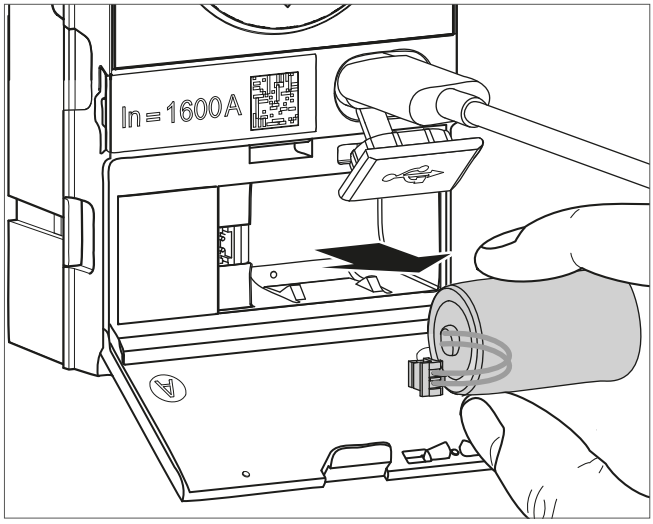
① Low or missing battery icon

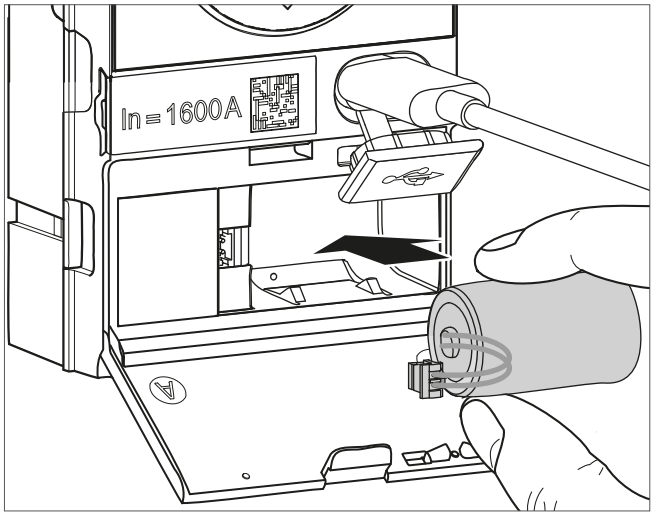
ATTENTION
If the backup battery is discharged, the electronic trip unit will be unable to display the cause of any tripping unless an external 24 V DC SELV power supply is connected or an external battery is connected on the USB-C port of the electronic trip unit.

To do so:

	Action	Illustration
1	If required, remove the seal to open the trip unit transparent door.	

	Action	Illustration
2	Insert a screwdriver into the notch.	
3	Then open the cover.	
4	Remove the USB-C port cover.	

	Action	Illustration
5	Then connect an external battery to the USB-C port to continue powering the electronic trip unit's internal clock.	
6	Remove the old battery.	

	Action	Illustration
7	Replace it with a new battery.	

CAUTION

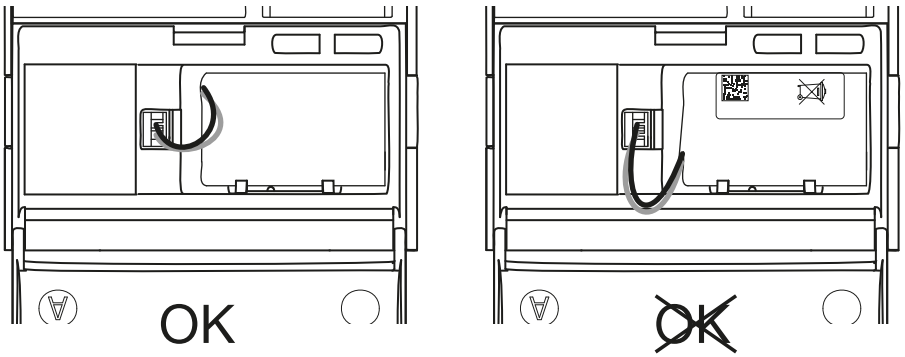
Improper handling may result in a fire or chemical reaction.

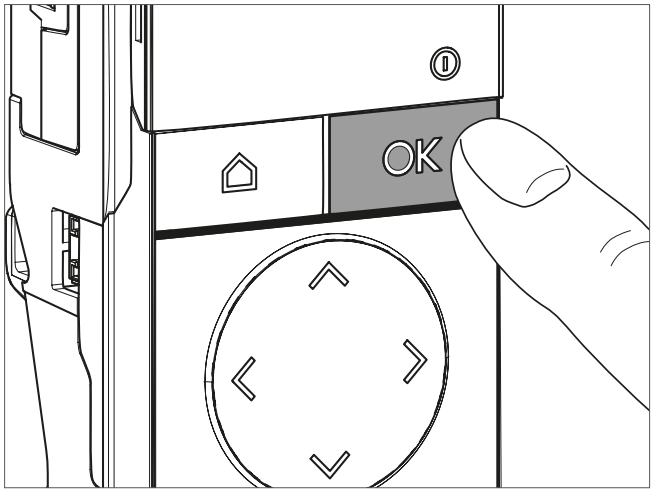
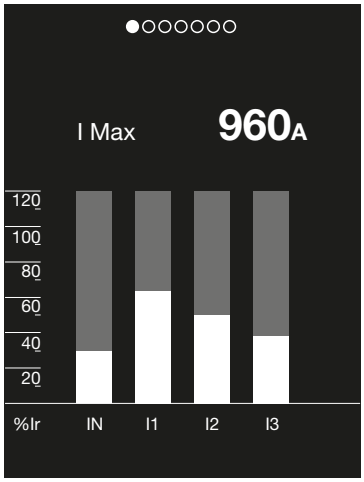
- Do not handle the battery without protection if you detect leaking electrolyte or if heat is given off.
- Place the old battery only in a place intended for recycling.
- To guarantee reliability, personal safety and material security, use only the Hager battery HWW463H, which is available as an accessory.

ATTENTION

Risk of property damage

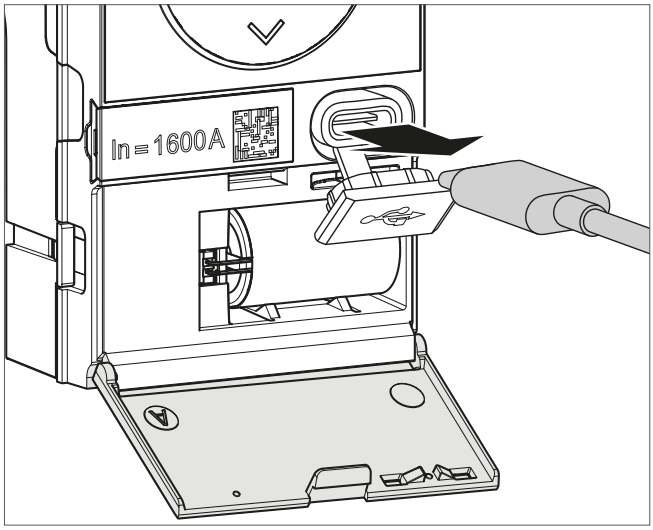
Position the back-up battery and its wiring correctly inside the housing, then close the hatch.

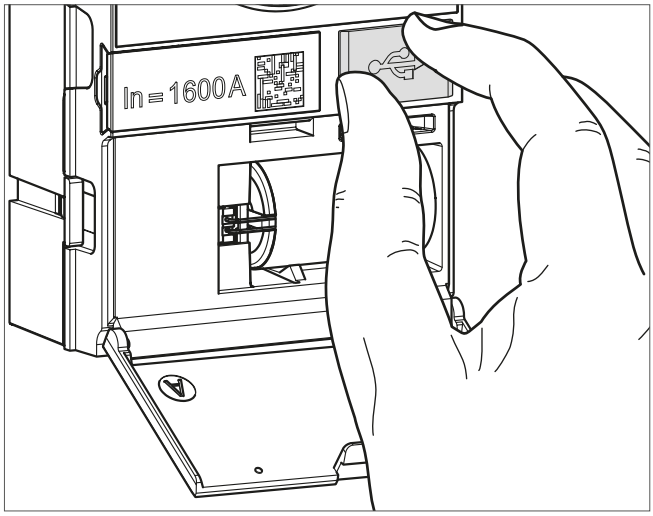
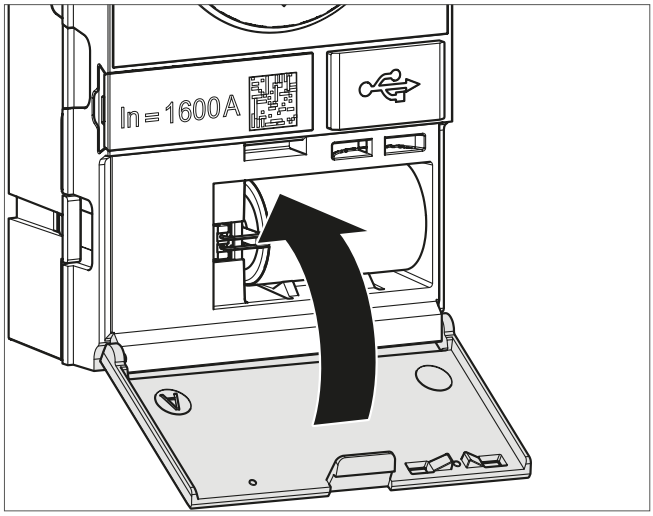
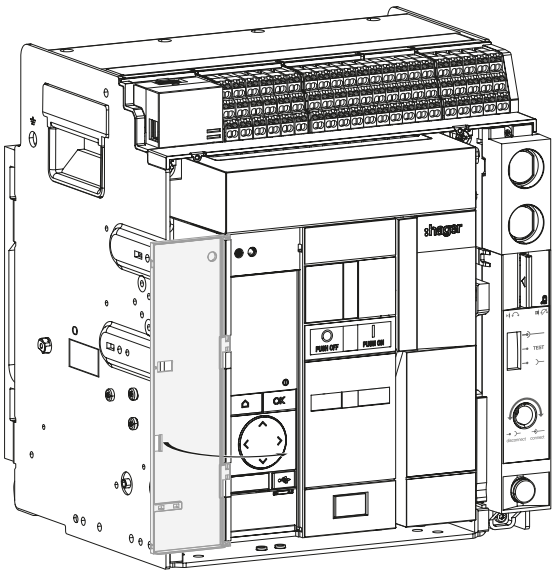


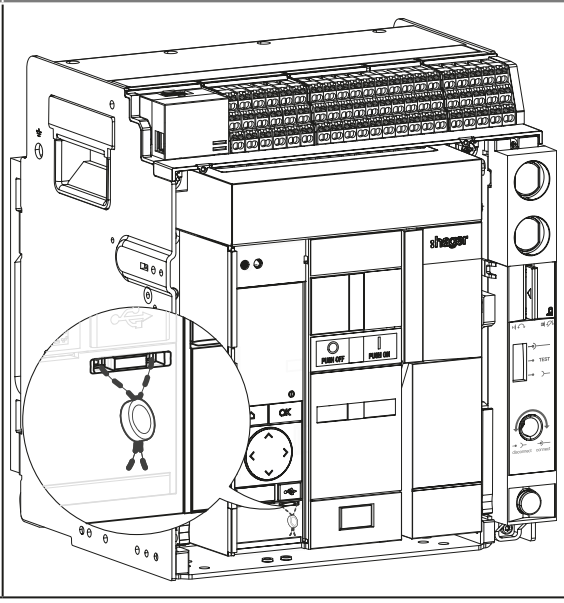
	Action	Illustration
8	check that there is no alarm on the display. Briefly press the OK button to acknowledge the battery low or absent indicator.	
9	Check that the battery low or absent icon disappears after 5 seconds.	

ATTENTION

If an error appears, refer to Chapter 03 hw+ circuit breaker troubleshooting in the 6LE007897A maintenance guide.

10	Remove the external battery.	

	Action	Illustration
11	Close the USB-C port cover.	
12	Close the cover.	
13	Close the transparent cover.	

	Action	Illustration
14	Apply a seal to the cover if necessary.	

The value of the nominal current In can be changed by replacing the rating plug located on the front face of the sentinel Energy trip unit.

Rated current In	Reference of the standard rating plug	Reference of the Meter Plus rating plug	Reference of the Harmonic rating plug	Reference of the Advanced rating plug	Reference of the Ultimate rating plug
400 A	HWW464HSA	HWW664HSA	HWW484HSA	HWW704HSA	HWW724HSA
630 A	HWW465HSA	HWW665HSA	HWW485HSA	HWW705HSA	HWW725HSA
800 A	HWW466HSA	HWW666HSA	HWW486HSA	HWW706HSA	HWW726HSA
1000 A	HWW467HSA	HWW667HSA	HWW487HSA	HWW707HSA	HWW727HSA
1250 A	HWW468HSA	HWW668HSA	HWW488HSA	HWW708HSA	HWW728HSA
1600 A	HWW469HSA	HWW669HSA	HWW489HSA	HWW709HSA	HWW729HSA
2000 A	HWW470HSA	HWW670HSA	HWW490HSA	HWW710HSA	HWW730HSA
2500 A	HWW471HSA	HWW671HSA	HWW491HSA	HWW711HSA	HWW731HSA
3200 A	HWW472HSA	HWW672HSA	HWW492HSA	HWW712HSA	HWW732HSA
4000 A	HWW473HSA	HWW673HSA	HWW493HSA	HWW713HSA	HWW733HSA
5000 A	HWW474HSA	HWW674HSA	HWW494HSA	HWW714HSA	HWW734HSA
6300 A	HWW475HSA	HWW675HSA	HWW495HSA	HWW715HSA	HWW735HSA

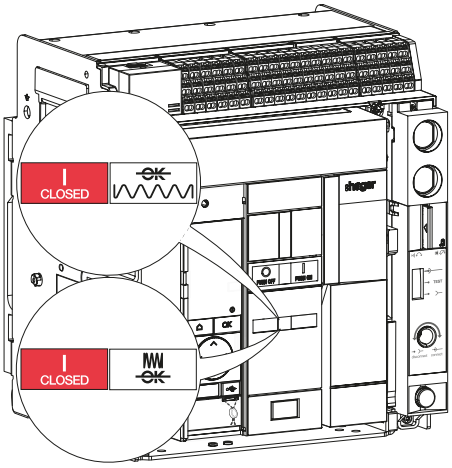
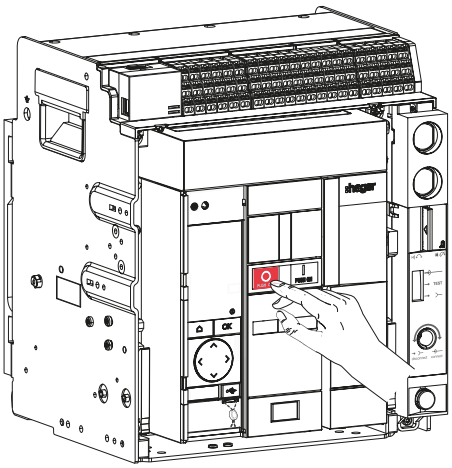
ATTENTION

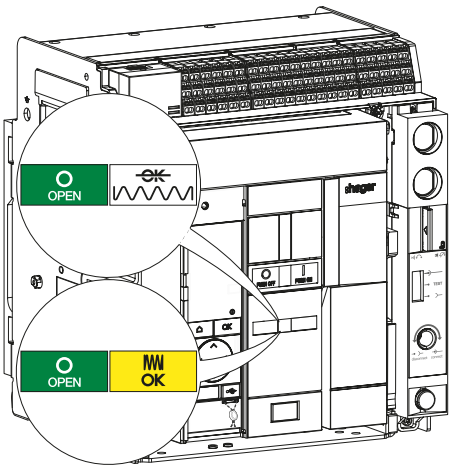
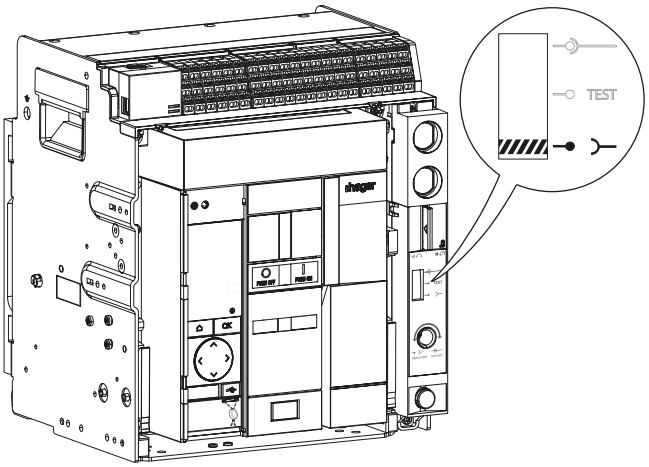
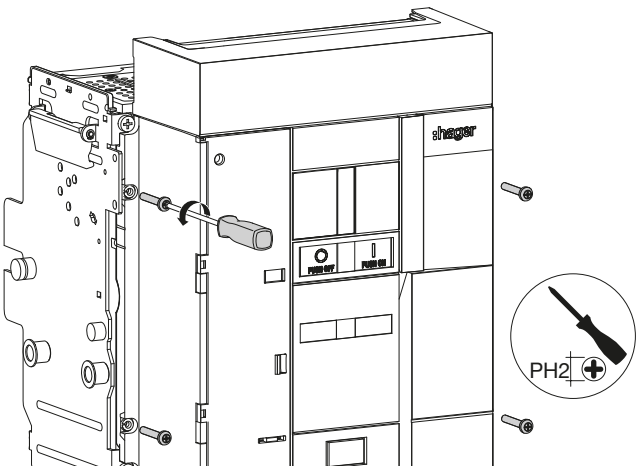
The value In of the rating plug cannot exceed the maximum rated current on the front of the circuit breaker.
The minimum value In of the rating plug depends on the size of the rating plug chosen. It is particularly 400 A for HW1, 630 A for HW2, 1000 A for HW4 and 3200 A for HW6.

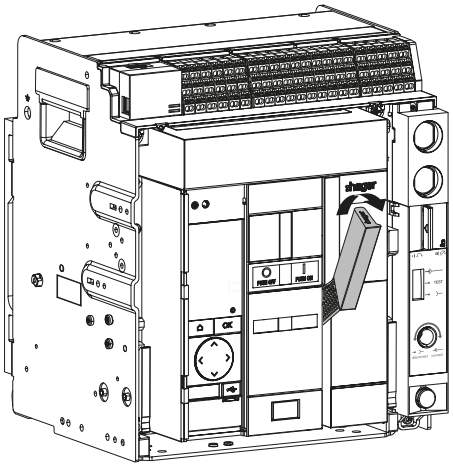
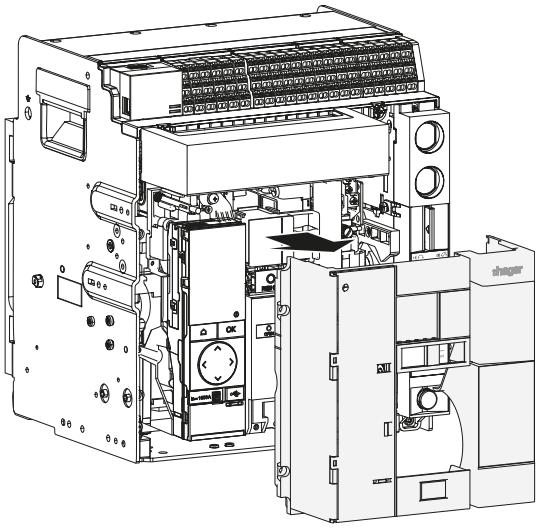
⚠ CAUTION

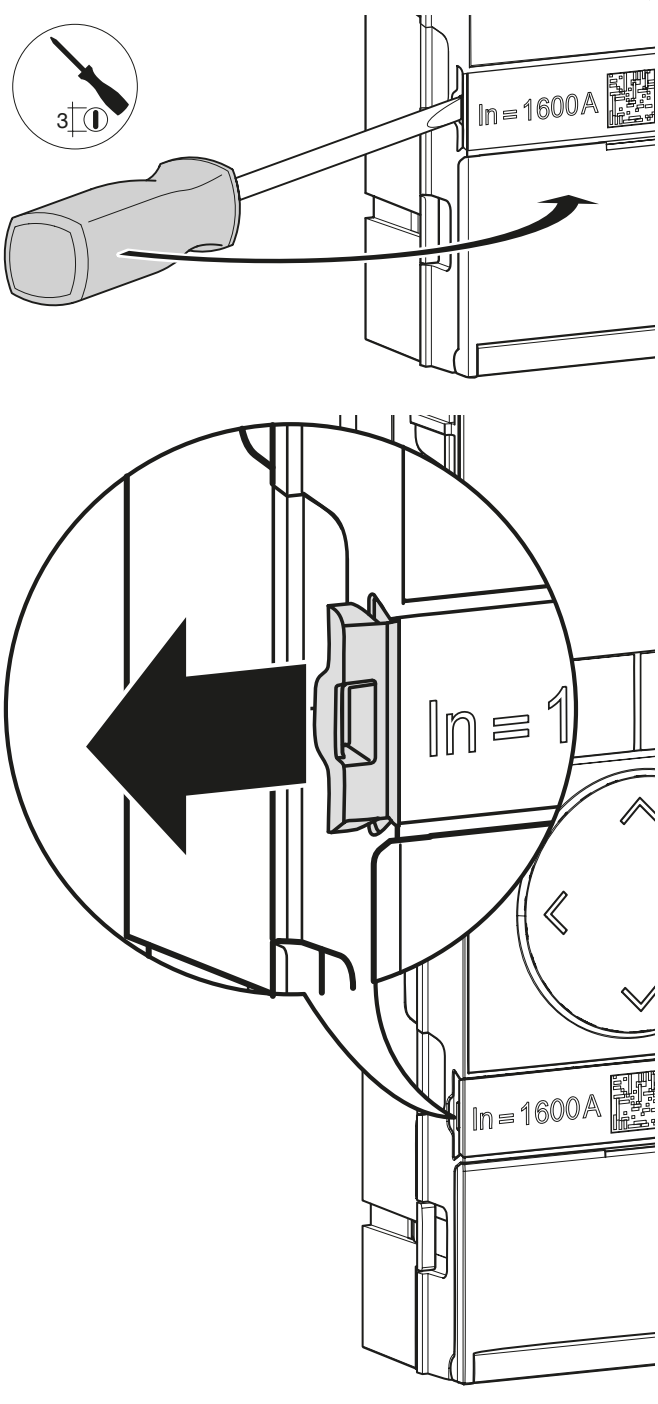
Danger to life, risk of injury due to electric shock, or risk of serious injury.
Before any intervention, ensure that the circuit breaker has been isolated from upstream and downstream power and control sources. Ensure that the MO charging motor is disconnected from its electrical supply.

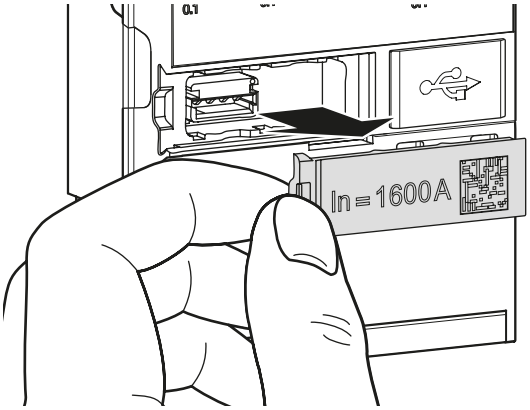
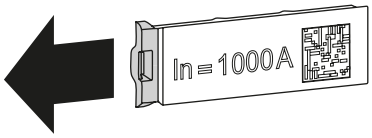
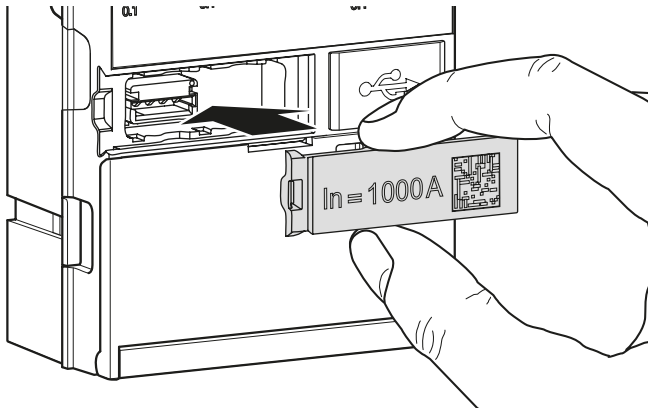
To do so:

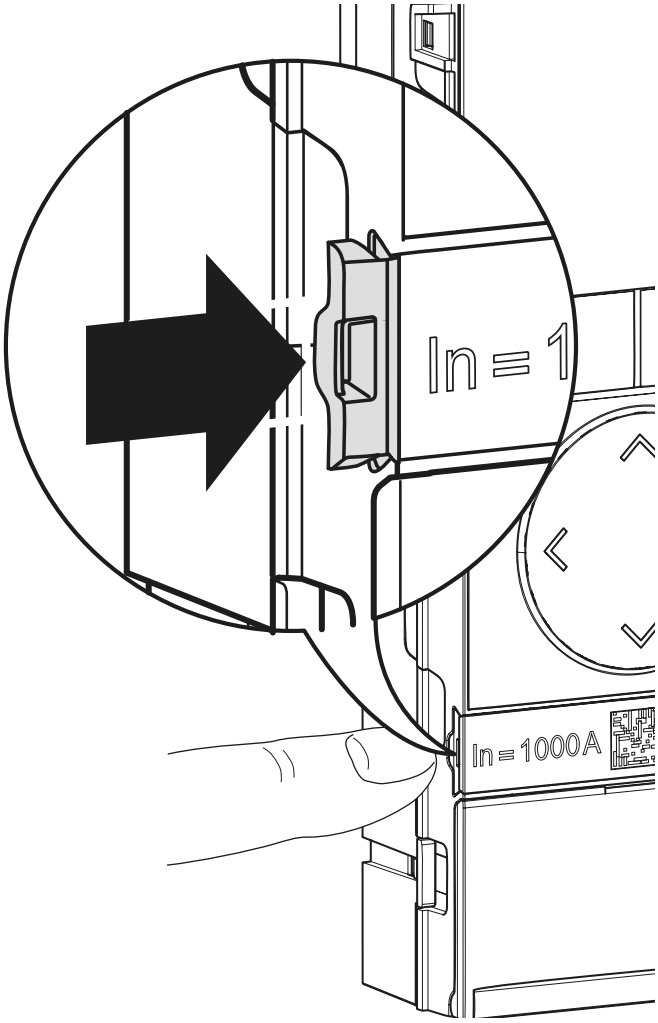
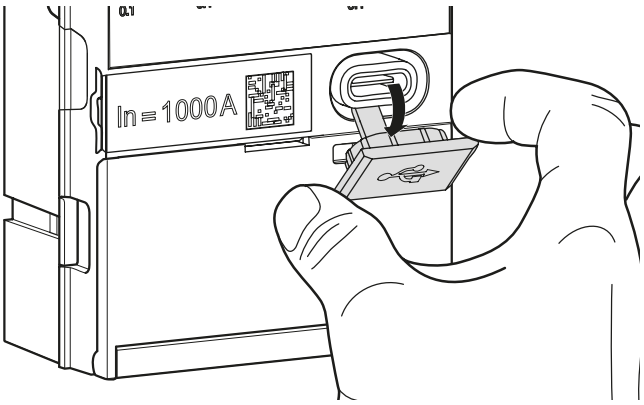
	Action	Illustration
1	The circuit breaker is closed, and the spring is discharged or charged.	
2	Open the circuit breaker by pressing the opening  .	

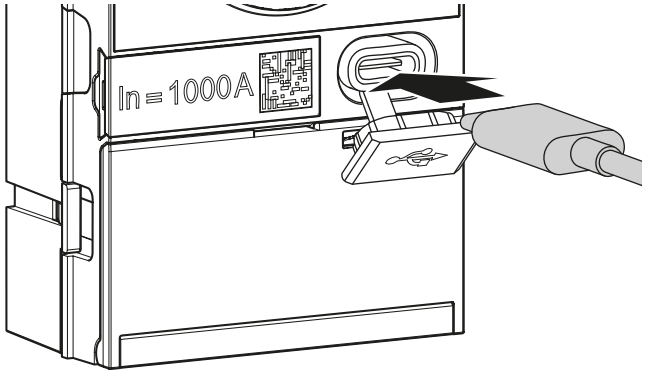
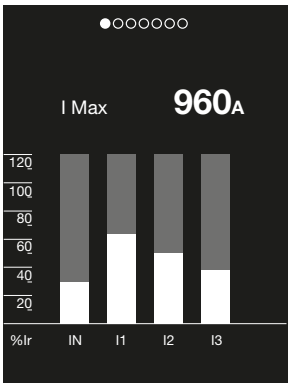
	Action	Illustration
3	check that the indicators change status.	
4	For the drawout circuit breaker, place the circuit breaker in the disconnected position (see Installation Manual 6LE007893A).	
5	If necessary, remove the seal from the transparent cover, which protects access to the trip unit, then unscrew the 4 screws.	

	Action	Illustration
6	Lower the charging handle.	
7	Remove the cover in order to access the trip unit.	

	Action	Illustration
8	Insert a flat screwdriver into the tab then apply leverage to unlock it.	

	Action	Illustration
9	Remove the rating plug.	
10	Pull the tab of the new rating plug to the left.	
11	Insert the rating plug into its housing.	

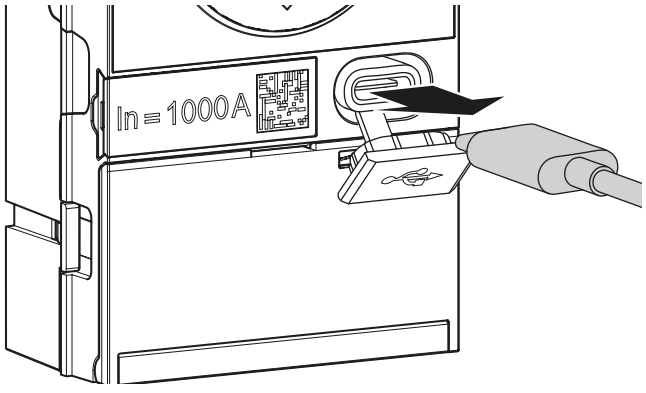
	Action	Illustration
12	Push the lever to the right to lock the rating plug.	
13	Remove the USB-C port cover.	

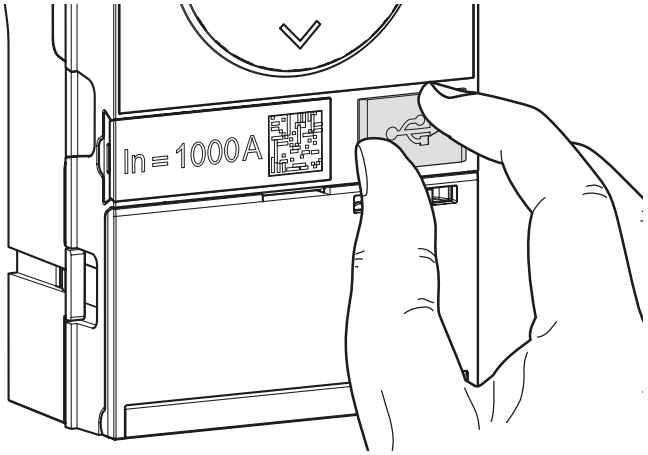
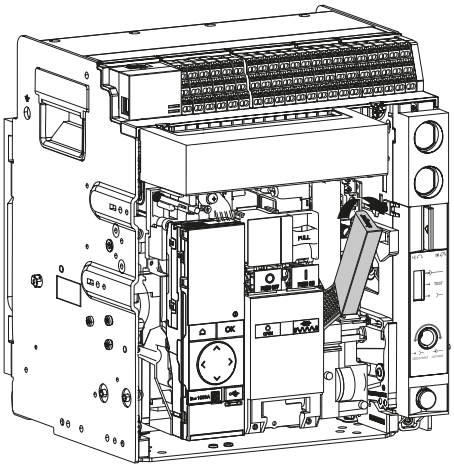
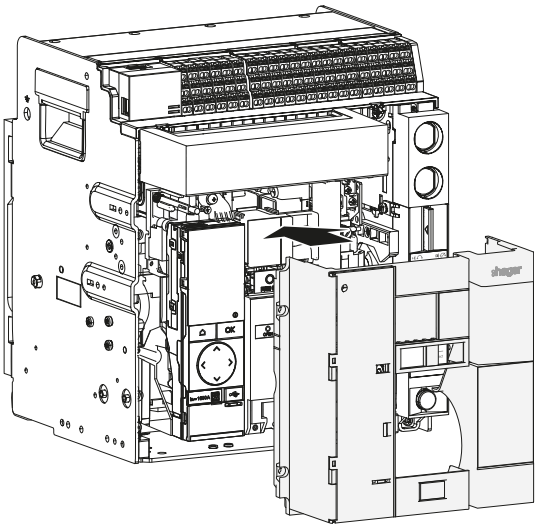
	Action	Illustration
14	Connect the external battery to the USB-C port.	
15	Check that there is no alarm or ReadyToProtect LED on the display.	

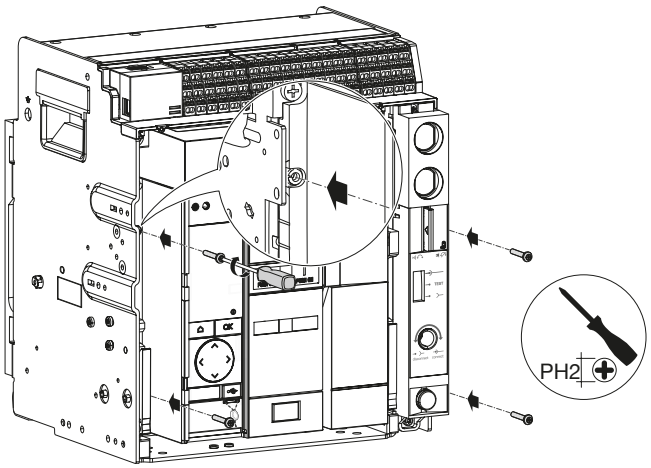
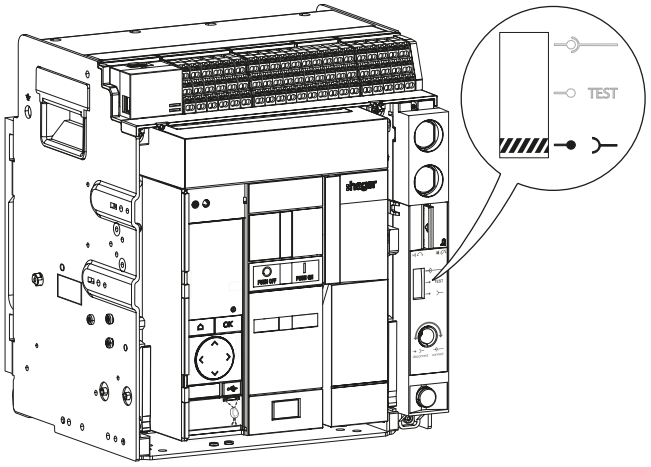
ATTENTION

If one of the following alarms displays, the rating plug is faulty.

Remove the external battery and replace the original rating plug or a new rating plug as described above. If the problem persists, contact your Hager representative or local Hager technical support (contact details for your country can be found on the Hager website).

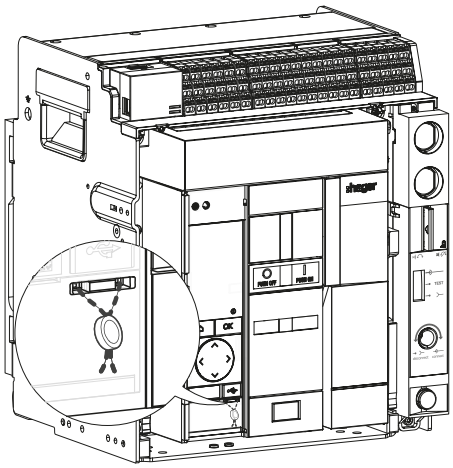
16	Remove the external battery.	

	Action	Illustration
17	Close the USB-C port cover.	
18	Lower the charging handle.	
19	Place the cover back to its position.	

	Action	Illustration
20	Retighten the 4 screws.	
21	For the drawout circuit breaker, place it in the connected position.	

WARNING

Risk of unexpected operation.
Before closing the transparent cover, check the settings.

22	Replace the transparent cover protecting access to the sentinel trip unit if necessary.	

ANSI
American National Standards Institute. Each electrical protection corresponds to an ANSI code.

CIP
Communications interface port with the panel display.

DHCP
Dynamic Host Configuration Protocol. Dynamic Host Configuration Protocol used to manage IP addresses.

ENCT
External neutral current sensor.

ENVA
External neutral potential.

GF
Earth fault protection.

HWF
Internal protection against electronic failures in the trip unit (hardware failure).

INST
Instantaneous Protection.

LTD
Long Time Delay Protection.

MCR
Making Current Release. Automatic instantaneous protection upon closure of the power contacts for short-circuit fault.

MHT
Magnetic Hold trigger. Coil connected directly to the electronic trip unit, which activates the mechanical opening lock of the circuit breaker in case of electrical fault or action by an SH shunt trip coil or UV undervoltage release coil.

OAC
Output alarm contact.

PF
Power factor. Power factor.

Breaking capacity
The value of the prospective current that a switching device is capable of breaking at a stated voltage under prescribed conditions of use and behaviour.
Reference is generally made to the rated ultimate short-circuit (Icu) breaking capacity and to the service short-circuit breaking capacity (Ics).

Rated ultimate short-circuit breaking capacity (Icu)
Expressed in kA, it indicates the maximum breaking capacity of the circuit breaker. It is confirmed by a test sequence O - t - CO (according to IEC 60947-2) at Icu, followed by a test to prove that the circuit is correctly isolated. This test ensures safety for the user.

PTA
Overload pre-alarm.

SNTP
Simple Network Time Protocol. Used by a server managing the date and time of the communication network.

STD
Short Time Delay Protection.

Thi
Thermal image. Default setting of the Long time delay protection in accordance with IEC 60947-2.

ZSI
Zone selectivity.

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