FANOX
Safely protected

SIL-G

Feeder & Generator Protection Relay



KEMA Labs

USER'S MANUAL

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1 INTRODUCTION

Scope:

This manual describes the functions and technical features of Fanox relays. The information included in this document is reviewed regularly, so any correction or improvement will be included in the following revisions.

The right to make technical improvements without notice is reserved.

Conformity:

This product is designed according to IEC60255-1 Standard and it is provided with CE marking. See paragraph 16.4 Standards to analyze the passed EMC and climatic tests.

Technical support: Contact Fanox technical Service: www.fanox.com

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Warranty: Fanox warrants the correct working of the devices under normal use for FIVE (5) YEARS from the date of dispatch.

Safety recommendations: The warning contained in this manual are important to ensure the safety.

CAUTION **Personal injury or property damage can result if precautions are not taken.**

Installation and commissioning must be carried out by qualified personnel. In paragraph 2 the reception, handling, and commissioning processes are explained deeply. Please, follow the instructions.

CAUTION **Settings must be established based on the coordination study. The default values and the examples included in the manual are for educational purposes and they do not be used for real application in any case.**

2 RECEIVING, HANDLING AND INSTALLATION

2.1 Unpackaging

Relays must only be handled by qualified personnel and special care must be taken to protect all their parts from any damage while they are being unpacked and installed.

The use of good illumination is recommended to facilitate the relay visual inspection.

The facility must be clean and dry, and relays should not be stored in places that are exposed to dust or humidity. Special care must be taken if construction work is taking place.

2.2 Receiving of relays

It is necessary to inspect the relay at the time it is delivered to ensure that the relays have not been damaged during transport.

If any defect is found, the transport company and FANOX should be informed immediately.

If the relays are not for immediate use, they should be returned to their original packaging.

2.3 Handling of electronic devices

Relays contain an electronic component that is sensitive to electrostatic discharges.

Just by moving, a person can build up an electrostatic potential of several thousand volts.

Discharging this energy into electronic components can cause serious damage to electronic circuits. It is possible that this damage may not be detected straight away, but the electronic circuit reliability and life will be reduced. This electronic component in the relay is well protected by the metal housing, which should not be removed as the relay cannot be adjusted internally.

If it is necessary to disassemble the electronic component, this must be carried out with care and contact with electronic components, printed circuits and connections must be avoided to prevent an electrostatic discharge that could damage one of the components. If the electronic components are stored outside the metal housing, they must be placed in an antistatic conductive bag.

If it is necessary to open a module, care must be taken to preserve the relay reliability and the duration of the life cycle as designed by the manufacturer, taking the following actions:

- Touch the housing to ensure that you have the same potential.
- Avoid touching the electronic components and handle the module by its edges.
- Remember that everyone who handles the module must have the same potential.
- Use a conductive bag to transport the module.

For more information about how to handle electronic circuits, consult official documents such as the IEC 147-OF.

2.4 Installation, commissioning, and service

The personnel in charge of installing, commissioning, and maintaining this relay must be qualified and must be aware of the procedures for handling it. The product documentation should be read before installing, commissioning, or carrying out maintenance work on the relay.

Personnel should take specific protection measures to avoid the risk of electronic discharge when access is unlocked on the rear part of the relay.

To guarantee safety, the crimp terminal and a suitable tool must be used to meet isolation requirements on the terminal strip. Crimped terminations must be used for the voltage and current connections.

It is necessary to connect the relay to earth through the corresponding terminal, using the shortest possible cable. As well as guaranteeing safety for the personnel, this connection allows high frequency noise to be evacuated directly to earth.

The following checks must be performed before the relay is supplied:

- The rated voltage and polarity.
- The power rating of the CT circuit and the integrity of the connections.
- The power rating of the VT circuit and the integrity of the connections.
- The integrity of the earth connection.

The relay must be used within the stipulated electrical and environmental limits.

NOTE: current transformer circuits: Do not open a live CT secondary circuit. The resulting high voltage could damage the isolation and threaten lives.

2.5 Storage

If the relays are not going to be installed immediately, they must be stored in a dust- and humidity free environment after the visual inspection has been performed.

2.6 Recycling

Before recycling the relay, the capacitors should be discharged through the external terminals. All electrical power sources should be removed before performing this operation to avoid the risk of electrical discharge.

This product must be disposed of in a safe way. It should not be incinerated or brought into contact with water sources like rivers, lakes, etc.

Fanox Electronic, S.L. adheres itself to the 1st additional disposal of the Spanish 11/97 Standard in which it is said that the final user of the containers should give them, properly segregated by materials, to an authorized recovery, recycler, or valuer company.

3 IDENTIFICATION OF THE RELAY

3.1 Ratings / Technical features of the relay

Rated current I_N	1/5 A
Rated voltage U_N:	With VT: 50-130 V (P-P)
	Direct connection: 200-480 V (P-P)
	With voltage sensors: 8 Vrms LEA maximum, 1 MOhm
	5,2 Vrms LEA maximum, 2 MOhm
	16 Vrms LEA maximum, 2 MOhm
	2,8 Vrms LEA maximum, 20 MOhm
Rated frequency	50/60 Hz
Rated auxiliary voltage:	24-48 Vdc (±20%)
	48-220 Vac/dc (48-220 Vdc (±20%) / 48-230 Vac (±15%)
	24-220 Vdc/Vac (24-220 Vdc (±20%) / 100-230 Vac (±15%))
Binary input voltage	24-230 Vdc & Vac
Output contact continuous current	5 A
Maximum operating temperature	+70 ºC
Minimum operating temperature	-40 ºC
Maximum storage temperature	+80 ºC
Minimum storage temperature	-40 ºC
Classification	
IP-Class	IP 54 (Front)
	IP 40 (Top, bottom, left, right and back)
	IP 20 (Terminals)
Mechanical class	1
EMC emission class	A
EMC immunity zone	A
Overvoltage category	III
Pollution degree	2
Insulation type	Functional

4 SUMMARY OF THE MAIN FEATURES

- The SIL-G is a feeder relay with current, voltage and frequency functions for primary and secondary distribution with auxiliary power supply of 24- 230 Vdc/ac, 48-230 Vdc/ac or 24-48 Vdc (depending on model).

- 4 current channels for conventional /1 and /5 current transformers and up to 5 voltage channels with conventional VTs. Depending on the model 6 voltage channels for capacitive and resistive low power voltage sensors (LEAs) are available.

- Capability of measuring up to 1.000 volts when it is connected directly to the low voltage line.

- Metal housing with high electromagnetic compatibility level (EMC) and wide range of operating temperature.

- Protection against decoupling, load shedding and Loss of Main (islanding). Loss of Main (islanding) occurs when part of the public utility network loses connection with the rest of the system. In case this situation is not detected, a network safety hazard can be present if the generator remains connected, since an automatic reconnection of the generator may occur causing damage to the generator and the network. SIL-G relay detects this hazardous situation thanks to its voltage and frequency functions based on the Rate of Change of Frequency (ROCOF) method.

- Signaling and control of the circuit breaker (52 function) and the recloser (79 function).

- The front part of the SIL-G relay is provided with a navigation keypad made of 7 keys (including the RESET key), 6 programmable hot keys that by default are configured: two (2) keys to open and close the CB, two (2) keys to block and unblock the recloser and two (2) keys to put the relay in local or remote mode with their associated three (3) configurable control LEDs. Besides, eight (8) programmable alarm LEDs.

- Arc Flash detection (AFD) with 4 AFD inputs and 4 high-speed outputs available depending on model. This functionality, along with the possibility of having WIFI communication, allows the users to set and configure the relay through Fanox free software and to operate the relay without being present in the installation prioritizing the security.

- In case a CB is manually closed, a switch on to an existing fault may occur. This fault condition is critical if the overcurrent protection function does not clear the fault until the adjusted time delay is finished. It is necessary, in those cases, to clear the fault quickly through the SOTF function.

- To allow the communication, the SIL-G relays are provided with a local micro-USB front port and with remote communication options (ports and protocols) on the rear side:

    - Rear Serial Port (RS485): Modbus RTU, DNP3.0 Serial or IEC60870-5-103 (selectable by general settings).

    - Rear Ethernet Port (RJ45, FO-LC or SFP Cage): Modbus TCP/IP, DNP3.0 TCP/IP, IEC60870- 5-104 or IEC61850 (selectable by general settings) + SNTP Protocol + Web Server.

    - HSR/PRP (RJ45 or SFP Cages): Modbus TCP/IP, DNP3.0 TCP/IP, IEC60870- 5-104 or IEC61850 (selectable by general settings) + SNTP Protocol + Web Server.

- Wireless communication (Wi-Fi) and synchronization through IRIG-B are optional (depending on the model).

- Alarms panel is available.
- The SIL-G is provided with (depending on the model):
    - 8 configurable inputs and 7 configurable outputs.
    - 24 configurable inputs and 7 configurable outputs.
    - 8 configurable inputs and 18 configurable outputs.
    - 16 configurable inputs and 11 configurable outputs.
    - 8 configurable inputs, 7 configurable outputs, 4 AFD inputs, and 4 High-Speed outputs.
    - 8 configurable inputs, 7 configurable outputs, 4 AFD inputs, and 4 High-Speed outputs with high breaking capacity at 24-48Vdc.
- SIL-G is fitted with the demand of power (LDP - Load Data Profiling) with the following characteristics:
    - Number of records: 2160.
    - Circular recording mode.
    - Sampling rate (interval): configurable through communications (1-60 min).
- SIL-G is provided with non-volatile RAM memory in order to store up to 3072 events and the disturbance fault recording (DFR), maintaining date & time thanks to its internal RTC (real Time Clock). The configurable options are:
    - 5 records in data and COMTRADE format (300 cycles each record): 1 to 8 pre-fault cycles + 292 to 299 postfault cycles.
    - 25 records in data and COMTRADE format (60 cycles each record): 1 to 8 pre-fault cycles + 52 to 59 postfault cycles.
    - 50 records in data and COMTRADE format (30 cycles each record): 1 to 8 pre-fault cycles + 22 to 29 postfault cycles.
    - 100 records in data and COMTRADE format (15 cycles each record): 1 to 8 pre-fault cycles + 7 to 14 postfault cycles.
- Each oscillographic record contains 10 analog channels and up to 96 configurable digital channels. The oscillography is downloaded by the communications port. The SICom communications program allows the oscillography record to be downloaded and saved in COMTRADE format (IEEE C37.111-1991).

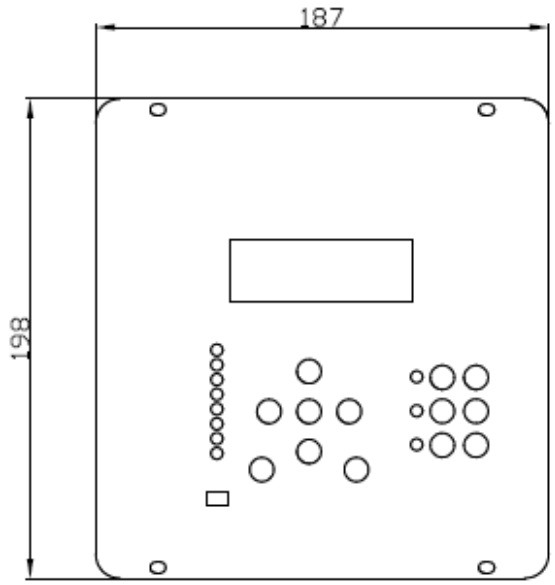
5 DIMENSIONS AND CONNECTION DIAGRAMS

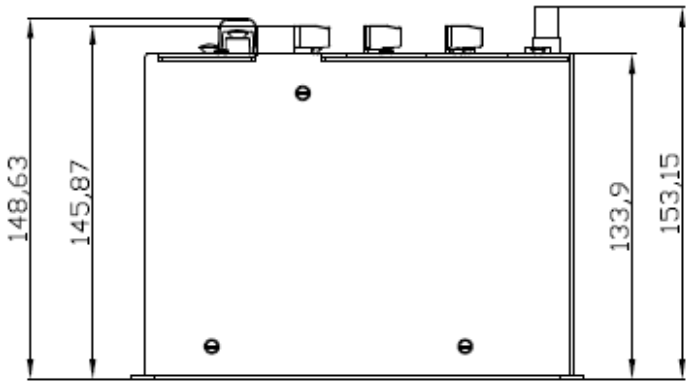
5.1 Relay front view

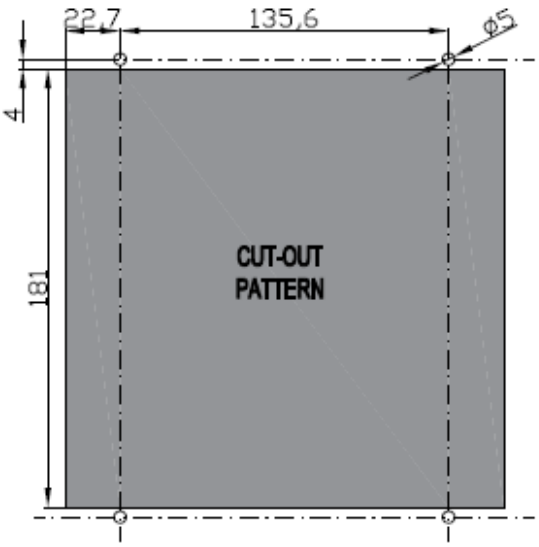


5.2 Relay dimensions

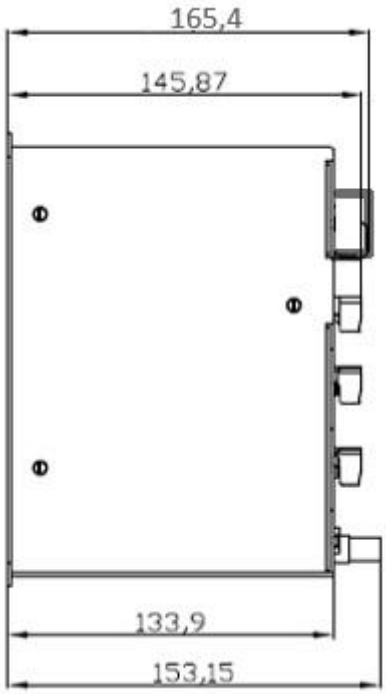
NOTE 1: The dimensions are in “mm”. **NOTE 2:** The required screws to fix the relay should be M4.





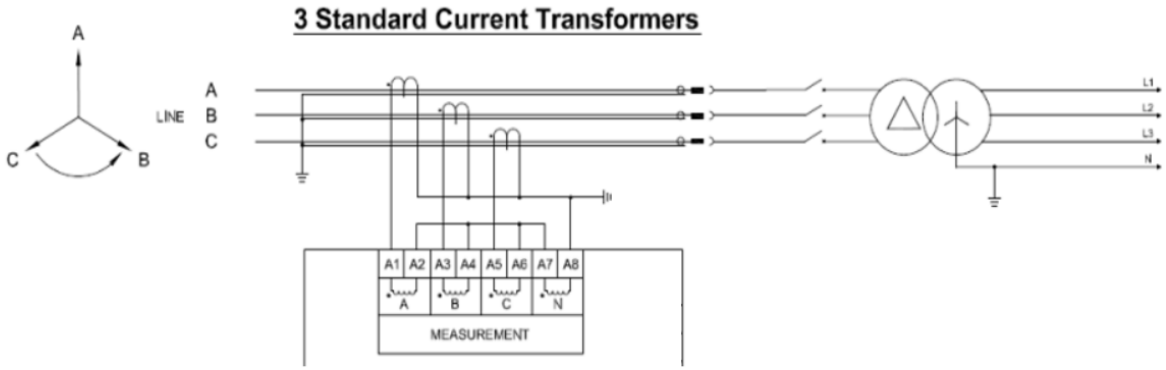


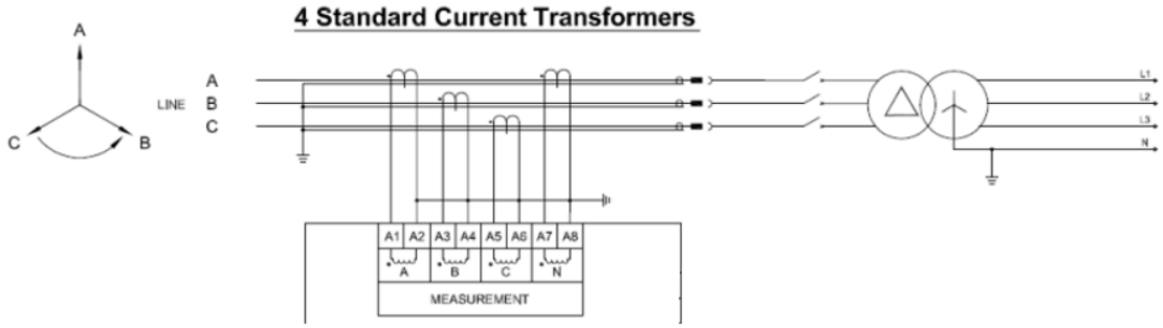
From fw version 3.01.00 onwards, a short-circuitable terminal is available for model SILG1xxxxxxxxB. Note that this model is only available with a /1 secondary.



5.3 Connection diagrams

5.3.1 Analog current connections





5.3.2 Analog voltage connections

In the SIL-G relay it is important to consider the connection type is configurable by the user. Depending on model the following options are available:

SIL-Gxxxx0xxxxx (without ANSI 25): (Un = 50-130 V)

3 VT Phase-Neutral configuration.

3 VT Phase-Neutral configuration + residual voltage.

3VT Phase-Phase configuration.

3VT Phase-Phase configuration + residual voltage.

2VT Phase-Phase configuration + residual voltage.

Connecting the relay directly to Low Voltage line (Un = 200-480 V)

Phase to phase configuration.

SIL-Gxxxx1xxxxx (with ANSI 25): (Un = 50-130 V)

3 VT Phase-Neutral configuration + Phase B line voltage.

3 VT Phase-Neutral configuration + residual voltage + Phase B line voltage.

3VT Phase-Phase configuration + residual voltage + Phase B line voltage.

2VT Phase-Phase configuration + residual voltage + Phase B line voltage.

If phase to phase connection is selected, the line functions will be base in phase-phase nominal voltage. However, for the synchronism, as only one channel is available in the line side, phase-neutral measurements are considered.

SIL-Gxx(1,2,3,4)xxxxxxx: voltage sensors (LEAs)

If the voltage connection is done through sensors, the connection is always phase-neutral.

6 voltage inputs are available. Depending on the user's needs the connections can be as follows:

3 Voltage sensors + 4 standard current transformers.

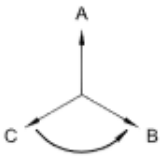
4 Voltage sensors + 4 standard current transformers.

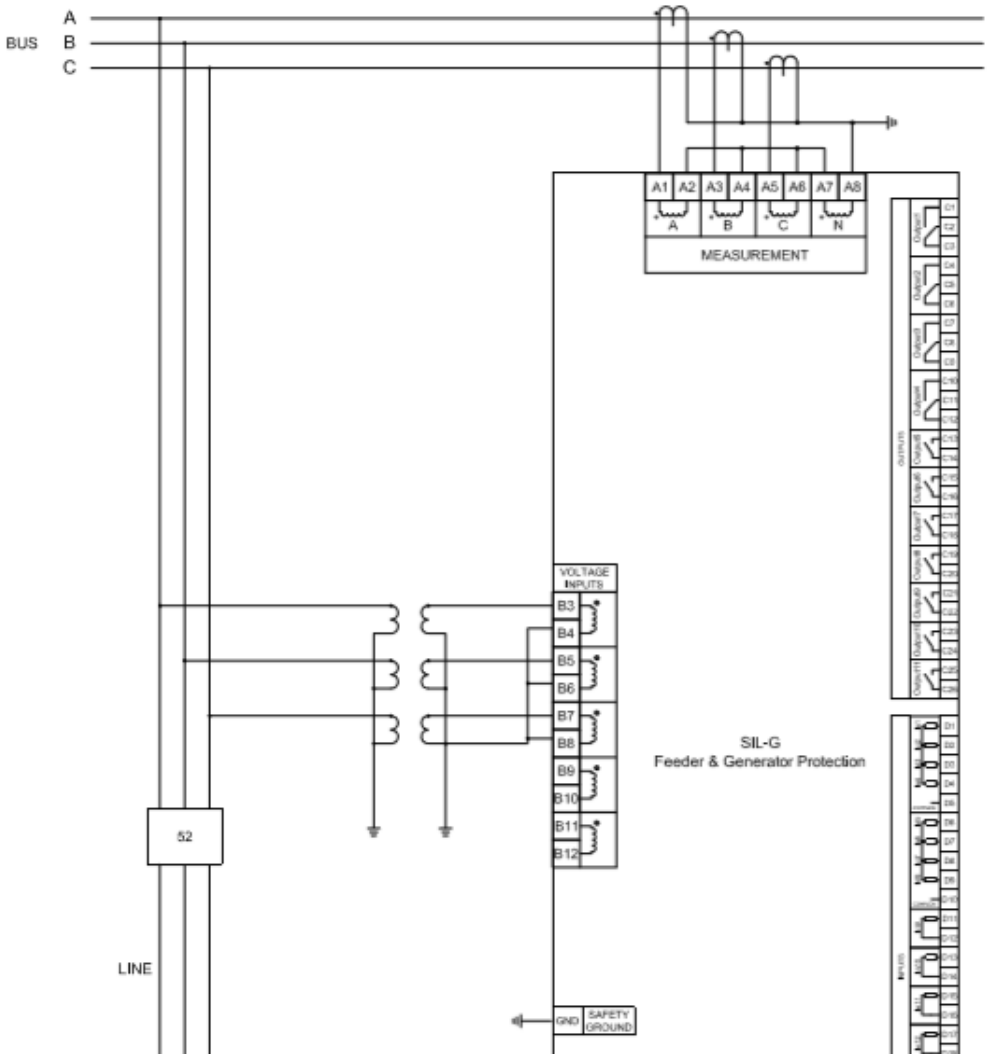
6 Voltage sensors + 3 standard current transformers.

The neutral voltage is internally calculated by the relay.

(*) In the following connections diagrams, 16 Inputs and 11 Outputs are included, but other possibilities are available in the selection and ordering codes.

3 VT configuration (phase-neutral)





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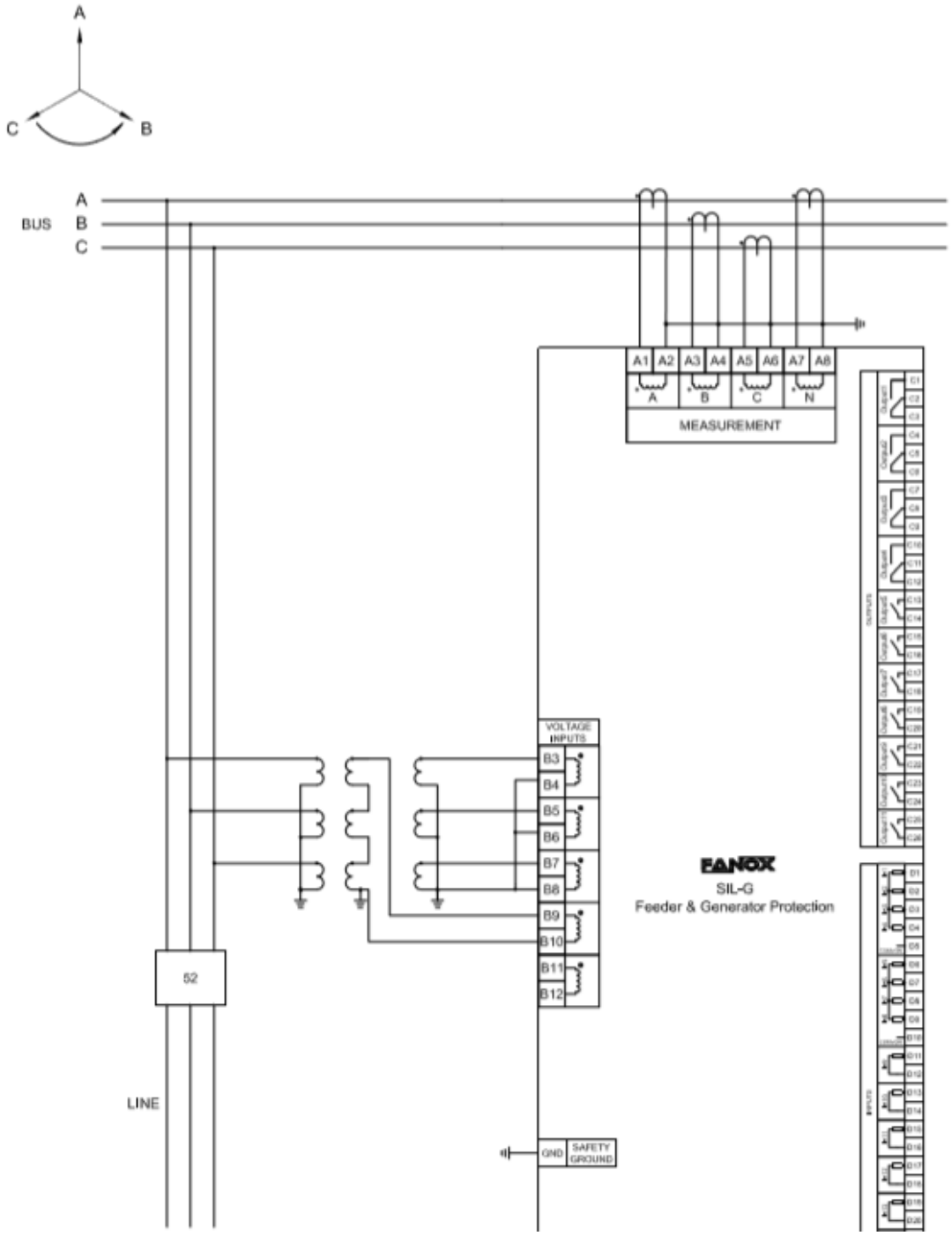
3 VT configuration (phase-neutral) + residual voltage



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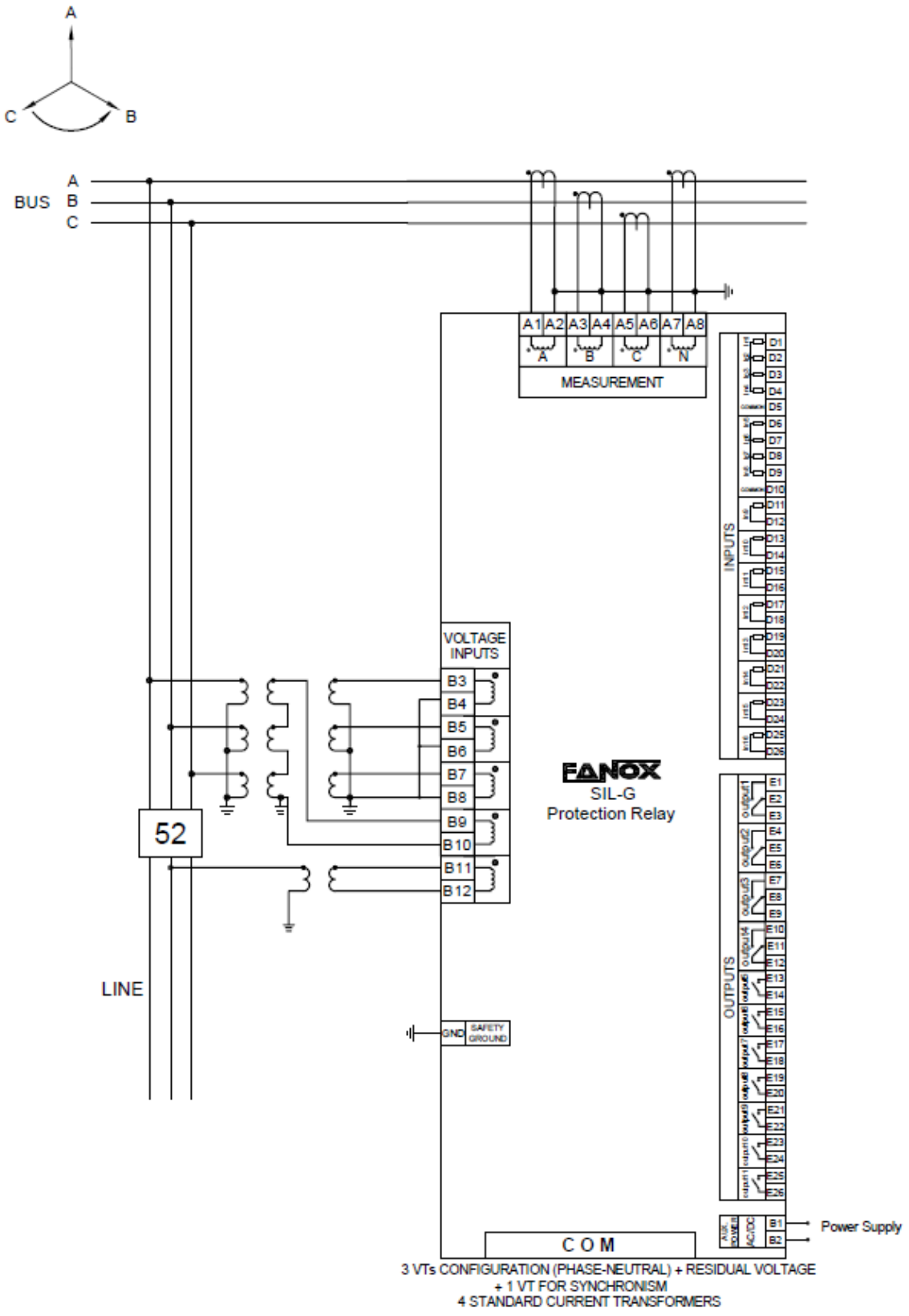
3 VT configuration (phase-neutral) + residual voltage + 1 VT for synchronism



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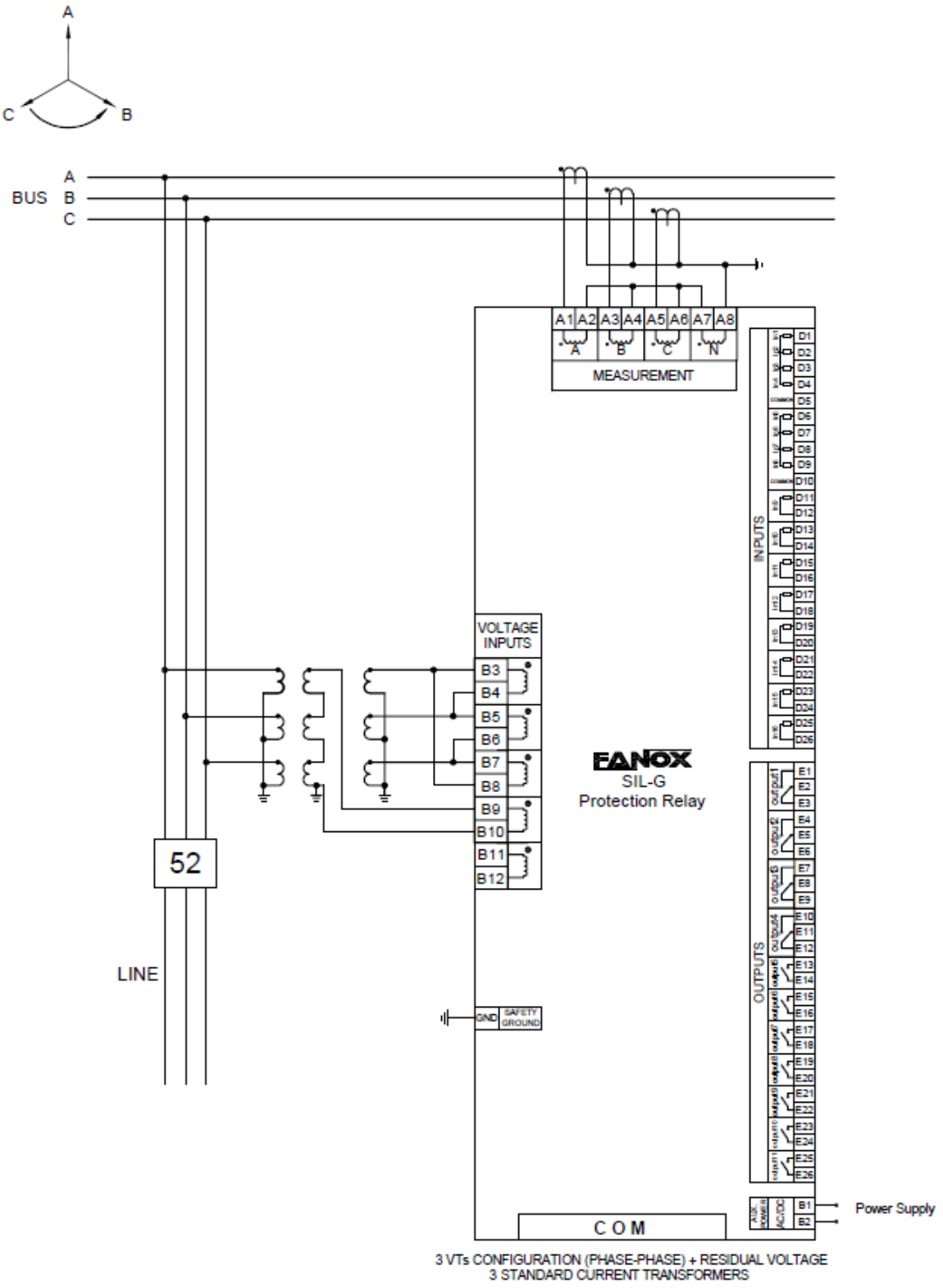
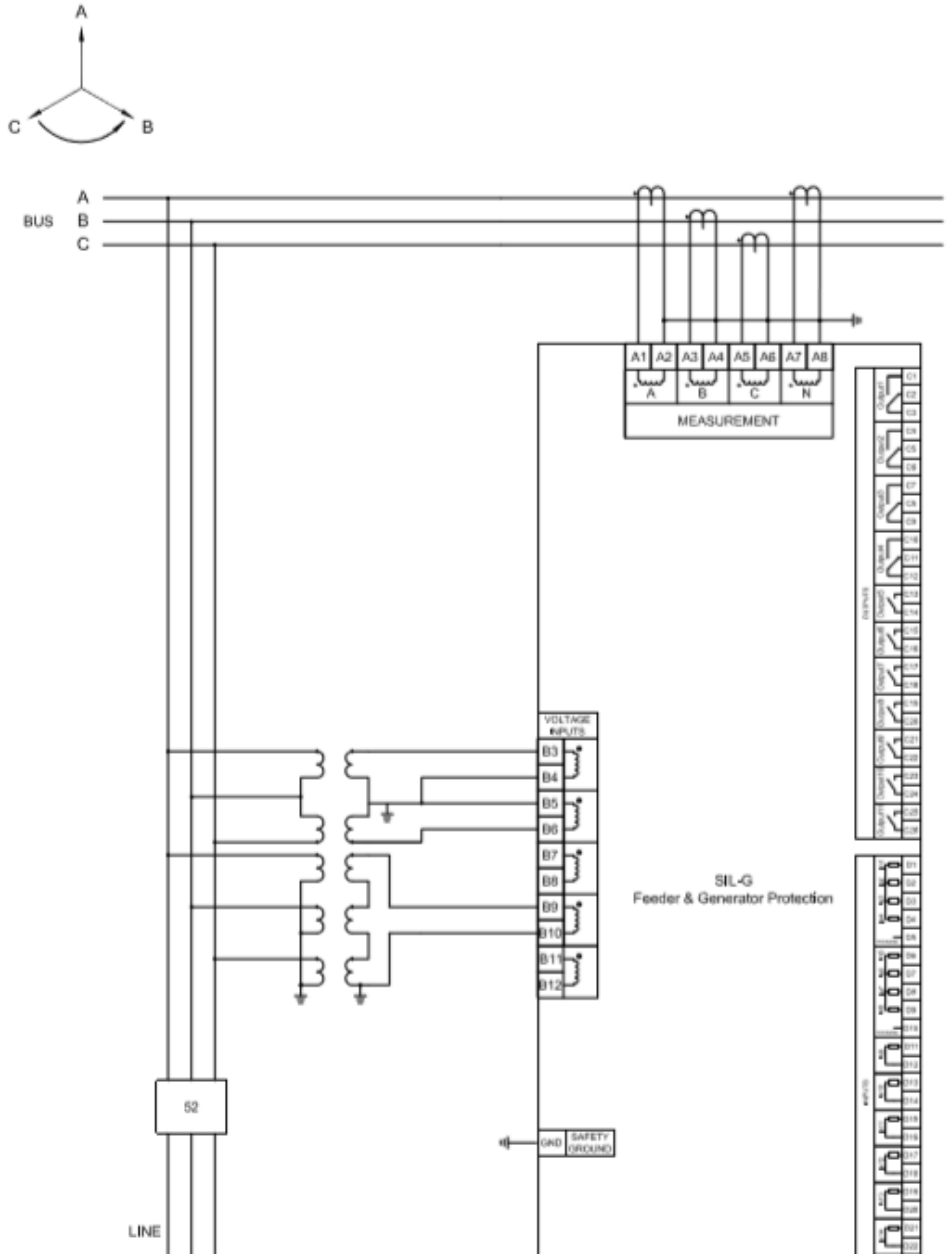
3 VT configuration (phase-phase) + residual voltage



3 VTs CONFIGURATION (PHASE-PHASE) + RESIDUAL VOLTAGE
3 STANDARD CURRENT TRANSFORMERS

2VT configuration (phase-phase) + residual voltage



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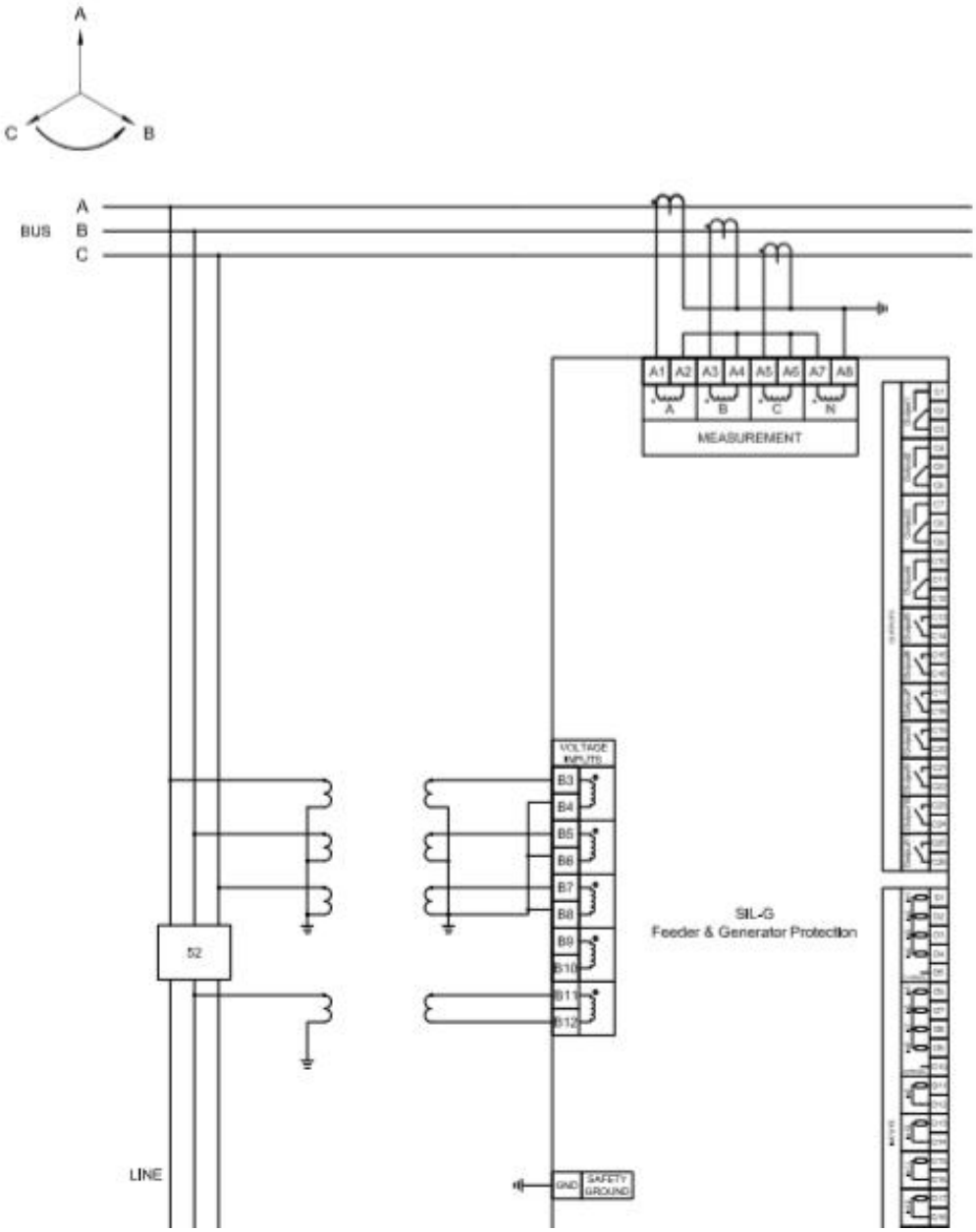
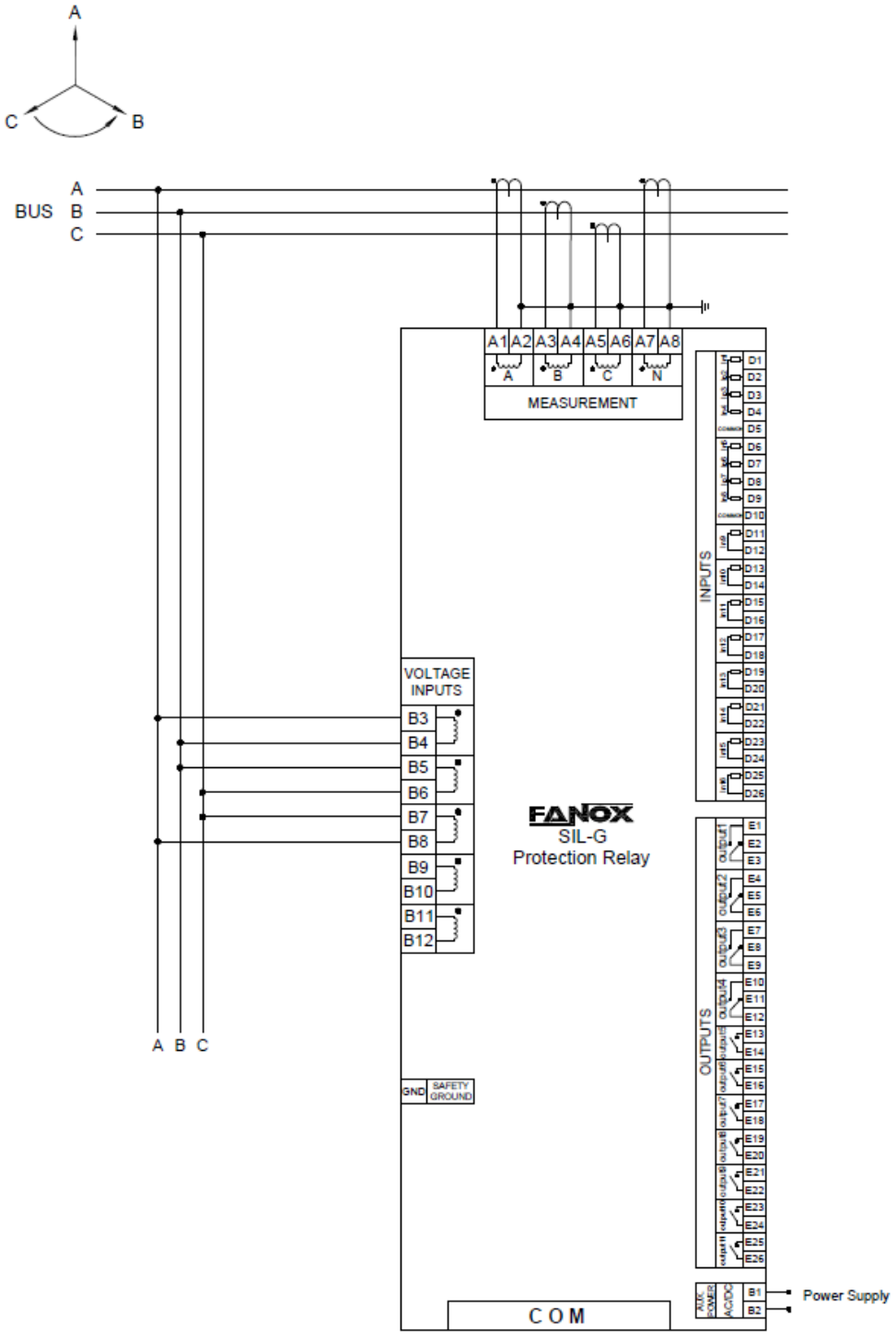
3 VT configuration (phase-neutral) + phase B line voltage



Connecting the relay directly to Low Voltage line (Un = 200-480 V)

Phase-phase connection



NOTE. Voltage Neutral protections (50N, 67/51N and 59N), voltage ground protections (50G, 67/51G and 59G) and voltage sequence protection (47) are not available with this configuration.

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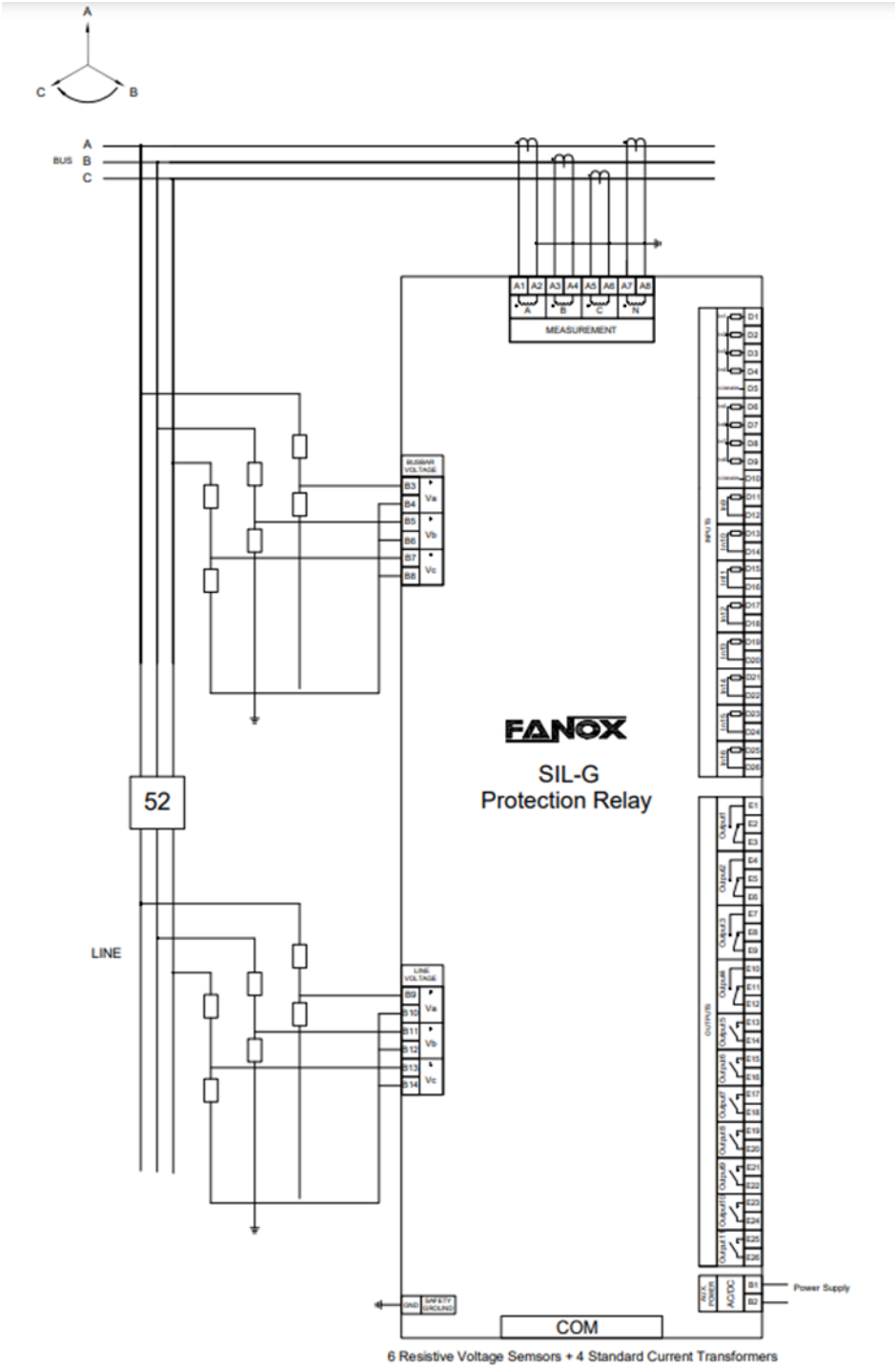
Resistive voltage sensors + 4 standard CT



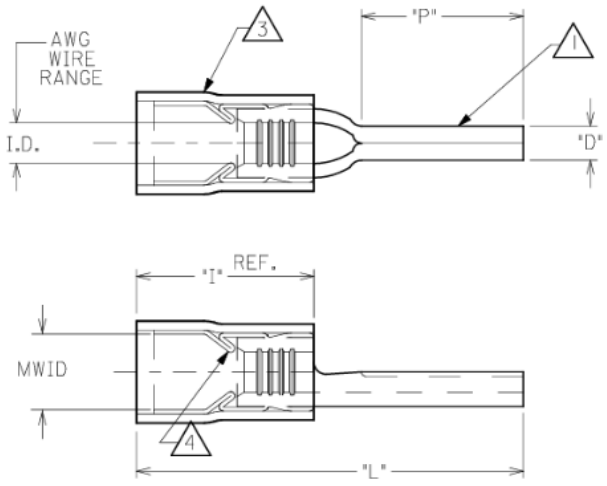
5.3.3 Terminals

The following types of terminals are used in the relay:

	Terminals	Reference	Features	
CT current inputs	A1-A8	0387416608 (Molex)	24 AWG – 10 AWG: 0.2 – 4 mm^2 cable with a torque of 13 in-lbs	
VT voltage inputs	B3-B12	1766990 (Phoenix Contact)	24 AWG – 12 AWG: 0.2 – 2.5 mm^2 cable with a torque of 0.5-0.6 Nm	
Inputs/Outputs/Auxiliary Supply/RS485 terminals/High Speed Outputs (Depending on model)	B1-B2 C1-C26 D1-D26 E1-E26 F1-F8	1757022 (Phoenix Contact) (different number of poles are included, but all the pins with the same reference)	24 AWG – 12 AWG: 0.2 – 2.5 mm^2 cable (**) with a torque of 0.5-0.6 Nm	 The figure shows a 10-position version of the product
Voltage sensor inputs	B3-B14(*)			

(*) Only for models with voltage sensors.

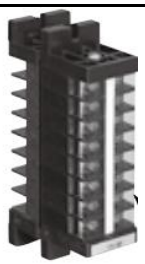
(**) Compatible with 2.5 - 4mm^2 cables using pin terminals. For example, a 10-12AWG pin terminal as shown in the picture below:



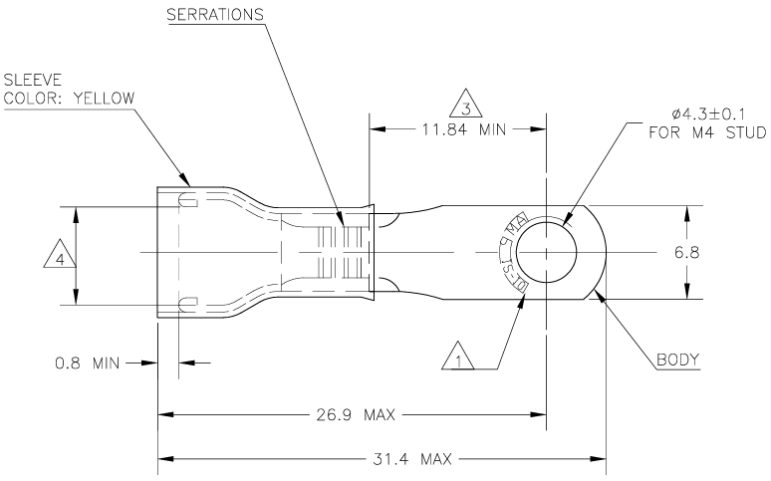


Where "I.D". is 12-10AWG, "L" max is 28.7mm, "P" min 10.4mm, "D" 2.72mm, "MWID" is 5.72mm and "I" max is 14.5mm.

From fw version 3.01.00 onwards, a short-circuitable terminal is available for model SILG1xxxxxxxxB. Note that this model is only available with a /1 secondary.

	Terminals	Reference	Features	Picture
CT current inputs	A1-A8	CTM Type (Fuji)	14 AWG: 2 mm^2 cable (*)	

(*) Compatible with 2.5 - 4mm^2 cables using crimped ring-lug terminals. For example, a 10-12AWG ring-lug terminal as shown in the picture below:



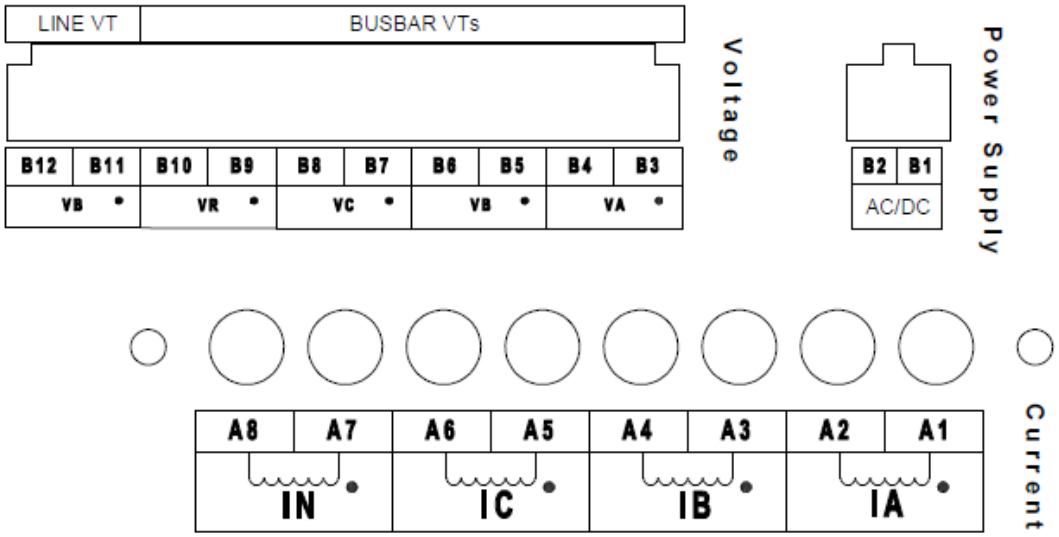


5.3.4 Current and voltage terminals

All models have the same terminals for current (*).

For voltage connections, there are two options:

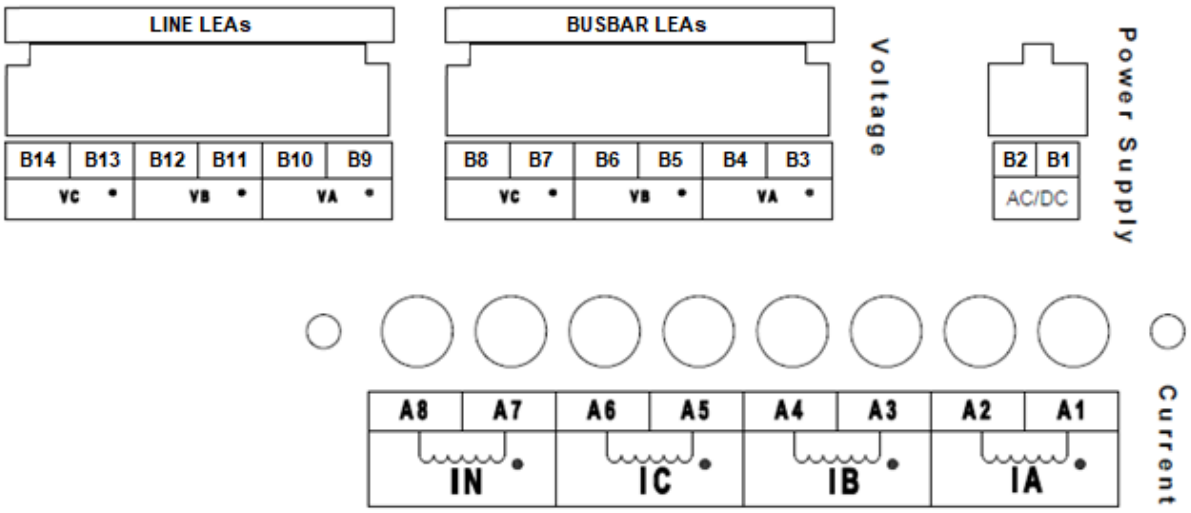
- Models with conventional VTs:



A1	Phase A current input
A2	Phase A current output
A3	Phase B current input
A4	Phase B current output
A5	Phase C current input
A6	Phase C current output
A7	Neutral current input
A8	Neutral current output

B1-B2	Auxiliary voltage
B3	Busbar Phase A voltage input
B4	Busbar Phase A voltage output
B5	Busbar Phase B voltage input
B6	Busbar Phase B voltage output
B7	Busbar Phase C voltage input
B8	Busbar Phase C voltage output
B9	Busbar Neutral voltage input
B10	Busbar Neutral voltage output
B11	Line Phase B voltage input
B12	Line Phase B voltage output

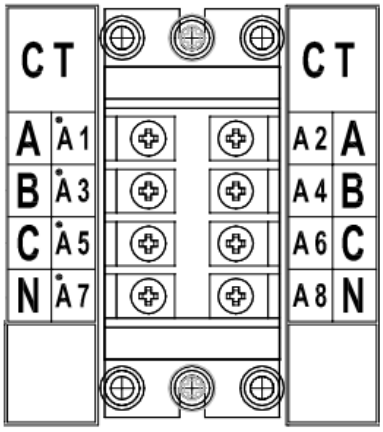
- Models with voltage sensors:



A1	Phase A current input
A2	Phase A current output
A3	Phase B current input
A4	Phase B current output
A5	Phase C current input
A6	Phase C current output
A7	Neutral current input
A8	Neutral current output

B1-B2	Auxiliary voltage
B3	Busbar Phase A voltage input
B4	Busbar Phase A voltage output
B5	Busbar Phase B voltage input
B6	Busbar Phase B voltage output
B7	Busbar Phase C voltage input
B8	Busbar Phase C voltage output
B9	Line Phase A voltage input
B10	Line Phase A voltage output
B11	Line Phase B voltage input
B12	Line Phase B voltage output
B13	Line Phase C voltage input
B14	Line Phase C voltage output

(*) From fw version 3.01.00 onwards, a short-circuitable terminal is available for model SILG1xxxxxxxxB. Note that this model is only available with a /1 secondary.



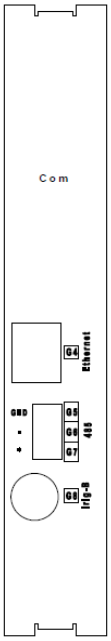
A1	Phase A current input
A2	Phase A current output
A3	Phase B current input
A4	Phase B current output
A5	Phase C current input
A6	Phase C current output
A7	Neutral current input
A8	Neutral current output

5.3.5 Communication terminals

Depending on the selected communications for the chosen model, the following configurations are available.

NOTE: For communication digit A the available port RS485 is included in the inputs/outputs slot and the terminals are described in the corresponding section.

5.3.5.1 Communication digits B, G, O and P



SLOT 5 (COM)	
G4	Ethernet (RJ45 connector)
G5	RS485 GND
G6	RS485 - connection
G7	RS485 + connection
G8	IRIG-B

Note: Models G and P also include WiFi.

5.3.5.2 Communication digit E and J

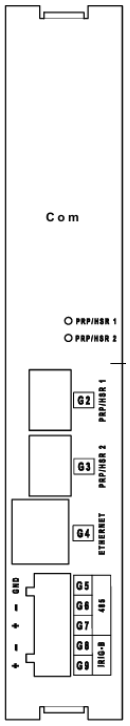


SLOT 5 (COM)	
G2	Ethernet (RJ45 connector)
G3	Ethernet (RJ45 connector)
G5	RS485 GND
G6	RS485 – connection
G7	RS485 + connection
G8	IRIG-B

From firmware version 3.01 onwards:

Model J available.

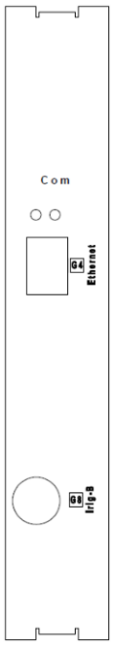
Both for models E and J terminals are:



SLOT 5 (COM)	
G2	HSR/PRP SFP Cage 1
G3	HSR/PRP SFP Cage 2
G4	Ethernet (RJ45 connector)
G5	RS485 GND
G6	RS485 – connection
G7	RS485 + connection
G8	IRIG-B - connection
G9	IRIG-B + connection

Note: Model J also includes WiFi.

5.3.5.3 Communication digits Q and R



SLOT 5 (COM)	
G3	Ethernet (FO-LC connector)
G8	IRIG-B

Note: Model R also includes WiFi.

5.3.5.4 Communication digits 2 and 3

Available from firmware version 3.01 onwards.

SLOT 5 (COM)	
G2	Ethernet HSR/PRP 1 (RJ45 connector)
G3	Ethernet HSR/PRP 2 (RJ45 connector)
G4	Ethernet (RJ45 connector)
G5	RS485 GND
G6	RS485 - connection
G7	RS485 + connection
G8	IRIG-B - connection
G9	IRIG-B + connection

Note: Model 3 also includes WiFi.

5.3.5.5 Communication digits M and N

Available from firmware version 3.01 onwards.

SLOT 5 (COM)	
G2	Ethernet 1 (RJ45 connector)
G3	Ethernet 2 (RJ45 connector)
G5	RS485 GND
G6	RS485 - connection
G7	RS485 + connection
G8	IRIG-B - connection
G9	IRIG-B + connection

Note: Model N also includes WiFi.

5.3.5.6 Communication digits U and V

Available from firmware version 3.01 onwards.

SLOT 5 (COM)	
G3	SFP Cage
G4	Ethernet (RJ45 connector)
G5	RS485 GND

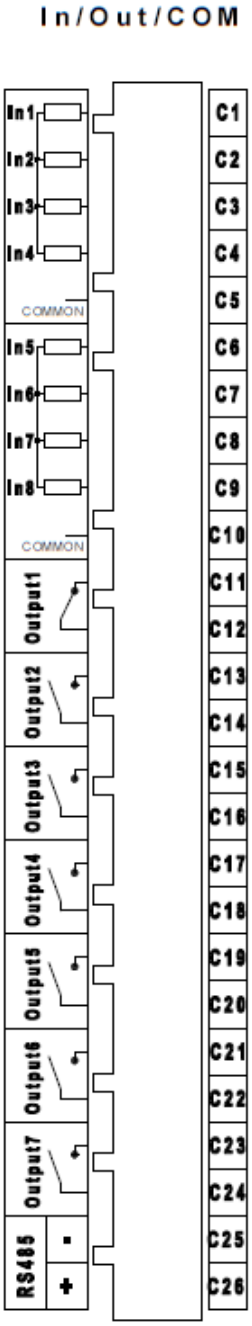
G6	RS485 - connection
G7	RS485 + connection
G8	IRIG-B - connection
G9	IRIG-B + connection

Note: Model V also includes WiFi.

5.3.6 Input and output terminals

Depending on the number of Inputs/Outputs chosen by model, following configurations are available:

5.3.6.1 SILGxxxxxx0xxx (8 inputs + 7 outputs)

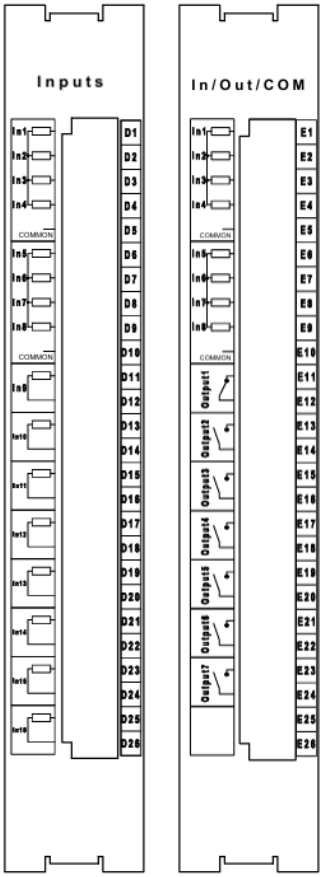


SLOT 3 (In/Out/COM)	
C1	Digital input 1
C2	Digital input 2
C3	Digital input 3
C4	Digital input 4
C5	Common of digital inputs 1, 2, 3 and 4
C6	Digital input 5
C7	Digital input 6
C8	Digital input 7
C9	Digital input 8
C10	Common of digital inputs 5, 6, 7 and 8
C11-C12	Digital output 1 NC
C13-C14	Digital output 2 NO
C15-C16	Digital output 3 NO
C17-C18	Digital output 4 NO
C19-C20	Digital output 5 NO
C21-C22	Digital output 6 NO
C23-C24	Digital output 7 NO
C25-C26*	RS-485 connection

* Only for communication digit A, for the rest digits it is in slot 5.

SLOT 4	
-	EMPTY

5.3.6.2 SILGxxxxxx5xxx (24 Inputs + 7 outputs)



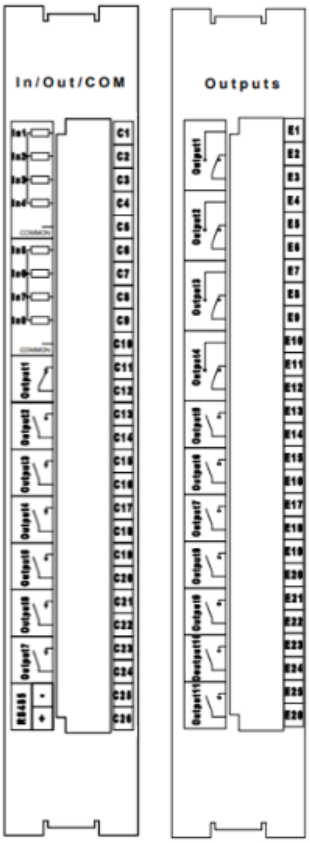
SLOT 3 (Inputs)	
D1	Digital input 1
D2	Digital input 2
D3	Digital input 3
D4	Digital input 4
D5	Common of digital inputs 1, 2, 3 and 4
D6	Digital input 5
D7	Digital input 6
D8	Digital input 7
D9	Digital input 8
D10	Common of digital inputs 5, 6, 7 and 8
D11-D12	Digital input 9
D13-D14	Digital input 10
D15-D16	Digital input 11
D17-D18	Digital input 12
D19-D20	Digital input 13
D21-D22	Digital input 14
D23-D24	Digital input 15
D25-D26	Digital input 16

SLOT 4 (In/Out/COM)	
E1	Digital input 17
E2	Digital input 18
E3	Digital input 19
E4	Digital input 20
E5	Common of digital inputs 17, 18, 19 and 20
E6	Digital input 21
E7	Digital input 22
E8	Digital input 23
E9	Digital input 24
E10	Common of digital inputs 21, 22, 23 and 24
E11-E12	Digital output 1 NO
E13-E14	Digital output 2 NO
E15-E16	Digital output 3 NO
E17-E18	Digital output 4 NO
E19-E20	Digital output 5 NO
E21-E22	Digital output 6 NO
E23-E24	Digital output 7 NO
E25-E26	RS-485 – connection*

* Only for communication digit A, for the rest digits it is in slot 5.

FANOX
Safely protected

5.3.6.3 SILGxxxxxx6xxx (8 inputs + 18 outputs)



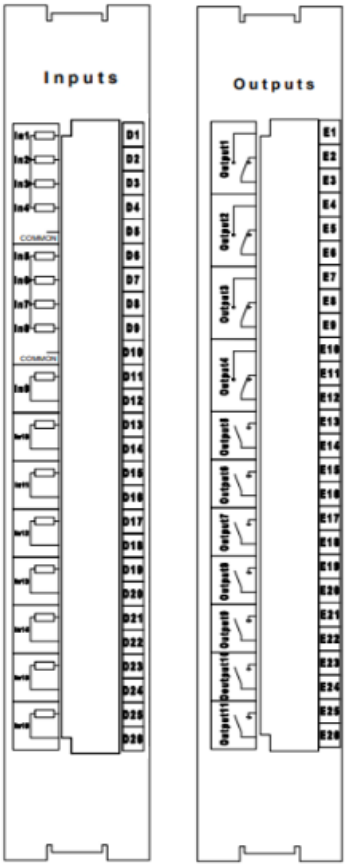
SLOT 3 (In/Out/COM)	
C1	Digital input 1
C2	Digital input 2
C3	Digital input 3
C4	Digital input 4
C5	Common of digital inputs 1, 2, 3 and 4
C6	Digital input 5
C7	Digital input 6
C8	Digital input 7
C9	Digital input 8
C10	Common of digital inputs 5, 6, 7 and 8
C11-C12	Digital output 1 NC
C13-C14	Digital output 2 NO
C15-C16	Digital output 3 NO
C17-C18	Digital output 4 NO
C19-C20	Digital output 5 NO
C21-C22	Digital output 6 NO
C23-C24	Digital output 7 NO
C25-C26	RS-485 – connection*

* Only for communication digit A, for the rest digits it is in slot 5

SLOT 4 (Outputs)	
E1	NO contact output 8
E2	NC contact output 8
E3	Common point output 8
E4	NO contact output 9
E5	NC contact output 9
E6	Common point output 9
E7	NO contact output 10
E8	NC contact output 10
E9	Common point output 10
E10	NO contact output 11
E11	NC contact output 11
E12	Common point output 11
E13-E14	Digital output 12 NO
E15-E16	Digital output 13 NO
E17-E18	Digital output 14 NO
E19-E20	Digital output 15 NO
E21-E22	Digital output 16 NO
E23-E24	Digital output 17 NO
E25-E26	Digital output 18 NO

FANOX
Safely protected

5.3.6.4 SILGxxxxxx7xxx (16 inputs + 11 outputs)

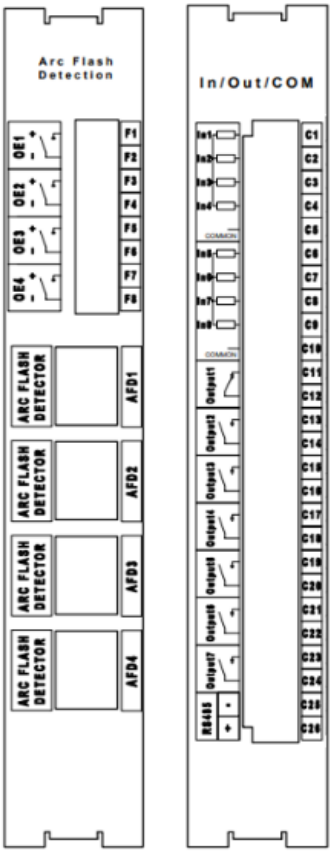


SLOT 3 (Inputs)	
D1	Digital input 1
D2	Digital input 2
D3	Digital input 3
D4	Digital input 4
D5	Common of digital inputs 1, 2, 3 and 4
D6	Digital input 5
D7	Digital input 6
D8	Digital input 7
D9	Digital input 8
D10	Common of digital inputs 5, 6, 7 and 8
D11-D12	Digital input 9
D13-D14	Digital input 10
D15-D16	Digital input 11
D17-D18	Digital input 12
D19-D20	Digital input 13
D21-D22	Digital input 14
D23-D24	Digital input 15
D25-D26	Digital input 16

SLOT 4 (Outputs)	
E1	NO contact output 1
E2	NC contact output 1
E3	Common point output 1
E4	NO contact output 2
E5	NC contact output 2
E6	Common point output 2
E7	NO contact output 3
E8	NC contact output 3
E9	Common point output 3
E10	NO contact output 4
E11	NC contact output 4
E12	Common point output 4
E13-E14	Digital output 5 NO
E15-E16	Digital output 6 NO
E17-E18	Digital output 7 NO
E19-E20	Digital output 8 NO
E21-E22	Digital output 9 NO
E23-E24	Digital output 10 NO
E25-E26	Digital output 11 NO

FANOX
Safely protected

5.3.6.5 SILGxxxxxxAxxx & SILGxxxxxxBxxx (8 inputs + 7 outputs and 4 inputs + 4 outputs for AFD)



SLOT 3 (In/Out/COM)	
C1	Digital input 1
C2	Digital input 2
C3	Digital input 3
C4	Digital input 4
C5	Common of digital inputs 1, 2, 3 and 4
C6	Digital input 5
C7	Digital input 6
C8	Digital input 7
C9	Digital input 8
C10	Common of digital inputs 5, 6, 7 and 8
C11-C12	Digital output 1 NC
C13-C14	Digital output 2 NO
C15-C16	Digital output 3 NO
C17-C18	Digital output 4 NO
C19-C20	Digital output 5 NO
C21-C22	Digital output 6 NO
C23-C24	Digital output 7 NO
C25-C26	RS-485 – connection**

SLOT 4 (AFD)	
F1 – F2	High-speed output 1 NO*
F3 – F4	High-speed output 2 NO*
F5 – F6	High-speed output 3 NO*
F7 – F8	High-speed output 4 NO*
AFD1	Arc Flash Detector input 1
AFD2	Arc Flash Detector input 2
AFD3	Arc Flash Detector input 3
AFD4	Arc Flash Detector input 4

**For model B, AFD outputs have a high breaking capacity at 24-48Vdc. To activate de outputs, dc voltage is required.*

The positive pole should be connected to the upper terminals.

** Only for communication digit A, for the rest digits it is in slot 5

6 DESCRIPTION

6.1 Introduction

The energy sector is currently immersed in a deep change worldwide. As a result of high levels of energy demand, more distribution lines and advanced supervision systems are required. Given the need for creating intelligent infrastructures, Fanox has developed the SIL and SIR families to carry out this goal.

This relay is designed to protect a feeder system using current and voltage functions. It is designed to use a circuit breaker as a cut-off component.

The protection functions may be activated selectively either by using the front-mounted panel or through the communications link to the SICom software, which facilitates accurate coordination with another relay.

As an additional advantage all the models have been designed such that they can be powered by an external battery. This eases putting centres into operation, event management and specific work under adverse conditions.

6.2 Description

SIL-G can be powered by an auxiliary voltage, that is equal to, depending on model:

24-48 Vdc (±20%).

48-230 Vac/dc (48-220 Vdc (±20%) / 48-230 Vac (±15%)).

24-230 Vdc/ac (24-220 Vdc (±20%) / 100-230 Vac (±15%)).

The following protection functions are available on the SIL-G:

- Phase and neutral/ground definite-time and inverse-time (IEC and IEEE curves) overcurrent protections, with directional discrimination.
- Negative sequence overcurrent protection. A broken conductor is also detected.
- Undercurrent protection.
- Phase and neutral/ground overvoltage protection (for the bar phases and phase B of the line or all the phases).
- Phase undervoltage protection (for bar phases and for phase B of the line or all the phases).
- Directional overpower protection.
- Incipient fault detection
- Phase reversal protection.
- Thermal overload protection.
- Overfrequency and underfrequency protection.
- Rate Of Change Of Frequency.
- Vector shift (Out of Step).
- Cold Load Pickup (CLP).
- Second Harmonic Blocking (SHB).
- Switch On To Fault (SOTF).
- Incipient Fault Detection*.
- Fault Locator*.

- Load Management System**.

**Available from FW version 1.21.00 onwards for models with voltage sensors and from 3.00.00 onwards for models with conventional CTs.*

*** Available in models with conventional VTs from version 3.00.00 onwards.*

It is also fitted with an AC reclosing device (79). This automated device allows the line to be closed, up to four times. Each reclosure time can be programmed. The device can be locked in different ways: from the keypad (for which there is a separate key), from remote communications stations and through an input.

Besides that, control functions are included such as VT supervision, CT supervision, trip circuit monitoring or breaker failure monitoring.

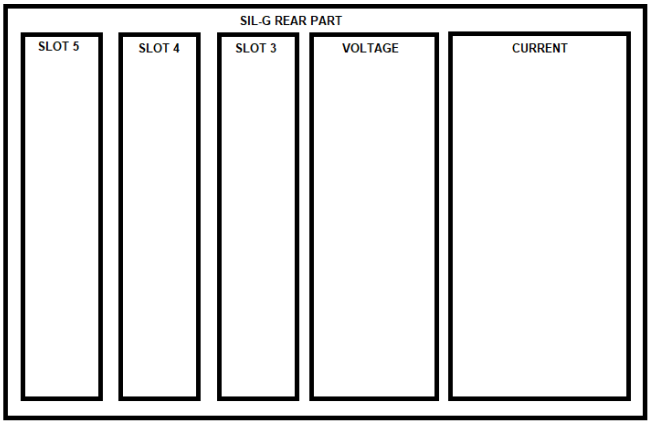
All models include a circuit breaker management block, which:

- Monitors the condition of the circuit breaker, the number of openings and accumulated amperes. Generates an indication when there is an excessive number of openings and accumulated amperes.
- Determines if an opening fault has occurred.
- Allows circuit breaker opening and closing commands to be given from the HMI (using different keys) and through local and remote communications.

The following measurements are provided by the SIL-G device:

- Phase currents and neutral (measured and calculated), maximum current, positive sequence current and negative sequence current, I-2/I-1.
- Second harmonic current per phase and neutral.
- Simple voltages, phase-to-phase voltages, neutral voltage (calculated and measured), maximum voltage, line voltage, positive sequence voltage and negative sequence voltage.
- Current angle for each phase and calculated and measured neutral (referred to VA).
- Voltage angle per each phase and neutral (referred to VA).
- Line voltage angle.
- Active, reactive and apparent powers (3- phase and per phase).
- Total and per phase power factor (cos PHI).
- Thermal image.
- Line frequency and busbar frequency.
- Rate Of Change Of Frequency (ROCOF).
- V/Hz related to nominal Vn/fn.
- Current Total harmonic distortion.

Depending on the model, the relay can include different slots regarding inputs and outputs:



The slots 3 and 4 include the inputs and outputs that depending on the model offered:

- SILGxxxxxx0xxx: 7 outputs and 8 inputs. All the outputs and inputs are included in **SLOT 3**, being **SLOT 4** empty.
- SILGxxxxxx5xxx: 7 outputs and 24 inputs. The 16 inputs are included in the **SLOT 3** and in the SLOT4 the other 8 inputs and 7 outputs.
- SILGxxxxxx6xxx: 18 outputs and 8 inputs. 8 inputs and 7 outputs are included in the **SLOT 3** and the 11 outputs in **SLOT 4**.
- SILGxxxxxx7xxx: 11 outputs and 16 inputs. The 16 inputs are included in the **SLOT 3** and the 11 outputs in the **SLOT 4**.
- SILGxxxxxxAxxx: 7 outputs, 8 inputs, 4 AFD inputs and 4 high-speed outputs. The 7 inputs and 8 outputs are included in **SLOT 3**, and the 4 AFD inputs and 4 high-speed outputs included in **SLOT 4**.
- SILGxxxxxxBxxx: 7 outputs, 8 inputs, 4 AFD inputs and 4 high-speed outputs with high breaking capacity at 24-48Vdc. The 7 inputs and 8 outputs are included in **SLOT 3**, and the 4 AFD inputs and 4 high-speed outputs included in **SLOT 4**.

Both, the inputs, and outputs can be configured by the user. Depending on the configuration:

The outputs located in slot 3:

- 250 Vac – 8 A.
- 30 Vdc – 8A.

The outputs located in slot 4:

- Terminals E1-E22:
  - 250 Vac – 8 A.
  - 30 Vdc – 8 A.
- Terminals E23-E26:
  - 250 Vac – 16 A.
  - 30 Vdc – 16 A.

The device is housed in a metal case and all measurement and digital inputs and outputs have galvanized isolation (except for local communications and battery power, as these are occasional connections). Thus, this gives the device the highest degree of electromagnetic compatibility, both in terms of radiated and conduced EMI emissivity and immunity. Said levels are those established for primary substations.

It has an LCD with four rows and twenty columns, a 6 key membrane keypad to display the status of the relay, measurements, settings of the protection functions and the events or events associated with the relay, and a reset key to reset signals and events. In addition to these keys used to navigate through the menus, some special keys are also configurable by the PC software. By default:

- I/O of the circuit breaker. Used to close and open the circuit breaker.
- Block/Unblock 79. Used to block and unblock the recloser.
- Local/Remote Control. Used to forbid/allow remote communications.

The relay has 11 front-mounted configurable LEDs, 8 LEDs are shown also in the alarm panel menu and the other 3 are associated to the special front keys.

- Status of the circuit breaker.
- Status of the recloser.
- Status of the communication (Local control or Remote control).

The SIL-G is provided with non-volatile RAM memory in order to store up to 3072 events and disturbance fault recording (DFR), maintaining date & time thanks to its internal RTC (real Time Clock).

- 5 records in data and COMTRADE format (300 cycles for each record): 1 to 8 pre-fault cycles + 292 to 299 postfault cycles.
- 25 records in data and COMTRADE format (60 cycles for each record): 1 to 8 pre-fault cycles + 52 to 59 postfault cycles.
- 50 records in data and COMTRADE format (30 cycles for each record): 1 to 8 pre-fault cycles + 22 to 29 postfault cycles.
- 100 records in data and COMTRADE format (15 cycles for each record): 1 to 8 pre-fault cycles + 7 to 14 postfault cycles.

Each oscillography record contains 10 analog channels and up to 96 configurable digital channels. The oscillography is downloaded by communications port. The SICom communications software allows the oscillography record to be downloaded and saved in COMTRADE format (IEEE C37.111-1991).

To allow communication, relays are provided with a local micro micro-USB front port and with remote communication with different options (ports and protocols) on the rear side:

COMMUNICATION DIGITS	PROTOCOLS
A	**USB:** Modbus RTU **RS485:** Modbus RTU, IEC60870-5-103 or DNP3.0 Serial
B	**USB:** Modbus RTU **RS485:** Modbus RTU, IEC60870-5-103 or DNP3.0 Serial **RJ45:** Modbus TCP, DNP3.0 TCP or IEC60870-5-104, SNTP Protocol + Web Server
2	**USB:** Modbus RTU **RS485:** Modbus RTU, IEC60870-5-103 or DNP3.0 Serial **RJ45:** Modbus TCP, DNP3.0 TCP, IEC60870-5-104 or IEC61850, SNTP Protocol + Web Server **HSR/PRP RJ45:** Modbus TCP, DNP3.0 TCP, IEC60870-5-104 or IEC61850, SNTP Protocol + Web Server

E	**USB:** Modbus RTU **RS485:** Modbus RTU, IEC60870-5-103 or DNP3.0 Serial **RJ45:** Modbus TCP, DNP3.0 TCP, IEC60870-5-104 or IEC61850, SNTP Protocol + Web Server **HSR/PRP SFP Cages:** Modbus TCP, DNP3.0 TCP, IEC60870-5-104 or IEC61850, SNTP Protocol + Web Server
G	**USB:** Modbus RTU **WiFi:** Modbus RTU **RS485:** Modbus RTU, IEC60870-5-103 or DNP3.0 Serial **RJ45:** Modbus TCP, DNP3.0 TCP or IEC60870-5-104, SNTP Protocol + Web Server
3	**USB:** Modbus RTU **WiFi:** Modbus RTU **RS485:** Modbus RTU, IEC60870-5-103 or DNP3.0 Serial **RJ45:** Modbus TCP, DNP3.0 TCP, IEC60870-5-104 or IEC61850, SNTP Protocol + Web Server **HSR/PRP RJ45:** Modbus TCP, DNP3.0 TCP, IEC60870-5-104 or IEC61850, SNTP Protocol + Web Server
J	**USB:** Modbus RTU **WiFi:** Modbus RTU **RS485:** Modbus RTU, IEC60870-5-103 or DNP3.0 Serial **RJ45:** Modbus TCP, DNP3.0 TCP, IEC60870-5-104 or IEC61850, SNTP Protocol + Web Server **HSR/PRP SFP Cages:** Modbus TCP, DNP3.0 TCP, IEC60870-5-104 or IEC61850, SNTP Protocol + Web Server
M	**USB:** Modbus RTU **RS485:** Modbus RTU, IEC60870-5-103 or DNP3.0 Serial **2xRJ45:** Modbus TCP, DNP3.0 TCP, IEC60870-5-104 or IEC61850, SNTP Protocol + Web Server
N	**USB:** Modbus RTU **WiFi:** Modbus RTU **RS485:** Modbus RTU, IEC60870-5-103 or DNP3.0 Serial **2xRJ45:** Modbus TCP, DNP3.0 TCP, IEC60870-5-104 or IEC61850, SNTP Protocol + Web Server
O	**USB:** Modbus RTU **RS485:** Modbus RTU, IEC60870-5-103 or DNP3.0 Serial **RJ45:** Modbus TCP, DNP3.0 TCP, IEC60870-5-104 or IEC61850, SNTP Protocol + Web Server
P	**USB:** Modbus RTU **WiFi:** Modbus RTU **RS485:** Modbus RTU, IEC60870-5-103 or DNP3.0 Serial

	RJ45: Modbus TCP, DNP3.0 TCP, IEC60870-5-104 or IEC61850, SNTP Protocol + Web Server
Q	**USB:** Modbus RTU **RS485:** Modbus RTU, IEC60870-5-103 or DNP3.0 Serial **FO-LC:** Modbus TCP or DNP3.0 TCP, IEC60870-5-104 or IEC61850, SNTP Protocol + Web Server
R	**USB:** Modbus RTU **WiFi:** Modbus RTU **RS485:** Modbus RTU, IEC60870-5-103 or DNP3.0 Serial **FO-LC:** Modbus TCP or DNP3.0 TCP, IEC60870-5-104 or IEC61850, SNTP Protocol + Web Server
U	**USB:** Modbus RTU **RS485:** Modbus RTU, IEC60870-5-103 or DNP3.0 Serial **RJ45:** Modbus TCP or DNP3.0 TCP, IEC60870-5-104 or IEC61850, SNTP Protocol + Web Server **SFP Cage:** Modbus TCP or DNP3.0 TCP, IEC60870-5-104 or IEC61850, SNTP Protocol + Web Server
V	**USB:** Modbus RTU **WiFi:** Modbus RTU **RS485:** Modbus RTU, IEC60870-5-103 or DNP3.0 Serial **RJ45:** Modbus TCP or DNP3.0 TCP, IEC60870-5-104 or IEC61850, SNTP Protocol + Web Server **SFP Cage:** Modbus TCP or DNP3.0 TCP, IEC60870-5-104 or IEC61850, SNTP Protocol + Web Server

The login allows four levels of access by password, which can be set by the user through SICom software.

Thanks to the protection functions that are available, its user-friendly interface, its reduced maintenance requirements and simple integration, the SIL-G is an accurate and practical solution for protecting a feeder system. SIL-G offers protection against earth faults that is sensitive enough to be used with any low earth failure current electrical system (it can be adjusted down to 0.01 times the rated current, so low rated levels can be selected).

The main features of the device are listed below. These will be described in greater detail in this manual:

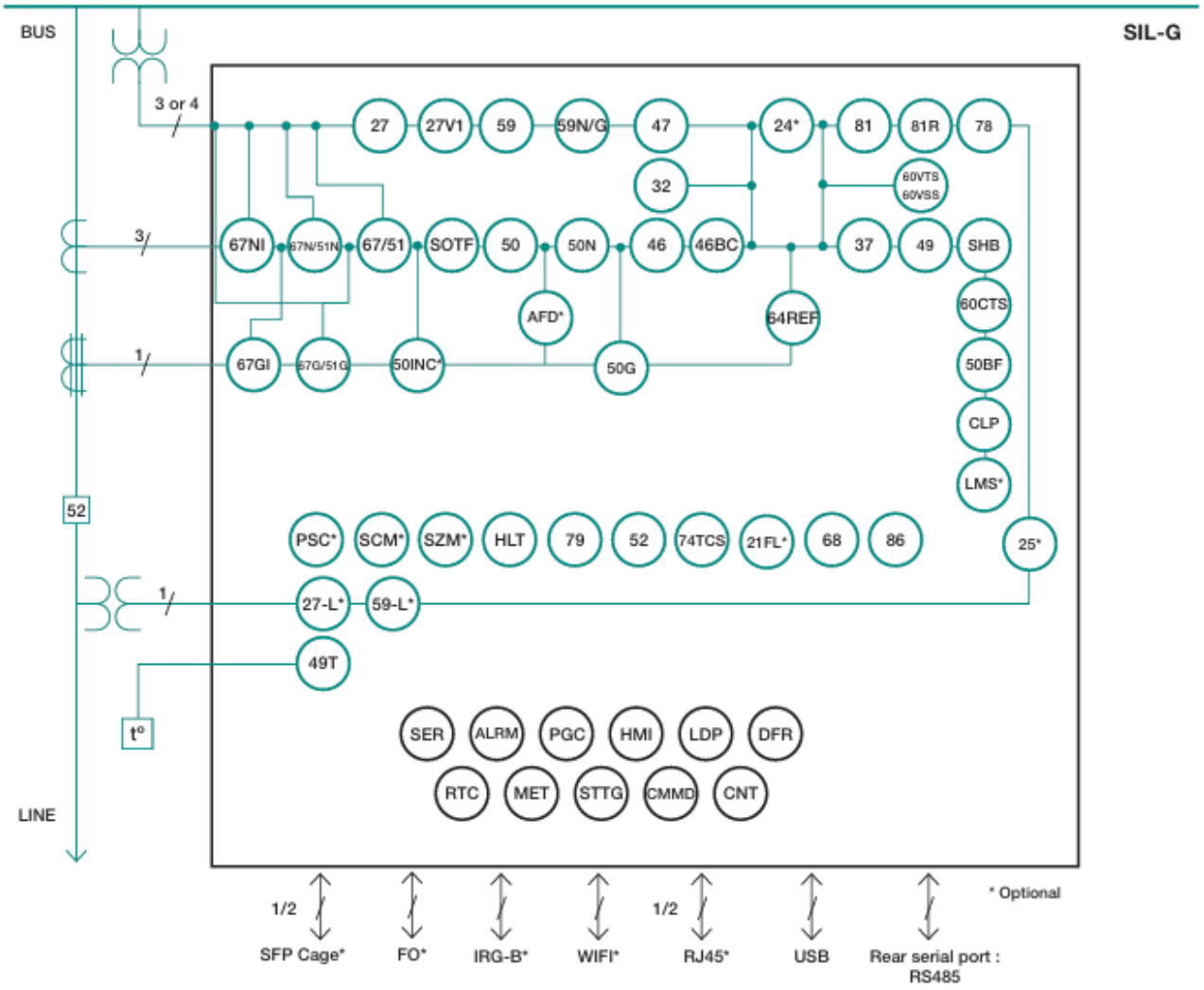
Function	Description	SIL-G
Protection		
50	Instantaneous phase overcurrent	2
SOTF	Switch On To Fault	1
50G	Instantaneous measured neutral overcurrent	1
50N	Instantaneous calculated neutral overcurrent	1
67/51	Inverse time directional phase overcurrent	4
67G/51G	Inverse time directional measured neutral overcurrent	2

67N/51N	Inverse time directional calculated neutral overcurrent	2
67GI	Directional measured neutral overcurrent	1
67NI	Directional calculated neutral overcurrent	1
50INC	Incipient Fault detection	1
64REF	Restricted Earth Fault	1
46	Phase balance current protection	1
46BC	Broken Conductor Detection	1
49	Thermal overload	1
49T	External Trip	1
37	Instantaneous phase undercurrent	1
AFD	Arc Flash Detection	1 (4 AFD inputs + 4 high-speed outputs)
27	Instantaneous phase udervoltage	2
27V1	Instantaneous positive sequence undervoltage	1
27-L	Instantaneous line undervoltage	1 (Optional)
59	Instantaneous phase overvoltage	2
59N/G	Instantaneous calculated/measured neutral overvoltage	2
59-L	Instantaneous line overvoltage	1 (Optional)
47	Phase balance voltage protection	1
32	Directional overpower	4
81U/O	Under/Overfrequency	6 (2 of them optional)
81R	Rate Of Change Of Frequency (ROCOF)	4 (2 of them optional)
78	Out of Step (Vector Shift)	1
24	Overfluxing	2 (Optional)
79	AC reclosing device	✓ Up to 4 attempts.
HLT	Hot Line Tag	✓
25	Synchro Check	1 (Optional)
74TCS	Trip Circuit Supervision	1
60CTS	Phase Current Transformer Supervision	1
60VTS	Phase Voltage Transformer Supervision	1
50BF	Circuit Breaker Failure	1

SHB	Second Harmonic Blocking	1
CLP	Cold Load Pickup	1
52	Breaker Wear Monitoring	✓
86	Trip lockout	✓
SCM	Sequence Coordination Mode	1 (Optional)
SZM	Sectionalizer Mode	1 (Optional)
PSC	Power Supply Control	1 (Optional)
21FL	Fault Locator	1 (Optional)
LMS	Load Management System	1 (Optional)
Circuit breaker		
52	State and command of the circuit breaker	✓
	Counter for the number of openings	✓
	Counter for accumulated amperes	✓
	Maximum number of openings in a time window	✓
Inputs and Outputs		
	Configurable inputs	Depending on model: 8 inputs 16 inputs 24 inputs 8 inputs + 4 AFD Inputs
	Configurable outputs	Depending on the model: 7 outputs: 1 NC or 1 NO (depending on the model) + 6 NO 11: 4 NO/NC + 7 NO 18: 4 NO/NC + 1 NC + 13 NO 7: 1 NC + 6 NO + 4 High-Speed outputs (optional with high breaking capacity)
Communication and HMI		
	LOCAL Port: Modbus RTU, IEC60870-5-103 or DNP3.0 Serial	✓
	REMOTE Ports: Modbus TCP, DNP3.0 TCP, IEC60870-5-104 or IEC61850, SNTP Protocol, Web Server, IRIG-B	✓ (Optional)
	SICom Software for Windows 8, 8.1, 10 or 11	✓
	Session: 4 log-in levels with a configurable password	✓
	HMI: LCD, 20x4	✓

	Keypad: 6 keys + 1 reset button + 2 keys to open/close 52 + 2 key to block/unblock 79 + 2 keys to change local/remote control	✓
	LED indicators	11 configurable
Power Supply		
	Auxiliary voltage	Depending on the model: 24-48 Vdc (±20%). 48-230 Vac/dc (48-220 Vdc (±20%) / 48-230 Vac (±15%)). 24-230 Vdc/ac (24-220 Vdc (±20%) / 100-230 Vac (±15%)).
Monitoring and Recording		
	Events stored in the non-volatile RAM memory	3072
	Oscillographic logs in the non-volatile FRAM memory	1500 cycles at 32 samples/cycle Number of configurable cycles: 300 cycles→ are recorded in 5 oscillography records (length 300x5=1500). 60 cycles→ are recorded in 25 oscillography records (length 60x25=1500). 30 cycles→ are recorded in 50 oscillography records (length 30x50=1500). 15 cycles→ are recorded in 100 oscillography records (length 15x100=1500).
	Load data profiling (LDP)	✓ 2160 records
	Alarms Panel	✓ 32 alarms
	Real Time Clock (RTC 1 millisecond)	✓
	IRIG-B synchronism	✓ (Optional)
	Test menu	✓
	Self-diagnostic	✓
Settings Group		
	Using configurable inputs Using communications By general settings By users commands	4 settings group 6 settings group (Optional)
Mechanics		
	Dimensions	HxWxD: 198x187x153.15 (mm)

6.3 Functional diagram



Example with VTs. Voltage sensors are available depending on model.

6.4 Selection & Ordering codes

SIL-G

Feeder & Generator Protection Relay

0 1										**PHASE CURRENT MEASUREMENT** 1 A or 5 A 1 A (Short-circuitable terminal)[1]
	0 1									**NEUTRAL CURRENT MEASUREMENT** **1 A or 5 A (Only for phase current measurement digit 0)** 1 A or 0.1 A
		0 1 2 3 4								**VOLTAGE MEASUREMENT** Up to 1000 V (direct connection) or 250 V (with VTs) 8 Vrms LEA maximum, 1 MOhm 5.2 Vrms LEA maximum, 2 MOhm 16 Vrms LEA maximum, 2 MOhm 2.8 Vrms LEA maximum, 20 MOhm
			A B C							**POWER SUPPLY** 24-48 Vdc 48-220 Vdc / 48-230 Vac 24-220 Vdc / 100-230Vac
				0 1 2 3 4						**ADDITIONAL FUNCTIONS** - +25 + 27-L + 59-L + LMS[1] + 21FL[3] + 50INC[3] + 21FL[3] + 50INC[3] + LMS
					A B 2 E G 3 J M N O P Q R U V					**COMMUNICATIONS** A: 1xUSB + 1xRS485 B: 1xUSB + 1xRS485 + 1xRJ45 + IRIG-B 2 : 1xUSB + 1xRS485 + 1xRJ45 + HSR/PRP RJ45 + IRIG-B E: 1xUSB + 1xRS485 + 1xRJ45 + HSR/PRP SFP Cages + IRIG-B G: 1xUSB + WiFi + 1xRS485 + 1xRJ45 + IRIG-B 3 : 1xUSB + WiFi + 1xRS485 + 1xRJ45 + HSR/PRP RJ45 + IRIG-B J: 1xUSB + WiFi + 1xRS485 + 1xRJ45 + HSR/PRP SFP Cages + IRIG-B M: 1xUSB + 1xRS485 + 2xRJ45 + IRIG-B N: 1xUSB + WiFi + 1xRS485 + 2xRJ45 + IRIG-B O: 1xUSB + 1xRS485 + 1xRJ45 + IRIG-B P: 1xUSB + WiFi + 1xRS485 + 1xRJ45 + IRIG-B Q: 1xUSB + 1xRS485 + 1xFO-LC+ IRIG-B R: 1xUSB + WiFi + 1xRS485 + 1xFO-LC + IRIG-B U: 1xUSB + 1xRS485 + 1xRJ45 + 1xSFP Cage + IRIG-B V: 1xUSB + WiFi + 1xRS485 + 1xRJ45 + 1xSFP Cage + IRIG-B
						0 5 6 7 A B				INPUTS AND OUTPUTS 8 Inputs + 7 Outputs 24 Inputs + 7 Outputs 8 Inputs + 18 Outputs 16 Inputs + 11 Outputs 8 Inputs + 7 Outputs + 4 AFD Inputs + 4 High-speed Outputs 8 Inputs + 7 Outputs + 4 AFD Inputs + 4 High-speed Outputs with high breaking capacity at 24-48Vdc[3]
							4 5			**MECHANICAL ASSEMBLY** Vertical Assembly Vertical Assembly with tropicalization
								A E F		**LANGUAGE** English, Spanish, German and French English, Spanish, Turkish and Russian English, Spanish, German and Portuguese
									B	**ADAPTATION** (2) 50 + SOTF + 50G + 50N + (4) 67/51 + (2) 67G/51G + (2) 67N/51N + 67GI + 67NI + 64REF + 46 + 46BC + 49 + 49T + 37 + (2) 27+ 27V1 + (2) 59 + (2) 59N/G[1] + 47 + (4) 32 + (4) 81U/O_(6) 81U/O[2] + (4) 81R_(2) 81R[2] + 78 + (2) 24[1] + 79 + 74TCS + 60CTS + 60VTS/VSS[2] + 50BF + SHB + CLP + 52 + 86 + SCM[2] + SZM[2] + HLT + Power Supply Control[2]

Example of ordering code:

0	0	0	C	1	F	0	4	A	B	SIL G 0 0 0 C 1 F 0 4 A B
SIL-G										

PORTS	**PROTOCOLS**	
USB	Modbus RTU	
WiFi	Modbus TCP	
RS485	Modbus RTU, IEC60870-5-103 or DNP3.0 Serial	
FO-LC	Modbus TCP, DNP3.0 TCP, IEC60870-5-104 or IEC61850 + SNTP Protocol	
SFP Cage	Modbus TCP, DNP3.0 TCP, IEC60870-5-104 or IEC61850 + SNTP Protocol	
RJ45	**Communications digits B and G** **RJ45:** Modbus TCP, DNP3.0 TCP or IEC60870-5-104 + SNTP Protocol	**Communications digits 2, E, 3, J, M, N, O, P, U and V:** **RJ45:** Modbus TCP, DNP3.0 TCP, IEC60870-5-104 or IEC61850, SNTP Protocol

Not all combinations are possible. Please, confirm with Fanox chosen model.

NOTES:

- ANSI 67, ANSI 67G and ANSI 67N can be converted into ANSI 51, ANSI 51G and ANSI 51N respectively by setting the “Directionality” parameter to NO.
- ANSI 50G, ANSI 67G and ANSI 67GI will be converted into ANSI 50GS, ANSI 67GS and ANSI 67GSI in the model with neutral current measurement digit 1 (IN = 0.1A or 1A).
- Not all combinations are possible. Please, confirm with Fanox chosen model.
- [1] Available in models with conventional VTs (50G not available for voltage sensors).
- [2] Only for the models with voltage sensors (“voltage measurements” digits 1, 2, 3, 4). Available from fw version 1.21.00 onwards.
- [3] Available from FW version 1.21.00 onwards for models with voltage sensors and from 3.00.00 onwards for models with conventional CTs.
- For communication digits E, J, U and V, SFP transceivers will be installed by the user, and the following specifications must be fulfilled:

  Supply: 3.3v.

  Speed: 100BASE-FX, Fast Ethernet.

  The SFP module must support SerDes.

6.5 Phase CT and neutral CT selection

SIL-G measures from 0.01 to 30 times the nominal current.

The following table shows a summary of the phase and neutral CT combinations:

Model	In	Phase range	Neutral Range
SIL-G00	5 A	0.05-150 A	0.05-150 A
	1 A	0.01-30 A	0.01-30 A
SIL-G01*	5 A	0.05-150 A	-
	1 A	0.01-30 A	0.01-30 A
	0.1A	-	0.001-3 A

**SIL-G01 is available from firmware version 1.04.00 onwards.*

6.6 Phase LPVT selection

For the models with voltage sensors, a certain range of voltages in the secondary of the voltage sensors is required by the SIL-G to achieve the necessary accuracy.

The following table shows an example of standard sensors for the voltage levels:

Nominal Phase to Phase Voltage (V)	Phase to Neutral Voltage (V)	Recommended Sensor Ratio
24000	**13856**	**10000: 1 (20 Moms)** **20000/$\sqrt{3}$:3.25/$\sqrt{3}$ (2 MOhms)**
27000	**15588**	**6000:1 (2 MOhms)**

The example below shows the choice of the appropriate SIL-G model depending on the sensor used.

With a 24kV voltage, for example:

Vn primary phase-to-phase = 24,000 V V phase-to-neutral = 13,856 V.

Case 1: 10000:1 sensor

V primary sensor = 10,000 V. V secondary sensor = 1 V.

Vn secondary = V phase-neutral / (V primary sensor/ V secondary sensor).

Vn secondary = 13856 / (10000/1) = 1.39 V.

To choose the optimal model, 2xVn is considered, in this case: 2 x 1.39 = 2,77 V.

The SIL-G model is chosen with a maximum Vrms as close as possible to the 2xVn value (preferably the closest upper value). In this case 2,8 Vrms.

Case 2: 20000:3,25 sensor

V primary sensor = 20,000 V V secondary sensor = 3,25 V

Vn secondary = V phase-neutral / (V primary sensor/ V secondary sensor).

Vn secondary = 13856 / (20000:3.25) = 2,25 V.

To choose the optimal model, 2xVn is considered, in this case: 2 x 2,25 = 4,50 V.

The SIL-G model is chosen with a maximum Vrms as close as possible to the 2xVn value (preferably the closest upper value). In this case 5,2 Vrms.

These values are an example. Please, confirm with Fanox the ratio of the chosen sensors for each application.

7 GENERAL SETTINGS

General settings establish some parameters that are necessary for the relay to operate. These settings are defined as general because they affect the entire relay, and as a result they are not subject to a change of table.

Any change in the settings involves resetting the functions, regardless of whether them being active or not.

7.1 Measurements

For models using conventional VTs:

Function	Description	Minimum	Maximum	Step	Unit	Default
	Measurements					
	Frequency	50	60	50/60	Hz	50
	Phase Nominal Current	1	5	1/5	A	1
	Neutral Nominal Current	0.1	5	0.1/1/5	A	1
	CT Phase Ratio	1.0	3000.0	0.1	-	1000.0
	CT Neutral Ratio	1.0	3000.0	0.1	-	1000.0
	Current Presence (2)	0.000	0.500	0.001	xIn	0.100
	VT Connection			(1)	-	3 VT P-N + Vr
	Phase-Phase Nominal Voltage	50.0 (*)	480.0	0.1	V	110
	Voltage Nominal Neutral (2)	20.0	260.0	0.1	V	63.5
	VT Phase Ratio	1.0	3000.0	0.1	-	100.0
	VT Neutral Ratio	1.0	3000.0	0.1	-	100.0
	Voltage Presence (2)	0.00	0.50	0.01	xVn	0.10
	Voltage Block Frequency (3)	0.50	0.95	0.01	xVn	0.50
	IA Deadband (4)	0.03	0.50	0.01	In	0.1
	IB Deadband (4)	0.03	0.50	0.01	In	0.1
	IC Deadband (4)	0.03	0.50	0.01	In	0.1
	IN Deadband (4)	0.03	0.50	0.01	In	0.1
	VA Deadband (4)	0.03	0.50	0.01	Vn	0.1
	VB Deadband (4)	0.03	0.50	0.01	Vn	0.1
	VC Deadband (4)	0.03	0.50	0.01	Vn	0.1
	VN Deadband (4)	0.03	0.50	0.01	Vn	0.1

(1) 3VTs P-N, 3VTs P-N + Vr, 3VT P-P + Vr, 2VTs P-P +Vr, 3VT P-P.

(1) Minimum P-P Nominal voltage setting at 50V from FW version M01.03.00 onwards. For previous FW versions, the minimum setting is 100 V.

(2) Settings available from FW version 3.00.00 onwards. It is recommended to set "Current Presence" and "Voltage Presence" parameters to a value lower than the adjusted tap of the protection and control and supervision functions.

(3) Setting available from FW version 3.01.00 onwards.

(4) From fw version 1.03 onwards there is a dedicated menu to configure deadbands. Please check point 15.3. Deadbands for further information.

For models using voltage sensors:

Function	Description	Minimum	Maximum	Step	Unit	Default
	Measurements					
	Frequency	50	60	50/60	Hz	50
	Phase Nominal Current	1	5	1/5	A	1
	Neutral Nominal Current	1	5	1/5	A	1
	CT Phase Ratio	1.0	3000.0	0.1	-	100.0
	CT Neutral Ratio	1.0	3000.0	0.1	-	100.0
	Phase-Phase Nominal voltage	6000	69000	1	V	10000
	Bus Bar Voltage Ratio	1	30000	1	-	6153.8
	Line Voltage Ratio	1	30000	1	-	6153.8
	Current Presence (*)	0.005	0.3	0.001	In	0.010
	Current Absence (*)	0.005	0.3	0.001	In	0.008
	V-A RCF	0.500	2.000	0.001	-	1.000
	V-B RCF	0.500	2.000	0.001	-	1.000
	V-C RCF	0.500	2.000	0.001	-	1.000
	VL-A RCF	0.500	2.000	0.001	-	1.000
	VL-B RCF	0.500	2.000	0.001	-	1.000
	VL-C RCF	0.500	2.000	0.001	-	1.000
	IA Deadband (*)	0.03	0.50	0.01	In	0.10
	IB Deadband (*)	0.03	0.50	0.01	In	0.10
	IC Deadband (*)	0.03	0.50	0.01	In	0.10
	IN Deadband (*)	0.03	0.50	0.01	In	0.10
	VA Deadband (*)	0.03	0.50	0.01	Vn	0.10
	VB Deadband (*)	0.03	0.50	0.01	Vn	0.10
	VC Deadband (*)	0.03	0.50	0.01	Vn	0.10
	VN Deadband (*)	0.03	0.50	0.01	Vn	0.10

	VA-L Deadband (*)	0.03	0.50	0.01	Vn	0.10
	VB-L Deadband (*)	0.03	0.50	0.01	Vn	0.10
	VC-L Deadband (*)	0.03	0.50	0.01	Vn	0.10
	VN-L Deadband (*)	0.03	0.50		Vn	0.10

(*) Optional depending on the model.

Frequency: Displays the device's frequency. It is possible to change the rated frequency (50/60Hz).

The phase and neutral CT nominal current setting allow choosing between 1A or 5A.

The phase and neutral CT transformation ratio settings allow the measurements of the primary values from the protection transformer to be shown.

VT Connection and LPVT connection. Please see point 5.3.2 Analog Voltage Connections for available configurations.

Phase-Phase nominal voltage. It is possible to set the nominal voltage between phases with this parameter. For models with sensors for voltage measurement all the voltage functions work with P-N voltage, so Un will be the ***Nominal V. P-P*** setting (available in the general settings) divided by $\sqrt{3}$. Models with conventional VTs for voltage measurement work with P-N or P-P voltage depending on the VT connection.

Voltage nominal neutral parameter is used for the neutral voltage functions depending on the chosen VT connection. **Voltage Nominal Neutral** will be used when de connection type is 3VTs P-N + Vr, 3VTs P-P + Vr or 2VTs P-P +Vr and ***Nominal V. P-P setting***/$\sqrt{3}$ when the connection type is 3VTs P-N or 3VTs P-P.

The phase and neutral VT transformation ratio settings and the sensor transformation ratio ones allow the measurements of the primary values from the protection transformer or sensor to be shown.

Vx-RCF: correction factor. It is possible to set a correction factor in the voltage sensor to calibrate the voltage measurement (phase and line) once the relay is installed.

7.2 DFR

Function	Description	Minimum	Maximum	Step	Unit	Default
	DFR					
	Number of records	-	-	5*300 cycles, 25*60 cycles. 50*30 cycles, 100*15 cycles	-	25*60 cycles
	Prefault cycles	1	8	1	-	8

The change of any of these settings will provoke the erased of the fault reports (and of the oscillography - COMTRADE) buffer.

7.3 LDP

Function	Description	Minimum	Maximum	Step	Unit	Default
	LDP					

	Current Level	0.010	2.000	0.001	xIn	0.400
	Interval Time	1	60	1	min	1

7.4 Self-Diagnosis

The Power Supply Control “PSC”* is used to detect usual auxiliary supply and report if the value of the auxiliary power supply voltage is below the set threshold. This control function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
	SELF DIAGNOSIS					
	V Supply Alarm L1	19	220	1	V	20
	V Supply Alarm L1	19	220	1	V	55

If the auxiliary supply voltage is lower than the “Vsupply Alarm” setting, an alarm state will be activated in the self-diagnosis criteria. There are two adjustment levels with two alarms.

The alarms activate at 100% of the adjusted voltage and deactivates at 102%.

Note: The power supply control is working if the supply is DC voltage as it is focused on the external battery supply.

** Only available for the models with voltage sensors (“voltage measurements” digits 1, 2, 3, 4).*

7.5 Date

Function	Description	Minimum	Maximum	Step	Unit	Default
	Date					
	Sync. Time	1	12000	1	min	300
	GMT	-720	720	1	min	0

From version M01.04 onwards of the SILG the GMT setting has been added to the Date criterion.

The relay assumes that the incoming time is UTC when synchronizing via IRIG-B and SNTP, and local time when synchronizing via Modbus RTU, Modbus TCP, DNP3 serial, DNP3 TCP, IEC 60870-5-104, IEC 60870-5-103 and web server. When GMT is set, the relay changes the received UTC time by applying the corresponding GMT with respect to UTC. When GMT is set to 0, no changes will apply to the synchronized time.

7.6 General

Function	Description	Minimum	Maximum	Step	Unit	Default
	General settings					
	Identification	-	-	-	-	my IED
	Serial Number	-	-	-	-	*(*)*
	Language	-	-	-	-	English
	Settings Group	1	4 or 6(**)	1	-	1
	Reset Time	0.000	300.000	0.001	s	0.100
	CB Opening Time(**)	0.000	0.300	0.001	s	0.012
	Min. Response Time(**)	0.000	300.000	0.001	s	0.000

(*) The Serial number is a read-only setting.

(**) Only available for the models with voltage sensors ("voltage measurements" digits 1, 2, 3, 4).

Identification: It is an ASCII text used to identify the relay. Protection devices are normally associated with a specific line or position, and this setting is used for identification. It is important to fill in this field correctly, as the events and oscillography data are accompanied by this information. This setting can only be adjusted through communications.

Language: The device can display messages in four languages, one of which is English in all of them. Please see the list of models to find out about available languages.

Active settings group: The Settings group used by default can be selected with this parameter.

Reset time: It is the reset time for all current functions. This time is applied to reset of the trip of all the current protection functions. The accuracy of the reset time delay is equal to the theoretical time ±30ms or ±5% (whichever is greater).

CB Opening Time: Time interval between the fault inception and the fault clearance. This time is the longest fault current interruption time of the associated circuit breaker for the elimination of the fault current in the faulty device.

Min. Response Time: The minimum time that the relay waits to trip when a curve is selected.

From fw version 3.00.00 onwards

Function	Description	Minimum	Maximum	Step	Unit	Default
	General settings					
	Identification	-	-	-	-	my IED
	Serial Number	-	-	-	-	*(*)*
	Language	-	-	-	-	English
	Settings Group	1	4 or 6(**)	1	-	1
	CB Opening Time	0.000	0.300	0.001	s	0.010

	Min. Response Time	0.000	300.000	0.001	s	0.010
	Ph. Reset Time	0.000	300.000	0.001	s	0.100
	N. Reset Time	0.000	300.000	0.001	s	0.100

(*) The Serial number is a read-only setting.

Ph. Reset time: It is the reset time for all the phase current functions. This time is applied to reset of the trip of all the phase current protection functions. The accuracy of the reset time delay is equal to the theoretical time ±30ms or ±5% (whichever is greater).

N. Reset time: It is the reset time for all the neutral current functions. This time is applied to reset of the trip of all the neutral current protection functions. The accuracy of the reset time delay is equal to the theoretical time ±30ms or ±5% (whichever is greater).

7.7 Inputs

Function	Description	Minimum	Maximum	Step	Unit	Default
	Inputs					
	Debounce time	5	255	1	ms	15 ms

7.8 USB communication

Function	Description	Minimum	Maximum	Step	Unit	Default
	USB COM					
	Slave Address	1	247	1	-	1

7.9 Wi-Fi communication (*)

Function	Description	Minimum	Maximum	Step	Unit	Default
	Wi-Fi Communications					
	WIFI Enable	-	-	No/Yes	-	Yes
	SSID Hidden	-	-	No/Yes	-	No
	TCP Port	1	65.535	1	-	502
	IP Address	1.0.0.1	223.255.255.254	-	-	192.168.200.100
	Channel Number	1	13	1	-	5
	Slave Address	1	247	1	-	1

(*) Optional depending on model.

***When the relay is connected through wi-fi connection and the IP address is changed, the relay must switch off and on to ensure that the relay takes the new IP address. ***

7.10 Remote communications

7.10.1 Rear Serial Communication

Function	Description	Minimum	Maximum	Step	Unit	Default
	Rear Serial Communications					
	Protocol	-	-	Modbus RTU, IEC 60870-5-103 or DNP3.0		Modbus RTU
	Baud rate	4800	115200	4800, 9600, 19200, 38400, 57600, 115200	bauds	19200
	Parity	-	-	8-N-1, 8-E-1, 8-O-1, 9-N-1, 8-N-2, 8-E-2, 8-O-2, 9-N-2		8-N-1

MODBUS RTU

Function	Description	Minimum	Maximum	Step	Unit	Default
	MODBUS RTU Communications					
	Slave address	1	247	1	-	2

DNP3.0 Serial

Function	Description	Minimum	Maximum	Step	Unit	Default
	DNP3.0 Communications					
	Slave address	1	65,519	1	-	3
	Master address	1	65,519	1	-	1
	Multi Master	-	-	Yes or No	-	No
	Unsolicited Retries	1	255	1	-	10
	Unsolicited Timeout	0.020	300.000	0.001	s	2.000

Notes:

- **Pre-transmission delay:** time to wait since the frame is ready until it is finally sent.
- **Is Multi-Master:** the device admits various masters. If there is only one master (i.e., Is Multi-Master = false), then the device does only respond to the requests of the master whose address is the same as the one stored in the Master Address parameter, whenever the destination address is the same as the one stored in the Slave Address parameter. Is Multi-Master = true, then the device will respond to any request if the destination address is the same as the one assigned to the device itself.
- **Bits Timeout:** indicates how many bytes have to follow until it is considered that the message from the master has ended. It doesn't refer to the number of bits, but to the time associated with the number of bits that have to pass.
- **Unsolicited Response Retries:** whenever an unsolicited response is sent by the slave device, it should wait for a confirmation from the master. If a confirmation is not received within a

determined time (specified by the Unsolicited response timeout parameter), it should commit a retry, that is, the slave device should send again the last message that was sent to the master. This parameter specifies the number of times that the slave device should re-send the message.

- **Unsolicited Response Timeout:** it is the time that the device has to wait for until trying to send again the unsolicited response message if no confirmation has been received from the slave. If no retries are left (that is, the number of retries has been already spent), then the slave device should assume that there is no forthcoming confirmation from the master.

IEC60870-5-103

Function	Description	Minimum	Maximum	Step	Unit	Default
	IEC 60870-5-103 Communications					
	Slave address	1	254	1	-	3

7.10.2 Rear TCP Communications

Function	Description	Minimum	Maximum	Step	Unit	Default
	Rear TCP Communications					
	Protocol	-	-	Modbus TCP, DNP3.0 TCP, IEC60870-5-104 or IE61850 (*)		Modbus TCP
	IP Address	1.0.0.1	255.255.255.255	-	-	192.168.200.100
	Subnet	1.0.0.1	255.255.255.255	-	-	255.255.255.0
	Gateway	1.0.0.1	255.255.255.255	-	-	192.168.200.1
	DNS-1	0.0.0.0	255.255.255.255	-	-	0.0.0.0
	DNS-2	0.0.0.0	255.255.255.255	-	-	0.0.0.0
	Redundancy Type (*)	-	-	No redundancy, PRP Redundancy, HSR Redundancy	-	PRP Redundancy
	SNTP [1]	-	-	-	-	0.es.pool.ntp.org

(*) Depending on the model

[1] Available from firmware version M01.04 onwards.

MODBUS TCP

Function	Description	Minimum	Maximum	Step	Unit	Default
	MODBUS TCP					
	Slave address	1	247	1	-	2
	Modbus Port	1	65,535	1	-	502

DNP3.0 TCP

Function	Description	Minimum	Maximum	Step	Unit	Default
	DNP3.0 TCP					
	Slave address	1	65,519	1	-	3
	DNP3 Master address	1	65,519	1	-	1
	DNP3 TCP Port	1	65,535	1	-	20,000
	Multimaster	-	-	Yes or No	-	No
	Unsolicited Retries	1	255	1	-	10
	Unsolicited Timeout	0.020	300.000	0.001	s	2.000

IEC60870-5-104

Function	Description	Minimum	Maximum	Step	Unit	Default
	IEC 60870-5-104					
	OutStation Address (*)	1	65,534	1	-	1
	Port	1	65,535	1	-	2,404
	T0 (*)	1.000	255.000	0.001	s	30.000
	T1 (*)	1.000	255.000	0.001	s	15.000
	T2 (*)	1.000	255.000	0.001	s	10.000
	T3 (*)	1.000	255.000	0.001	s	20.000
	K parameter (*)	1	32,767	1	-	12
	W parameter (*)	1	32,767	1	-	8
	CYC Period (*)	0.000	300.000	0.001	s	0.000
	Back Period (*)	0.000	300.000	0.001	s	0.000
	Spontaneous Enable (*)	-	-	Yes or No	-	Yes
	Buffering Time (*)	0.010	0.500	0.001	s	0.020
	Max Command Delay (*)	0.010	300.000	0.001	s	0.020
	Select Timeout (*)	0.000	300.000	0.001	s	30.000
	IP Address 1 (*)	0.0.0.0	255.255.255.255	-		0.0.0.0
	IP Address 2 (*)	0.0.0.0	255.255.255.255	-		0.0.0.0
	Clock Sync Enabled (*)	-	-	Yes/No	-	No

(*) Optional depending on the model.

8 CURRENT PROTECTION FUNCTIONS

To be able to trip with any of the protection functions, the setting Function Enable must be set to a value different from No. There are 3 different options: Alarm, Trip or SHB Trip.

In the two first cases, the function will trip, but only if the Function Enable is set to Trip the protection function will participate in the GENERAL TRIP.

If SHB Trip is selected, the SHB function is checked (if enabled) and if a second harmonic is responsible for the pickup, the trip is blocked.

NOTE: Minimum TMS setting at 0.01 from FW version M01.03.00 onwards. For previous FW version, the minimum setting is 0.05.

8.1 Function 50. Instantaneous phase overcurrent

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
50-1 50-2	**Instantaneous phase overcurrent**					
	Function Enable	-	-	No/Alarm/Trip/SHB Trip	-	No
	Current Tap	0.010	30.000	0.001	xIn	5.000
	Time Delay	0.000	300.000	0.001	s	0.200

The time delay is independent of the operating current flowing through the relay. So, if the phase current exceeds its predetermined value during an equal or greater amount of time than this preset value, the protection function activates (trips) and does not reset itself until the average value of the phase drops below the point of the current pick-up. The function activates at 100% of the preset input and deactivates at 95%. The reset is instantaneous.

The accuracy of the Time Delay is equal to that of the set time delay ±35ms or ±0.5% (whichever is greater).

The reset time of the trip will depend on the “reset time”, which is set in the general settings.

8.2 Function SOTF. Switch On To Fault

This protection function can be set by using the following parameters:

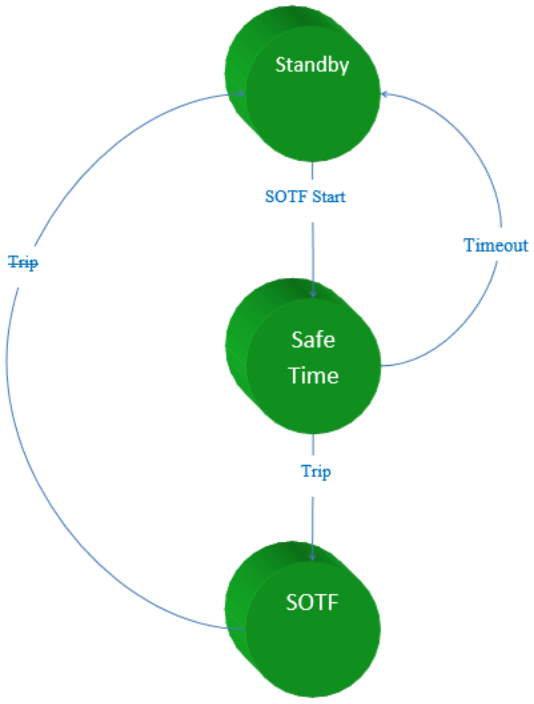
Function	Description	Minimum	Maximum	Step	Unit	Default
SOTF	**Switch On To Fault**					
	Function Enable	-	-	No/Alarm/Trip/SHB Trip	-	No
	Current Tap	0.010	30.000	0.001	xIn	5.000
	Time Delay	0.000	295.000	0.001	s	0.050
	Safe Time	0.020	300.000	0.001	s	2.000

When the logic signal '**SOFT Start**' is activated, the pickup of the function will start if the current is higher than the preset value. This protection is provided for high-speed clearance of detected faults immediately after the Manual Closure of the Circuit Breaker or any other conditions selectable through this logical signal.

The function is active during the time adjusted in Safe Time and this setting must be coordinated with the Time Delay to allow the correct behavior of the function.

The time delay is independent of the operating current flowing through the relay. So, if the phase current exceeds its predetermined value during an equal or greater amount of time than this preset value, the protection function activates (trips) and does not reset itself until the average value of the phase drops below the point of the current pick-up. The function activates at 100% of the preset input and deactivates at 95%. The reset is instantaneous.

The accuracy of the Time Delay is equal to that of the set time delay ±35ms or ±0.5% (whichever is greater).



8.3 Function 67/51. Inverse time directional phase overcurrent

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
67/51-1 67/51-2 67/51-3 67/51-4	**Inverse time directional phase overcurrent**					
	Function Enable	-	-	No/Alarm/Trip/SHB Trip	-	No
	Curve Type	-	-	(1)	-	IEC Standard Inverse
	Time Dial (TMS)	0.01	25.00	0.01	(2)	1.00
	Current Tap	0.010	20.000	0.001	xIn	5.000
	Time Delay	0.000	300.000	0.001	s	0.200
	Directionality	-	-	No/Forward/Reverse	-	No
	Polarization voltage	0.08	2.00	0.01	xUn	0.50
	Operating angle	0	359	1	degrees	90
	Half-cone angle	10	170	1	degrees	90

"Un" will be ***Nominal V. P-P*** setting (available in general settings) regardless the VT connection type, due to the polarization voltage is always considered as phase-phase voltage.

(1) Definite time and 8 curves are included to be selected by the user:

TYPE	NAME
DT	Definite Time
IEC	Standard Inverse
	Very Inverse
	Extremely Inverse
	Long Time Inverse
	Short time Inverse
IEEE	Moderately Inverse
	Very Inverse
	Extremely Inverse

(2) The range of the time Multiplier setting will depend on the curve. The range of this setting for each curve family is as follows:

TIME DIAL (TMS)						
	Description	**Minimum**	**Maximum**	**Step**	**Unit**	**Default**
IEC	Time Multiplier	0.01	1.00	0.01	-	1.00
IEEE	Time Multiplier	0.01	25.00	0.01	-	1.00

If the option 'Defined time' is selected for the curve setting, the unit behaves like an instantaneous directional overcurrent unit. In this case, the unit time delay is adjusted by using the parameter 'Time delay'.

If a curve is selected for the curve setting, the time delay depends on the curve, dial, and tap settings.

If the unit operates as defined time, the function is activated at 100% of the set tap value, and it deactivates at 95%.

If the unit operates with a curve, the function is activated at 110% of the set tap value, and it deactivates at 100%.

The reset time of the trip will depend on the “reset time”, which is set in the general settings.

If the unit operates as defined time, the accuracy of the Time Delay is equal to that of the set time delay ±35ms or ±0.5% (whichever is greater).

If a curve is selected for the curve setting, the accuracy of the time delay is equal to that of the theoretical time ±30ms or ±5% (whichever is greater).

The curves used are IEC 60255-151 and IEEE, which are described in the corresponding section.

This function uses the cross-phase voltage as a polarization magnitude and the phase current as an operating magnitude. The intervention sector is defined in the following way: the operating angle is rotated anticlockwise from the positive polarization voltage for forwarding directionality (negative polarization voltage for reverse directionality) which gives us the maximum torque direction. A cone is drawn, with the half-cone angle adjusted, over this maximum torque direction.

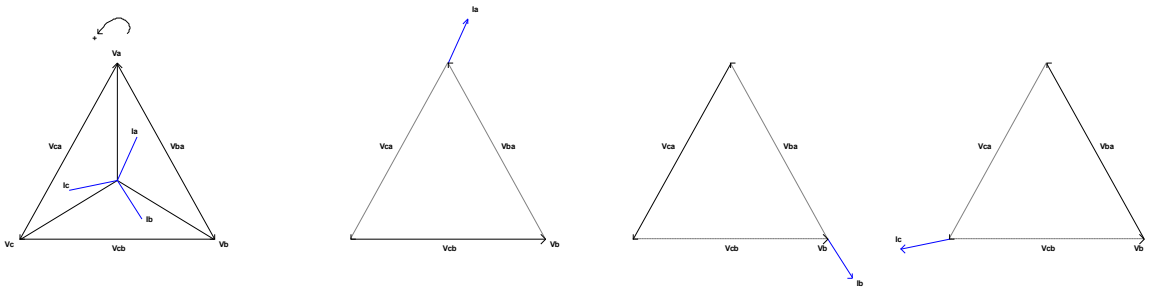
If the directionality option is not activated, the 67 functions behave like a 51/50 function.

The actuation time starts when the following conditions are met simultaneously:

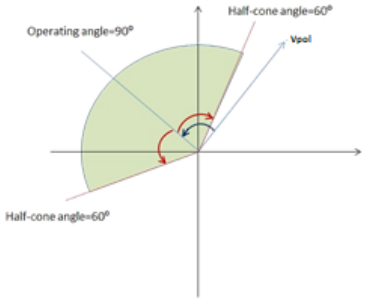
- Phase current higher than adjusted.
- The polarization voltage is higher than the adjusted (activation at 100%). To reset this condition, it is required a value lower than 95% of the adjusted voltage.
- The angle of the phase current is inside the intervention sector. The activation occurs when the angle of the phase current reaches the limits of the intervention sector or is inside this area. The deactivation occurs within a range of 3º out of the calculated limits of the intervention sector.

The following table shows the operating and polarization magnitudes used for each phase. Those magnitudes are displayed graphically below the table.

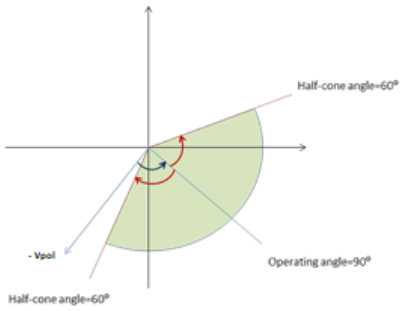
Phase	Operating magnitude	Polarization magnitude
Phase A	IA Current	UBC Voltage
Phase B	IB Current	UCA Voltage
Phase C	IC Current	UAB Voltage



The following figure shows a graphic representation of the directional actuation zone, adjusted with an operating angle of 90° and a half-cone angle of 60°.



FORWARD



REVERSE

Note: the directionality of this function is determined by the polarization voltage. Once the relay trips the directionality is no longer supervised, thus the function will continue tripped if the current and voltage are above their taps regardless of whether the angle of the current is in the intervention sector or not.

8.4 Function 50G. Instantaneous measured neutral overcurrent

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
50G	**Instantaneous measured neutral overcurrent**					
	Function Enable	-	-	No/Alarm/Trip/SHB Trip	-	No
	Current Tap	0.010	30.000	0.001	xIn	5.000
	Time Delay	0.000	300.000	0.001	s	0.200

The time delay is independent of the operating current flowing through the relay. So, if the measured neutral current exceeds its predetermined value for an equal or greater amount of time than this preset value, the protection function activates (trips) and does not reset itself until the average value of the phase drops below the point of the current pick-up.

The function activates at 100% of the preset input and deactivates at 95%.

The reset time of the trip will depend on the “reset time”, which is set in the general settings.

The accuracy of the Time Delay is equal to that of the set time delay ±35ms or ±0.5% (whichever is greater).

8.5 Function 50N. Instantaneous calculated neutral overcurrent

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
50N	**Instantaneous calculated neutral overcurrent**					
	Function Enable	-	-	No/Alarm/Trip/SHB Trip	-	No
	Current Tap	0.050	30.000	0.001	xIn	5.000
	Time Delay	0.000	300.000	0.001	s	0.200

The time delay is independent of the operating current flowing through the relay. So, if the calculated neutral current exceeds its predetermined value for an equal or greater amount of time than this preset value, the protection function activates (trips) and does not reset itself until the average value of the phase drops below the point of the current pick-up.

The function activates at 100% of the preset input and deactivates at 95%.

The reset time of the trip will depend on the “reset time”, which is set in the general settings.

The accuracy of the Time Delay is equal to that of the set time delay ±35ms or ±0.5% (whichever is greater).

8.6 Function 67G/51G. Inverse time directional measured neutral overcurrent

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
67G/51G-1 **67G/51G-2**	**Inverse time directional measured neutral overcurrent**					
	Function Enable	-	-	No/Alarm/Trip/SHB Trip	-	No
	Curve Type	-	-	(1)	-	IEC Standard Inverse
	Time Dial (TMS)	0.01	25	0.01	(2)	1.00
	Current Tap	0.010	20.000	0.001	xIn	5.000
	Time Delay	0.000	300.00	0.001	s	0.200
	Directionality	-	-	No/Forward/Reverse	-	No
	Polarization voltage	0.08	2.00	0.01	xUn	0.5
	Operating angle	0	359	1	degrees	90
	Half-cone angle	10	170	1	degrees	90

“Un” will be ***Nominal V. P-P setting***/$\sqrt{3}$ (available in general settings) regardless the VT connection type.

From FW version 3.00.00 onwards “Un” will be **Voltage Nominal Neutral** (available in general settings) when de connection type is 3VTs P-N + Vr, 3VTs P-P + Vr or 2VTs P-P +Vr. When the connection type is 3VTs P-N or 3VTs P-P, “Un” will be ***Nominal V. P-P setting***/$\sqrt{3}$ (available in general settings).

(1) Definite time and 8 curves are included to be selected by the user:

TYPE	NAME
DT	Definite Time
IEC	Standard Inverse
	Very Inverse
	Extremely Inverse
	Long Time Inverse
	Short time Inverse
IEEE	Moderately Inverse
	Very Inverse
	Extremely Inverse

(2) The range of the time Multiplier setting will depend on the curve. The range of this setting for each curve family is as follows:

TIME DIAL (TMS)						
	Description	Minimum	Maximum	Step	Unit	Default
IEC	Time Multiplier	0.01	1.00	0.01	-	1.00
IEEE	Time Multiplier	0.01	25.00	0.01	-	1.00

If the option ‘Defined time’ is selected for the curve setting, the unit behaves like an instantaneous directional overcurrent unit. In this case, the unit time delay is adjusted by using the parameter ‘Time delay’.

If a curve is selected for the curve setting, the time delay depends on the curve, dial, and tap settings.

If the unit operates as defined time, the function is activated at 100% of the set tap value, and it deactivates at 95%.

If the unit operates with a curve, the function is activated at 110% of the set tap value, and it deactivates at 100%.

The reset time of the trip will depend on the “reset time”, which is set in the general settings.

If the unit operates as defined time, the accuracy of the Time Delay is equal to that of the set time delay ±35ms or ±0,5% (whichever is greater).

If a curve is selected for the curve setting, the accuracy of the time delay is equal to that of the that of theoretical time ±30ms or ±5% (whichever is greater).

The curves used are IEC 60255-151 and IEEE, which are described in the corresponding section.

This function uses the neutral voltage as a polarization magnitude and the neutral current as an operating magnitude. The intervention sector is defined in the following way: the operating angle is rotated anticlockwise from the positive polarization voltage for forward directionality (negative polarization voltage for reverse directionality) which gives us the maximum torque direction. A cone is drawn, with the half-cone angle adjusted, over this maximum torque direction.

If the directionality option is not activated, the 67G functions behave like a 51G/50G function.

The actuation time starts when the following conditions are met simultaneously:

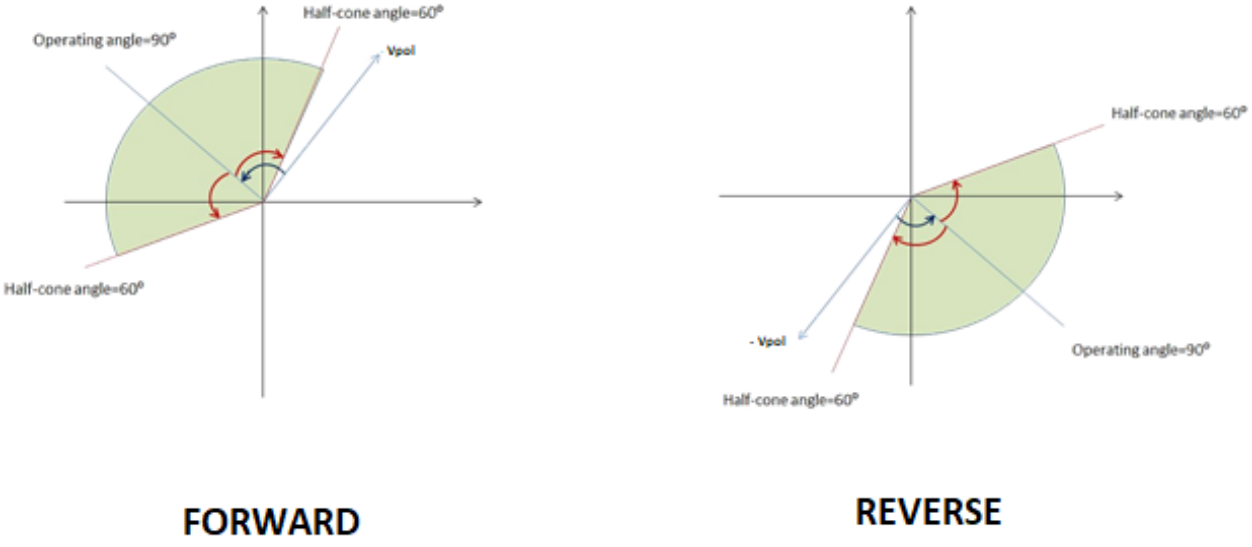
- The neutral current is higher than the adjusted.
- The polarization voltage is higher than the adjusted (activation at 100%). To reset this condition, it is required a value lower than 95% of the adjusted voltage.
- The angle of the neutral current is inside the intervention sector. The activation occurs when the angle of the neutral current reaches the limits of the intervention sector or is inside this area. The deactivation occurs within a range of 3º out of the calculated limits of the intervention sector.

The following table shows the operating and polarization magnitudes used for this function. Those magnitudes are displayed graphically below the table.

Neutral	Operating magnitude	Polarization magnitude
Neutral	IN Current	Vr if available or 3V-0 Voltage

For this function, depending on the VT connection, the polarization voltage will be the Residual Voltage (Vr) when available or the calculated 3V-0 when there is no direct measurement of the neutral voltage.

The following figure shows a graphic representation of the directional actuation zone, adjusted with an operating angle of 90° and a half-cone angle of 60°.



FORWARD **REVERSE**

Note: the directionality of this function is determined by the polarization voltage. Once the relay trips the directionality is no longer supervised, thus the function will continue tripped if the current and voltage are above their taps regardless of whether the angle of the current is in the intervention sector or not.

8.7 Function 67N/51N. Inverse time directional calculated neutral overcurrent

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
67N/51N-1 **67N/51N-2**	**Inverse time directional calculated neutral overcurrent**					
	Function Enable	-	-	No/Alarm/Trip/SHB Trip	-	No
	Curve Type	-	-	(1)	-	IEC Standard Inverse
	Time Dial (TMS)	0.01	25.00	0.01	(2)	1.00
	Current Tap	0.050	20.000	0.001	xIn	5.000
	Time Delay	0.000	300.000	0.001	s	0.200
	Directionality	-	-	No/Forward/Reverse	-	No
	Polarization voltage	0.08	2.00	0.01	xUn	0.50
	Operating angle	0	359	1	degrees	90
	Half-cone angle	10	170	1	degrees	90

"Un" will be ***Nominal V. P-P setting***/$\sqrt{3}$ (available in general settings) regardless the VT connection type.

From FW version 3.00.00 onwards "Un" will be **Voltage Nominal Neutral** (available in general settings) when de connection type is 3VTs P-N + Vr, 3VTs P-P + Vr or 2VTs P-P +Vr. When the connection type is 3VTs P-N or 3VTs P-P, "Un" will be ***Nominal V. P-P setting***/$\sqrt{3}$ (available in general settings).

(1) Definite time and 8 curves are included to be selected by the user:

TYPE	NAME
DT	Definite Time
IEC	Standard Inverse
	Very Inverse
	Extremely Inverse
	Long Time Inverse
	Short time Inverse
IEEE	Moderately Inverse
	Very Inverse
	Extremely Inverse

(2) The range of the time Multiplier setting will depend on the curve. The range of this setting for each curve family is as follows:

TIME DIAL (TMS)						
	Description	**Minimum**	**Maximum**	**Step**	**Unit**	**Default**
IEC	Time Multiplier	0.01	1.00	0.01	-	1.00
IEEE	Time Multiplier	0.01	25.00	0.01	-	1.00

If the option ‘Defined time’ is selected for the curve setting, the unit behaves like an instantaneous directional overcurrent unit. In this case, the unit time delay is adjusted by using the parameter ‘Time delay’.

If a curve is selected for the curve setting, the time delay depends on the curve, dial and tap settings.

If the unit operates as defined time, the function is activated at 100% of the set tap value, and it deactivates at 95%.

If the unit operates with a curve, the function is activated at 110% of the set tap value, and it deactivates at 100%.

The reset time of the trip will depend on the “reset time”, which is set in the general settings.

If the unit operates as defined time, the accuracy of the Time Delay is equal to the set time delay ±35ms or ±0,5% (whichever is greater).

If a curve is selected for the curve setting, the accuracy of the time delay is equal to the theoretical time ±30ms or ±5% (whichever is greater).

The curves used are IEC 60255-151 and IEEE, which are described in the corresponding section.

This function uses the calculated neutral voltage as a polarization magnitude and the neutral current as an operating magnitude. The intervention sector is defined in the following way: the operating angle is rotated anticlockwise from the positive polarization voltage for forward directionality (negative polarization voltage for reverse directionality) which gives us the maximum torque direction. A cone is drawn, with the half-cone angle adjusted, over this maximum torque direction.

If the directionality option is not activated, the 67N functions behave like a 51N/50N function.

The actuation time starts when the following conditions are met simultaneously:

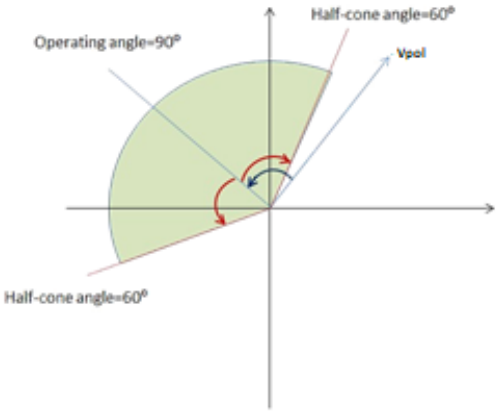
- The neutral current is higher than the adjusted.
- The polarization voltage is higher than the adjusted (activation at 100%). To reset this condition, it is required a value lower than 95% of the adjusted voltage.
- The angle of the neutral current is inside the intervention sector. The activation occurs when the angle of the neutral current reaches the limits of the intervention sector or is inside this area. The deactivation occurs within a range of 3º out of the calculated limits of the intervention sector.

The following table shows the operating and polarization magnitudes used for this function. Those magnitudes are displayed graphically below the table.

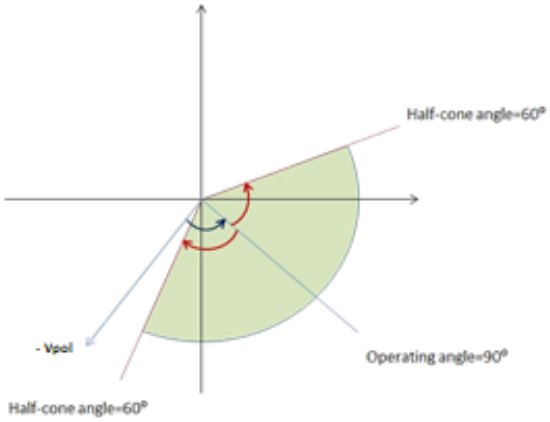
Neutral	Operating magnitude	Polarization magnitude
Neutral	3I-0 Current	Vr if available or 3V-0 Voltage

For this function, depending on the VT connection, the polarization voltage will be the Residual Voltage (Vr) when available or the calculated 3V-0 when there is no direct measurement of the neutral voltage.

The following figure shows a graphic representation of the directional actuation zone, adjusted with an operating angle of 90° and a half-cone angle of 60°.



FORWARD



REVERSE

Note: the directionality of this function is determined by the polarization voltage. Once the relay trips the directionality is no longer supervised, thus the function will continue tripped if the current and voltage are above their taps regardless of whether the angle of the current is in the intervention sector or not.

8.8 Function 67GI. Directional measured neutral overcurrent

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
67GI	**Directional measured neutral overcurrent**					
	Function enable	-	-	No/Alarm/Trip/SHB Trip	-	No
	Directionality	-	-	No/Forward/Reverse	-	No
	Low Current Tap	0.010	30.000	0.001	In	1
	Low Voltage Tap	0.08	2.00	0.01	Un	0.300
	High Current Tap	0.010	30.000	0.001	In	2
	High Voltage Tap	0.08	2.00	0.01	Un	0.600
	Time delay	0.000	300.000	0.001	s	0.200
	Operating angle	0	359	1	° (deg)	90
	Half-cone angle	10	170	1	° (deg)	90

“Un” will be ***Nominal V. P-P setting***/$\sqrt{3}$ (available in general settings) regardless the VT connection type.

From FW version 3.00.00 onwards “Un” will be **Voltage Nominal Neutral** (available in general settings) when de connection type is 3VTs P-N + Vr, 3VTs P-P + Vr or 2VTs P-P +Vr. When the connection type is 3VTs P-N or 3VTs P-P, “Un” will be ***Nominal V. P-P setting***/$\sqrt{3}$ (available in general settings).

This function uses the neutral voltage as a polarization magnitude and the neutral current as an operating magnitude. The intervention sector is defined in the following way: the operating angle is

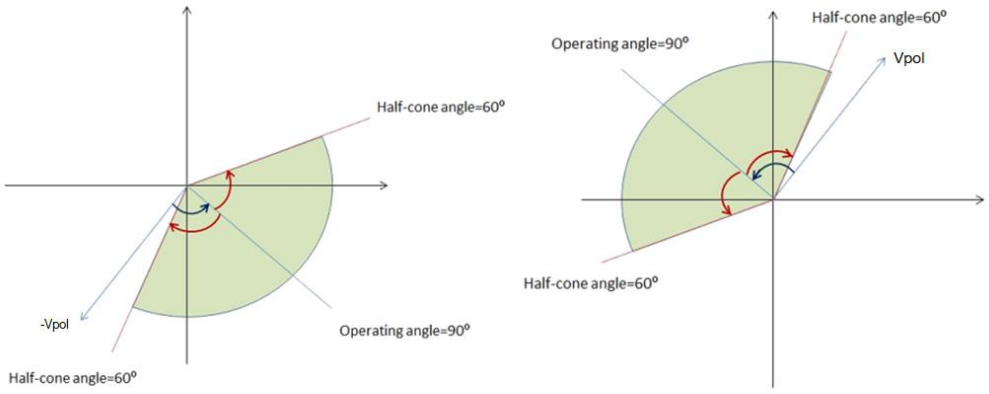
rotated anticlockwise from the negative polarization voltage for forwarding directionality (positive polarization voltage for reverse directionality) which gives us the maximum torque direction. A cone is drawn, with the half-cone angle adjusted, over this maximum torque direction.

The following table shows the operating and polarization magnitudes used for this function. Those magnitudes are displayed graphically below the table.

Neutral	Operating magnitude	Polarization magnitude
Neutral	I-N Current	Vr if available or 3V-0 Voltage

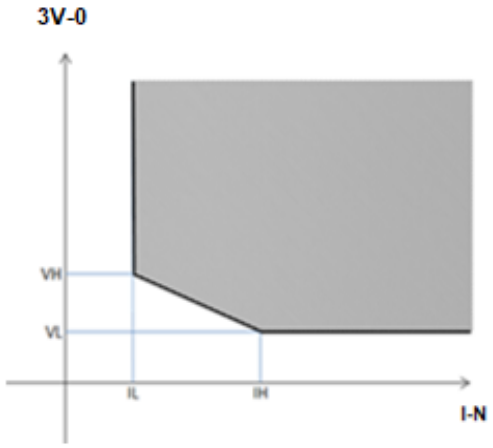
For this function, depending on the VT connection, the polarization voltage will be the Residual Voltage (Vr) when available or the calculated 3V-0 when there is no direct measurement of the neutral voltage.

The following figure shows a graphic representation of the directional actuation zone, adjusted with an operating angle of 90° and a half-cone angle of 60°.



FORWARD REVERSE

To perform the module evaluation, the residual voltage and the residual current measurements are used, defining a working area according to the settings of the low and high currents and the low and high voltages.



Working area characteristic of I-N and 3V-0 or Vr.

The actuation time starts when the following conditions are met simultaneously:

- The phase shift of the neutral current and neutral voltage is such that the neutral current is within the intervention sector.
- The neutral voltage and current are inside the working area of the adjusted characteristic.

- The neutral current is higher than the adjusted.
- The polarization voltage is higher than the adjusted (activation at 100%). To reset this condition, it is required a value lower than 95% of the adjusted voltage.
- The angle of the neutral current is inside the intervention sector. The activation occurs when the angle of the neutral current reaches the limits of the intervention sector or is inside this area. The deactivation occurs within a range of 3º out of the calculated limits of the intervention sector.

The function starts up at 100% of the adjusted pickup and resets at 95%.

The reset time of the trip will depend on the “reset time”, which is set in the general settings.

The actuation time accuracy is ±30ms or ±5% of the theoretical actuation time, whichever is higher.

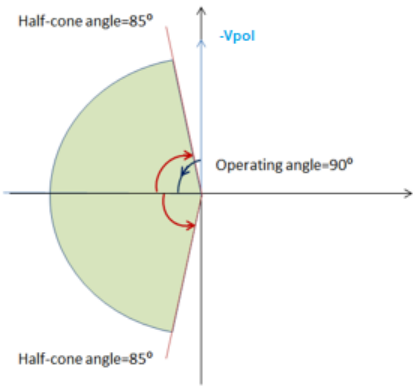
Note: the directionality of this function is determined by the polarization voltage. Once the relay trips the directionality is no longer supervised, thus the function will continue tripped if the current and voltage are above their taps regardless of whether the angle of the current is in the intervention sector or not.

Application example:

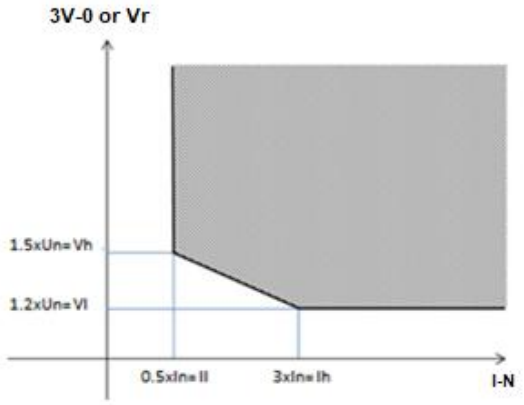
67GI parameters:

- Permission: Yes
- Directionality: Forward
- Low current: 0.5 (In=1)
- High current: 2 (In=1)
- Low voltage: 1.2xUn
- High voltage: 1.5x Un
- Operating time: 0.1s
- Operating angle: 90º
- Halfcone angle: 85º

The directional operation area will be defined according to the following characteristic:



The working area will be defined according to the following characteristic:



8.9 Function 67NI. Directional calculated neutral overcurrent

This function is based on two supervisions: The analog to the one that uses the 67NI to check that the residual current is inside the area defined by the settings of directionality, operation angle and half-cone, and the second supervision of the modules of the residual voltage and current. This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
67NI	**Directional calculated neutral overcurrent**					
	Function Enable	-	-	No/Alarm/Trip/SHB Trip	-	No
	Directionality	-	-	No/Forward/Reverse	-	No
	Low current Tap	0.050	30.000	0.001	In	1
	Low Voltage Tap	0.08	2.00	0.01	Un	0.300
	High Current Tap	0.050	30.000	0.001	In	2
	High Voltage Tap	0.08	2.00	0.01	Un	0.600
	Time delay	0.000	300.000	0.001	s	0.200
	Operating angle	0	359	1	degrees	90
	Half-cone angle	10	170	1	degrees	90

"Un" will be ***Nominal V. P-P setting***/$\sqrt{3}$ (available in general settings) regardless the VT connection type.

From FW version 3.00.00 onwards "Un" will be **Voltage Nominal Neutral** (available in general settings) when de connection type is 3VTs P-N + Vr, 3VTs P-P + Vr or 2VTs P-P +Vr. When the connection type is 3VTs P-N or 3VTs P-P, "Un" will be ***Nominal V. P-P setting***/$\sqrt{3}$ (available in general settings).

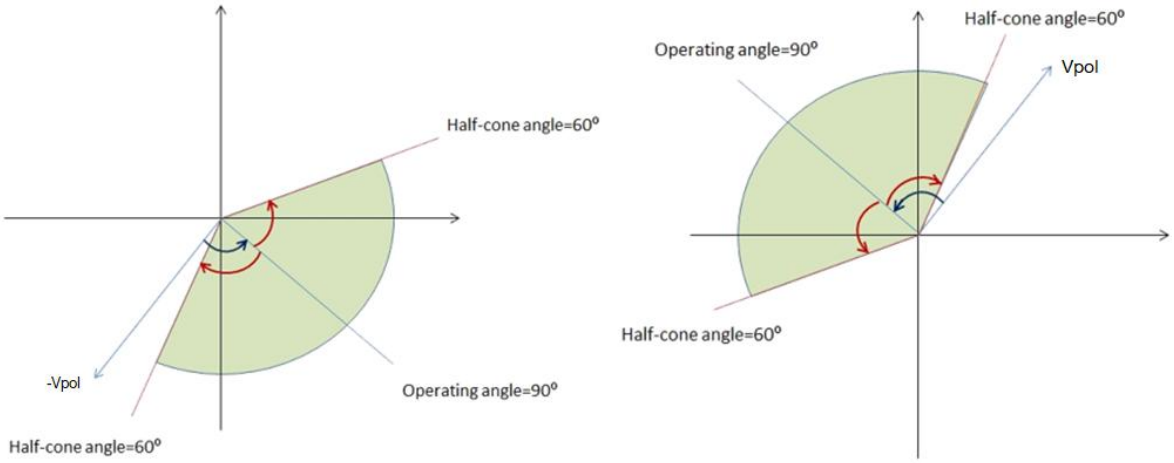
This function uses the neutral voltage as a polarization magnitude and the neutral current as an operating magnitude. The intervention sector is defined in the following way: the operating angle is rotated anticlockwise from the negative polarization voltage for forward directionality (positive polarization voltage for reverse directionality) which gives us the maximum torque direction. A cone is drawn, with the half-cone angle adjusted, over this maximum torque direction.

The following table shows the operating and polarization magnitudes used for this function. Those magnitudes are displayed graphically below the table.

Neutral	Operating magnitude	Polarization magnitude
Neutral	3I-0 Current	Vr if available or 3V-0 Voltage

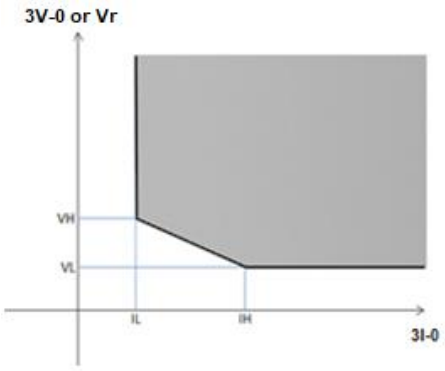
For this function, depending on the VT connection, the polarization voltage will be the Residual Voltage (Vr) when available or the calculated 3V-0 when there is no direct measurement of the neutral voltage.

The following figure shows a graphic representation of the directional actuation zone, adjusted with an operating angle of 90° and a half-cone angle of 60°.



FORWARD REVERSE

To perform the module evaluation, the residual voltage and the residual current measurements are used, defining a working area according to the settings of the low and high currents and the low and high voltages.



Working area characteristic of 3I-0 and 3V-0 or Vr.

The actuation time starts when the following conditions are met simultaneously:

- The phase shift of neutral current and neutral voltage is such that the neutral current is inside the intervention sector.
- The neutral voltage and current are inside the working area of the adjusted characteristic.
- The neutral current is higher than the adjusted.
- The polarization voltage is higher than the adjusted (activation at 100%). To reset this condition, it is required a value lower than 95% of the adjusted voltage.
- The angle of the neutral current is inside the intervention sector. The activation occurs when the angle of the neutral current reaches the limits of the intervention sector or is inside this

area. The deactivation occurs within a range of 3º out of the calculated limits of the intervention sector.

The function starts up at 100% of the adjusted pickup and resets at 95%.

The reset time of the trip will depend on the “reset time”, which is set in the general settings.

The actuation time accuracy is ±30ms or ±5% of the theoretical actuation time, whichever is higher.

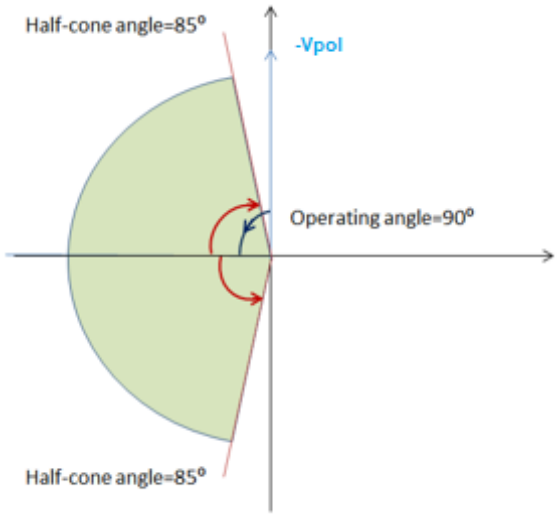
Note: the directionality of this function is determined by the polarization voltage. Once the relay trips the directionality is no longer supervised, thus the function will continue tripped if the current and voltage are above their taps regardless of whether the angle of the current is in the intervention sector or not.

Application example:

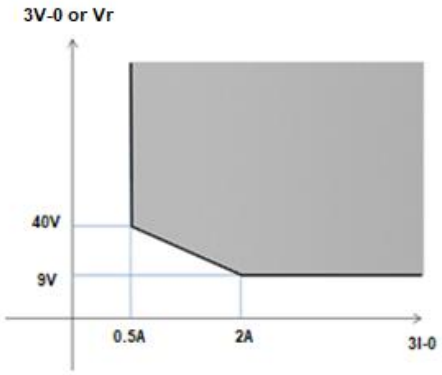
67NI parameters:

- Permission: Yes
- Directionality: Forward
- Low current: 0.5 (In=1)
- High current: 2 (In=1)
- Low voltage: 1.2xUn
- High voltage: 1.5x Un
- Operating time: 0.1s
- Operating angle: 90º
- Halfcone angle: 85º

The directional operation area will be defined according to the following characteristic:



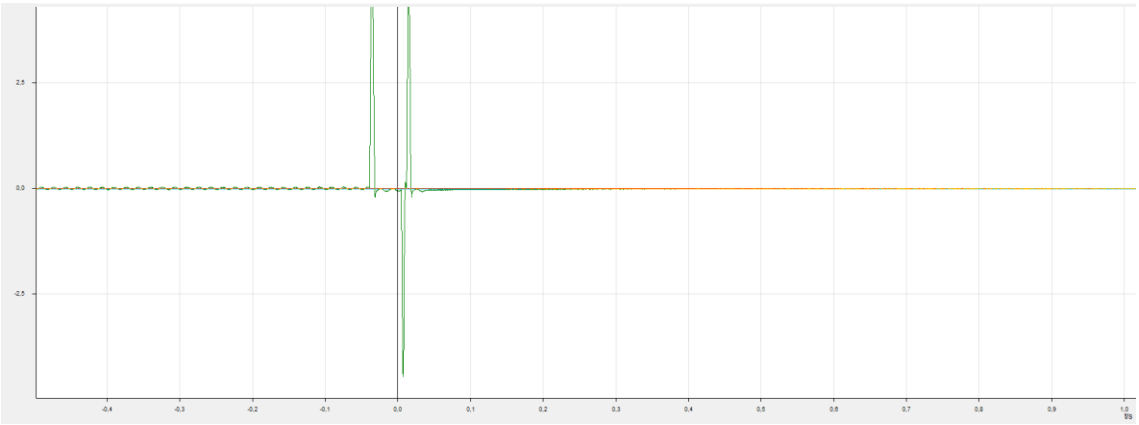
The working area will be defined according to the following characteristic:



8.10 Function 50INC. Incipient Fault detection

The incipient faults are special faults due to cable insulation breakdowns induced because of aging, mechanical, thermal, and environmental issues. The lack of insulation of the cable causes an electric discharge to ground detected as non-periodic, asymmetric and sporadic current burst of random magnitude.

These incipient faults last from half a cycle to a cycle and they usually extinguish at the next zero crossing.



This short burst makes it difficult for traditional overcurrent protection functions to detect this type of faults. The overcurrent functions are based on signal fundamental component (signal DFT) that filter this kind of signals which do not spread in time enough to trip

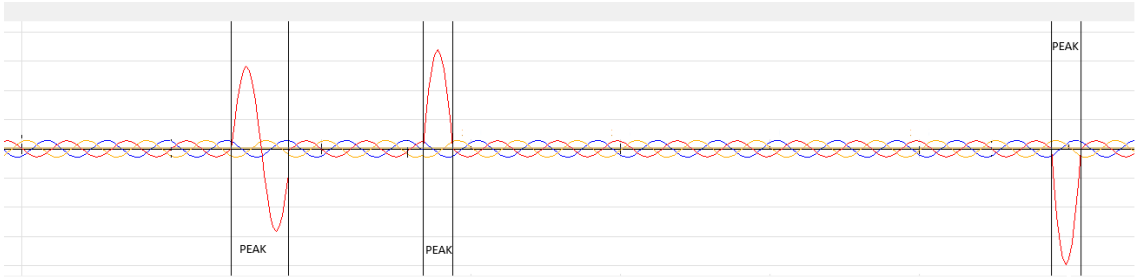
These kinds of signals are filtered by DFT fundamental component, and they do not last enough to activate the overcurrent functions.

To detect these incipient faults, the equipment must detect and distinguish this type of signals according to their time and magnitude characteristics.

Fanox relay “50 Incipient protection” is based on phase and neutral current samples to distinguish this type of signals. This protection function implements a peak detector algorithm.

The algorithm will check each sample to determine if it is greater than the limit set by the settings. It will detect how many samples are greater than the limit inside a cycle.

It will determine that a peak has occurred if at least two samples are detected in half a cycle, and the next half cycle has no samples greater than the limit. It will also be considered as a peak if the relay detects samples greater than the limit in a whole cycle and the next half cycle does not have any of them.



This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
50INC	**Incipient Fault Detection**					
	Function Enable	-	-	No/Alarm/Trip	-	No
	Phase Current Tap	0.5	20	0.001	xIn	7
	Neutral Current Tap	0.5	20	0.001	xIn	7
	Pickup Peaks Number	1	10	1	-	1
	Trip Peaks Number	1	10	1	-	1

If "**Function Enable"** setting is set to "Alarm", it will enable the function, but the trip will not activate the General Trip, to contribute to it, the setting must be set to "Trip".

"**Current Tap**" settings will be translated to instantaneous values of the sampled wave.

"**Pickup Peaks Number**" setting determines the number of peaks detected by each phase to activate the state pickup.

"**Trip Peaks Number**" setting establishes the number of peaks detected by each phase to trip. Trip Peaks Number must be equal or greater than "Pickup Peaks Number".

8.10.1 Blocking and Reset Signals

There is a control signal in the Fanox relay that can be configured by the user to reset phase and neutral peak counters, hence, it deactivates the pickup and trip states. This control signal is called "*50INC Reset*" inside PGC logic.

Another control signal available inside the PGC logic of the relay is called "*50INC Block*". This signal blocks the peak detector algorithm and deactivates all pickup and trip signals of this protection function while it is activated.

Both logics can be set through the protection settings menu.

8.10.2 Accuracy

Peak Detection: Fanox relays sampling frequency is 32 samples per cycle. Depending on the “Tap setting” and peak duration, it is necessary that the peak lasts 6-8ms at 50Hz (a period of 20ms) and 6-7ms at 60Hz (a period of 16ms) in order to get at least two samples in half a cycle.

States activation: The activation of the pickup and trip states will be at the end of the next half cycle with no peaks, once the number of peaks has reached.

8.11 Function 64REF. Restricted Earth Fault

The **low impedance restricted earth fault** is a sensitive ground fault differential protection and no external stabilizing resistors are needed.

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
64REF	**Restricted Earth Fault**					
	Function Enable	-	-	No/Alarm/Trip/SHB Trip	-	No
	Current Tap	0.050	20.000	0.001	xIn	0.500
	Time delay	0.020	300.000	0.001	s	0.200
	In SHB Tap	5	50	1	%	20

The Restricted Earth Fault protection function is used to detect ground faults in solidly grounded or impedance-grounded power transformers, grounding transformers, and shunt reactors. It can be used to protect rotating machines if the machine’s neutral point is grounded.

The term "REF protection" means not to sense any earth faults outside this restricted zone. REF protection is fast and can isolate winding faults extremely quickly, thereby limiting damage and consequent repair costs. If CTs are located on the transformer terminals only the winding is protected. However, quite often the secondary CT is placed in the distribution switchboard, thereby extending the protection zone to include the main cable.

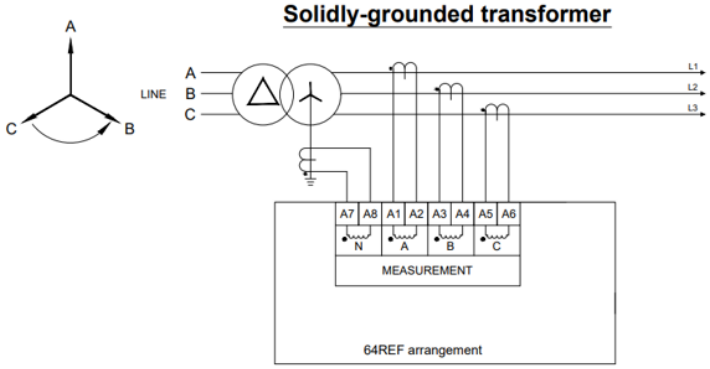
Historically, because of equipment and technology limitations, only high-impedance REF relay was available. This relay has a certain level of immunity to CT saturation during external faults. However, the use of this relay requires that: the number of turns ratios of the phase and neutral CTs must be the same, the saturation characteristics of the CTs should be the same, and the CTs should have closely similar and high knee-point voltage. Also, a specific connection between them is required.

Modern REF operation is based on the low impedance principle. A significant difference with the high-impedance one is that the operating current of the low-impedance REF protection is not realized by the CT connection. With low-impedance REF, the relay measures all of the four CTs necessary to accomplish the protection. A very important advantage of low impedance REF protection is the fact that the CT ratios for the phase CTs and neutral CTs do not have to be the same.

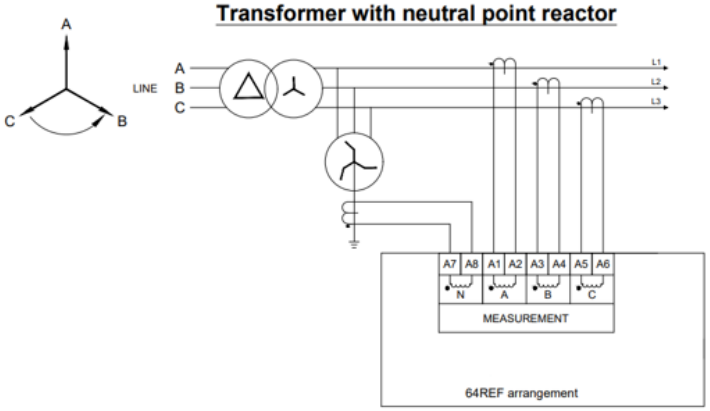
It is also very selective protection because the protection zone is limited by the CTs. Because of this, the REF does not require additional time delay for the protection of transformers or rotation machines against internal ground faults. Because of the differential protection principle, it is also very sensitive which makes it suitable for detecting faults located near the neutral point of the protected device.

Please, see CT wiring and connections for each situation (coordination between CT's polarity on phase and neutral must be respected):

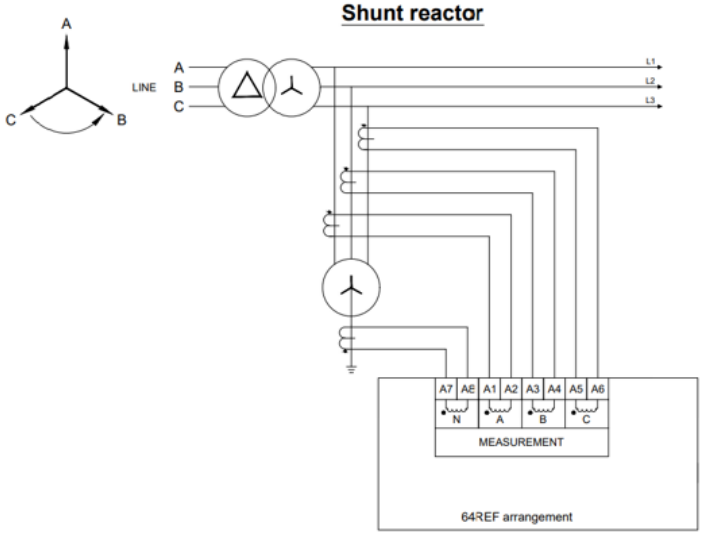
Solidly-grounded transformer

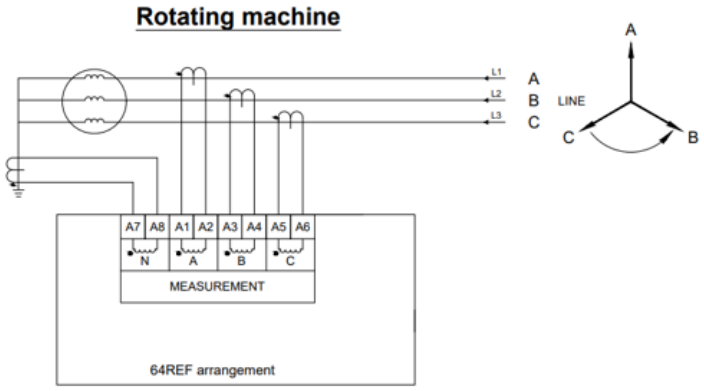


Transformer with neutral point reactor



Shunt reactor





The REF principle is based on the differential protection principle and is sensitive to the fundamental frequency component of the measured currents. The function is based on the difference between the calculated residual current ($3I_0$) and the current measured at the neutral point (I_n).

The function calculates the differential current I_D according to:

$$\overrightarrow{ID} = \overrightarrow{3I0} - \overrightarrow{IN}$$

And the angle difference between those 2 vectors:

$$\varphi = \mathrm{ang}(\overrightarrow{3I0}\,;\,\overrightarrow{IN})$$

Being the operating current I_{DF} defined as (this is the value to be compared with the Current Tap setting):

$$IDF = \left|\overrightarrow{3I0} - \overrightarrow{IN}\right| * cos\varphi$$

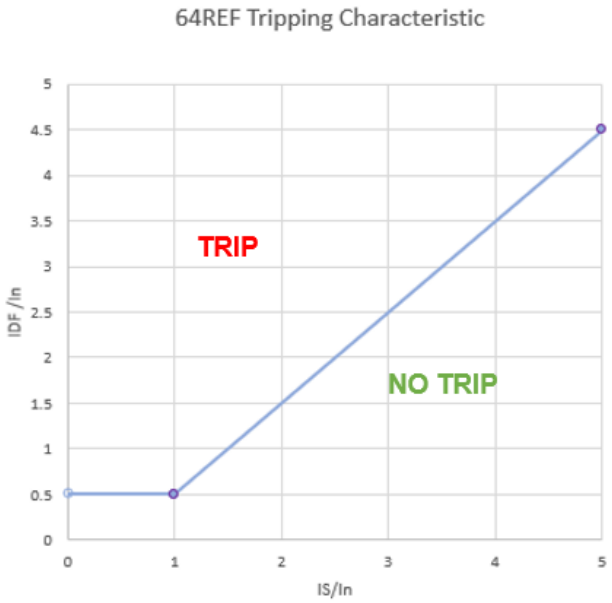
And the restraint characteristics "I_S" is defined as:

$$IS = max\,(IA, IB, IC)$$

When "I_S" is lower than the Current Tap, the adjusted tap value is applied. However, when "I_S" is higher than the Current Tap, this tap needs to be adjusted (increased) to avoid undesirable trips due to CT saturation or inrush currents:

$$\mathbf{Adjusted\ Current\ Tap} = \mathbf{Current\ Tap} * [(\mathbf{Is} - \mathbf{1}) * \mathbf{Slope}]$$

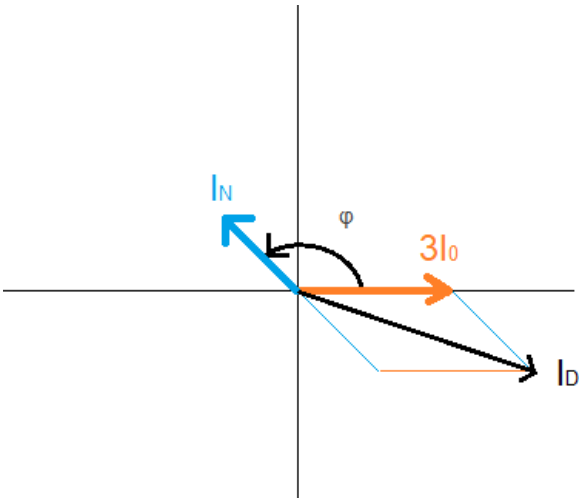
Tripping characteristic of 64REF is defined by two zones:



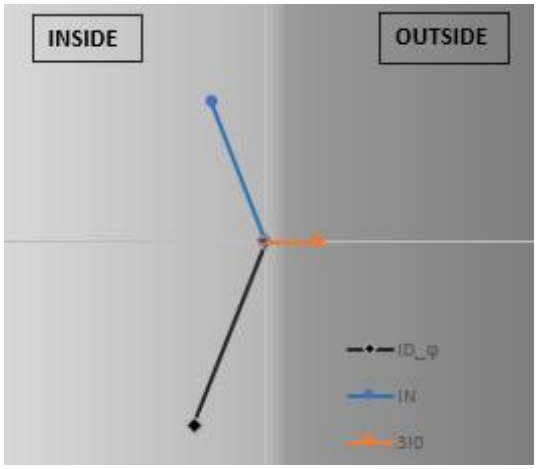
The first zone, when "I_S" is lower than the nominal current of the system, is defined just by the tap and the second zone, with a slope of 45º (100% increase), where the value of "I_S" is considered to determine if there is a trip condition or not.

During **healthy conditions**, the neutral point current (I_N) is near or equal to zero and the same is true for the calculated sum of the phase currents $3I_0=I_A+I_B+I_C$. During healthy conditions, the differential current I_{DF} is also close to zero and the REF protection function does not start.

When a fault occurs **in the protection zone**, the neutral current flowing into the protection zone has a positive current direction according to the current direction convention. Depending on the network conditions, an additional fault current may or may not flow into the zone along the line. This additional fault current manifests itself as a residual current. In other words, the neutral point current and the residual current are in an **opposite phase** which results in a high differential current IDF that activates the function.



This directionality (opposite phase) is determined by the modulus of I_D and the angle φ:



During a fault condition **outside the protection zone**, a ground fault current flowing from the faulty phase to the earth returns to the system's neutral point. Because of the convention of current directions and connections, the resulting neutral point current (I_N) and the calculated residual current ($3I_0$) are flowing in the **same direction**, resulting in zero or a very low differential current I_{DF} and the REF protection function does not start.

During a short-circuit fault outside the protection zone, the current transformers may be exposed to very high currents. These high fault currents may lead to different saturations of the phase current transformers resulting in an inaccurate $3I_0$ current. To ensure the correct operation of the protection function, a stabilization method that is based on restraining the I_S current has been implemented. The restraint current is applied to increase the pick-up threshold during external faults in case of a large fault current magnitude.

For example, in the following images the tripping characteristic (blue line) is defined as follows:

64REF:

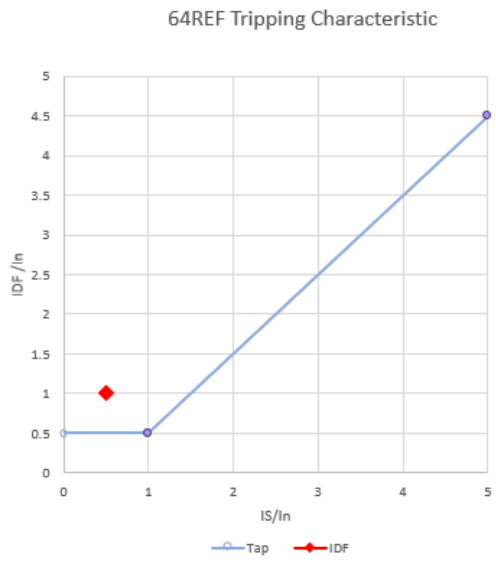
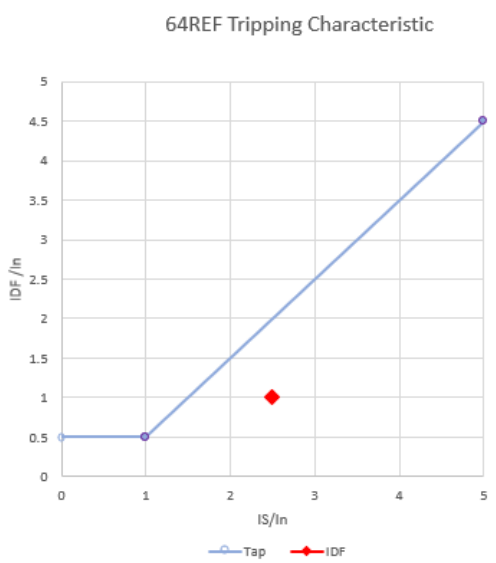
Function Enable: Trip

Current Tap: 0.5 x In

Time Delay: 0.200 s

In SHB Tap: 20%

And the characteristics of the system (red point) are as shown in the table below each graphic:

	
Injected phase currents (A) I_A= 1.5 A ⌞0º I_B= 1.0 A ⌞-120º I_C= 1.0 A ⌞120º	Injected phase currents (A) I_A= 3.5 A ⌞0º I_B= 3.0 A ⌞-120º I_C= 3.0 A ⌞120º
Calculated $3I_0$ (A) $3I_0$= 0.5 ⌞0º	Calculated $3I_0$ (A) $3I_0$= 0.5 ⌞0º
Injected measured neutral current (A) I_N= 0.5 A ⌞180º	Injected measured neutral current (A) I_N= 0.5 A ⌞180º

It can be seen how the increase on the phase currents, with the same resulting $3I_0$ and I_N, has displaced the characteristic of the system to the right on the x-axis, needing a higher difference I_{DF} to activate the function.

An additional second harmonic blocking system is also provided to avoid undesirable tripping based on the second harmonic content of the neutral current.

The function starts up at 100% of the adjusted pickup and resets at 90%.

The reset time of the trip will depend on the “reset time”, which is set in the general settings.

The actuation time is accurate to ±35ms or ±5% of the theoretical actuation time, whichever is higher.

8.12 Function 46. Phase balance current protection

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
46	**Phase balance current protection**					
	Function Enable	-	-	No/Alarm/Trip/SHB Trip	-	No
	Curve Type	-	-	(1)	-	IEC Standard Inverse
	Time Dial (TMS)	0.01	25.00	0.01	(2)	1.00
	Current Tap	0.050	20.000	0.001	xIn	5.000
	Time delay	0.000	300.000	0.001	s	0.200

(1) Definite time and 8 curves are included to be selected by the user:

TYPE	NAME
DT	Definite Time
IEC	Standard Inverse
	Very Inverse
	Extremely Inverse
	Long Time Inverse
	Short time Inverse
IEEE	Moderately Inverse
	Very Inverse
	Extremely Inverse

(2) The range of the time Multiplier setting will depend on the curve. The range of this setting for each curve family is as follows:

TIME DIAL (TMS)						
	Description	Minimum	Maximum	Step	Unit	Default
IEC	Time Multiplier	0.01	1.00	0.01	-	1.00
IEEE	Time Multiplier	0.01	25.00	0.01	-	1.00

If the option ‘Defined time’ is selected for the curve setting, the unit behaves like an instantaneous directional overcurrent unit. In this case, the unit time delay is adjusted by using the parameter ‘Time delay’.

If a curve is selected for the curve setting, the time delay depends on the curve, dial and tap settings.

If the unit operates as defined time, the function is activated at 100% of the set tap value, and it deactivates at 95%.

If the unit operates with a curve, the function is activated at 110% of the set tap value, and it deactivates at 100%.

The reset time of the trip will depend on the “reset time” set in general settings.

If the unit operates as defined time, the accuracy of the Time Delay is equal to the set time ±35ms or ±0.5% (whichever is greater).

If a curve is selected for the curve setting, the accuracy of the time delay is equal to the theoretical time ±30ms or ±5% (whichever is greater).

The curves used are IEC 60255-151 and IEEE, which are described in the corresponding section.

8.13 Function 46BC. Broken Conductor Detection

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
46BC	**Broken Conductor Detection**					
	Function Enable	-	-	No/Alarm/Trip	-	No
	Tap	15	100	1	%	50
	Operating time	0.030	300.000	0.001	s	0.200

This protection detects the percentage of the phase unbalance due to an open phase condition. It considers the measurement I2/I1 as a percentage.

If the measured relation between I2 and I1 is higher (in percentage) than the setting in the function during the adjusted time, the function will trip.

The function activates at 100% of the pre-set input and deactivates at 95%. The reset is instantaneous.

The accuracy of the time delay is equal to the set time delay ±30ms or ±0.5% (whichever is greater).

8.14 Function 49. Thermal overload

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
49	**Thermal overload**					
	Function Enable	-	-	No/Alarm/Trip	-	No
	Current Tap	0.100	2.400	0.001	xIn	1.200
	ζ Heating constant	3	600	1	min	3
	Cooling constant	1	6	1	x ζ Heating	1
	Alarm	20	99	1	%	80

The thermal image is a measurement of the heating and cooling of an electric machine. Contrary to an overcurrent protection time it does not start counting when a fault is detected. It continues to calculate the thermal status of the monitored machine. Tripping time depends on the adjusted thermal constants, the operative current, and the previous thermal status of the machine.

The thermal image is calculated based on the next equation:

$$\theta = 100 \times (I/It)^2 \times (1 - e^{-t/\zeta}) + \theta'0 \times e^{-t/\zeta}$$

where:

I, maximum three-phase fundamental current.

It, adjusted tap current.

ζ, thermal constant.

θ'0, initial thermal status.

Tripping time is determined by the next equation:

$$t = \zeta \times \ln \{[(I/It)^2 - (\theta'0 / 100)] / [(I/It)^2 - 1]\}$$

Tripping time accuracy is 5% over the theoretical time.

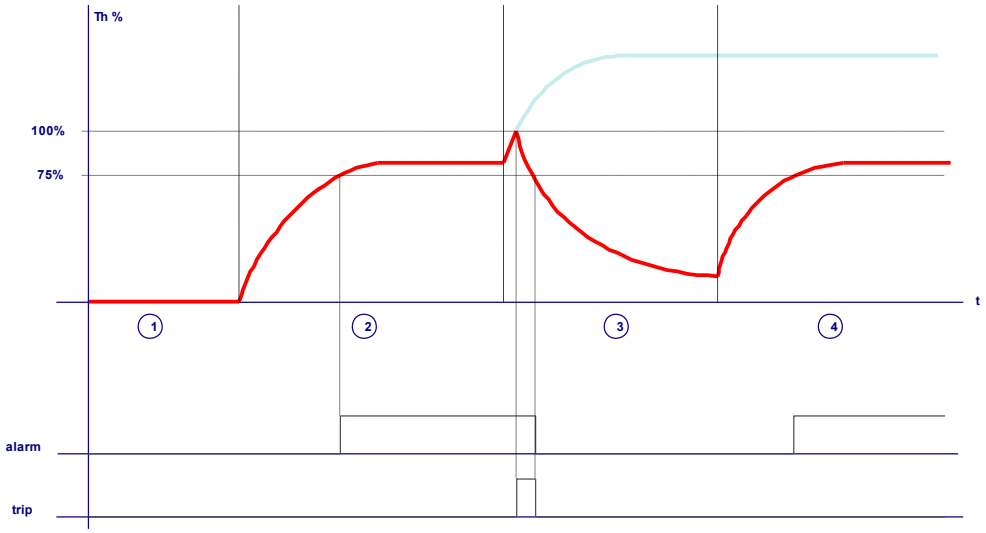
The algorithm uses the maximum current of the three-phase currents. If the maximum current is higher than the adjusted tap, the heating thermal constant is applied. If the maximum current is lower than the adjusted tap, the cooling thermal constant is applied.

The overload function trips when the thermal image reaches the value of 100%. This value is obtained when the flowing current is equal to the adjusted tap for the thermal image.

A configurable level is established to generate an alarm. If a trip happens, the overload function is reset when the thermal image is below the adjusted alarm level.

8.14.1 Thermal image measurement evolution graphic

In the next graphic, the thermal image measurement evolution can be observed depending on the applied current:



With the thermal image protection adjusted to a tap of 1.1 times the nominal current and an alarming level of 75%.

Zone 1: The machine is de-energized for a long time. The thermal image is 0%.

Zone 2: We supply the machine with the nominal current. The thermal image evolves towards the value of the thermal balance that corresponds to one time of the nominal current Th = $(I/It)^2$ = 82%. The time it takes to get this thermal balance depends on the adjusted heating constant.

Zone 3: Once reached the thermal image that corresponds to the application of one time of the nominal current, we apply 1.2 times the nominal current. The thermal image will evolve towards the thermal balance corresponding to 1,2 times the nominal current Th = $(I/It)^2$ = 119%. It will occur if the permission of the thermal function is disabled. If the permission is disabled, the protection function 49 is executed when the thermal image reaches the value of 100%. Once the function is tripped, the current stops and the thermal image starts getting cool based on the cooling constant.

Zone 4: Before getting cool, the nominal current is applied again and the thermal balance is reached once the time determined by the heating thermal constant elapses.

The thermal image protection alarm bit is active if the thermal image measurement is over the adjusted alarm level.

The thermal image protection trip bit is active when the measurement of the thermal image is over 100% and it is reset when the measurement of the thermal image is under the adjusted alarm level.

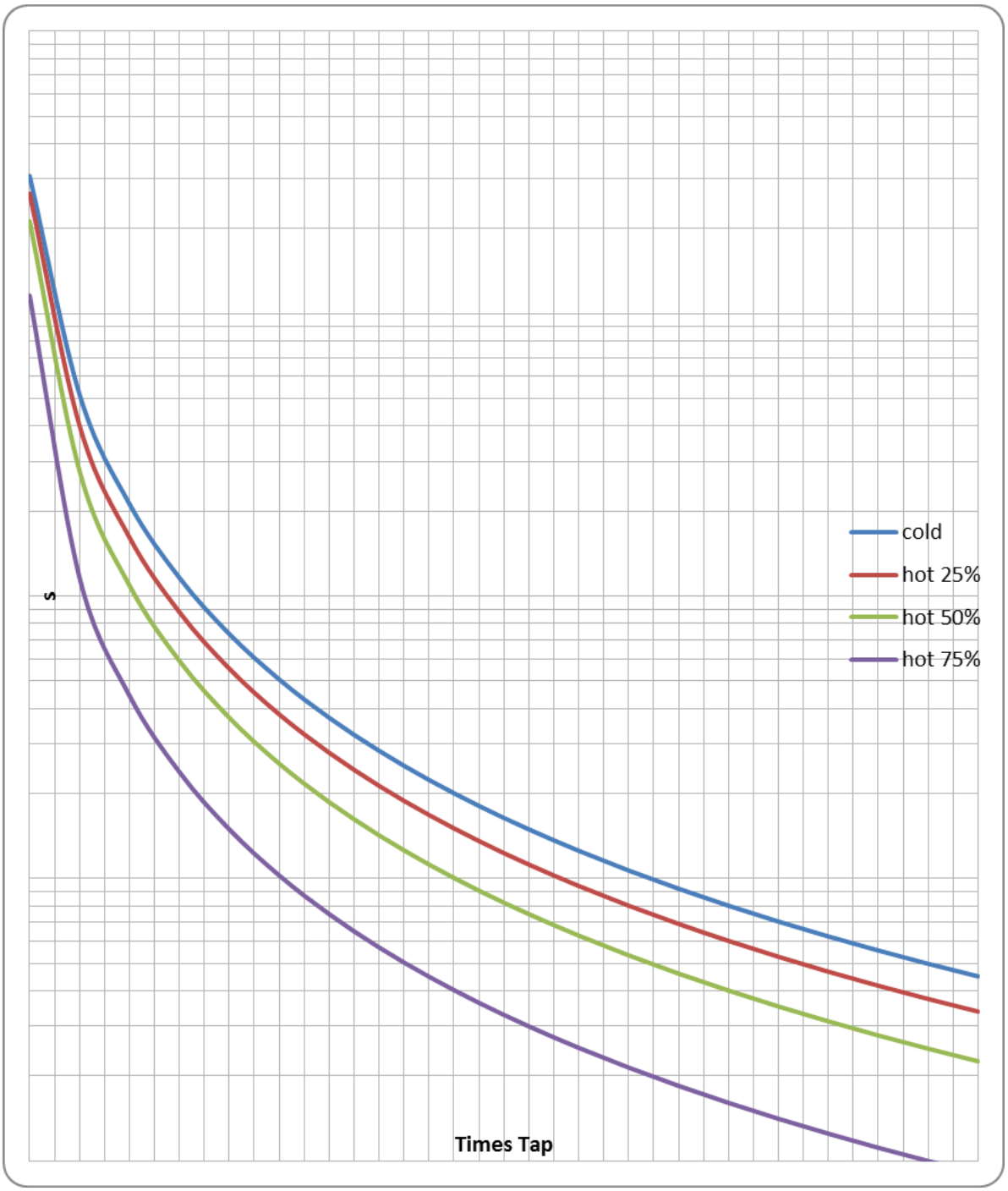
8.14.2 Thermal image with memory

The thermal image is stored in the non-volatile RAM memory periodically every second. In this way, in case the relay loses the power supply, it will keep the thermal status of the machine.

8.14.3 Thermal image measurement display. Reset.

The thermal image measurement is displayed on the Measurement menu. It is possible to reset the thermal image value on the Commands menu (Reset TI). This command resets the value of the thermal image to the value set in the alarm level.

8.14.4 Thermal protection curves



This is the thermal curve for ζ = 3 minutes.

8.15 Function 37. Instantaneous phase undercurrent

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
37	**Instantaneous phase undercurrent**					
	Function Enable	-	-	No/Alarm/Trip	-	No
	Current Tap	0.010	30.000	0.001	xIn	0.500
	Minimum Level	0.000	1.000	0.001	xIn	0.100
	Time delay	0.060	300.00	0.001	s	0.200

The setting “Minimum level” indicates the minimum level of current that is necessary to measure to work with the function. This is, if the measured current is lower than the “Minimum Level” setting, the function will not trip although this current is lower than the tap.

The time delay is independent of the operating current flowing through the relay, so if the phase current drops below its predetermined value during an equal or greater amount of time than this preset value, the protection function activates (trips) and does not reset itself until the average value of the phase current exceeds the point of the current pick-up.

The function activates at 100% of the preset input and deactivates at 105%.

The reset time of the trip will depend on the “reset time”, which is set in the general settings.

The accuracy of the Time Delay is equal to the set time delay ±30ms or ±0,5% (whichever is higher).

8.16 Function AFD. Arc Flash Detection

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
AFD	**Arc Flash Detection**					
	Function Enable	-	-	No/Alarm/Trip	-	No
	Current Tap	1	20	1	xIn	2
	Time delay	1	4	1	samples	1

The setting “Time delay” indicates the number of samples of the measurement that the relay will take before the trip.

The arc flash can be detected by two different methods:

- By current: When the current of the line is higher than the one set in the “current tap” the protection will trip.
- By light: When the arc flash sensor connected to the relay detects the light due to the arc appearing in the circuit breaker, it will trip.

To activate the high-speed output, it is recommended to apply at least 19VDC/AC.

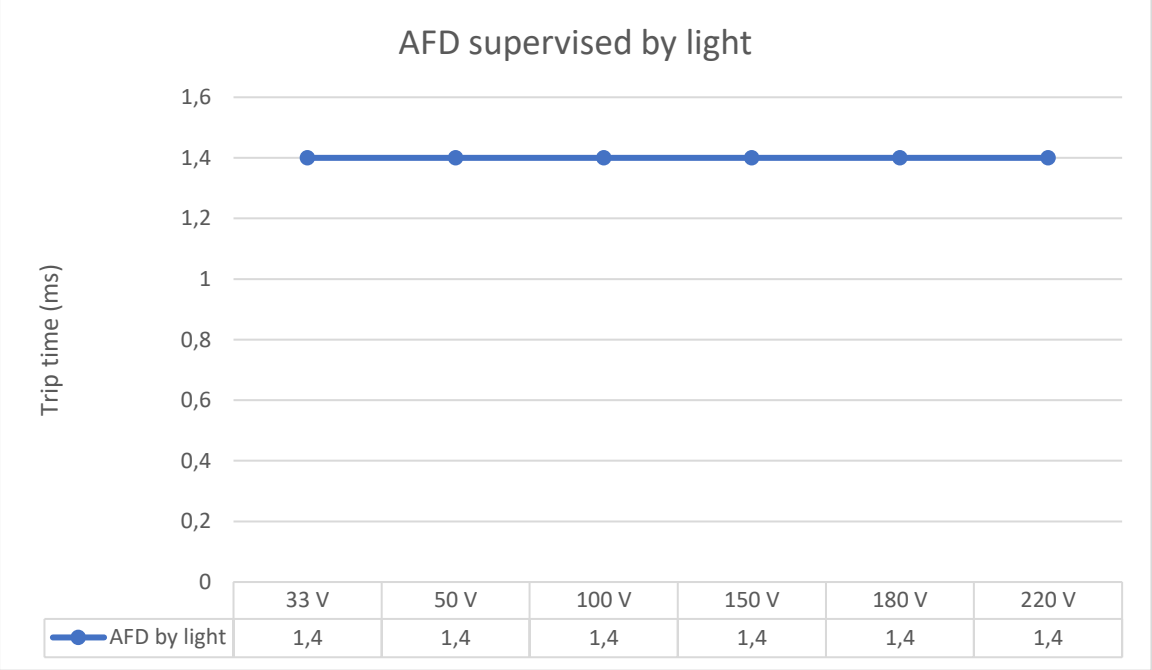
The detection method is configurable by the user in the “AFD Outputs”. By default, output 1 and output 2 are configured to detect the arc flash supervised by current, and output 3 and output 4 supervise the arc flash supervised by light:

OUTPUTS	LOGICAL GATE	BINARY STATES
HSO 1	*AND_PULSE*	• AFD Input 1 • AFD TestOK 1 • AFD Overcurrent
HSO 2	*AND_PULSE*	• AFD Input 2 • AFD TestOK 2 • AFD Overcurrent
HSO 3	*AND_PULSE*	• AFD Input 3 • AFD TestOK 3
HSO 4	*AND_PULSE*	• AFD Input 4 • AFD TestOK 4

The accuracy of the trip time depends on the method used to supervise the arc flash:

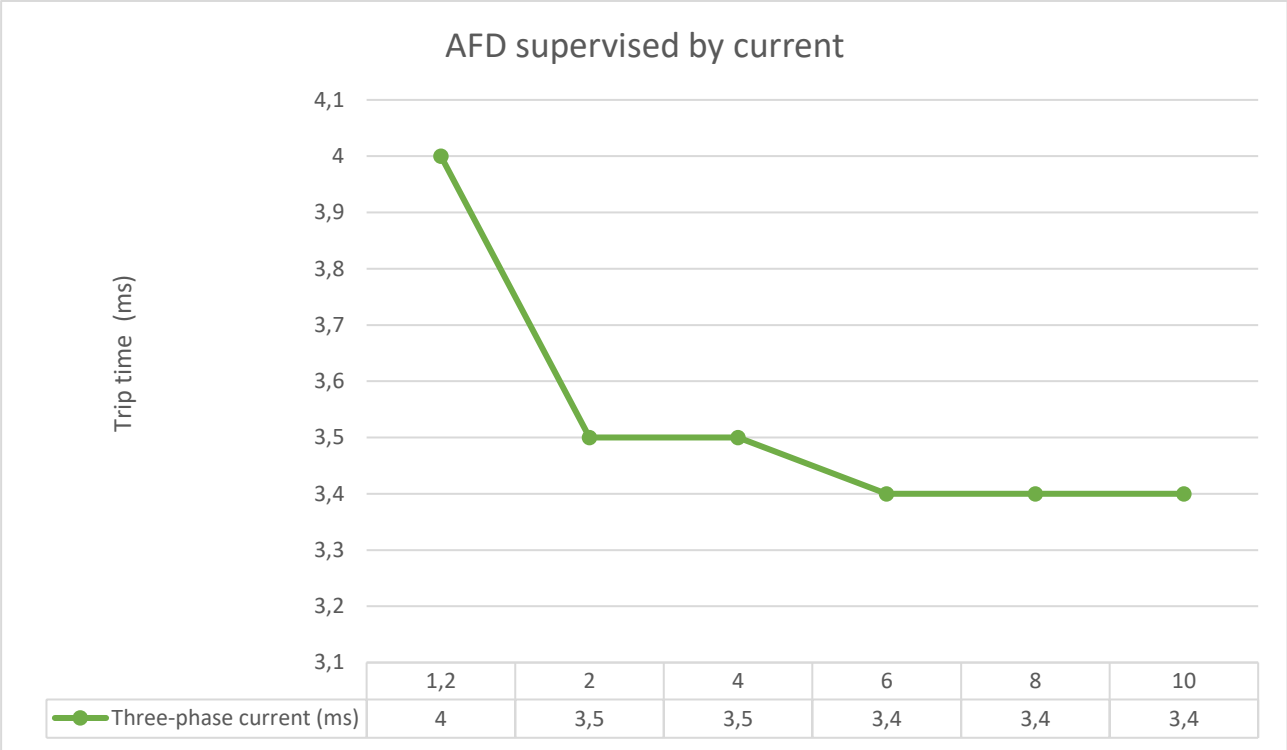
- Supervised by light: maximum trip time will be 1,4ms.
- Supervised by current: the maximum trip time will be 7,5ms. The trip time will depend on the injected current value above the “current tap” and the number of samples selected in the “time delay”. The following curves are made with the “current tap=1” and “time delay=1”.

AFD supervised by light:

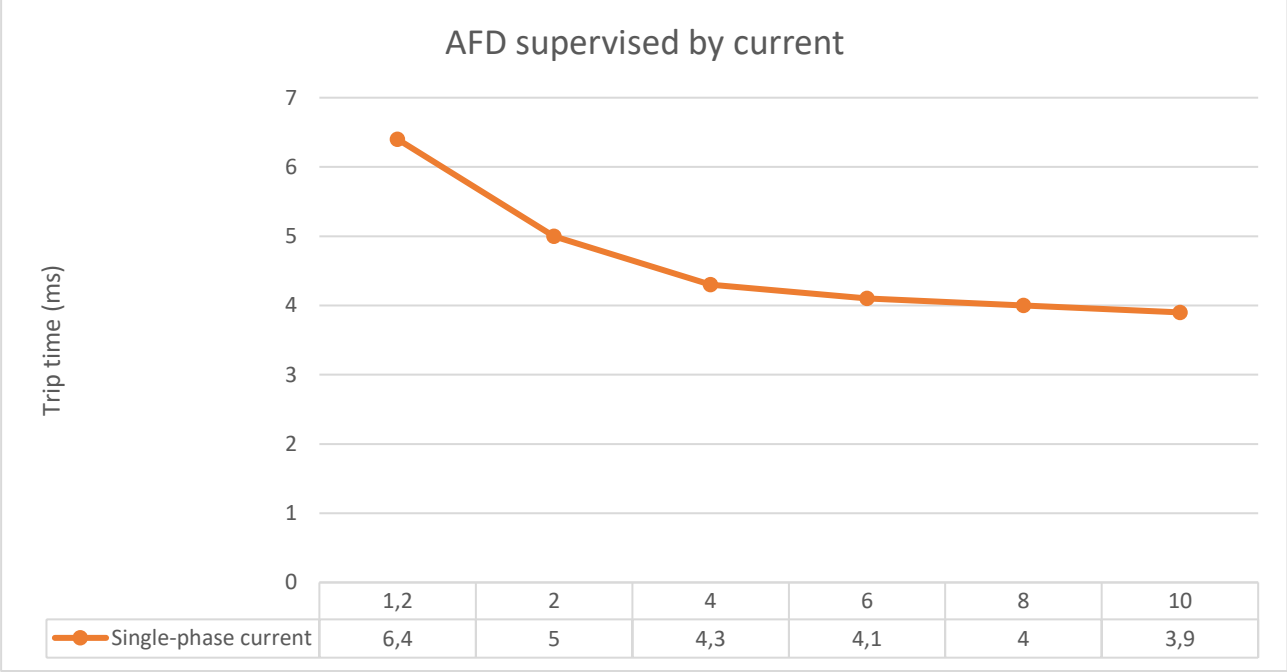


AFD supervised by current:

- Three-phase current:



- Single-phase current:

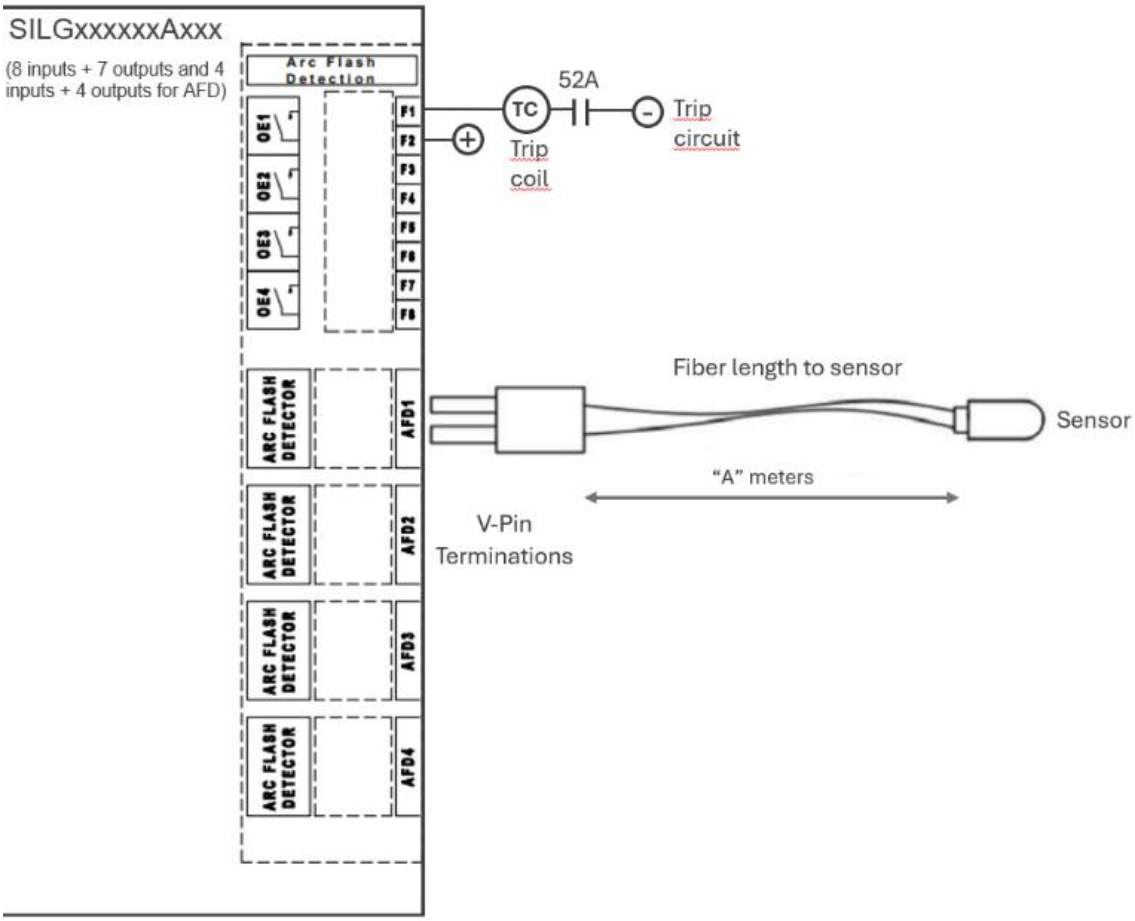


8.16.1 Sensor types

Point sensor

A **point sensor** is a localized optical sensor that detects arc flashes at a specific point within an electrical enclosure where an arc flash is likely to occur. It works by sensing the sudden increase in light intensity and sending a signal to the arc flash inputs of the relay. It requires multiple sensors to cover large areas or complex electrical cabinets and can provide a faster response time than loop sensors in a well-placed configuration.

In the following figure a schematic diagram of the point sensor assembly can be seen.

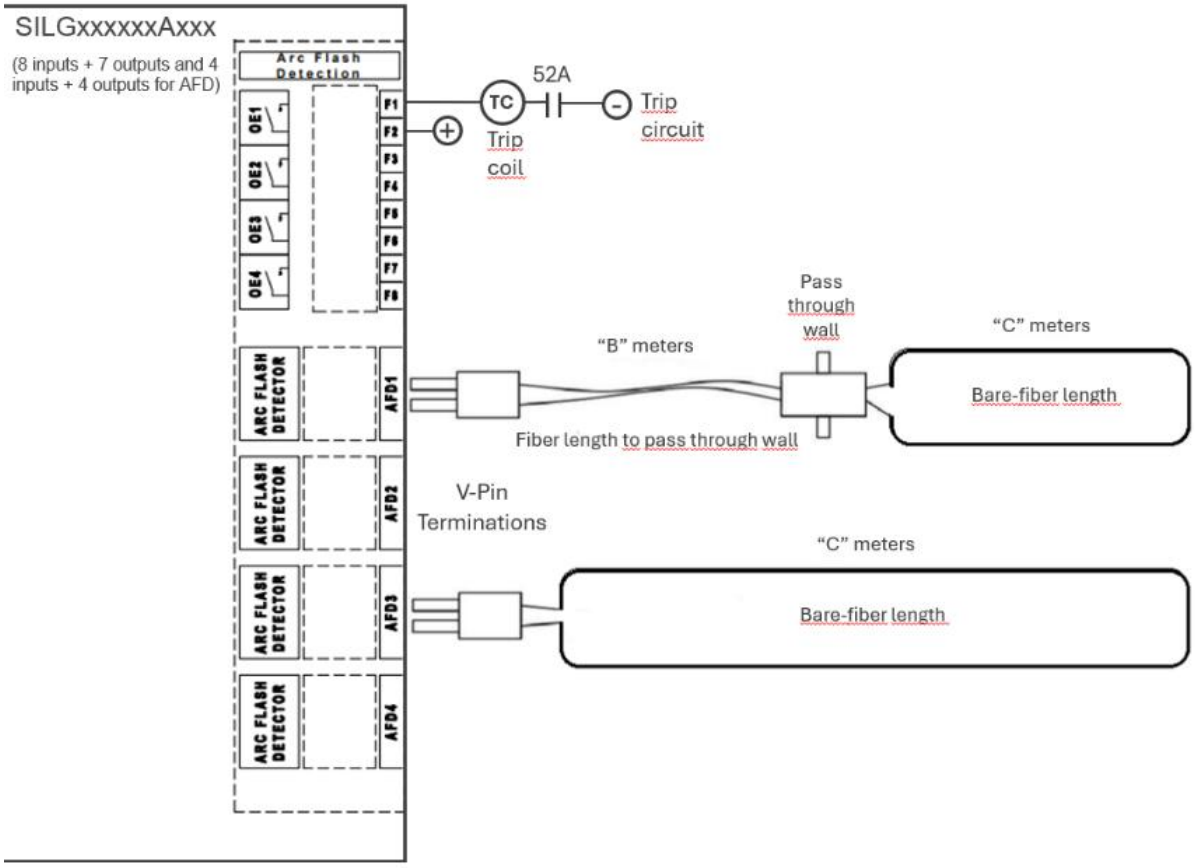


The maximum length for “A” factor is 15m.

Loop sensor

A **loop sensor** is a fiber-optic-based sensor that provides continuous arc flash detection along its entire length. It consists of a flexible optical fiber that detects intense light emissions caused by an arc fault in large enclosures. It provides fast and uniform coverage without blind spots.

In the following figure a schematic diagram of the loop sensor assembly can be seen.



The maximum length for bare-fiber loop:

• If pass through wall is not used, the maximum length for “C” factor is 35 m.

• If pass through wall is used, the maximum length for 2*”B”+”C” factor is 35 m.

9 VOLTAGE PROTECTION FUNCTIONS

To be able to trip with any of the protection functions, the setting Function Enable must be set to a value different from No. We have 2 different options: Alarm or Trip.

In both cases, the function will trip but only in case the Function Enable is set to Trip the protection function will participate in the GENERAL TRIP.

9.1 Function 27. Instantaneous phase undervoltage

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
27-1	**Instantaneous phase undervoltage**					
27-2	Function Enable	-	-	No/Alarm/Trip	-	No
	Voltage Tap	0.08(*)	2.00	0.01	xUn	0.5
	Minimum Level	0.00	1.00	0.01	xUn	0.10
	Time delay	0.060	300.000	0.001	s	0.200
	Reset time	0.020	300.000	0.001	s	0.200

(*) Voltage setting from 0.04 instead of 0.08 for the models with voltage sensors.

For conventional VTs, “Un” will be ***Nominal V. P-P*** setting (available in general settings) when the connection is phase to phase or ***Nominal V. P-P***/$\sqrt{3}$ if the connection is phase-neutral.

For voltage sensors, “Un” will be ***Nominal V. P-P setting***/$\sqrt{3}$ (available in general settings).

The setting “Minimum level” indicates the minimum level of voltage required by the measurement to work with the function. This is, if the measured voltage is lower than the “Minimum Level” setting, the function will not trip, although this voltage is lower than that of the tap.

The time delay is independent of the measured phase voltage through the relay, if any phase voltage is less than the adjusted value for an equal or greater amount of time than this preset value, the protection function activates (trips) and does not reset itself until the average value of the phase exceeds the 105% of the voltage pick-up.

The function activates at 99% of the preset input and deactivates at 101%. The reset time is configurable.

The accuracy of the Time Delay is equal to the set time delay ±30ms or ±0,5% (whichever is higher).

9.2 Function 27V1. Instantaneous positive sequence undervoltage

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
27V1	**Instantaneous positive sequence undervoltage**					
	Function Enable	-	-	No/Alarm/Trip	-	No
	Voltage Tap	0.15	2.00	0.01	xUn	0.50
	Minimum Level	0.00	1.00	0.01	xUn	0.10
	Time delay	0.060	300.000	0.001	s	0.200
	Reset time	0.020	300.000	0.001	s	0.200

"Un" will be always the setting ***Nominal V. P-P divided by*** $\sqrt{3}$ regardless the connection type, due to the positive sequence voltage is always calculated in a phase-neutral system.

The setting "Minimum level" indicates the minimum level of voltage required by the measurement to work with the function. This is, if the measured voltage is lower than the "Minimum Level" setting, the function will not trip, although this voltage is lower than that of the tap.

The time delay is independent of the measured phase voltage through the relay, if any phase voltage is lower than the adjusted value for an equal or greater amount of time than this preset value, the protection function activates (trips) and does not reset itself until the average value of the phase exceeds the 101% of voltage pick-up.

The function activates at 99% of the preset input and deactivates at 101%. The reset time is configurable.

The accuracy of the Time Delay is equal to the set time delay ±30ms or ±0,5% (whichever is higher).

9.3 Function 27-L. Instantaneous line undervoltage

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
27-L (*)	**Instantaneous line undervoltage**					
	Enable	-	-	No/Alarm/Trip	-	No
	Voltage Tap(**)	0.08	2.00	0.01	xUn	0.50
	Minimum Level	0.00	1.00	0.01	xUn	0.10
	Time delay	0.060	300.000	0.001	s	0.200
	Reset time	0.020	300.000	0.001	s	0.200

(*) Optional depending on model

(**) Voltage setting from 0.04 instead of 0.08 for the models with voltage sensors.

For conventional VTs, "Un" will be ***Nominal V. P-P*** setting (available in general settings) when the connection is phase to phase or ***Nominal V. P-P***/$\sqrt{3}$ if the connection is phase-neutral.

For voltage sensors, "Un" will be ***Nominal V. P-P setting***/$\sqrt{3}$ (available in general settings).

This function is only available for the models provided with the synchronism function. Its working principle is the same as ANSI 27, but it considers the voltage measured on the line instead of the busbar.

The setting “Minimum level” indicates the minimum level of voltage required by the measurement to work with the function. This is, if the measured voltage is lower than the “Minimum Level” setting, the function will not trip, although this voltage is lower than that of the tap.

The time delay is independent of the measured phase voltage through the relay, if any phase voltage is lower than the adjusted value for an equal or greater amount of time than this preset value, the protection function activates (trips) and does not reset itself until the average value of the phase exceeds the 101% of voltage pick-up.

The function activates at 99% of the preset input and deactivates at 101%. The reset time is configurable.

The accuracy of the Time Delay is equal to the set time delay ±30ms or ±0,5% (whichever is higher).

NOTE: The connected line voltage (phase-neutral or phases-phase depending on the adjusted system) must coincide with the busbar voltage phase-neutral or phases-phase (depending on the adjusted system) connected to the terminals B5-B6 (due to these voltages will be compared to determine if the synchronism exists).

9.4 Function 59. Instantaneous phase overvoltage

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
59-1	**Instantaneous phase overvoltage**					
59-2	Function Enable	-	-	No/Alarm/Trip	-	No
	Voltage Tap	0.08(*)	2.00	0.01	xUn	1.20
	Time delay	0.045	300.000	0.001	s	0.200
	Reset Time	0.020	300.000	0.001	s	0.200

(*) Voltage setting from 0.04 instead of 0.08 for the models with voltage sensors.

For conventional VTs, “Un” will be ***Nominal V. P-P*** setting (available in general settings) when the connection is phase to phase or ***Nominal V. P-P***/$\sqrt{3}$ if the connection is phase-neutral.

For voltage sensors, “Un” will be ***Nominal V. P-P setting***/$\sqrt{3}$ (available in general settings).

The time delay is independent of the measured phase voltage through the relay, if any busbar phase voltage exceeds the adjusted value during an equal or greater amount of time than this preset value, the protection function activates (trips) and does not reset itself until the measured value of the phase voltage drops below the voltage pick-up.

The function activates at 101% of the preset input and deactivates at 99%. The reset time is configurable.

The accuracy of the Time Delay is equal to the set time delay ±30ms or ±0,5% (whichever is higher).

9.5 Function 59N/G. Instantaneous calculated/measured neutral overvoltage

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
59N/G-1(*) **59N/G-2 (*)**	**Instantaneous calculated/measured neutral overvoltage**					
	Function Enable	-	-	No/Alarm/Trip	-	No
	Voltage Tap	0.08(**)	2.00	0.01	xUn	0.10
	Time delay	0.045	300.000	0.001	s	0.200
	Reset Time	0.020	300.000	0.001	s	0.200

(*) 50G-1 and 50G-2 only available for relays with conventional VTs for voltage measurement.

(**) Voltage setting from 0.04 instead of 0.08 for the models with voltage sensors.

As this is always a voltage to neutral (measured or calculated), on the setting Voltage Tap "Un" will be ***Nominal V. P-P***/$\sqrt{3}$.

From FW version 3.00.00 onwards "Un" will be **Voltage Nominal Neutral** (available in general settings) when de connection type is 3VTs P-N + Vr, 3VTs P-P + Vr or 2VTs P-P +Vr. When the connection type is 3VTs P-N or 3VTs P-P, "Un" will be ***Nominal V. P-P setting***/$\sqrt{3}$ (available in general settings).

The neutral voltage will be calculated or measured depending on the VT connection. For models with voltage sensors the neutral voltage will be calculated.

The time delay is independent of the measured/calculated neutral voltage through the relay, if the busbar neutral voltage exceeds the adjusted value during an equal or greater amount of time than this preset value, the protection function activates (trips) and does not reset itself until the measured/calculated neutral voltage drops below the voltage pick-up.

The function activates at 101% of the preset input and deactivates at 99%. The reset time is configurable.

The accuracy of the Time Delay is equal to the set time delay ±30ms or ±0.5% (whichever is higher).

9.6 Function 59-L. Instantaneous line overvoltage

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
59-L (*)	**Instantaneous line overvoltage**					
	Function Enable	-	-	No/Alarm/Trip	-	No
	Voltage Tap	0.08(**)	2.00	0.01	xUn	1.20
	Time delay	0.045	300.000	0.001	s	0.200
	Reset Time	0.020	300.000	0.001	s	0.200

(*) Optional depending on model

(**) Voltage setting from 0.04 instead of 0.08 for the models with voltage sensors.

For conventional VTs, "Un" will be ***Nominal V. P-P*** setting (available in general settings) when the connection is phase to phase or ***Nominal V. P-P***/$\sqrt{3}$ if the connection is phase-neutral.

For voltage sensors, "Un" will be ***Nominal V. P-P setting***/$\sqrt{3}$ (available in general settings).

This function is only available for the models provided with the synchronism function. Its working principle is the same as ANSI 59, but it considers the voltage measured on the line instead of the busbar.

The time delay is independent of the measured phase voltage through the relay, if the line phase voltage exceeds the adjusted value during an equal or greater amount of time than this preset value, the protection function activates (trips) and does not reset itself until the measured value of the phase voltage drops below the voltage pick-up.

The function activates at 101% of the preset input and deactivates at 99%. The reset time is configurable.

The accuracy of the Time Delay is equal to the set time delay ±30ms or ±0,5% (whichever is higher).

NOTE: The connected line voltage (phase-neutral or phases-phase depending on the adjusted system) must coincide with the busbar voltage phase-neutral or phases-phase depending on the adjusted system) connected to the terminals B5-B6 (due to these voltages will be compared to determine if the synchronism exists).

9.7 Function 47. Phase balance voltage protection

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
47	**Phase balance voltage protection**					
	Function Enable	-	-	No/Alarm/Trip	-	No
	Voltage Tap	0.08(*)	2.00	0.01	xUn	0.200
	Time delay	0.045	300.000	0.001	s	0.200
	Reset Time	0.020	300.000	0.001	s	0.200

(*) Voltage setting from 0.04 instead of 0.08 for the models with voltage sensors

"Un" will be always the setting ***Nominal V. P-P divided by*** $\sqrt{3}$ regardless the connection type, due to the negative sequence voltage is always calculated in a phase-neutral system.

The time delay is independent of the negative sequence voltage, if the negative sequence voltage exceeds the adjusted value during an equal or greater amount of time than this preset value, the protection function activates (trips) and does not reset itself until the negative sequence voltage drops below the 99% of the voltage pick-up.

The function activates at 101% of the preset input and deactivates at 99%. The reset time is configurable.

The accuracy of the Time Delay is equal to the set time delay ±30ms or ±0,5% (whichever is higher).

10 POWER PROTECTION FUNCTIONS

To be able to trip with any of the protection functions, the setting Function Enable must be set to a value different to No. We have 2 different options: Alarm or Trip.

In both cases, the function will trip but only in case the Function Enable is set to Trip the protection function will participate in the GENERAL TRIP.

10.1 Function 32. Directional overpower

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
32-1	**Directional overpower**					
32-2	Function Enable	-	-	No/Alarm/Trip	-	No
32-3	Activation Level	0.02	2.00	0.01	xSn	1.20
32-4	Operating Angle	0	359	1	degrees	30/60/90/120
	Time Delay	0.020	300.000	0.001	s	0.200

The time delay is independent of the measured phase apparent power through the relay, if any phase apparent power exceeds the adjusted value during an equal or greater amount of time than this preset value, the protection function activates (trips) and does not reset itself until the measured value of the phase apparent power drops below the activation level pick-up.

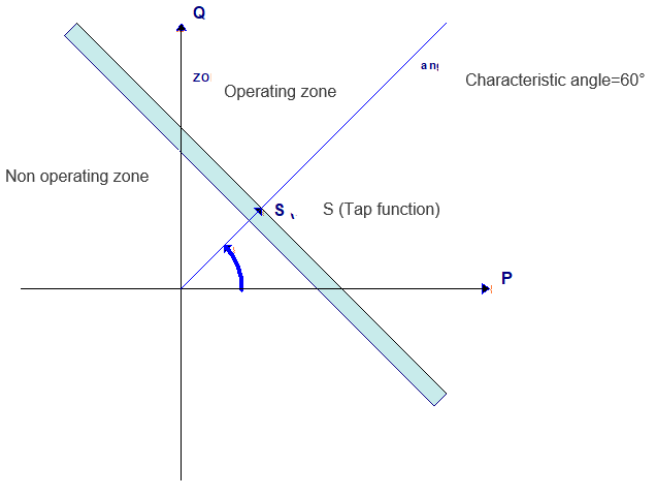
The function activates at 100% of the preset input and deactivates at 95%. This protection function has a hysteresis for its activation: it takes a minimum of 0.3 volts in secondary for the 32 functions to be operational. If the measured voltage is less than 0.3 volts in the secondary the protection function will not act.

The accuracy of the Time Delay is equal to the set time delay ±30ms or ±0.5% (whichever is higher).

Apparent power is defined as S=V* Iconjugated.

The intervention sector is defined in the following way: the characteristic angle is rotated anticlockwise along the active power axis, which gives us the maximum torque direction. A straight line is drawn perpendicular to this maximum torque direction at the adjusted pickup point, to establish two half-planes, which define the operating and non-operating zones.

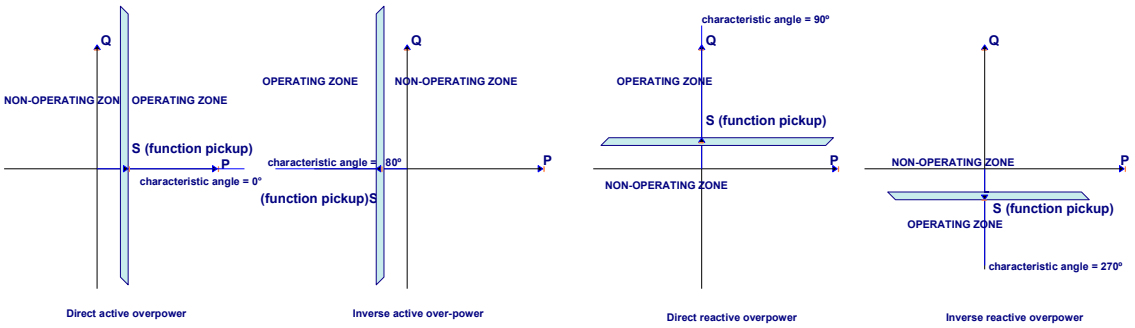
The directional power protection function operates in accordance with the following characteristic:



An operating zone is established based on the tap setting of the function and the setting of the characteristic angle. The function trips if the measured power is maintained in the operating zone during the time established using the corresponding time setting.

As the characteristic angle can be adjusted from 0° to 359°, we can adjust the function to obtain direct active overpower, reverse active overpower, direct reactive overpower and reverse reactive overpower.

Characteristic angle	Description	Direction
0º	Active overpower	Direct
180º	Active overpower	Inverse
90º	Reactive overpower	Direct
270º	Reactive overpower	Inverse



Note:

- Q- y P+ → Consumes P and Q.
- Q+ y P+ → Consumes P and produces Q.
- Q- y P- → Produces P and consumes Q.
- Q+ y P- → Produces P and Q.

11 FREQUENCY PROTECTION FUNCTIONS

To be able to trip with any of the protection functions, the setting Function Enable must be set to a value different to No. We have 2 different options: Alarm or Trip.

In both cases, the function will trip but only in case the Function Enable is set to Trip the protection function will participate in the GENERAL TRIP.

11.1 Function 81U/O. Under/Overfrequency

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
81-1 81-2 81-3 81-4 81-5(**) 81-6(*)	**Under/Overfrequency**					
	Function Enable	-	-	No/Alarm/Trip	-	No
	Type	-	-	Overfrequency / Underfrequency	-	Overfrequency
	Activation level	45.000	65.000	0.001	Hz	55.000
	Time Delay	0.020	300.000	0.001	s	0.200
	Reset time	0.020	300.000	0.001	s	0.200

(*) Only available in models with voltage sensors.

(**)Available from FW version 03.01.00 onwards.

The functions can be configured independently as overfrequency or underfrequency units.

If the unit is set as overfrequency, the activation of the function occurs at 100% of the set frequency level, and it is reset when the measured frequency is 50mHz lower than set start level.

If the unit is set as underfrequency, the activation of the function occurs at 100% of the set frequency level, and it is reset when the measured frequency is 50mHz higher than the set start level.

The reset time is configurable.

The frequency measurement is done from the voltage of phase B. It has hysteresis for its activation:

- For models with conventional VTs: it takes a minimum of 20 volts P-N (35 volts P-P) to allow 81 functions to be operational. If the measured phase voltage is less than 15 volts P-N (26 volts P-P), it activates a status bit (**Busbar Frequency Block**) which indicates that the function is blocked. When the frequency measurement is valid again, the function begins in the start status with all bits reset.
- For models with voltage sensors: it takes a minimum of 5.77% of the LEA Vrms maximum value (2.8, 5.2, 8 or 16 Vrms depending on the model) to allow 81 functions to be operational. If the measured phase voltage is less than 4.8% of the LEA Vrms maximum value (2.8, 5.2, 8 or 16 Vrms depending on the model), it activates a status bit (**Busbar Frequency Block**) which indicates that the function is blocked. When the frequency measurement is valid again (above 6%), the function begins in the start status with all the bits reset.
- From fw version 3.01.00 onwards: the minimum value to allow 81 functions to be operational is defined by the setting Voltage Block Frequency in General settings. If the measured phase voltage is less than 75% of the set voltage it activates a status bit (**Busbar Frequency Block**)

which indicates that the function is blocked. When the frequency measurement is valid again, the function begins in the start status with all bits reset.

EXAMPLE:

LEA TYPE	LEA MAXIMUM VOLTAGE	RATIO	MINIMUM VOLTAGE TO ACTIVATE THE FUNCTION	MINIMUM VOLTAGE TO BLOCK THE FUNCTION
1	8	2500:1=2500	0.0577x8x2500= 1154 V	0.048x8x2500= 960 V
2	5,2	20000:3.25=6153.8	0.0577x5.2x6153.8= 1846 V	0.048x5.2x6153.8= 1536 V
3	16	2800:1=2800	0.0577x16x2800= 2585 V	0.048x16x2800= 2150.4 V
4	2,8	10000:1=10000	0.0577x2.8x10000= 1615.6 V	0.048x2.8x10000= 1344 V

The frequency measurement is an average value of the measured frequency during 8 cycles. The accuracy of the Time Delay is the adjusted value plus the necessary time to achieve a stable measurement during 8 cycles (this time will depend on the frequency of the system) or ±0,5% (whichever is higher).

11.2 Function 81R. Rate Of Change Of Frequency (ROCOF)

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
81R-1 81R-2 81R-3 (*) 81R-4 (*)	**Rate of Change of Frequency (ROCOF)**					
	Function Enable	-	-	No/Alarm/Trip	-	No
	Type	-	-	Increase / Decrease	-	Increase
	Activation level	0.10	5.00	0.01	Hz/s	1.00
	Time Delay	0.060	40.000	0.001	s	1.000
	Reset time	0.020	300.000	0.001	s	0.200

(*) Only available in models with voltage transformers VTs.

The functions can be configured independently as increase or decrease rate of the frequency change units.

If the unit is set as an increase, the activation of the function occurs at 100% of the set activation level and, it is reset when the measured rate of change is 90% lower than the set start level.

If the unit is set as a decrease, the activation of the function occurs at the 100% frequency level set, and it is reset when the measured rate of change is 90% lower than the set start level.

The reset time is configurable.

The frequency measurement is done from the voltage of phase B. It has a hysteresis for its activation:

- For models with conventional VTs: it takes a minimum of 20 volts P-N (35 volts P-P) to allow 81R functions to be operational. If the measured phase voltage is less than 15 volts P-N (26 volts P-P), it activates a status bit (**Busbar Frequency Block**) which indicates that the function

is blocked. When the frequency measurement is valid again, the function begins in the start status with all bits reset.

- For models with voltage sensors: it takes a minimum of 5.77% of the LEA Vrms maximum value (2.8, 5.2, 8 or 16 Vrms depending on the model) to allow 81R functions to be operational. If the measured phase voltage is less than 4.8% of the LEA Vrms maximum value (2.8, 5.2, 8 or 16 Vrms depending on the model), it activates a status bit (**Busbar Frequency Block**) which indicates that the function is blocked. When the frequency measurement is valid again (above 6%), the function begins in the start status with all the bits reset.
- From fw version 3.01.00 onwards: the minimum value to allow 81 functions to be operational is defined by the setting Voltage Block Frequency in General settings. If the measured phase voltage is less than 75% of the set voltage it activates a status bit (**Busbar Frequency Block**) which indicates that the function is blocked. When the frequency measurement is valid again, the function begins in the start status with all bits reset.

EXAMPLE:

LEA TYPE	LEA MAXIMUM VOLTAGE	RATIO	MINIMUM VOLTAGE TO ACTIVATE THE FUNCTION	MINIMUM VOLTAGE TO BLOCK THE FUNCTION
1	8	2500:1=2500	0.0577x8x2500= 1154 V	0.048x8x2500= 960 V
2	5,2	20000:3.25=6153.8	0.0577x5.2x6153.8= 1846 V	0.048x5.2x6153.8= 1536 V
3	16	2800:1=2800	0.0577x16x2800= 2585 V	0.048x16x2800= 2150.4 V
4	2,8	10000:1=10000	0.0577x2.8x10000= 1615.6 V	0.048x2.8x10000= 1344 V

The frequency measurement is an average value of the measured frequency during 8 cycles. The accuracy of the Time Delay is the adjusted value plus the necessary time to achieve a stable measurement during 8 cycles (this time will depend on the frequency of the system) or ±0,5% (whichever is higher).

If the variation is close to the activation level, this time can be higher.

11.3 Function 78. Out of Step (vector shift)

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
78	**Out of Step (vector shift)**					
	Function Enable	-	-	No/Alarm/Trip	-	No
	Activation level	1	25	1	Degrees	1
	Reset time	0.020	300.000	0.001	s	0.200

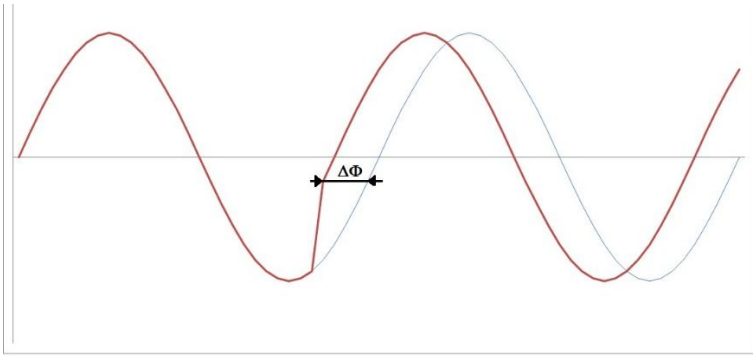
The relay has one Out-of-Step element to detect perturbations in the system and to disconnect the generators connected to it. This detection is based on the phase B voltage when passing through zero and it is intended to detect vector shifts from 1 to 25 degrees.

The frequency measurement is done from the voltage of phase B. It has hysteresis for its activation:

- For models with conventional VTs: it takes a minimum of 20 volts P-N (35 volts P-P) to allow 78 function to be operational. If the measured phase voltage is less than 15 volts P-N (26 volts P-P), it activates a status bit (**Busbar Frequency Block**) which indicates that the function is blocked. When the frequency measurement is valid again, the function begins in the start status with all bits reset.
- For models with voltage sensors: it takes a minimum of 5.77% of the LEA Vrms maximum value (2.8, 5.2, 8 or 16 Vrms depending on the model) to allow 78 function to be operational. If the measured phase voltage is less than 4.8% of the LEA Vrms maximum value (2.8, 5.2, 8 or 16 Vrms depending on the model), it activates a status bit (**Busbar Frequency Block**) which indicates that the function is blocked. When the frequency measurement is valid again (above 6%), the function begins in the start status with all the bits reset.
- From fw version 3.01.00 onwards: the minimum value to allow 81 functions to be operational is defined by the setting Voltage Block Frequency in General settings. If the measured phase voltage is less than 75% of the set voltage it activates a status bit (**Busbar Frequency Block**) which indicates that the function is blocked. When the frequency measurement is valid again, the function begins in the start status with all bits reset.

EXAMPLE:

LEA TYPE	LEA MAXIMUM VOLTAGE	RATIO	MINIMUM VOLTAGE TO ACTIVATE THE FUNCTION	MINIMUM VOLTAGE TO BLOCK THE FUNCTION
1	8	2500:1=2500	0.0577x8x2500= 1154 V	0.048x8x2500= 960 V
2	5,2	20000:3.25=6153.8	0.0577x5.2x6153.8= 1846 V	0.048x5.2x6153.8= 1536 V
3	16	2800:1=2800	0.0577x16x2800= 2585 V	0.048x16x2800= 2150.4 V
4	2,8	10000:1=10000	0.0577x2.8x10000= 1615.6 V	0.048x2.8x10000= 1344 V



If Δϕ exceeds the value adjusted in the “Activation Level” setting, the function activates (trips) immediately. The accuracy is ±1 degree or ±10% (whichever is higher).

The reset time is configurable.

11.4 Function 24. Overfluxing

This protection function detects overfluxing of transformer or generator magnetic circuits by calculating the ratio between the greatest phase-to-neutral or phase-to-phase voltage divided by the frequency.

This protection function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
24-1(*) 24-2(*)	**Overfluxing**					
	Enable	-	-	No/Alarm/Trip	-	No
	Curve Type	-	-	(1)	-	Definite Time
	Time Dial (TMS)	0.05	300.00	0.01	(2)	1.00
	Activation Level	0.50	2.00	0.01	Un/fn	1.100
	Time Delay	0.020	300.000	0.001	s	0.200
	Reset Time	0.00	300.000	0.001	s	0.200

(*) This function is only available for models with voltage transformers VTs

(1) Definite time and 3 curves are included to be selected by the user:

TYPE
Definite Time
Inverse A
Inverse B
Inverse C

(2) The range of the Time Dial setting will depend on the curve. The range of this setting for each curve family is as follows:

TIME DIAL (TMS)					
Description	**Minimum**	**Maximum**	**Step**	**Unit**	**Default**
Curve (A, B or C)	0.1	300	0.01	-	1.00

The overfluxing protection is used as protection of the generator and connected transformer (e.g., auxiliary services transformer) against loss of insulation between the laminations of the magnetic circuit leading to overheating produced by the iron losses due to the induction increase (over-excitation).

The overfluxing condition may occur:

- With generators disconnected from the network during Start-up or standing, due to automatic control of the voltage regulator which, at low frequency, forces excitation increasing the flux in order to keep the voltage constant.
- For failure of the voltage regulator in automatic control or wrong operations on manual control.
- Following the over-voltage produced by the shedding of a significant load, whilst the voltage regulator is not operating sufficiently quickly to reduce the overvoltage.

The device measures the ratio between the injected U/f and Un/fn, which is proportional to the excitation level of the generator or transformer. The calculation is based on the ratio between the maximum voltage of the three phases voltage and the frequency. The function picks up when the excitation level exceeds the activation level.

If the option ‘Defined time’ is selected for the curve setting, the unit behaves like an instantaneous overflux unit. In this case, the unit time delay is adjusted by using the parameter ‘Time delay’.

If a curve is selected for the curve setting, the time delay depends on the curve, dial and activation level settings.

The function is activated at 100% of the set tap value, and it deactivates below 100% of the tap.

The reset will depend on “Reset Time” setting in both cases.

If the unit operates as defined time, the accuracy of the Time Delay is equal to the set time ±30ms or ±0.5% (whichever is greater).

If a curve is selected for the curve setting, the accuracy of the time delay is equal to the theoretical time ±30ms or ±5% (whichever is greater).

12 CONTROL AND SUPERVISION FUNCTIONS

12.1 Function 79. AC Reclosing device

The reclosing function tries to reconnect the circuit breaker after a fault. It has four reclosing attempts capacity. After them, if the circuit breaker has not reclosed correctly, it goes to 'Lockout' state.

The reclose can be disable if it is not required, by setting the **Number of Recloses** to 0.

Disable must not be confused with blocked. Disable means that the recloser shall never be in operation, regardless of the controls performed on it. A blocked recloser means that the recloser is not operative, but either because it has reached the end of the reclosing cycle, or an irregularity has been detected, or someone has performed a control procedure on it reaching the Lockout state.

Each reclosing cycle has its own specific operation time (**Reclose Time #**) that can be set independently. Also, up to four different signals with a logic condition can be assigned to the start condition (logic signal - **79N# Start**) of each cycle. The cycles are always done sequentially, that is, if the function is going to start the first reclose cycle, but the reclose condition for the first cycle is not achieved and the condition for the second cycle is, then the function will not start.

If in **Hold Enable** Yes is selected, once the cycle is initiated, another permission (logic signal - **79Enable**) can be used to indicate that the recloser must wait another period of time **(Hold time**) before closure. During this waiting time, usually an external condition wired to an external input, such as closure synchronism, give the authorization to reconnect. If in **Hold Enable** No time is selected, there will no limitation in terms of time, the only way to reconnect is through the logic signal 79Enable.

Apart from these times, two additional times must be set on this function:

- ✓ **Reset time**: This is the waiting time for the recloser for a final closure. If during this time, there is another trip, the recloser count will increase.
- ✓ **Safe time**: Is the security time used by the recloser. When it comes from a lockout mode consequence of an unexpected condition of a reclose cycle and the circuit breaker is closed this waiting time must be observed. On exceeding this time without a circuit breaker opening, the recloser switches to Standby mode.

Function	Description	Minimum	Maximum	Step	Unit	Default
79	**AC Reclosing Device**					
	Number of Recloses	0	4	1	-	0
	Reset Time	0.020	2000.000	0.001	s	5.000
	Reclose time 1	0.020	2000.000	0.001	s	0.250
	Reclose time 2	0.020	2000.000	0.001	s	2.000
	Reclose time 3	0.020	2000.000	0.001	s	2.000
	Reclose time 4	0.020	2000.000	0.001	s	20.000
	Hold Enable	-	-	No/Yes/No time	-	Yes
	Hold time	0.020	2000.000	0.001	s	5.200
	Safe time	0.020	2000.000	0.001	s	5.000

Another time setting, configurable in function 52, is used on the state machine on the recloser.

- ✓ **Closing Time:** During this state the recloser sends a closing command and for this reason, if you wish to associate an output to that command, the output must be set to the 79 Closing Time bit.

It must be possible to block the recloser, specially is maintenance tasks are carried out on the substation. To achieve this, there is two logical signals **79Block Command** and **79Unblock Command** where up to 4 logical inputs can assigned to each one. By default, they are configured as follows:

79Block Command	
Input	**Logical Gate**
Block Command USB COM	OR
Block Command HMI	
Block Command Rear COM	

79Unblock Command	
Input	**Logical Gate**
Block Command USB COM	OR
Block Command HMI	
Block Command Rear COM	

So, it can be (un)blocked with the next options:

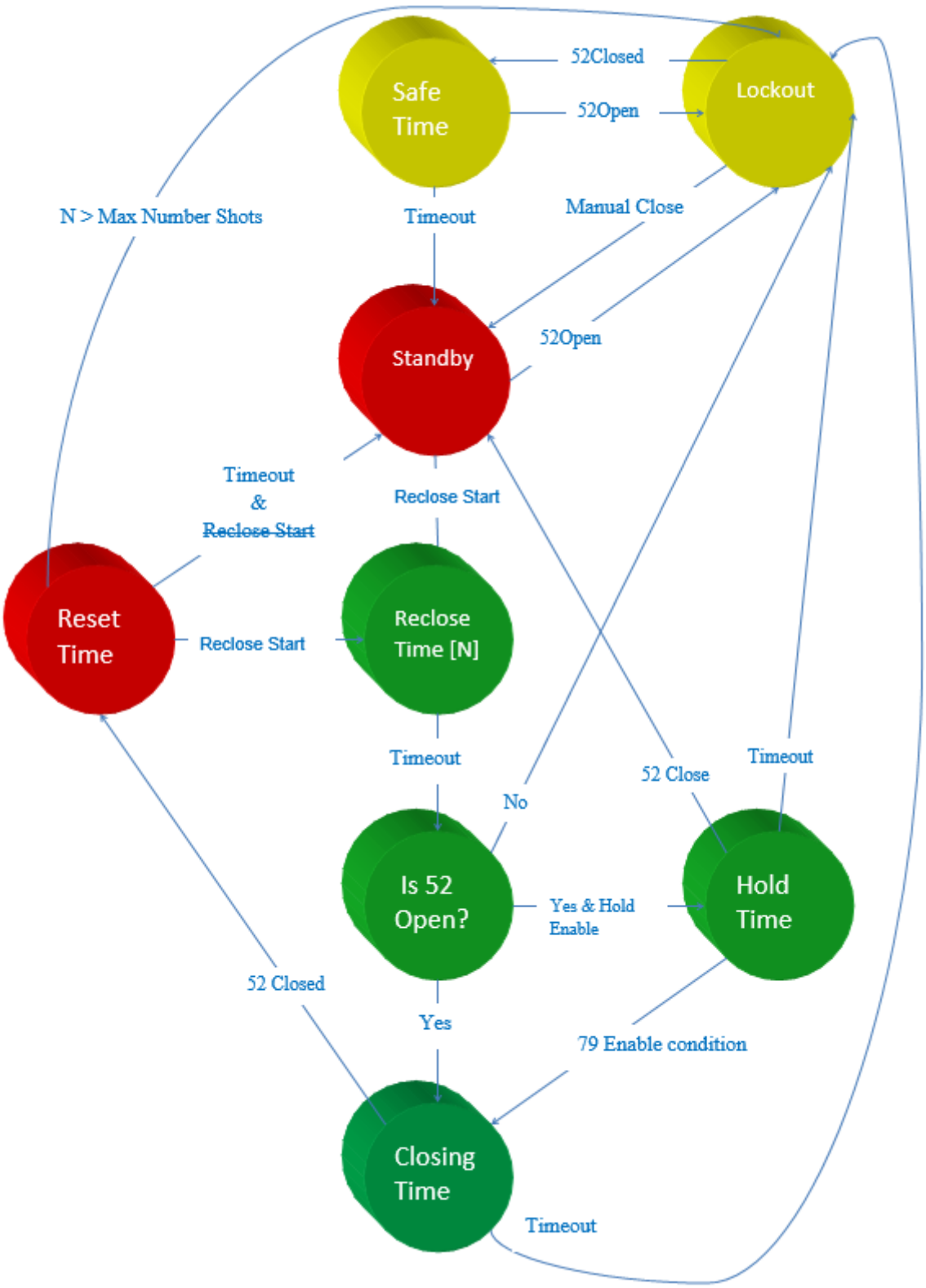
- ✓ **From the HMI.** There are two specific keys marked 79 Block and Unblock, plus a specific signal led, allowing recloser operation, blocking or unblocking it.
- ✓ **From the HMI.** This command can be executed from the command menu.
- ✓ **Via protocol.** This is performed via any means of communication. This is carried out as if it was a command, and the normal conditions of any command must be met.

In all these cases, the relay stores the block situation in the non-volatile memory, as the last command must be known for a possible re-start.

The logic signal **Hot Line Tag** also affects the behaviour of this function. Hot line tag application it is used to increase safety when the maintenance is made When it is activated, the function is blocked, and reclosing is not permitted.

Also, this logic signal can be configured to change the Settings Groups through PGC. This can be useful to achieve a fast tripping of protection functions in Hot Line Tag Mode.

The auto-recloser´s start up is shown in the following figure:



There are two stable conditions here, Standby and Lockout, the other conditions are transient.

In case the “79 Enable” signal is activated before reaching “Is 52 Open?” state, it does not wait the hold time and goes directly to “Closing Time”.

On Standby, the recloser can leave this mode via two conditions:

- ✓ Manual or remote control opening of the circuit breaker. In this situation it shall switch to lockout mode.
- ✓ Circuit breaker trip. This shall start the reclosing cycles. This start may arise either from the trip itself, or from an external input if external protection is fitted.

When blocked, the recloser has are two possible paths, depending on if the locked mode is the result of:

- ✓ Circuit breaker closing (from manual or remote control): it switches to Standby.
- ✓ Unexpected condition from a reclose cycle: it switches to Safe time.

There are 4 logic outputs “79N# Start” in the configurable logic. Default configuration is as follow:

Reclose Condition	Default Configuration
79N1 Start	General Trip AND Standby
79N2 Start	General Trip AND 79 Reclose 1
79N3 Start	General Trip AND 79 Reclose 2
79N4 Start	General Trip AND 79 Reclose 3

12.1.1 Hot Line Tag

Hot line tag application it is used to increase safety when the maintenance is made. When hot line tag is activated, any autoreclose sequence will be inhibited and autoreclose lockout will be activated.

12.1.2 Counter to record the number of reclosings

The relay has a counter that registry the reclosing actions.

12.2 Function 25. Synchronism Check

This function is available depending on the selected model. The synchro-check function is designed to give a time window in which the voltage in both sides of the switch is in sync. The voltage of both ends of the switchgear must comply three conditions to ensure that there is synchronization:

- Same module.
- Same phase.
- Same frequency.

Associated with the function, we have a line voltage and bar voltage monitoring unit, which will define the state of the line and the bar, being able to give the following combinations:

- Dead Line - Dead Bar (DLDB).
- Dead Line - Live Bar (DLLB).
- Live Line - Dead Bar (LLDB).
- Live Line - Live Bar (LLLB).

This control function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
25 (*)	**Synchronism Check**					
	Dead Tap(**)	0.08	2.00	0.01	xUn	0.50
	Live Tap(**)	0.08	2.00	0.01	xUn	0.70
	Voltage Supervision Time	0.060	300.000	0.001	s	3.000
	Voltage Difference	0.05	2.00	0.01	xUn	0.10
	Phase Difference	2	90	1	Degrees	2
	Frequency Difference	0.060	10.000	0.001	Hz	0.500
	Synchrocheck Time	0.020	300.000	0.001	s	1.000

(*) Optional depending on model.

(**) Voltage setting from 0.04 instead of 0.08 for the models with voltage sensors.

In case the line or bar or both are dead (LLDB, DLLB, DLDB situations) it is not necessary the synchronism to close the switchgear.

Transitions from dead to live and vice versa are timed with a user adjustable time (**Voltage Supervision Time**).

When the line and the bar are alive is the time to check the conditions of voltage magnitude, phase and frequency differences between line voltage and bar voltage to allow the closing. Also, it is verified that these conditions of voltage magnitude, phase difference and frequency differences are maintained over a set time (**Synchrocheck time**) to confirm that it is not a temporary situation.

Please, consider that the synchronism depends on three measurements: voltage measurement and phase measurement are achieved in 1 cycle, but frequency measurement may need 8 cycles to achieve a stable measure, so the synchrocheck time should be set according to this limitation.

If those conditions of synchronism are maintained during synchrocheck time, close permission will be allowed (state **Synchrocheck**).

This function states can be associated to an alarm, logic alarm and outputs through the configuration.

12.2.1 Synchronism (25) and AC Reclosing Device (79)

To close the circuit breaker when the reclosing device (79) is permitted, when both line & bar are alive it is necessary to achieve sync conditions. Only when these sync conditions are achieved, the recloser has the permission to close the circuit breaker.

To supervise the reclosing, it is necessary to set the **Synchrocheck** state of 25 function to the logical signal **79Enable**. Also, the states **DLDB**, **DLLB** and **LLDB** should be added to this logic signal (OR gate) as in those cases there is nothing to synchronize.

If the parameter **Hold Enable** of 79 function is set to No, any external condition won't be considered, and 79 function will work normally.

If **Hold Enable** of 79 function is set to Yes or No Time and the states DLDB, DLLB, LLDB and Synchrocheck of 25 function are associated to the logic signal 79 Enable, following cases can occur:

1. If line, bar or both are dead, the circuit breaker will always reclose because synchronism is not necessary.

2. If both, line and bar, are alive it will reclose only when the conditions of synchronism are achieved. If Hold Time is set to No time it will wait until those conditions are accomplished. If **Hold Time** is set to Yes, if those conditions are not fulfilled in the time set in **Hold Time** it will go to **Lockout**.

12.2.2 Synchronism (25) and Closing Breaker Command

If necessary, the same strategy can be used to supervise a manual closure. Using the logical gates available on SILG, a coordination of states can be set to supervise the closing command.

12.3 Function SZM. Sectionalizer Mode

This function is a sectionalize feature which allows the recloser control to sense upstream recloser operation and open during the upstream recloser´s open interval. This control function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
SZM(*)	**Sectionalizer Mode**					
	Function Enable	-	-	No/Yes	-	No
	Recloses Number	0	4	1	-	0
	Reset Time	0.020	2000.000	0.001	s	0.300
	Max Open Time	0.020	2000.000	0.001	s	0.300
	Max Close Time	0.020	2000.000	0.001	s	0.300
	Current Tap	0.010	20.000	0.001	xIn	2.000
	Neutral Tap	0.010	20.000	0.001	xIn	2.000
	Voltage Supervision Time	0.000	300.000	0.001	s	0.000
	Dead Tap	0.04	2.00	0.01	xUn	0.20

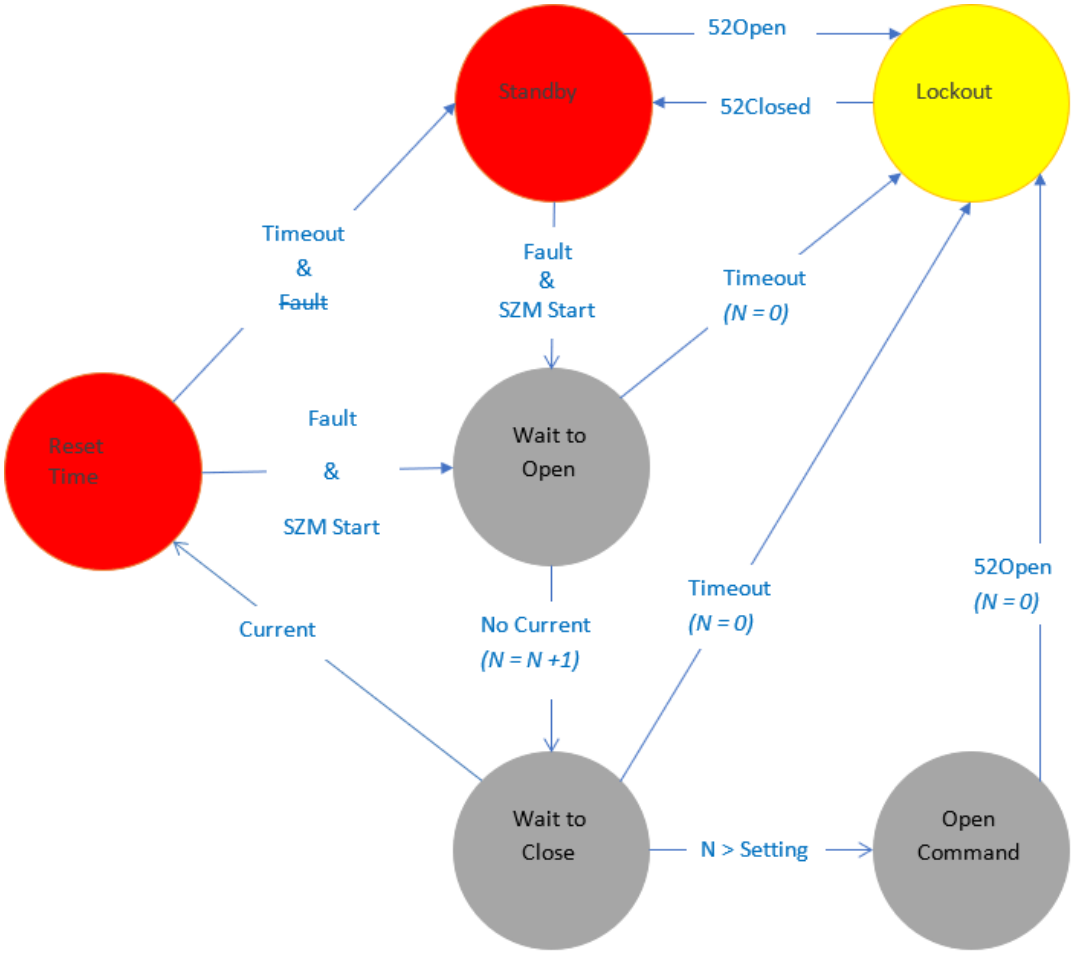
(*) Function only available for models with voltage sensors ("voltage measurements" digits 1, 2, 3, 4).

Setting	Description
Recloses Number	Number of desired recloses from upstream control before the opening of the sectionalizer.
Reset Time	Time that the control will wait to the next cycle trip. If a fault occurs during this time, it will be counted as same reclose cycle. If a fault occurs after this time, it will be counted as a new reclose cycle.
Max Open Time	Maximum time from the fault occurs to the upstream breaker to be open. If the circuit breaker is not open after this time, the SZM will go to lockout for safety reasons. (If the SZM opens the sectionalizer with the upstream circuit breaker not being able to open on time, it may cause damage on the sectionalizer)
Max Close Time	Maximum time from the upstream breaker opening to the reclose. If the circuit breaker is not closed after this time, the SZM will go to lockout for safety reasons. (If the upstream circuit breaker is not able to close, the reclose cycle can't continue) Recommended to take in mind the longest reclose time of the upstream control plus physical time of the circuit breaker expected closing time.
Current Tap	Phase current measured on the SZM control that will be considered as fault state to be open by the upstream circuit breaker.
Neutral Tap	Neutral current measured on the SZM control that will be considered as fault state to be open by the upstream circuit breaker.
Voltage Supervision Time	This is the necessary time to consider the dead situation.
Dead Tap	Voltage threshold that will allow the closing. If the voltage is higher than this setting the closing will not be permitted.

To identify if other device has tripped or reclosed upstream, the state of function 52 is checked in order to detect if there is current flowing through the circuit breaker or not.

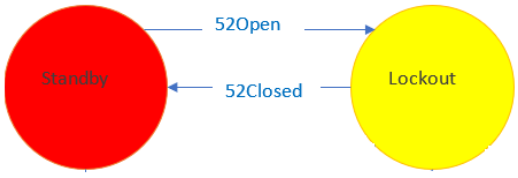
There is a logic signal to start the cycle, **SZM Start** that can be configured to add more restrains to the start of the function. If nothing is configured on it, just the conditions of Current Tap and Neutral Tap adjusted on the settings will apply.

The SZM cycle is shown in the following figure:



Being the function in STANDBY situation implies the downstream CB is closed. Being on this state 2 situations can happen:

1) The downstream CB open (manually for example), so the function will go to “LOCKOUT” state and this state will be left once the CB is closed again.



2) The conditions for starting the SZM cycle are met (current is higher than “Current Tap” or “Neutral Tap”, and “SZM Start” conditions, if any, are met)

In the second situation, the cycle will start. The SZM will go to “Wait to open”, where it will wait a maximun of “Max Open Time” to the upstream circuit breaker to open. To the circuit breaker to be identified as open, there should not be current on the line.

If there is sill current on the line, the SZM will go to lockout. If there is no current, it will add 1 to the number of trips cleared by the upstream control and will go to “wait to close”.

In “wait to close” if there is no current after the “Max Close Time”, the SZM will go to lockout since the circuit breaker is not following the reclose cycle.

If the current flows again before the “max close time”, the upstream circuit breaker will be considered closed, and the SZM will go to “Reset time”.

During the “reset time” if there is any other fault (current higher than “Current Tap” or “Neutral Tap”, and met “SZM Start” conditions, if any), the SZM will go again to “wait to open”.

If there are not faults during the “Reset time”, the SZM will go to Standby after the reset time setting.

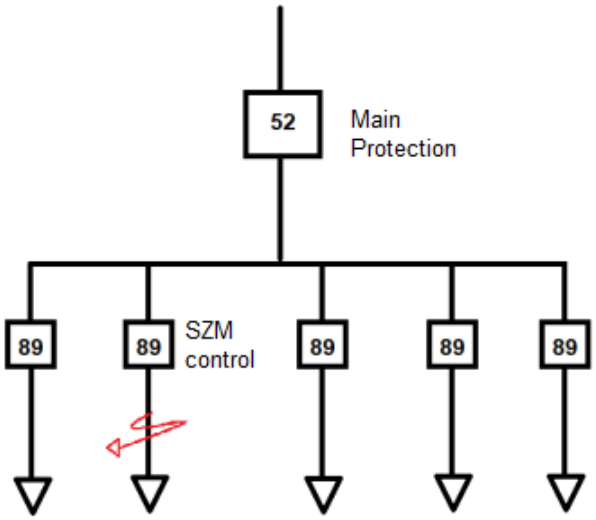
For the SZM to open the sectionalizer, after a fault and the upstream circuit breaker opening, if the already performed trips are higher than the “Number of Shots” setting, the “wait to close” state will be passed and the SZM will activate “SZM Open” state.

This state, as the other statuses of the function, can be associated with an alarm, logic alarm, and with the outputs through the configuration.

For the open output to be activated, “SZM Open” should be configured to the open output or to the Open PGC.

Example

The main protection is set to allow 3 reclosure cycles. The SZM relay is set to allow 2 reclosure cycles.



Fault 1

The main protection opens and recloses. The reclosure counter of the main protection registers 1 reclosure, and so does the SZM counter.

Fault 2

The main protection opens and recloses. The reclosure counter of the main protection registers 2 reclosures, and so does the SZM counter.

Fault 3

The main protection opens. Since we have reached the maximum number of reclosures set for the SZM relay, it interprets the fault as permanent and opens the disconnect switch. The main protection will reclose upstream and register a third reclosure, so that upon reclosure, the supply is restored to all "healthy" lines except line 2, where the fault occurred, and the disconnect switch will be closed (manually) once the issue is resolved.

12.4 Function SCM. Sequence Coordination Mode

The relay has a sequence coordination feature that allows the recloser to step through its “fast” curve without tripping to provide complete trip coordination with the downstream recloser.

This control function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
SCM(*)	**Sequence Coordination Mode**					
	Number of Shots	0	4	1	-	0
	Reset Time	0.020	2000.000	0.001	s	0.500

(*) Function only available for models with voltage sensors (“voltage measurements” digits 1, 2, 3, 4).

Number of Downstream Shots setting represents the cycles that the downstream recloser is going to perform. After this, the SIL-G control will be in charge to continue with the recloses set in the “Number of recloses” setting of the ANSI 79 function.

To know if the CB is open or closed this algorithm will evaluate the statuses of the Reclose function (ANSI 79), and the pickup and the trip of the protection functions.

Being the function in the STANDBY situation implies the downstream CB is closed. Being on this status 2 situations can occur:

1) The downstream CB has opened, so the function will go to the “LOCKOUT” status and this status will be left once the CB is closed again.
2) From “STANDBY”, there is a pickup of some of the protection functions.

Once the pickup occurs it can lead to 2 situations:

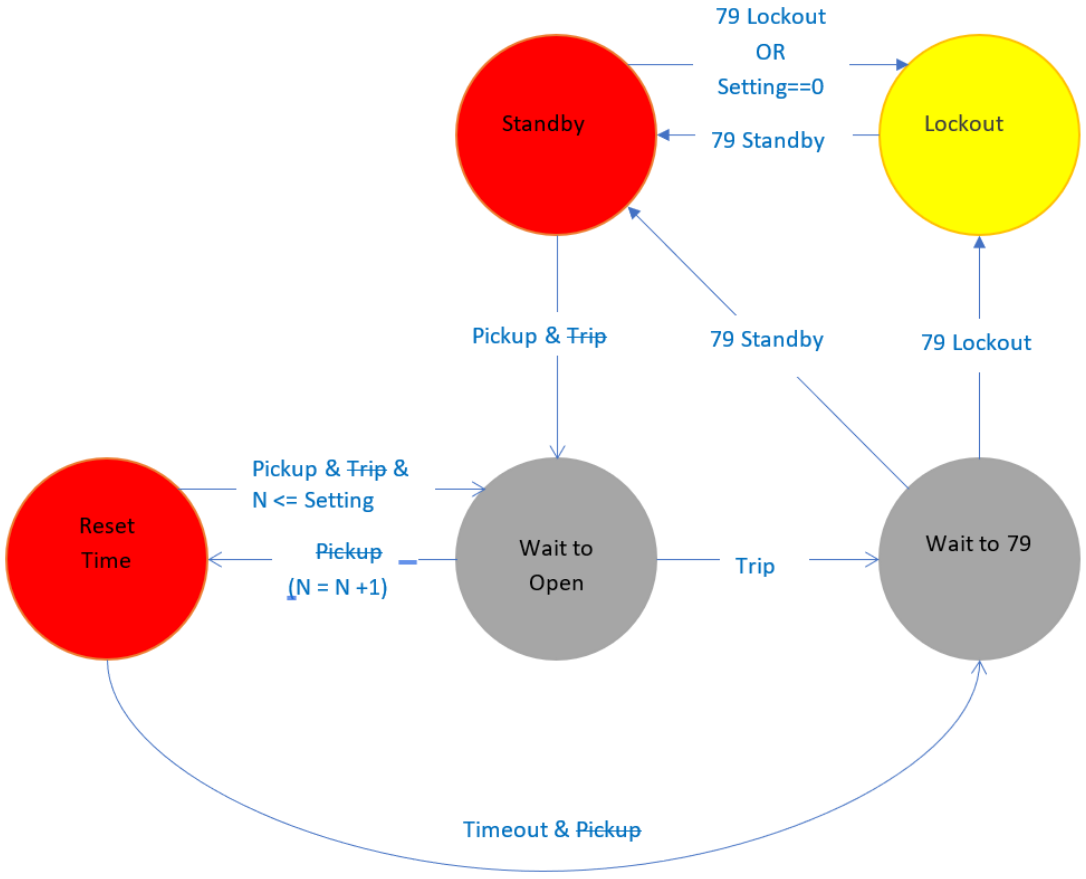
1) The downstream protection trips (so the downstream CB is open, and the pickup is deactivated) and the algorithm goes to “RESET TIME” status, thus increasing the reclosing number.
2) The relay trips before the downstream protection and the algorithm goes to “WAIT TO 79”, just waiting for the performance of the ANSI 79 function.

If the algorithm passes to “RESET TIME” there are 2 possibilities to leave this status:

1) The downstream recloser has reclosed and there is another fault situation (pickup of any protection function). In this case, the cycle will start again until the set number of recloses of the SCM function is completed. Once it is completed while the downstream CB is closed, the sequence coordination mode will be blocked, and the algorithm will be maintained in the “RESET TIME” status.
2) The downstream recloser has not been reclosed or has been reclosed, but there is no fault situation:
    a. The downstream recloser has not reclosed so the downstream CB is open (the reset time has finished but the reclosing cycle did not success). In this case, the algorithm goes to “WAIT TO 79” and due to the opening of the CB, it goes to “79 LOCKOUT” until a closing command occurs.

b. The downstream recloser has reclosed so the downstream CB is closed but there is no fault situation. In this case, the algorithm goes to “WAIT TO 79” and due to the closing of the CB, it goes to “79 STANDBY”, and keeps waiting for a new cycle.

The SCM start up is shown in the following figure:



These function statuses can be associated with an alarm, logic alarm, and with the outputs through the configuration.

12.5 Function 68. Zone Selection Interlocking (ZSI)

The device is provided with outputs and inputs which can be used for implementing a trip bus (inputs and outputs are configurable).

Configuration:

FEEDER RELAY

Output 1: startup of function 50 or 50/51.

Output 2: startup of function 50N/G or 50/51N/G.

SUPPLY RELAY

Input 1: block the trip of functions 50 and 50/51.

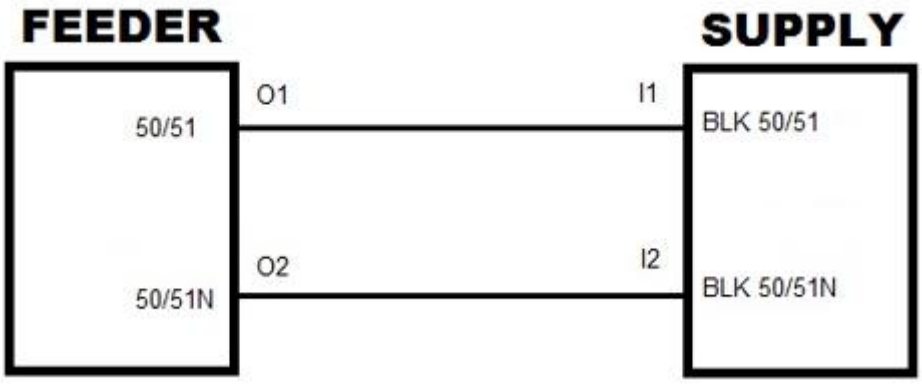
Input 2: block the trip of functions 50N/G and 50/51N/G.

Relays with feeder functionality must activate the output 1 when detect the startup of function 50 or 50/51 and must activate the output 2 when detect the startup of function 50N/G or 50/51 N/G.

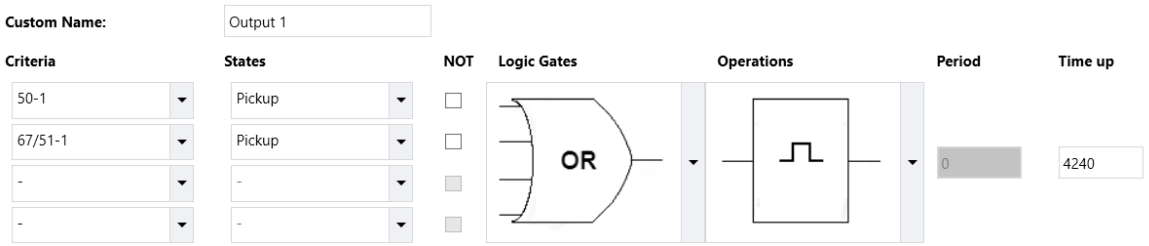
Relays with supply functionality, block the trip of functions 50 and 50/51 when detecting the activation of input 1 and block the trip of functions 50N/G and 50/51N/G when detecting the activation of input 2.

The physical connection which is needed to perform is next: output 1 of feeders must be connected to the input 1 of the supply device and outputs 2 of feeder devices must be connected to the input 2 of the supply device.

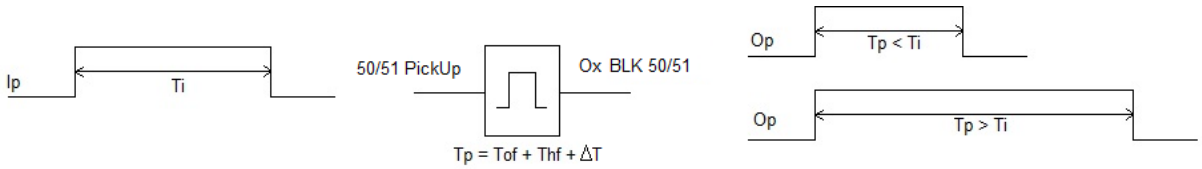
Once the physical connections are made, logical signals must be configured to physical inputs and outputs:



The pickup signals of the feeder relay should be connected to the outputs through an OR gate and a PULSE operation. The adjusted time must be the time of the feeder's functions (time delay setting), plus the trip holding time (in SIA-C this time is approximately 200 ms), plus the security time (to ensure the signal has dropped off).



The PULSE operation provides a pulse signal that will block the supply functions enough time to allow the feeder relay to trip, open its breaker, and make the fault disappear. The pulse operation guarantees that the output of the pulse will be activated at the adjusted time, once the input of the pulse is active, independently of the time the input remains active.



Tp = Time of the pulse (ms).

Tof = Time of operation of the feeder (ms).

Thf = Time of trip holding of the feeder (200ms).

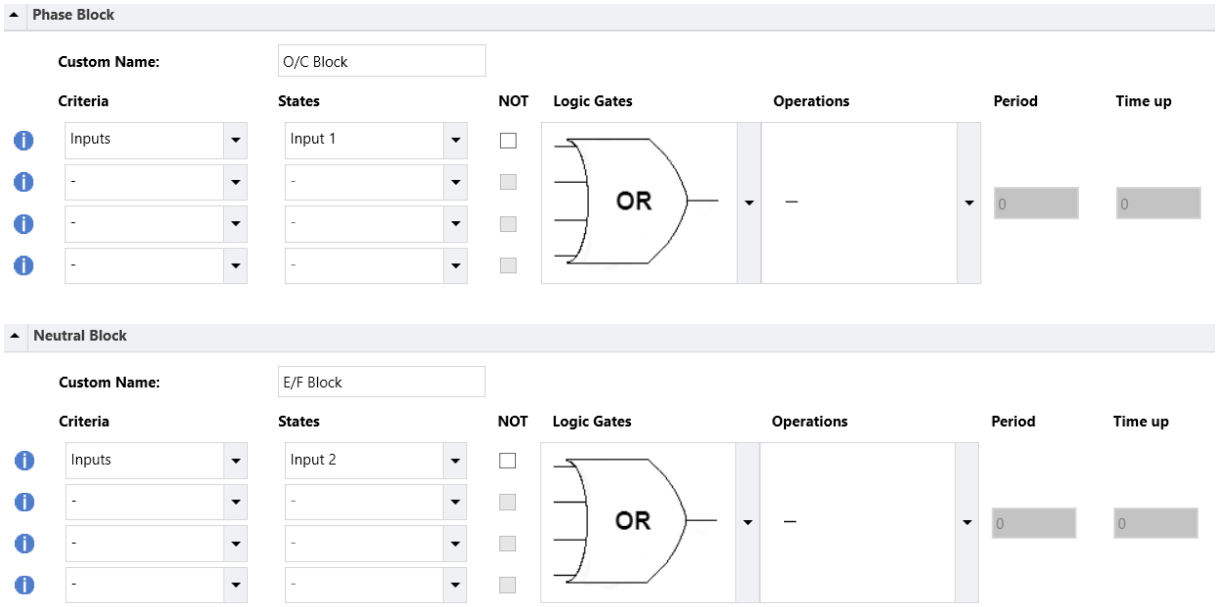
ΔT = Security time (approximately 40ms).

Tos = Time of operation of the supply (ms).

Ths = Time of trip holding of the supply (200ms).

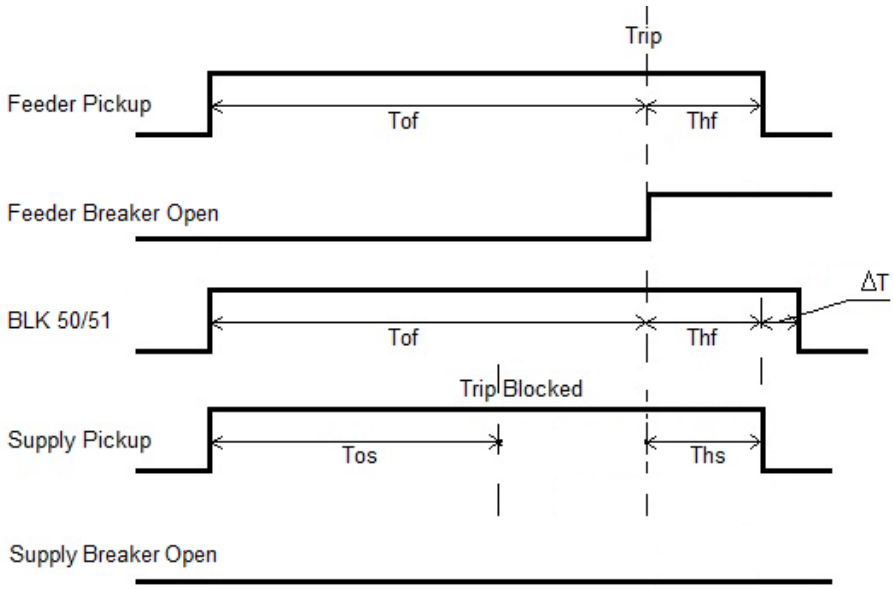
Please, take into account that 50 and 51 functions keep the trip output activated during the holding time (200ms), once the trip condition disappears.

The inputs of the supply relay should be connected to the blocking signals directly through an OR.

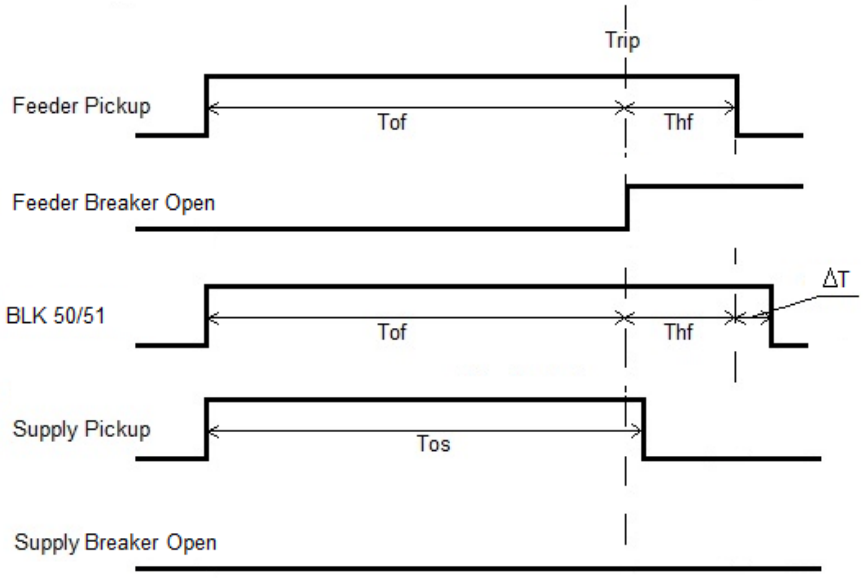


Next, different cases will be described:

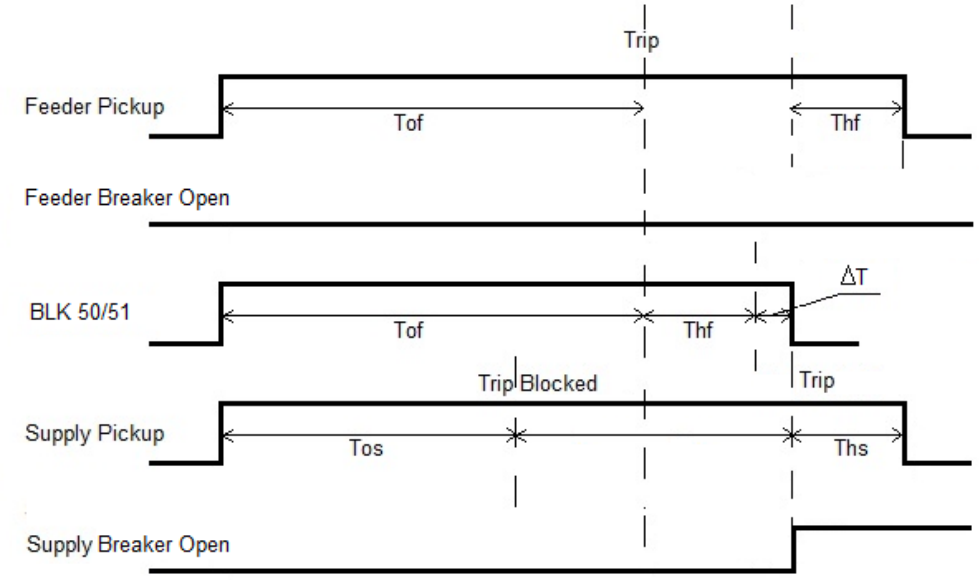
The feeder and supply will trip their functions as they see the fault. The supply's time of operation is shorter than the feeder's time, so the feeder will open its breaker, making the fault disappear, and it will block the supply trip output preventing the opening of the supply's breaker.



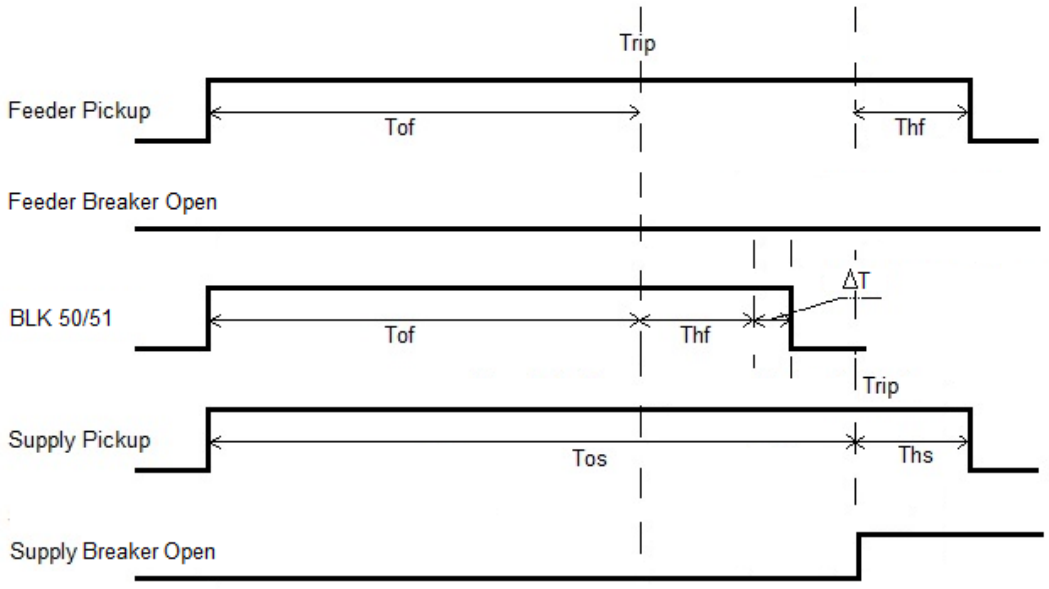
The feeder and supply will trip their functions as they see the fault. The supply's time of operation is larger than feeder's time, so the feeder will open its breaker, making the fault disappear, and block the supply function. The supply will not trip because the feeder makes the fault disappear before its time of operation is finished.



The feeder and supply will trip their functions as they see the fault. Supply's time of operation is shorter than feeder's time, so the supply function will trip but it will be blocked by the feeder. When the feeder trips, it is not able to open its breaker so the supply will trip once the block disappears since it can still see the fault.



The feeder and supply will trip their functions as they see the fault. The supply's time of operation is larger than the feeder's time, so the feeder will trip but it will not be able to open its breaker. The feeder will block the supply at the adjusted time, but in this case, the time of operation of the supply is larger than this blocking time, so the supply will trip once its time of operation finishes since it can still see the fault.



12.6 Function 74TCS. Trip Circuit Supervision

This control function can be set by using the following parameters:

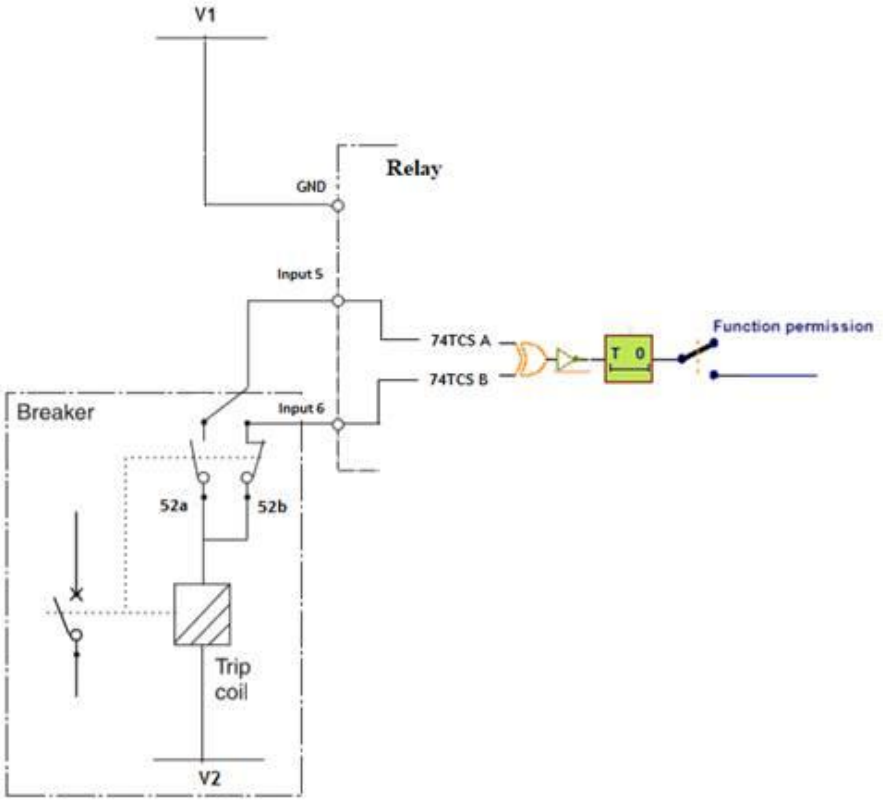
Function	Description	Minimum	Maximum	Step	Unit	Default
74TCS	Trip Circuit Supervision					
	Function Enable	-	-	Yes/No	-	No
	Time Delay	0.020	300.000	0.001	s	0.200

This function allows to monitor of the circuit breaker trip circuits. This is performed by verifying the continuity of the trip circuit, in both circuit breaker positions, open and closed. To avoid spurious results, it must be appropriate time delayed.

As this is a control function, it does not participate in the general trip. Its states can be associated with an alarm, logic alarm, and outputs through the configuration.

The accuracy is equal to the set time ±30ms or ±0.5% (whichever is greater).

The schematic for this function is as follows:



Note: On the schematic Input5 and Input6 are shown for illustrative purposes. Any other input can be chosen and associated to suitable logic PGC signals '**74TCS Coil A**' and '**74TCS Coil B**'.

12.7 Function 60CTS. Phase CT Supervision

This control function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
60CTS	**Phase CT Supervision**					
	Function Enable	-	-	Yes/No	-	No
	Time Delay	0.020	300.000	0.001	s	5

Current transformer supervision is provided to detect the loss of **one** of the phases.

If a current lower than 0.8% of the nominal current is detected in one phase during more than 40ms, the adjusted time starts to count, and the trip occurs after the set Time Delay.

The reset is instantaneous when a current higher than 0.8% of nominal current is detected. The accuracy of the time delay is equal to the initial 40ms plus the preset time ±30ms or ±0.5% (whichever is greater).

As this is a control function, it does not participate in the general trip. Its states can be associated with an alarm, logic alarm, and outputs through the configuration.

12.8 Function 60VTS/VSS. Phase VT/LPVT supervision

This control function can be set by using the following parameters:

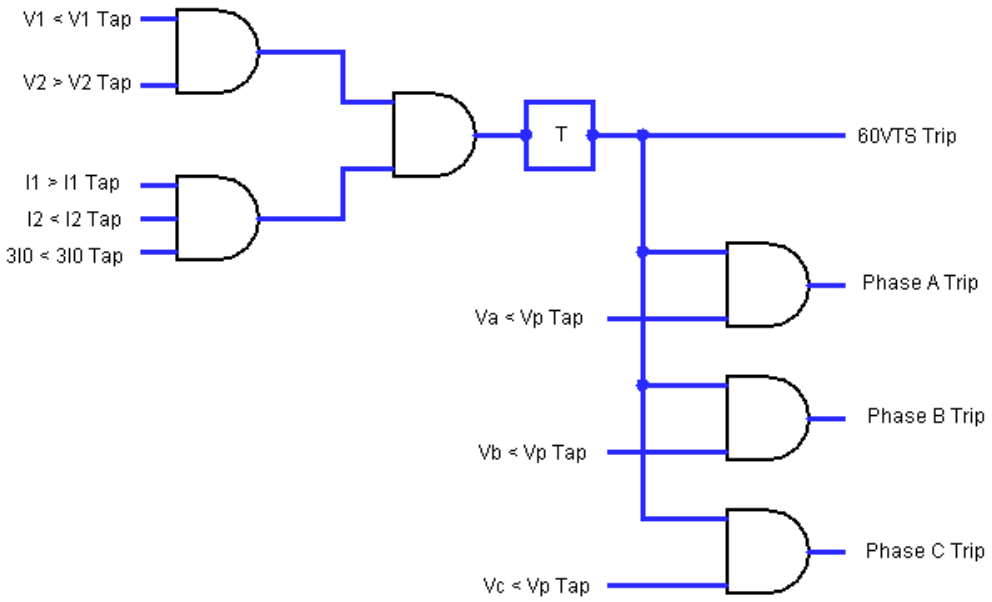
Function	Description	Minimum	Maximum	Step	Unit	Default
60VTS/VSS	**Phase VT Supervision**					
	Function Enable	-	-	Yes/No	-	No
	Time Delay	0.020	300.000	0.001	s	5.000
	V1 Tap(*)	0.08	2.00	0.01	xUn	0.75
	V2 Tap(*)	0.08	2.00	0.01	xUn	0.30
	VP Tap(*)	0.08	2.00	0.01	xUn	0.60
	I1 Tap	0.010	20.000	0.001	xIn	0.750
	I2 Tap	0.010	20.000	0.001	xIn	0.100
	3I0 Tap	0.010	20.000	0.001	xIn	0.100

(*) Voltage setting from 0.04 instead of 0.08 for the models with voltage sensors.
VP concerns to phase voltage.

When a situation of loss of one or more of the VT/LPVT signals occurs, the following conditions develop:

- There will be a drop in the positive sequence voltage accompanied by an increase in the negative sequence voltage magnitude. The magnitude of this drop depends on the number of phases impacted by a fuse failure.
- In case of a loss of VT/LPVT signal and contrary to a fault condition, there should not be any change in the current's magnitudes and phases. Therefore, the negative and zero sequence currents should remain below a small tolerance value. A fault condition be distinguished from a loss of VT/LPVT signal by monitoring the changes in the positive and negative current levels. In case of a loss of VT/LPVT signals, these changes should remain below a small tolerance level.

All the above conditions can incorporate into a complex logic scheme to determine if indeed there has been a condition of loss of VT/LPVT signal or a fault.



To obtain a stable measurement of currents and voltages a 40ms time delay is applied to the function.

The accuracy of the time delay is equal to these initial 40ms plus the preset time ±30ms or ±0.5% (whichever is greater).

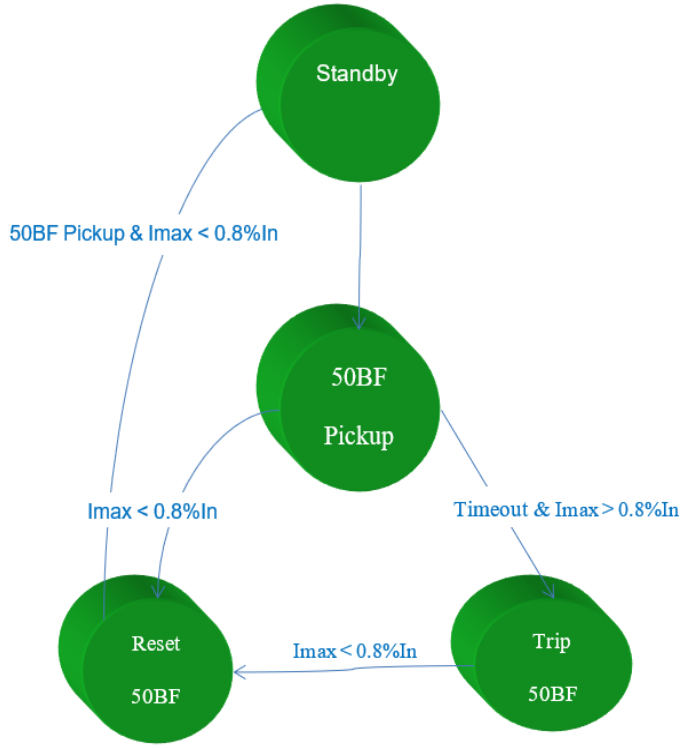
As this is a control function, it does not participate in the general trip. Its states can be associated with an alarm, logic alarm and outputs through the configuration.

12.9 Function 50BF. Circuit Breaker Failure

This control function can be set by using the following parameters:

Group	Description	Minimum	Maximum	Step	Unit	Default
50BF	**Circuit Breaker Failure**					
	Function Enable	-	-	Yes/No	-	No
	Time Delay	0.020	1.000	0.001	s	0.2

The following automaton describes the open failure function:



When the logic signal '**50BF Start**' is activated, it starts the pickup of the function. To monitor the circuit breaker opening the current measurement via the three phases is used. When the current in the three phases is less than 0.8% of the rated current, the circuit breaker is considered open and the function resets itself.

If the phase current exceeds its predetermined value (0.8%In) for an equal or greater amount of time than this preset value, the protection function activates (trips) and does not reset itself until the value of the phase drops below the point of current pickup (0.8%In).

As this is a control function, it does not participate in the general trip. Its states can be associated to an alarm, logic alarm and outputs through the configuration.

The '**50BF Start**' status is an adjustable logic PGC. By default, it is activated when a General Trip is generated.

From FW version 3.00.00 onwards:

When the logic signal '**50BF Start**' is activated, it starts the pickup of the function. To monitor the circuit breaker opening the current measurement via the three phases is used. When the current in the three phases is less than 80% of the adjusted current presence setting, the circuit breaker is considered open and the function resets itself.

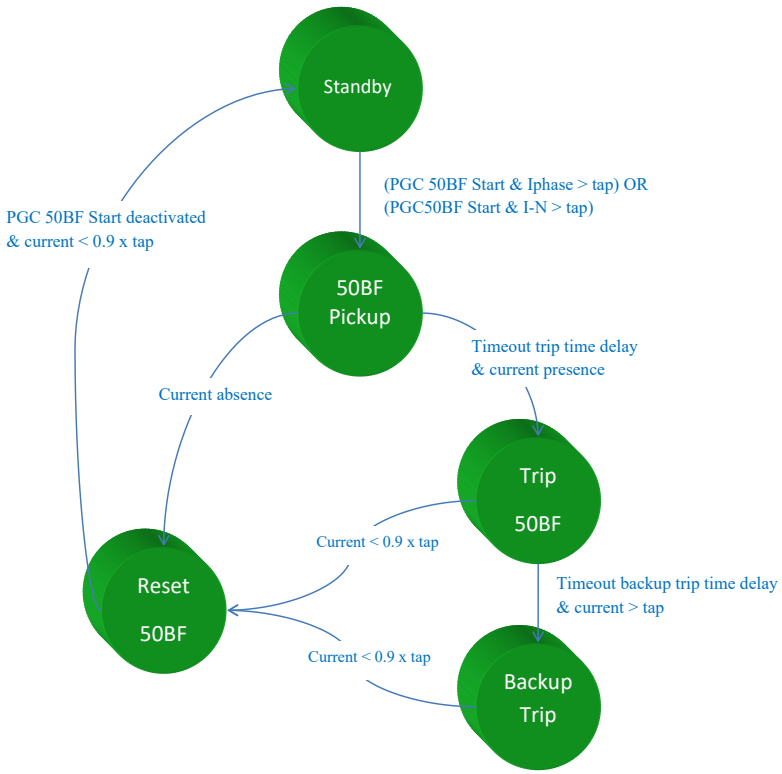
If the phase current exceeds the adjusted current presence setting for an equal or greater amount of time than this preset value, the protection function activates (trips) and does not reset itself until the value of the phase drops below the point of 80% of the adjusted current presence setting.

***From FW version 03.01.00 onwards**:*

This control function can be set by using the following parameters:

Group	Description	Minimum	Maximum	Step	Unit	Default
50BF	**Circuit Breaker Failure**					
	Function Enable	-	-	Yes/No	-	No
	Phase Curr. Tap	0.008	30	0.001	xIn	0.010
	Neutral Curr. Tap	0.008	30	0.001	xIn	0.05
	Time Delay	0.02	1	0.001	s	0.2
	Back Period	0.02	1	0.001	s	0.2
	50BF Start	PGC : General / Trip				

The following automaton describes the open failure function:



When the current of the phases or the ground is higher than the set tap, and the logic signal 'PGC-50BF Start' is activated, the pickup of the function starts. To monitor the circuit breaker opening the current measurement via the three phases is used. When the current in the three phases is less than the "current absence" level, defined as 80% of the current presence set on general settings, the circuit breaker is considered open and the function resets itself.

If the phase current exceeds the current presence level for an equal or greater amount of time than the trip delay time, the function activates (50BF trip alarm state activates) and does not reset itself until the value of the current (phase and neutral) drops below the pickup current. Hysteresis is applied to deactivation (0.9 x current tap).

If after the first trip, the current doesn't drop to the trip deactivation level and the backup trip timer is reached, the function will activate a second alarm for a backup trip.

When the value of the current (phase and neutral) drops below the pickup current, the function will reset.

From the reset status, if both the current of the phases and the current on the ground is less than each pickup level, and the 50BF start logical signal is deactivated, the function will go back to the standby state.

As this is a control function, it does not participate in the general trip. The trip states can be associated to an alarm, logic alarm and/or outputs through the configuration.

12.10 Function SHB. Second Harmonic Blocking

The second harmonic blocking is used to avoid undesirable behaviors due to inrush current when energizing a machine like a transformer or a generator. This control function can be set by using the following parameters:

Group	Description	Minimum	Maximum	Step	Unit	Default
SHB	**Second Harmonic Blocking**					
	Function Enable	-	-	Yes/No	-	No
	Current tap	5	50	1	%	20
	Reset Time	0.000	300.000	0.001	s	0.200
	Block Threshold	0.010	30.000	0.001	xIn	7.000

If the second harmonic measurement is higher than the current tap setting, the trip will be blocked. Once the second harmonic measurement is lower than the tap:

- If the reset time is set to 0, the blocking of trip disappears, and the functions will trip according to the implemented settings.
- If the reset time is different to 0, the blocking of the trip will be maintained for this time although the second harmonic is lower than the current tap setting.

The function picks-up at 100% of the adjusted current tap and the drop-out is at 95%. The reset type will depend on the adjusted reset time.

The SHB will only be applied in functions that have this option in the "function enable" setting. When the Function Enable of these protection functions is set to "SHB", the relay will supervise the second

harmonic content in order to trip or block the trip depending on the percentage of second harmonic present in the current signal.

Block threshold indicates the level of current from which the block will not apply. If the applied current is higher than the block threshold setting, the function will not block the trip although the injected second harmonic level is higher than the current tap setting.

The blocking is activated at 100% and deactivated at 95% of its value.

12.11 Function CLP. Cold Load Pickup

This control function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
CLP	Cold Load Pickup					
	Function Enable	-	-	Yes/No	-	No
	Settings group	1	4 or 6(*)	1	-	4
	No Load time	0.020	300.000	0.001	s	15
	Cold Load Time	0.020	300.000	0.001	s	15

(*) Only available for the models with voltage sensors ("voltage measurements" digits 1, 2, 3, 4).

This unit is used to prevent undesired operations of the overcurrent functions in the cases where the line is de-energized, and all the loads enter at the same time.

These two parameters have the following meaning:

- **No Load Time**: If the circuit has been open for less time than the setting, the Cold Load Pickup function is not in working conditions.

- **Cold Load Time**: If the Cold Load Pickup function is in working conditions (after the circuit has been closed), the new setting group is applied. After being in Close Cold Load or Open Cold Load (the red states of the automaton shown below) for the time defined in this parameter, the relay returns to the adjusted setting group. Changing the state of the circuit breaker (open or closed) restarts the timer as the states of the automaton change.

The controller has five states. In three of the states, the green ones on the diagram, the relay works with the usual setting group (the group adjusted in the general settings), and in the other two, the red ones, with the new setting group.

The relay uses the current level to determine the circuit breaker state (open or closed). When the current is less than 0.8% of the rated current, the line is considered open. When the current is higher than the 1% of the rated current the line is considered closed.

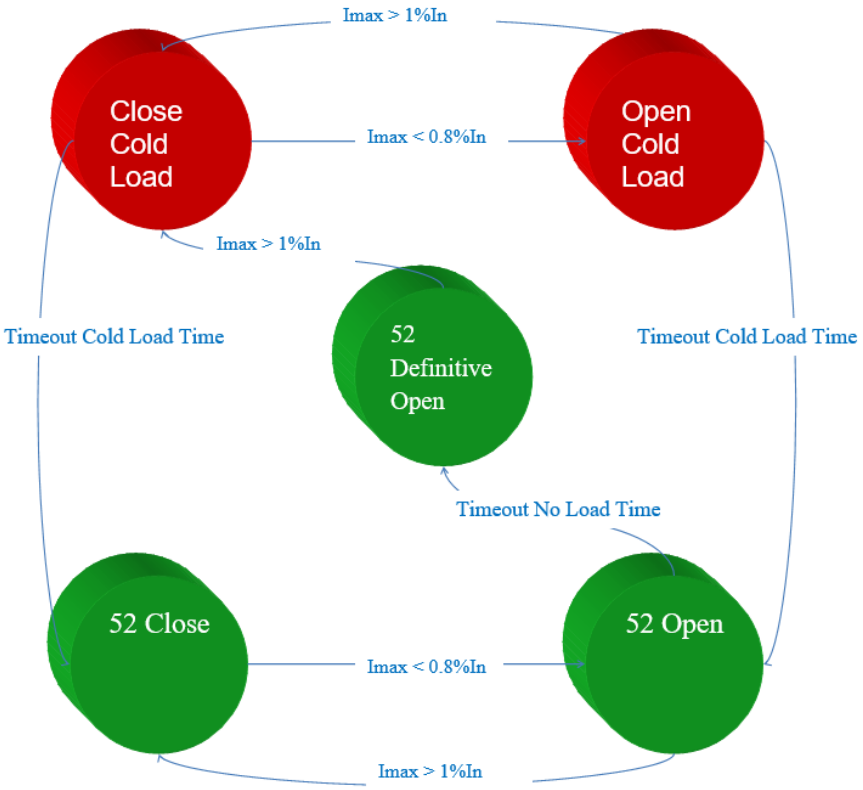
The relay usually operates with the settings in their active group. When the circuit breaker opens, a timer, "No Load Time' starts. After this time, the relay considers that the circuit breaker is open, so the CLP function is in working conditions.

Once the circuit breaker is closed, CLP function picks-up and 'Cold Load Time' starts to count. During this time, the relay will work with the new setting group. However, the Cold Load Time will restart anytime the state of the circuit breaker is changed. This is, the new setting group will be active until the circuit breaker is maintained closed or open, without changing the state, for the time defined in Cold Load Time.

From FW version 3.00.00 onwards:

The relay uses the current level to determine the circuit breaker state (open or closed). If the current is lower than 80% of the adjusted current presence setting is detected it is considered the breaker is open and if it is higher than the adjusted current presence setting is available, it is considered the breaker is closed.

If the breaker is open, the current value that must be detected to consider breaker closed again, has to be higher than the adjusted current presence setting. If the breaker is closed, the current value that must be detected to consider the breaker open, has to be lower than 80% of the adjusted current presence setting.



This function states can be associated to an alarm, logic alarm and outputs through the configuration.

12.12 Function 52. Breaker Wear Monitoring

This control function can be set by using the following parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
52	**Breaker Wear Monitoring**					
	Maximum number of openings	1	100000	1	-	1000
	Maximum accumulated amperes	1	100000	1	M(A²)	100
	Repetitive number of openings	1	100000	1	-	3
	Time for repetitive number of openings	1	300	1	min	3
	Maximum opening time	0.020	300.000	0.001	s	0.10
	Maximum closing time	0.020	300.00	0.001	s	0.10

NOTE: The “Maximum accumulated amperes” adjustment units are M(A²) (square mega amperes) whilst the “Accumulated amperes counter” units are K(A²) (square kilo amperes).

This function allows to monitor the status of the circuit breaker and to perform preventive maintenance.

The following statuses are associated with this function:

Function	Status	Description
52	Startup	These are the different statuses of the circuit breaker automatic control. The function only is initialized on Start when the relay is switched on. If the relay doesn’t lose power supply, the last state is maintained.
	Error	
	Open	
	Opening time	
	Opening error	
	Closed	
	Closing time	
	Closing error	
	Configured number of openings alarm	Activated if the counter that measures the number of openings exceeds the ‘Maximum number of openings’ setting
	Configured accumulated amperes (I^2t) alarm	Activated if the accumulated amps counter exceeds ‘Maximum Accumulated Amperes’ setting
	Configured number of openings in a time frame alarm	Activated if the number of openings exceeds the setting in ‘Maximum Number of Repetitive Openings’ during the time set in ‘Time of Repetitive Openings‘. It works like a time accumulator, to be active it needs to detect openings within the range defined by these two settings.

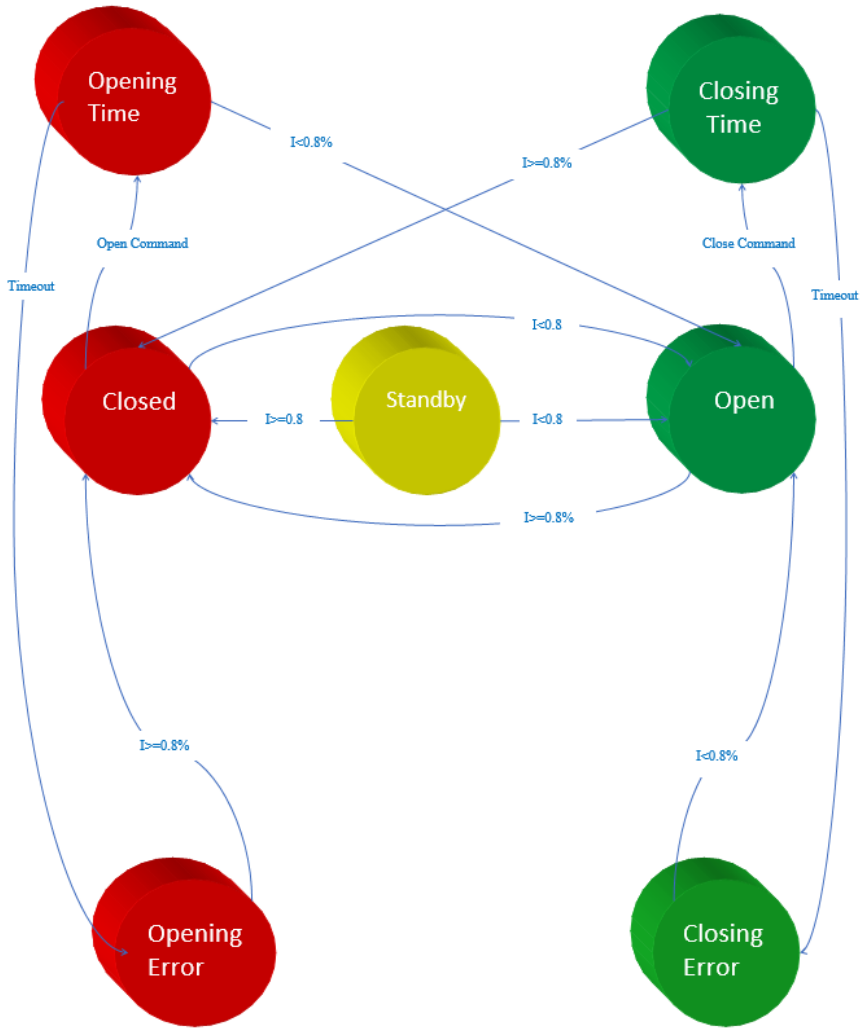
This function states can be associated with an alarm, logic alarm and outputs through the configuration.

Monitoring function of circuit breaker will be more difficult depending on the available circuit breaker contacts, zero, only one (52a or 52b) or both (52a and 52b).

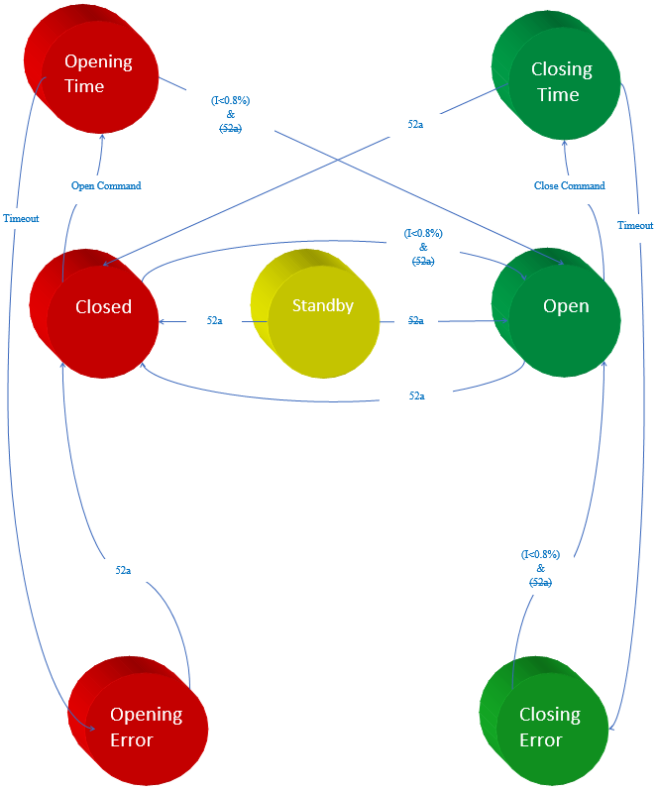
If **no breaker contacts** are used, the monitoring of the circuit breaker is made through the current measurement. This is, if less than 0.8% of rated current is detected it is considered the breaker is open and if more than 0.8% of rated current is available, it is considered the breaker is closed.

From FW version 3.00.00 onwards:

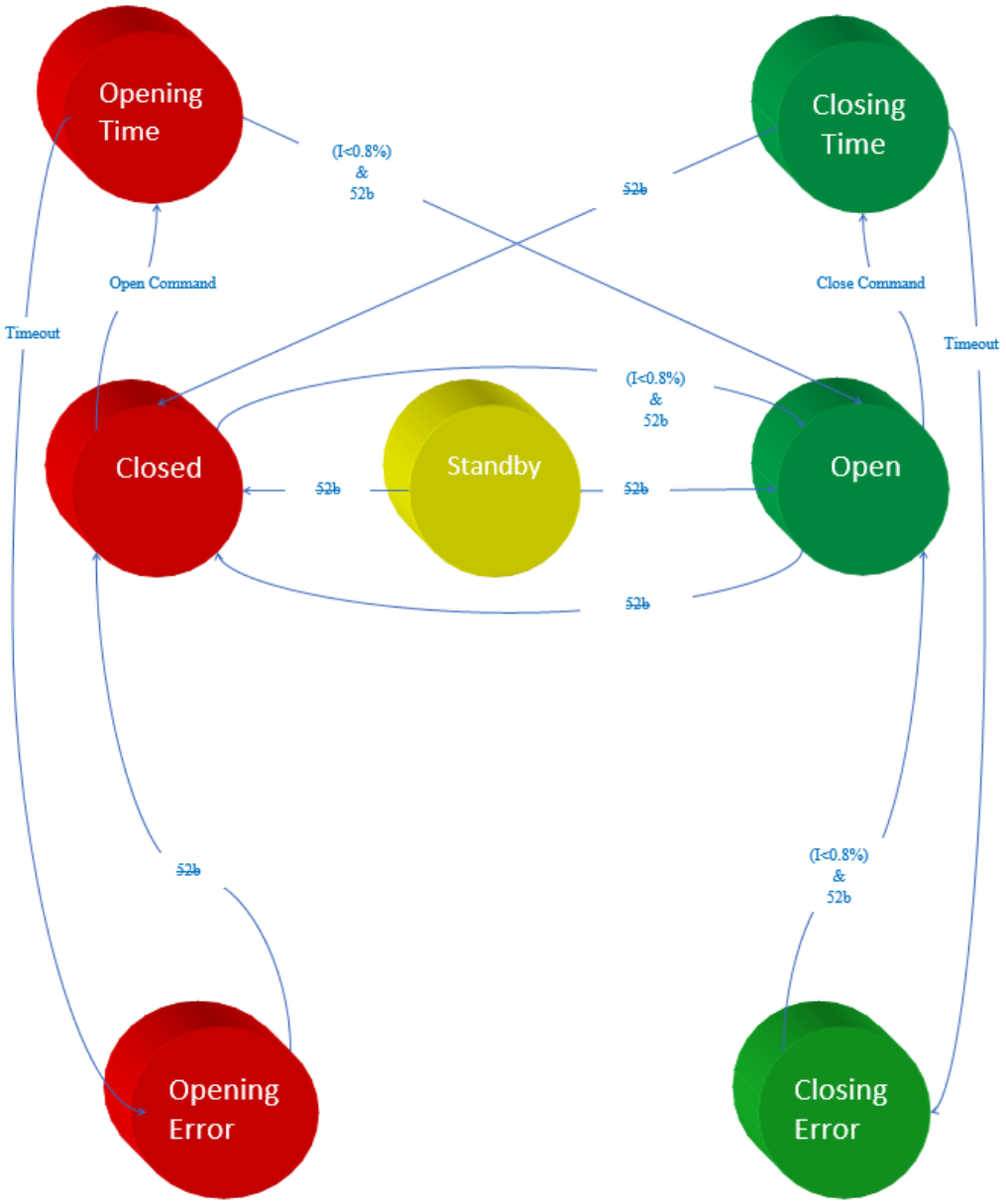
If **no breaker contacts** are used, the monitoring of the circuit breaker is made through the current measurement. This is, if a current lower than 80% of the adjusted current presence setting is detected it is considered the breaker is open and if a current higher than the adjusted current presence setting is available, it is considered the breaker is closed.



If only the circuit breaker **52a contact** is available, it should be wired to the corresponding physical input. This physical input is then assigned to the "52a Input" logical input. The 52b logical input is calculated internally as the negative of 52a. The circuit breaker performance is shown in the following finite state machine:

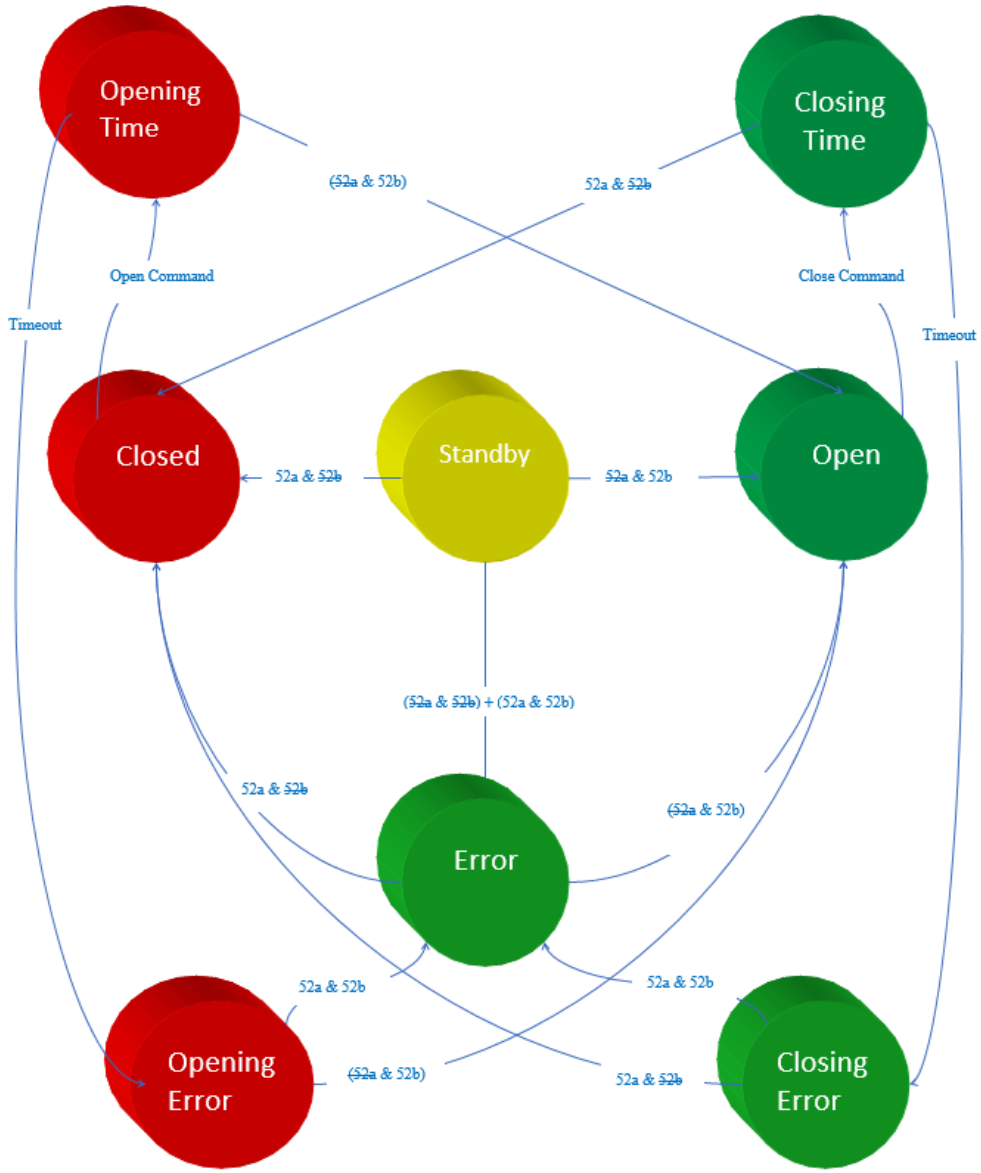


If only the circuit breaker **52b contact** is available, it should be wired to the corresponding physical input. This physical input is then assigned to the "52b Input" logical input. The 52a logical input is calculated internally as the negative of 52b. The circuit breaker performance is shown in the following finite state machine:



If **both circuit breaker contacts 52a and 52b** are available, they should be wired to the two physical inputs. These physical inputs are then assigned to the corresponding logical inputs: the circuit breaker 52a contact to the "52a Input" logical input, and the circuit breaker 52b contact to the "52b Input" logical input. The circuit breaker automaton is considered as having eight statuses: Startup, open, closed, error, opening time, opening error, closing time, and closing error.

The circuit breaker performance is shown in the following finite state machine:



12.12.1 Circuit Breaker opening and closing commands

The circuit breaker opening and closing commands are implemented. These commands can be executed from the HMI commands menu or using the HMI's specific keypad or from local or remote communications.

To execute the commands from remote communications it is necessary to execute the Remote Command, with this action, the Local Control bit is deactivated, and the remote actions are allowed.

Please, note that commands executed from HMI commands menu, HMI specific keys or Local Communication will be always executed, regardless the status of the bit 'Local Control'.

For the commands to have an effect, they should be assigned to the corresponding outputs. By default, the "Open circuit breaker" and "Close circuit breaker" bits are assigned to their corresponding outputs in the "PGC" states group in the ‘STATES’ menu.

12.12.2 ‘Openings Number’ counter

SILG relay has a counter which records the number of openings of circuit breaker.

This counter has associated the setting ‘Maximum number of openings’. When number of openings is higher than adjusted value the state “Number of openings” is activated, and associated event is created.

The value of this counter can be initialized to any value inside the range, by HMI or by communications, in case of installing this protection with a circuit breaker that was already working.

12.12.3 ‘Accumulated amperes: I^2t’ counter

There is also an ‘Accumulated amperes’ counter. This counter accumulates broken amperes by circuit breaker with its openings.

When a circuit breaker opening happens the maximum of primary amperes are detected in any phase. If the detected current is lower than the nominal current, nominal current is used to calculate the accumulation.

It is used with “Openings Number” counter, as an estimation of the aging of the circuit breaker.

As primary amperes are accumulated, is indispensable to correctly set the CT’s ratio of the phases.

Associated with this counter, there is a setting called ‘Maximum accumulated amperes’. When accumulated amperes are higher than the adjusted value, state ‘Accumulated amperes’ is activated, and an associated event is created.

The value of this counter can be initialized to any value inside the range, by HMI or by communications, in case of installing this protection with a circuit breaker that was already working.

12.12.4 Maximum openings in a time frame

As well as counting the number of times the circuit breaker opens, the relay sets up a time frame and the maximum number of openings allowed during this time. Both parameters can be adjusted.

It works like a time accumulator, to be active it needs to detect openings within the range defined by these two settings.

When this number is exceeded, the ‘Openings/Time Alarm’ status is activated, and its corresponding event is generated. This alarm resets itself when the corresponding time is exceeded with less trips than those indicated.

12.13 Function 21FL. Fault Locator

The Fault Locator (21FL) functionality provides fault location estimation based on simple reactance method.

$$m = \frac{I_m\left(\frac{V_S}{I_S}\right)}{X_{1L}}$$

The settings available for this function are listed below:

Function	Description	Minimum	Maximum	Step	Unit	Default
21FL(*)	**Fault Locator**					
	Function Enable	-	-	No/Yes	-	No
	Line Length	1	100	0.1	km	100.0
	Z1 Line Magnitude	0.001	5.000	0.001	Ω/km	0.010
	Z1 Line Angle	0	90	0.1	deg	85
	Z0 Line Magnitude	0.001	5.000	0.001	Ω/km	0.040
	Z0 Line Angle	0	90	0.1	deg	85

It is assumed all zero and positive impedances as well as lengths are the same for all phases.

(*) Available from FW version 1.21.00 onwards for models with voltage sensors and from 3.00.00 onwards for models with conventional CTs.

The fault location algorithm is applicable to Overcurrent and earth fault functions: 50, 67/51, 50G, 50N, 67G/51G, 67N/51N, 46, 46BC, 67NI, 67GI.

The start of the fault locator is conditioned by the activation of the pick-up of any of the listed functions and it is closed with the general trip. The minimum adjustable time delay in the protection functions for the FL to be operative is 30ms.

12.14 Function LMS. Load Management System

12.14.1 Load Management System (LMS) target

SIL-G relay can be provided with all the required technical features to perform LMS protection. It will be provided with the programmable logic control to configure the relay to cover LMS requirements, it is necessary to implement a specific function to perform the LMS functionality.

Thanks to this function, the relay will be able to control the consumed power and to determine if it overpasses the contractual value.

Besides it will be distinguished the peak period and no peak period and the automatic closure of the CB will be configurable by the user. Furthermore, the permissions of the function will allow the user to select if an alarm or a trip will be considered.

Standard period: If the current exceeds the “No peak value” the LMS Pickup state will be activated. If the current exceeds the “No peak value” for the time set in “No peak trip time” the LMS Trip state will be activated.

If Alarm mode is selected, the LMS trip will not provoke the general trip activation, so being the trip output configure to this signal, the CB opening will not happen.

If Trip mode is selected, the LMS trip will provoke the general trip activation, so being the trip output configure to this signal, the CB will be open.

Peak period: If the current exceeds the “Peak value” the LMS Pickup state will be activated.

If the current exceeds the “Peak value” for the time set in “No peak trip time” the LMS Trip state will be activated.

If Alarm mode is selected, the LMS trip will not provoke the general trip activation, so being the trip output configure to this signal, the CB opening will not happen.

If Trip mode is selected, the LMS trip will provoke the general trip activation, so being the trip output configure to this signal, the CB will be open.

In both cases, the automatic reclose is selectable by the user.

If the function is set to Alarm mode and the Peak or No Peak number of recloses is surpassed, a signal will be activated to indicate this event. This signal is called “Peak Max Alarm” o “No Peak Max Alarm”.

If the function is set to Trip mode and the Peak or No Peak number of recloses is surpassed, the closing sequence will not be performed, and the CB will remain open until a manual close is done.

12.14.2 Load Management System Settings

This function can be set by using the following parameters:

Group	Description	Minimum	Maximum	Step	Unit	Default
LMS (*)	**Load Management System**					
	Function Enable	-	-	Yes/No	-	No
	No Peak Mode	-	-	Alarm/Trip	-	Trip
	Peak Mode	-	-	Alarm/Trip	-	Trip
	Peak Period Starting Month	January	December	(**)	-	April
	Peak Period Starting Day	1	31	1	-	1
	Peak Period Ending Month	January	December	(**)	-	October
	Peak Period Ending Day	1	31	1	-	30
	Peak Period Starting Hour	0	23	1	hour	7
	Peak Period Starting Minute	0	59	1	min	0
	Peak Period Ending Hour	0	23	1	hour	17
	Peak Period Ending Minute	0	59	1	min	59
	Peak Period Starting Day of Week	Monday	Sunday	(***)	-	Monday
	Peak Period Ending Day of Week	Monday	Sunday	(***)	-	Friday

	Reset Time	0	18000	1	s	300
	Peak Period Tap	0.010	30	0.001	xIn	5
	Peak Trip Time 1	0	18000	1	s	300
	Peak Trip Time 2	0	18000	1	s	600
	Peak Trip Time 3	0	18000	1	s	600
	Peak Trip Time 4+	0	18000	1	s	600
	Peak Number of recloses	0	247	1	-	1
	Peak Interval Time 1	0	18000	1	s	300
	Peak Interval Time 2	0	18000	1	s	300
	Peak Interval Time 3	0	18000	1	s	300
	Peak Interval Time 4+	0	18000	1	s	300
	No Peak Period Tap	0.010	30	0.001	xIn	2
	No Peak Trip Time 1	0	18000	1	s	300
	No Peak Trip Time 2	0	18000	1	s	600
	No Peak Trip Time 3	0	18000	1	s	600
	No Peak Trip Time 4+	0	18000	1	s	600
	No Peak Number of recloses	0	247	1	-	1
	No Peak Interval Time 1	0	18000	1	s	300
	No Peak Interval Time 2	0	18000	1	s	300
	No Peak Interval Time 3	0	18000	1	s	300
	No Peak Interval Time 4+	0	18000	1	s	300
	ByPass					

(*) Available in models with conventional VTs

(**) January, February, March, April, May, June, July, August, September, October, November, December.

(***) Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday.

•The settings for the **date and time** will be used to determine if the relay is working in the peak period or not.

•**No Peak Period Tap**: This parameter indicates the threshold above which the trip will occur during standard period of time.

•**No Peak Period Time**: This setting indicates the trip time if the no peak period value is exceeded.

•**No Peak Number of recloses and Interval time**: These parameters are required to carry out the automatic closing when the function is working on the no peak period.

•**Peak Period Tap**: This parameter indicates the threshold above which the trip will occur during the peak period.

•**Peak Trip Time**: This setting indicates the trip time if the consumed of the power is higher than the peak period value.

•**Reset Time**: this setting applies to peak and no peak period; is the time the relay waits after closing the CB to stabilize the current before starting again the cycle.

•**Number of recloses and Interval time**: These parameters are required to carry out the automatic closing when the function is working on the peak period.

✓ **Closing Time**: During this state the recloser sends a closing command and for this reason, if you wish to associate an output to that command, the output must be set to the Peak or No Peak Closing Time bit.

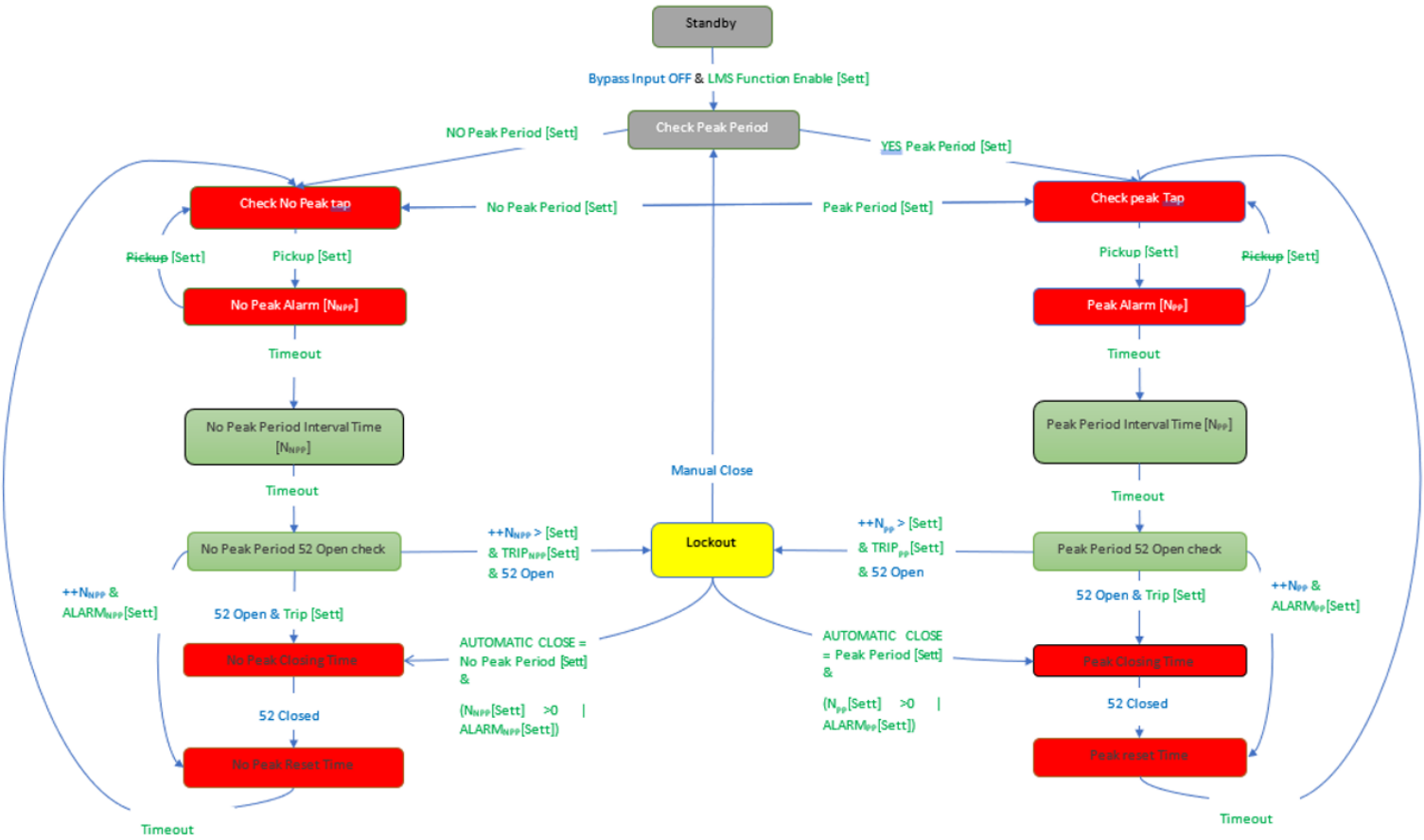
12.14.3 Load Management System operating principle

There will be 2 different working ways depending on if the peak period is activated or not.

There will be also an input (bypass input) that will guide if it is required to start the LMS sequence. If the input is activated (input ON), the relay will be kept reading the load without starting the LMS sequence. This logic can be set through the protection settings menu.

NOTE: The LMS Bypass logical signal can be configured to any input of the relay

If the input is off and the "function enable" setting of the LMS function is set to YES, the algorithm will start checking if the conditions of the peak period (depending on the adjusted settings in LMS function) are met or not.

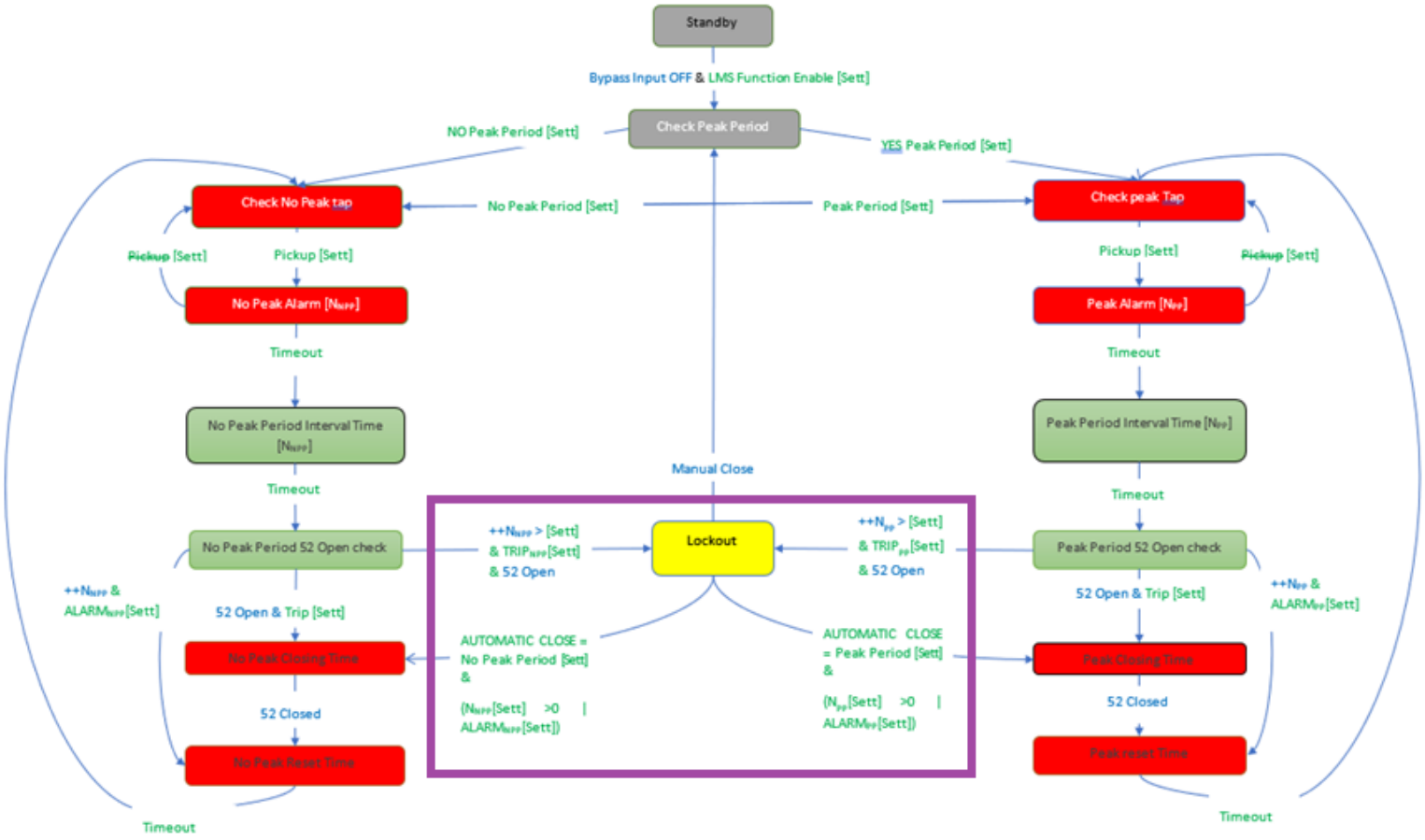


Considerations:

When the mode is set to ALARM we recommend setting the number of reclosings to 1 and the Interval T1 to 0:

In normal operation this will not have any effect as the CB is not open when we have the mode set to ALARM.

If being in No Peak Period we have a trip and the CB is open, the algorithm goes to LOCKOUT if the automatic closing is not activated. Being in Lockout, when the period changes from No Peak to Peak, we implemented the option to close automatically. To have this functionality it is necessary to have the Peak number of recloses to 1.



13 SETTINGS GROUPS

There are 4 settings group settings and one general group. The settings group which is active at a specific moment can be modified in several ways:

- Changing the active Settings group. In the general settings, inside the general menu, there is a setting that establishes which settings group is active.
- Using communications.
- Using user's commands: the user's commands can be configured to change the settings groups.
- By means of two logical conditions configurable through PGC (physical or logical inputs), four possibilities are defined:

Settings Group x2	Settings Group x1	
0	0	This situation is defined by the active settings group chosen in General Settings.
0	1	Settings group 1
1	0	Settings group 2
1	1	Settings group 3

In the zero position, the active item is defined by the active settings group defined in the general menu. Regarding other options, regardless of that established by the settings, the inputs prevail over the settings.

Settings group 4 can be used just from the active settings group defined in the general settings.

For models with voltage sensors there are 6 settings groups and one general group. The modification of the active setting group is the same as for models with voltage transformers, but instead of two logical conditions there are three double logical conditions configurable through the PGCs. Six possibilities are defined.

Settings Group x4	Settings Group x2	Settings Group x1	
0	0	0	This situation is defined by the active settings group chosen in the General Settings.
0	0	1	Settings group 1
0	1	0	Settings group 2
0	1	1	Settings group 3
1	0	0	Settings group 4
1	0	1	Settings group 5
1	1	0	Settings group 6

Settings group 6 can be used just for the active settings group defined in the general settings.

14 AVALIABLE CURVES

14.1 IEC 60255-151 Curves

The relay complies with the curves shown in standard IEC60255-151:

- Inverse Curve
- Very Inverse Curve
- Extremely Inverse Curve
- Long time inverse
- Short time inverse

There is a general mathematical equation that defines the time in seconds as a function of the current:

$$t = \frac{A \times D}{V^P - Q} + B \times D + K$$

Where:

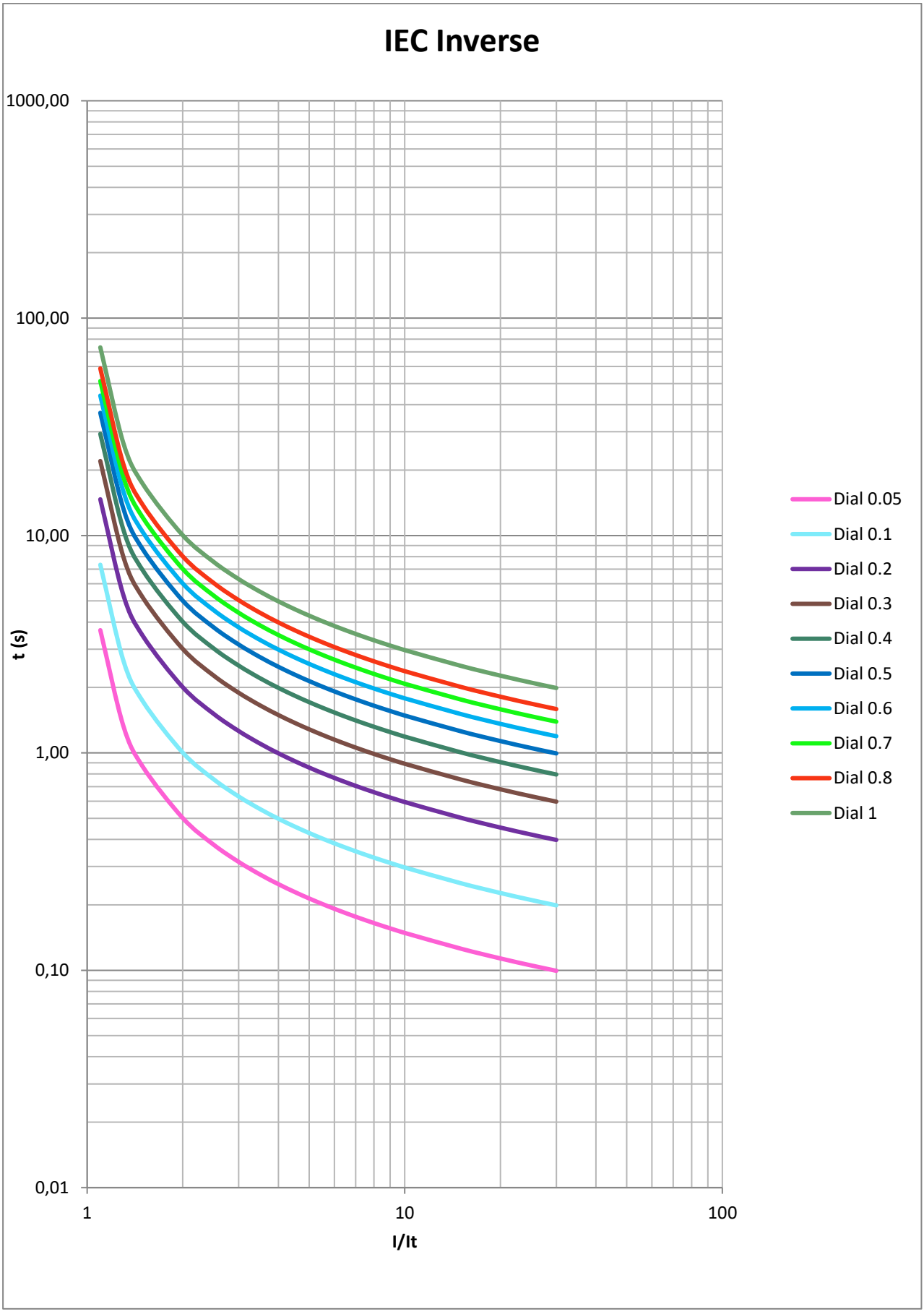
$$V = \frac{I}{I_{adjusted}}$$

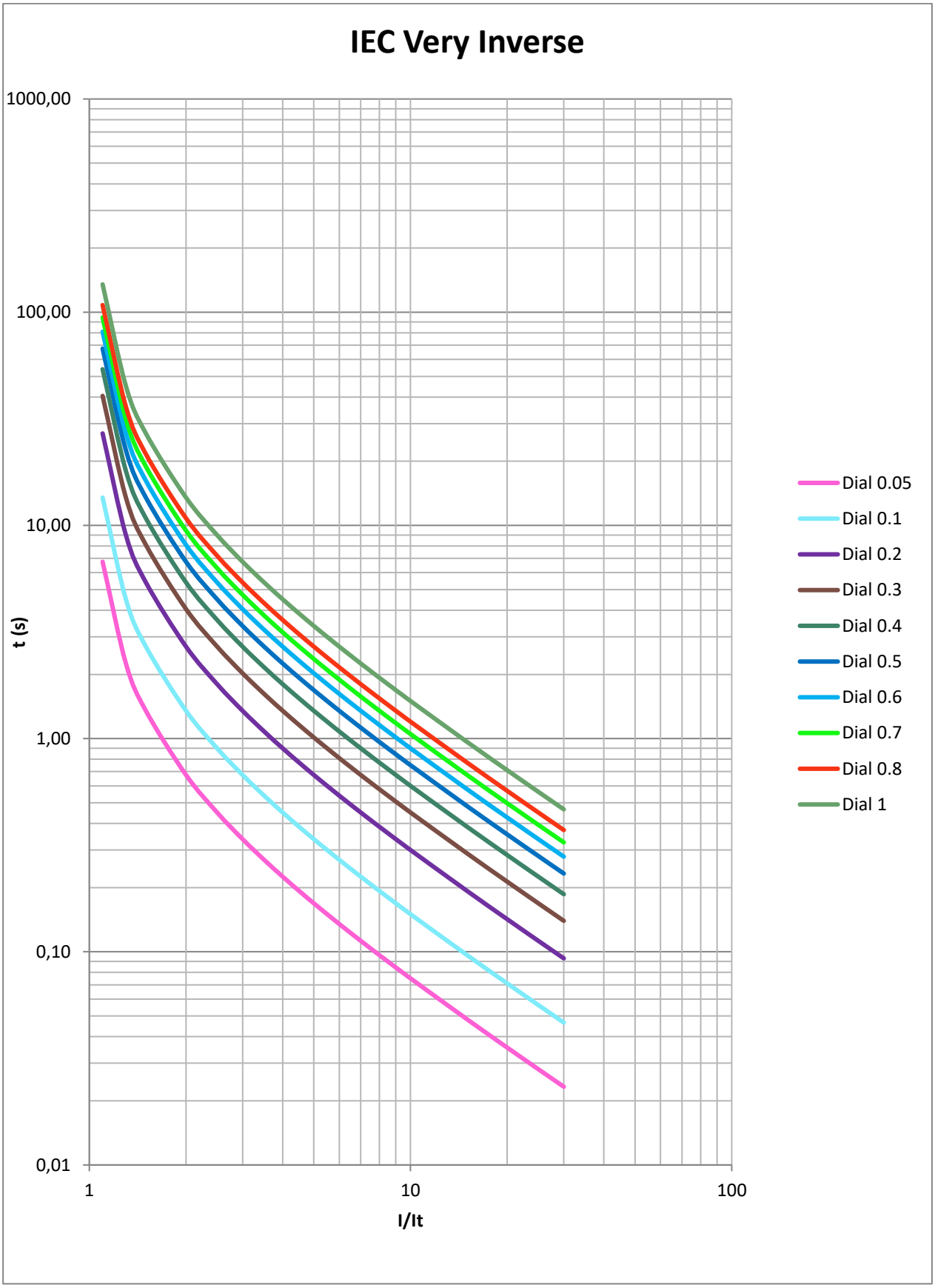
"V" must be 30 (maximum). If this relation is higher than 30, the relay will consider the corresponding theoretical trip time for this factor equal to 30.

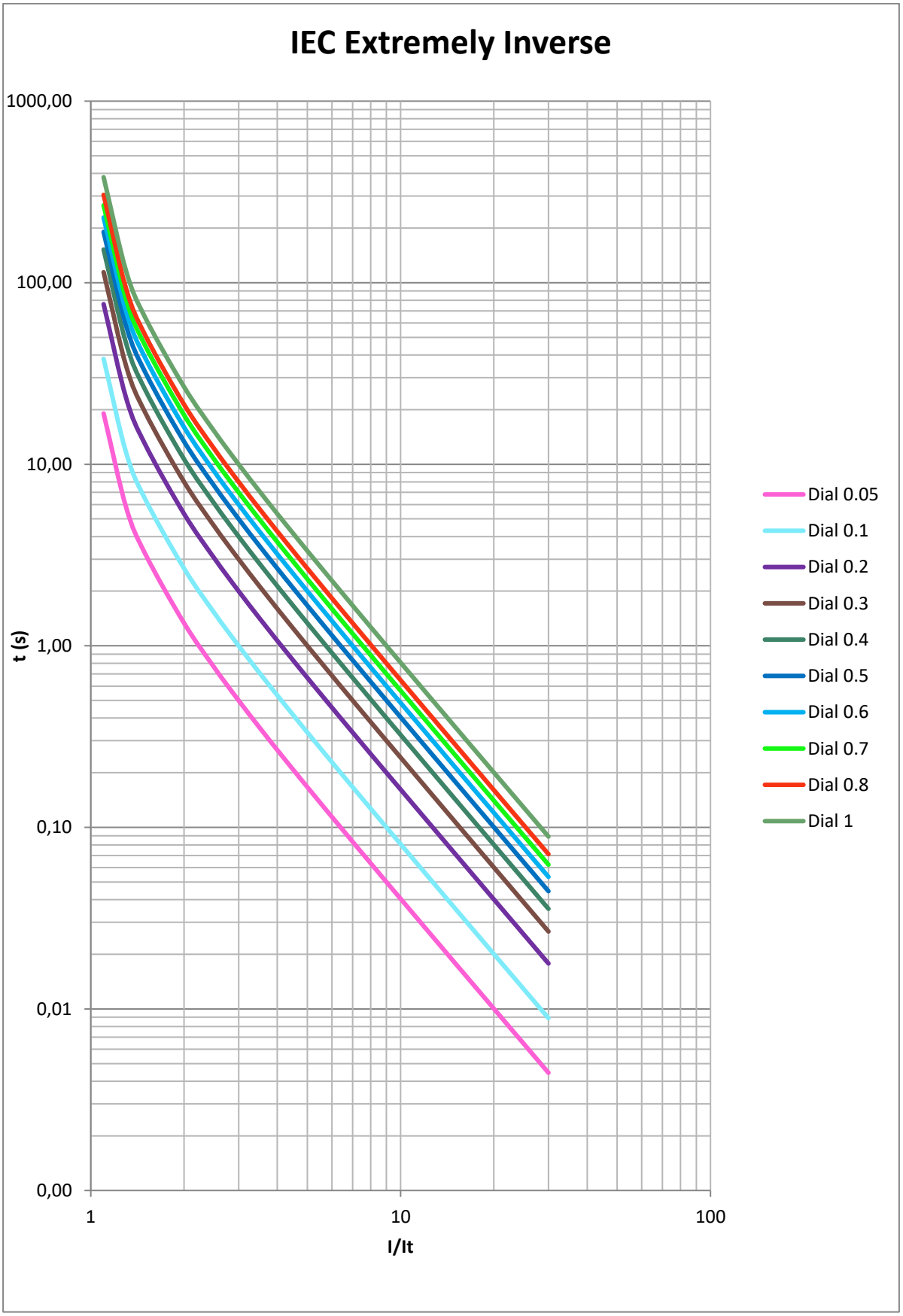
Parameters	A	P	Q	B	K
Long Time Inverse	120	1	1	0	0
Short Time Inverse	0.05	0.04	1	0	0
Ext. Inverse	80	2	1	0	0
Very Inverse	13,5	1	1	0	0
Inverse	0.14	0.02	1	0	0

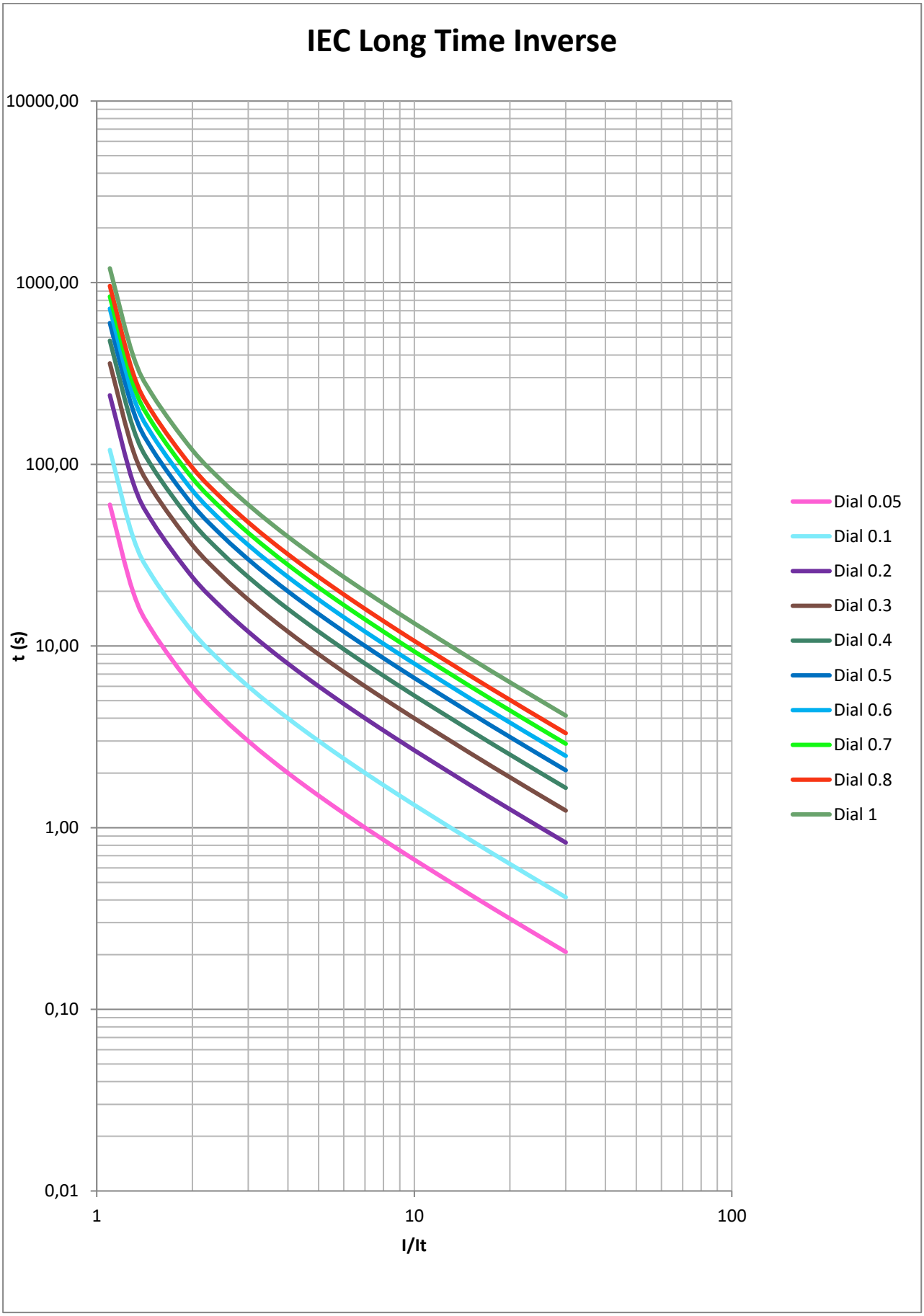
The curve can mode from its axis using the D time selection device, which the user can adjust.

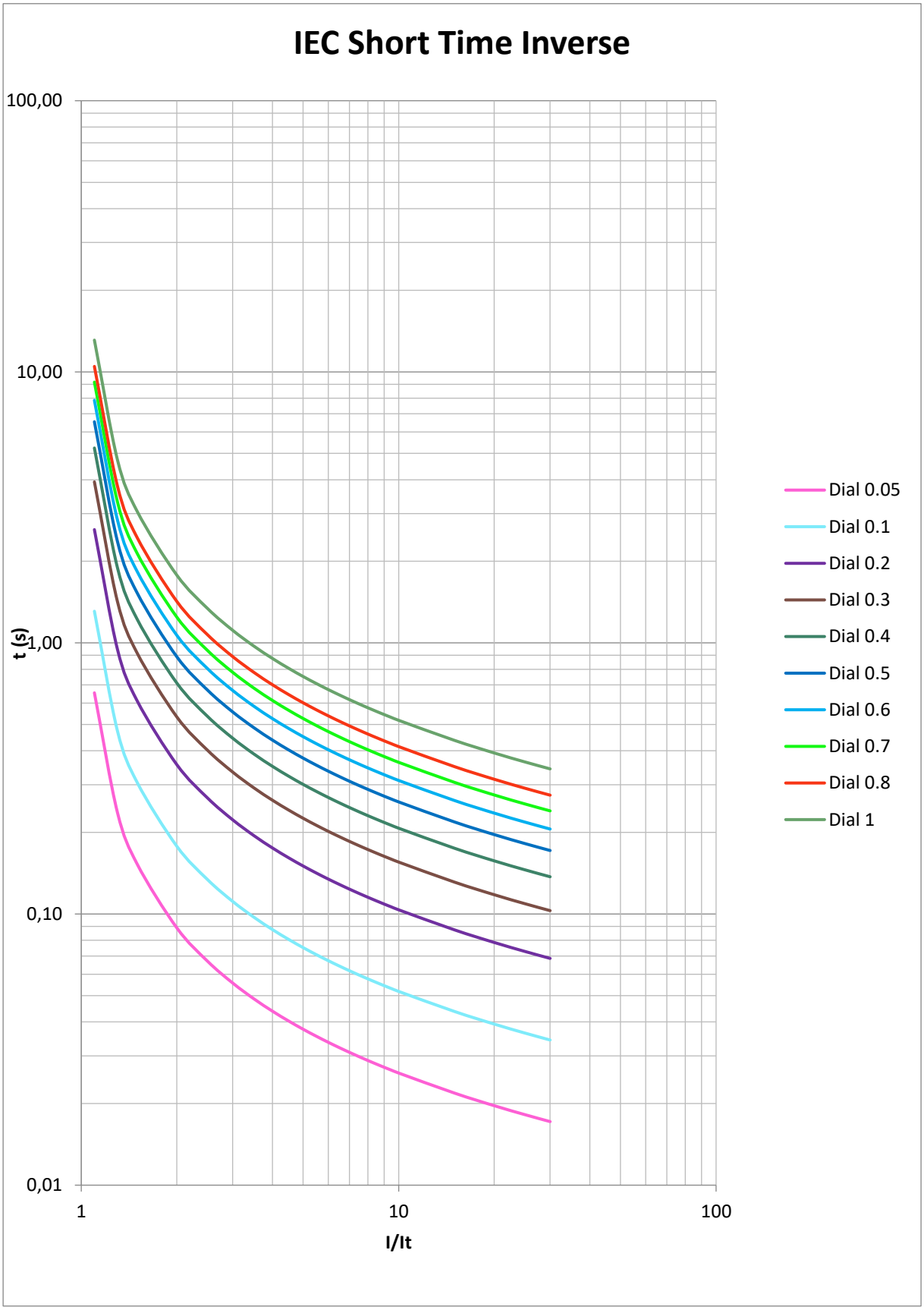
$I_{adjusted}$ is the initial operating current, set by the user.


IEC Inverse
1000,00
100,00
10,00
1,00
0,10
0,01
t (s)
1
10
100
I/It
Dial 0.05
Dial 0.1
Dial 0.2
Dial 0.3
Dial 0.4
Dial 0.5
Dial 0.6
Dial 0.7
Dial 0.8
Dial 1


IEC Very Inverse
1000,00
100,00
10,00
1,00
0,10
0,01
t (s)
1
10
100
I/It
Dial 0.05
Dial 0.1
Dial 0.2
Dial 0.3
Dial 0.4
Dial 0.5
Dial 0.6
Dial 0.7
Dial 0.8
Dial 1


IEC Extremely Inverse
1000,00
100,00
10,00
1,00
0,10
0,01
0,00
t (s)
1
10
100
I/It
Dial 0.05
Dial 0.1
Dial 0.2
Dial 0.3
Dial 0.4
Dial 0.5
Dial 0.6
Dial 0.7
Dial 0.8
Dial 1


IEC Long Time Inverse
10000,00
1000,00
100,00
10,00
1,00
0,10
0,01
t (s)
1
10
100
I/It
Dial 0.05
Dial 0.1
Dial 0.2
Dial 0.3
Dial 0.4
Dial 0.5
Dial 0.6
Dial 0.7
Dial 0.8
Dial 1


IEC Short Time Inverse
100,00
10,00
1,00
0,10
0,01
t (s)
1
10
100
I/It
Dial 0.05
Dial 0.1
Dial 0.2
Dial 0.3
Dial 0.4
Dial 0.5
Dial 0.6
Dial 0.7
Dial 0.8
Dial 1

14.2 IEEE Curves

The relay complies with the curves shown in standard IEEE:

- Moderately Inverse Curve
- Very Inverse Curve
- Extremely Inverse Curve

There is a general mathematical equation that defines the time in seconds as a function of the current:

$$t = (TD) \times \left[\left(\frac{A}{V^P - 1} \right) + B \right]$$

Where:

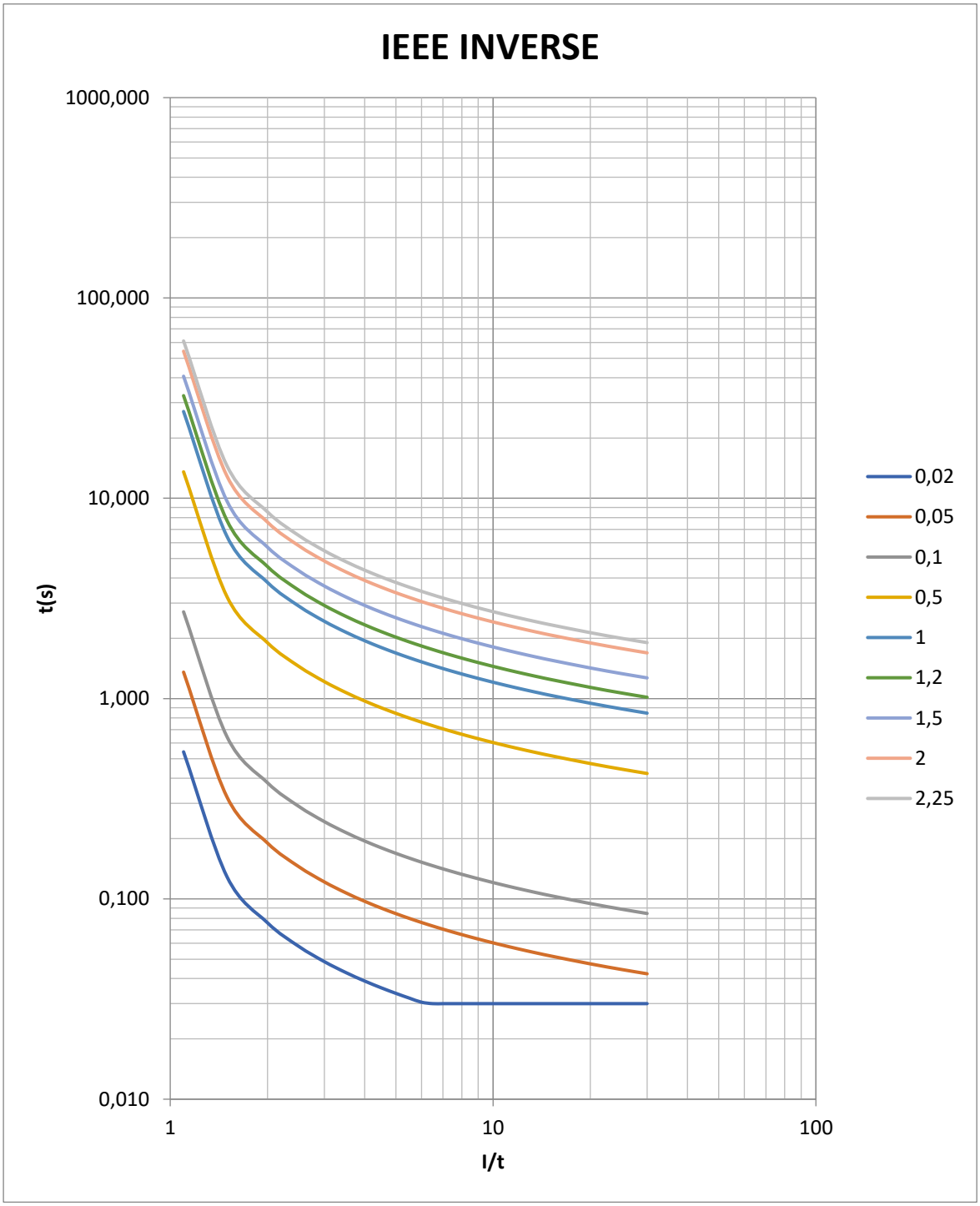
$$V = \frac{I}{I_{adjusted}}$$

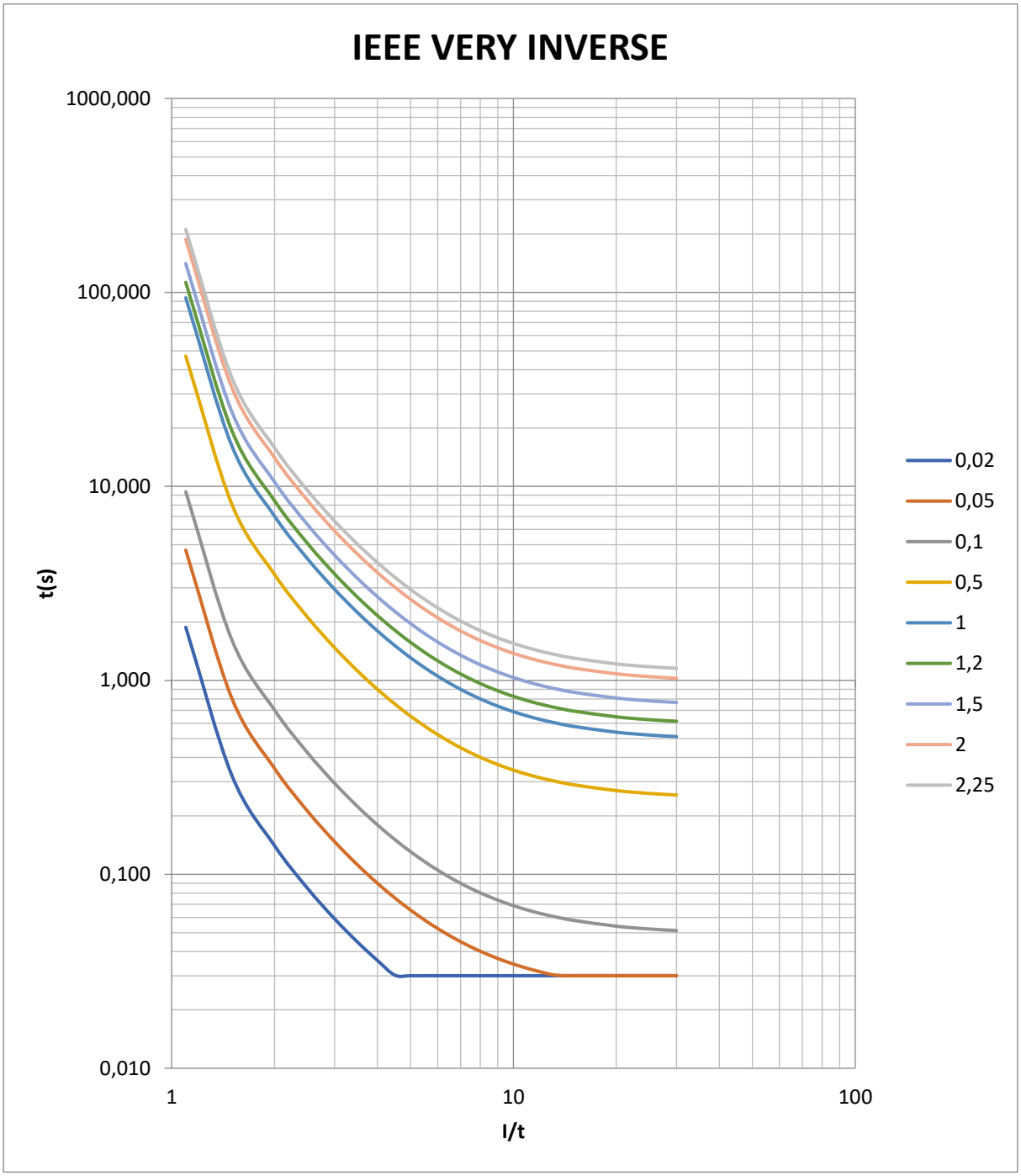
"V" must be 30 (maximum). If this relation is higher than 30, the relay will consider the corresponding theoretical trip time for this factor equal to 30.

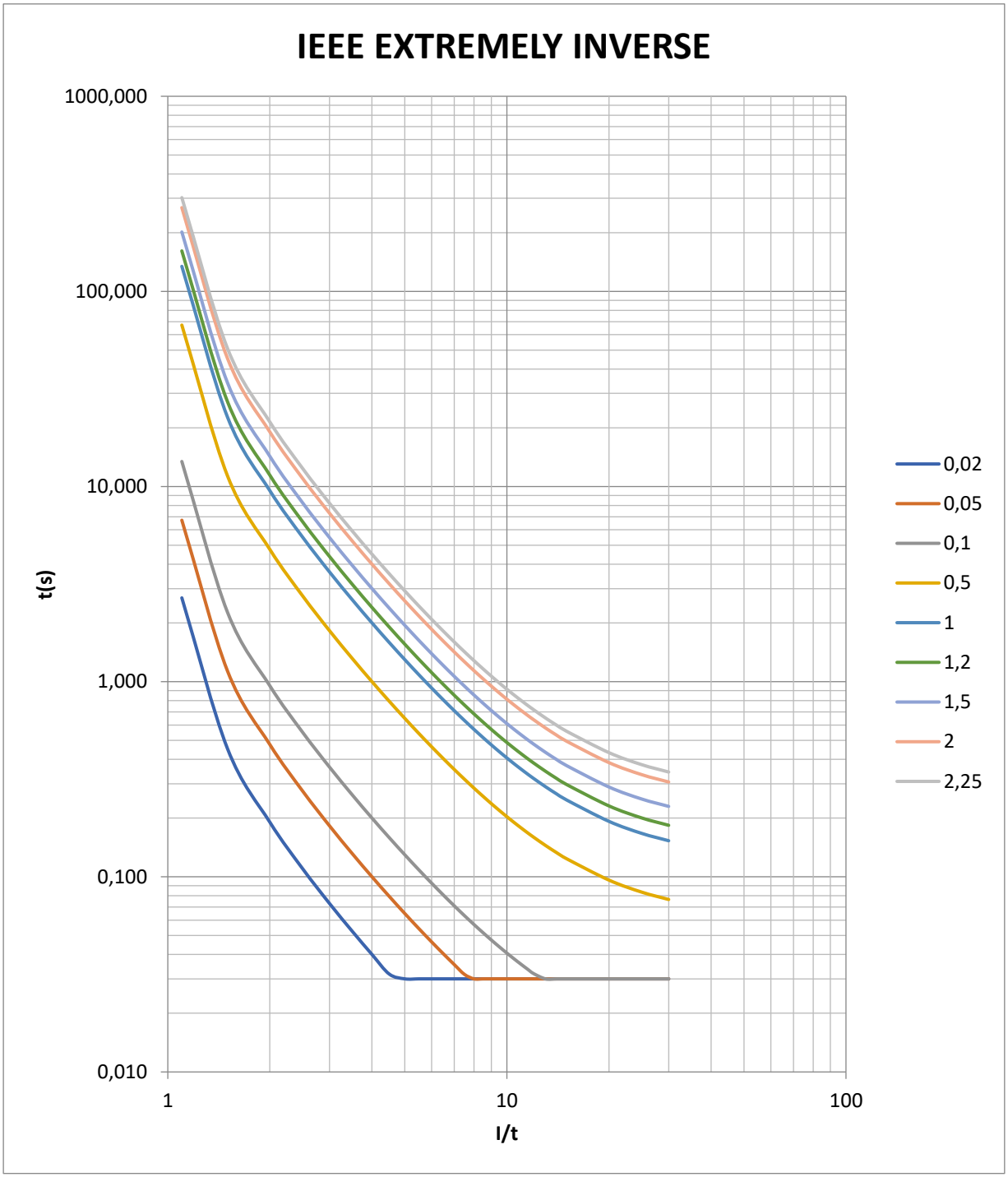
Parameters	A	P	B
Extremely Inverse	28.2	2.00	0.1217
Very Inverse	19.61	2.00	0.491
Moderately Inverse	0.0515	0.02	0.114

The curve can move from its axis using the TD time selection device, which the user can adjust.

$I_{adjusted}$ is the initial operating current, set by the user.


IEEE INVERSE
1000,000
100,000
10,000
1,000
0,100
0,010
t(s)
1
10
100
I/t
0,02
0,05
0,1
0,5
1
1,2
1,5
2
2,25


IEEE VERY INVERSE
1000,000
100,000
10,000
1,000
0,100
0,010
t(s)
1
10
100
I/t
0,02
0,05
0,1
0,5
1
1,2
1,5
2
2,25


IEEE EXTREMELY INVERSE
1000,000
100,000
10,000
1,000
0,100
0,010
t(s)
1
10
100
I/t
0,02
0,05
0,1
0,5
1
1,2
1,5
2
2,25

15 MONITORING AND CONTROL

15.1 Measurements

The relay is provided with the following measurements. Depending on the connection type (phase to phase or phase to neutral connection), the measurements will be shown according to the selected connection type.

Current measurement:

Range: 0.01-30xIn.

Phase and Neutral Accuracy (For 1A or 5A): ±2% in a band of ± 20% the nominal current and ±4% or ±5 mA (greater of both) in the rest of the band.

Neutral Accuracy (For 0.1A): ±2% in a band of ± 20% the nominal current and ±4% or ±0.5 mA (greater of both) in the rest of the band.

CURRENT
Phase A Current (I-A)
Phase B Current (I-B)
Phase C Current (I-C)
Measured neutral Current (I-N)
Calculated neutral current (3I-0)
Positive Sequence Current (I-1)
Negative sequence current (I-2)
Negative sequence current/ Positive Sequence Current (I-2/I-1)
Maximum Current (I-Max)
Phase A Second harmonic current (I-A2H)
Phase B Second harmonic current (I-B2H)
Phase C Second harmonic current (I-C2H)
Phase A current angle (Ang I-A)
Phase B current angle (Ang I-B)
Phase C current angle (Ang I-C)
Measured neutral current angle (Ang I-N)
Calculated neutral current angle (Ang 3I0)
Thermal Image (Therm. I %)
Phase A total harmonic Distortion (THD-A)
Phase B total harmonic Distortion (THD-B)
Phase C total harmonic Distortion (THD-C)
Positive Sequence Current angle (Ang I-1)
Negative Sequence Current angle (Ang I-2)

Voltage measurement:

Range:

For models with conventional VTs

Measured voltage:

Connection through VTs (Un setting: 50-130 V P-P): 3 to 250 V.

Direct connection to low voltage line (Un setting: 200-480 V P-P): 12 to 1000 V.

Accuracy:

Ambient temperature (15ºC to 35ºC): ±1% in a band covering the ±20% of the nominal voltage and ±4% in the rest of the range.

Out of ambient temperature: ±2.5% in a band covering the ±20% of the nominal voltage and ±4% in the rest of the range

Calculated voltage

Connection through VTs (Un setting: 50-130 V P-P): 6 to 250 V.

Direct connection to low voltage line: (Un setting: 200-480 V P-P): 12 to 1000 V.

Accuracy:

Ambient temperature (15ºC to 35ºC): ±2% in a band covering the ±20% of the nominal voltage and ±4% in the rest of the range.

Out of ambient temperature: ±2.5% in a band covering the ±20% of the nominal voltage and ±4% in the rest of the range.

For model with voltage sensors

Measured voltage: From 0,01282 x LEA Maximum voltage x Ratio up to 2,4 xUn.

EXAMPLE:

LEA TYPE	LEA MAXIMUM VOLTAGE	RATIO	MINIMUM MEASUREMENT
1	8	2500:1=2500	0.01282x8x2500= 256.4 V
2	5,2	20000:3.25=6153.8	0.01282x5.2x6153.8= 410.24 V
3	16	2800:1=2800	0.01282x16x2800= 574.34 V
4	2,8	10000:1=10000	0.01282x2.8x= 358.96 V

Accuracy: ±1% in a band covering ±20% of the nominal voltage and ±4% in the rest of the range.

Calculated voltage: From 0.013 x LEA Maximum voltage x Ratio up to 2,4 xUn.

EXAMPLE:

LEA TYPE	LEA MAXIMUM VOLTAGE	RATIO	MINIMUM MEASUREMENT
1	8	2500:1=2500	0.013x8x2500= 260 V
2	5,2	20000:3.25=6153.8	0.013x5.2x6153.8= 415.99 V
3	16	2800:1=2800	0.013x16x2800= 582.4 V
4	2,8	10000:1=10000	0.013x2.8x10000= 364 V

Accuracy: ±2% in a band covering ±20% of the nominal voltage and ±4% in the rest of the range.

VOLTAGE MEASUREMENT
Phase A Voltage (V-A)
Phase B Voltage (V-B)
Phase C Voltage (V-C)
Measured neutral voltage (V-R)(**)
Line voltage (V-L)(*)
AB Voltage (U-AB)
BC Voltage (U-BC)
CA Voltage (U-CA)
Calculated neutral Voltage (3V-0)
Positive Sequence Voltage (V-1)
Negative sequence Voltage (V-2)
Maximum Voltage (V-Max)
Phase A voltage angle (Ang V-A)
Phase B voltage angle (Ang V-B)
Phase C voltage angle (Ang V-C)
Measured neutral voltage angle (Ang V-R)(**)
Line voltage angle (Ang V-L)(*)
Calculated neutral voltage angle (Ang 3V-0)
AB voltage angle (Ang U-AB)
BC voltage angle (Ang U-BC)
CA voltage angle (Ang U-CA)

(*) For models with voltage sensors the line measurements are VL-A, VL-B, VL-C and for the line angles, Ang VL-A, Ang VL-B, Ang VL-C.

(**) Only for models with conventional VTs.

Power measurement:

Accuracy: 2% accuracy in rated values with a power factor between 1 and 0,7 (phase shift from 0 to ±45º).

POWER
Total Active Power (P-3P)
Total Reactive Power (Q-3P)
Total Apparent Power (S-3P)
Total Power Factor (cos φ)
Phase A Active power (P-A)
Phase A Reactive power (Q-A)
Phase A Apparent power (S-A)
Phase A Power Factor (cos φ-A)
Phase B Active power (P-B)
Phase B Reactive power (Q-B)
Phase B Apparent power (S-B)
Phase B Power Factor (cos φ-B)
Phase C Active power (P-C)
Phase C Reactive power (Q-C)
Phase C Apparent power (S-C)
Phase C Power Factor (cos φ-C)

Frequency measurement:

Range: 45-65 Hz

Minimum required voltage:

- For VTs: phase B voltage higher than 20 volts P-N (35 volts P-P)).
- For voltage sensors: 5,77% of the LEA Vrms maximum value (2,8, 5,2, 8 or 16 Vrms depending on the model). The minimum value to block the frequency functions: 4,8 % of the LEA Vrms maximum value (2,8, 5,2, 8 or 16 Vrms depending on the model).

Accuracy: ±0.005 Hz.

FREQUENCY MEASUREMENT
Bar frequency (f bar)
Line frequency (f line)
Rate of change of frequency (df/dt)
Voltage/frequency (V/Hz)(*)

(*) Only for models with conventional voltage transformers.

Angle measurement:

Range: 0-359 degrees (minimum required voltage in phases: 0.08xVnominal).

Accuracy: ± 2 degrees.

15.2 Alarms Panel

Once the alarms are activated according to their configurations, they can be recognized one at a time by holding RESET key on the selected alarm at the panel.

Depending on the configuration, after the recognition action, the alarms can still be activated, or they can be deactivated. In alarm panel menu, these features will be shown considering this behaviour, the possibilities for the alarms are:

ALARM STATE	
ACTIVATED	Recognized
	Not recognized
DEACTIVATED	Recognized (Not shown)
	Not Recognized

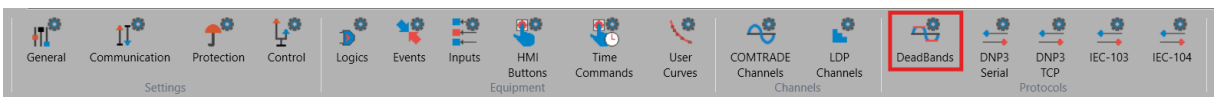
Once one alarm is deactivated and recognized, it will disappear from the Alarms Panel.

NOTE: If any LED/Alarm has a SRFF or a RSFF configured with the Reset Key as Reset reason, when pressing Reset from standby screen, the LED's will be reset. However, to recognize the alarms we shall do it from alarms panel menu.

15.3 Deadbands

Deadbands are communication protocol settings (DNP3.0, IEC 60870 5 103, IEC 60870 5 104 and IEC61850). Once the deadband is configured (as a percentage of the corresponding measurement), if the measurement varies —either above or below— more than the set percentage, the relay will spontaneously send the updated measurement.

From fw version 1.03 onwards there is a dedicated menu to configure deadbands. For previous versions they are configured in general settings menu.



Deadbands are available and can be configured on all the relay's measurement signals.

15.4 States and Sequential Events Recording (SER)

The state is given by real-time information generated by the relay. Some states have an event associated with them, which is a register of a change made to the state. There are states that have an activation event associated with them, and other states have two associated events: activation and deactivation. On the HMI, activation is shown with ┘ symbol and deactivation with ┐ symbol. These events are registered in a circular memory (buffer) with a capacity for up to 3072 events. The memory timestamp is accurate to 1 millisecond.

The events will be registered in non-volatile FRAM memory, and the events are conserved even if the relay is not powered. The relay keeps and processes the correct date and time, even without electrical power thanks to an internal supercapacitor.

The events can be browsed from the HMI or by using communications. Reading the events does not mean that they get deleted; they remain stored on the relay. To delete the events using the HMI requires to go to the events menu and hold the 'RESET' key until the number of events reads 1, corresponding this event to 'Events deleted'. To delete the events using communications, use the corresponding 'Delete Events' option. To delete the events, it is necessary to enter a password.

Events have the following structure:

Identifier	Unique event identifier: e.g.: Number of event, function and event description
State	Activated / Deactivated: an event is generated for Activation and Deactivation
Associated Measurement	Depending of the event
Date	Year, month, day, hour, minutes, seconds, milliseconds

The following list shows all the states of the relay and their associated events:

NOTE 1: The cause of events shown in the above table represents the default configured events in the relay. However, the user can mask and unmask, the events distinguishing if the action applies to the activation or deactivation reasons. **NOTE 2:** All the optional features are marked with (*).

Group	Status	Event	Cause	Measurement
Measurements				
Measurements	Measurement Error	Measurement Error	Activation/Deactivation	-
	Net Frequency 50 Hz	Net Frequency 50 Hz	Activation/Deactivation	-
	Line Frequency blocked	Line Frequency blocked	Activation/Deactivation	Line voltage (V-L)
	Bar Frequency Blocked	Bar Frequency Blocked	Activation/Deactivation	Phase B Voltage (V-B)
	Simulation (1)	Simulation	Activation/Deactivation	-
	VA Zero Crossing(*)	-	-	-
	VB Zero Crossing(*)	-	-	-
	VC Zero Crossing(*)	-	-	-
	VLA Zero Crossing(*)	-	-	-

	VLB Zero Crossing(*)	-	-	-
	VLC Zero Crossing(*)	-	-	-
	VA Presence	-	-	-
	VB Presence	-	-	-
	VC Presence	-	-	-
	V3 Phase Presence	-	-	-
Date[1]				
Date	Date/Time Set	Date/Time Set	Activation/Deactivation	-
	Need Sync.	Need Sync.	Activation/Deactivation	-
	Summer Time	Summer Time	Activation/Deactivation	-
	IRIG-B Synchronization	IRIG-B Synchronization	Activation/Deactivation	-
	SNTP Synchronization	SNTP Synchronization	Activation/Deactivation	-
Self-Diagnosis				
Self-Diagnosis	Model Error	Model Error	Activation/Deactivation	-
	Hardware Error	Hardware Error	Activation/Deactivation	-
	Slot 3 Empty	-	-	-
	Slot 4 Empty	-	-	-
	Slot 5 Empty	-	-	-
	COM Loading	COM Loading	-	-
	Test State	Test State	Activation/Deactivation	-
	Default Settings	Default Settings	Activation/Deactivation	-
	Error: Settings	Error: Settings	Activation/Deactivation	-
	Default Configuration	Default Configuration	Activation/Deactivation	-
	Error: Configuration	Error: Configuration	Activation/Deactivation	-
	Error: Curves	Error: Curves	Activation/Deactivation	-
	ENVM Full	ENVM Full	Activation/Deactivation	-
	VSupply Alarm L1(*)	VSupply Alarm L1	Activation/Deactivation	Aux Voltage
	VSupply Alarm L2(*)	VSupply Alarm L2	Activation/Deactivation	Aux Voltage

(1) Available from firmware version M01.04 onwards.

(*) Only available for models with voltage sensors.

A brief description of the general states:

- **Trip**: The relay has tripped.
- **External Trip**: A trip has been caused by the activation of the excess temperature input (external trip).
- **50 Hz**: If activated, the relay works at 50 Hz, if deactivated it works at 60Hz.
- **Trip Block Enable**: If the Trip Block functions is available in the model, it has been enabled.

- **Measurement error**: The self-diagnosis algorithms have detected a problem in the measurement block.
- **Ready**: No errors
- **Setting change**: Activated when the settings are changed.
- **Set date/time**: Activated when the date-time are synchronized.
- **Local**: Activated when the device is in Local Control mode.
- **Factory settings**: the relay is set to default settings.
- **Eeprom error**: The self-diagnosis algorithms have detected a problem in the Eeprom memory, which contains the settings.
- **Eeprom change**: Activated when the configuration or user passwords are changed.
- **Events error**: since the events buffer is circular, new events overwrite the older events once the buffer is full, and the older events are lost. To show this situation, the 'Events error' bit is activated. This bit is reset by deleting the events (from the HMI or by using communications).

Group	Status	Event	Cause	Measurement
General				
General	Trip	Trip	Activation/Deactivation	Maximum Current
	Ready	Ready	Activation/Deactivation	-
	Wrong Password	Wrong Password	Activation	-
	Set Date/time	Set Date/time	Activation	-
	Local Control	Local Control	Activation/Deactivation	-
	Error: SER	Error: SER	Activation/Deactivation	-
	SER Deleted	SER Deleted	Activation	-
	Wrong Access	Wrong Access	Activation	-
	Settings Change	Settings Change	Activation	-
	SER Overflow	SER Overflow	-	-
	Configuration Change	Configuration Change	Activation	-
	LDP Deleted	LDP Deleted	Activation	-
	New DFR	New DFR	Activation/Deactivation	-
	Phase Trip	Phase Trip	-	-
	Trip Block	Trip Block	Activation/Deactivation	Maximum Current
	Pickup	Phase Pickup	Activation/Deactivation	Maximum Current
	Phase A Pickup	Phase A Pickup	Activation/Deactivation	Phase A Current (A)
	Phase B Pickup	Phase B Pickup	Activation/Deactivation	Phase B Current (A)
	Phase C Pickup	Phase C Pickup	Activation/Deactivation	Phase C Current (A)
	Neutral Pickup	Neutral Pickup	Activation/Deactivation	Neutral Current (A)
	Phase A Trip	Phase A Trip	Activation/Deactivation	Phase A Current (A)
	Phase B Trip	Phase B Trip	Activation/Deactivation	Phase B Current (A)
	Phase C Trip	Phase C Trip	Activation/Deactivation	Phase C Current (A)
	Neutral Trip	Neutral Trip	Activation/Deactivation	Neutral Current (A)

	Settings Group 1	Settings Group 1	Activation	-
	Settings Group 2	Settings Group 2	Activation	-
	Settings Group 3	Settings Group 3	Activation	-
	Settings Group 4	Settings Group 4	Activation	-
	Settings Group 5(*)	Settings Group 5	Activation	-
	Settings Group 6(*)	Settings Group 6	Activation	-
	Set to FALSE	-	-	-
	Set to TRUE	-	-	-
Security [1]				
Security	Wrong Password	Wrong Password	Activation/Deactivation	-
	Wrong Access	Wrong Access	Activation/Deactivation	-
	Identification	Identification	Activation/Deactivation	-

(*) Only available for models with voltage sensors.

[1] *Available from firmware version M01.04 onwards.*

Group	Status	Event	Cause	Measurement
Disturbance Fault Recording				
DFR	-	Phase A Current	Activation	IA
	-	Phase B Current	Activation	IB
	-	Phase C Current	Activation	IC
	-	Neutral Current	Activation	IN
	-	Phase A Voltage	Activation	VA
	-	Phase B Voltage	Activation	VB
	-	Phase C Voltage	Activation	VC
	-	Line A Voltage(*)	Activation	
	-	Line B Voltage(*)	Activation	
	-	Line C Voltage(*)	Activation	
	-	Neutral Voltage	Activation	VN
	-	Phase B Line Voltage	Activation	VL
	-	Bar frequency	Activation	
	DFR Deleted	DFR Deleted	Activation	-
Breaker Wear Monitoring				
52	52 Startup	52 Startup	Activation	-
	52 Error	52 Error	Activation	-
	52 Open	52 Open	Activation	-
	52 Opening Time	52 Opening time	Activation	-
	52 Opening Error	52 Opening error	Activation	-
	52 Closed	52 Closed	Activation	-
	52 Closing Time	52 Closing time	Activation	-
	52 Closing Error	52 Closing error	Activation	-
	52 Maximum number of openings alarm	52 Maximum number of openings alarm	Activation/Deactivation	-

	52 Maximum accumulated amperes alarm	52 Maximum accumulated amperes alarm	Activation/Deactivation	-
	52 Excessive openings in a time window	52 Excessive openings in a time window	Activation/Deactivation	-
	52B Contact	52B Contact	Activation/Deactivation	-
	52A Contact	52A Contact	Activation/Deactivation	-
Inputs (Models SILGxxxxxx0xxx, SILGxxxxxx6xxx, SILGxxxxxxAxxx & SILGxxxxxxBxx)				
Inputs	Input 1	Input 1	Activation/Deactivation	-
	Input 2	Input 2	Activation/Deactivation	-
	Input 3	Input 3	Activation/Deactivation	-
	Input 4	Input 4	Activation/Deactivation	-
	Input 5	Input 5	Activation/Deactivation	-
	Input 6	Input 6	Activation/Deactivation	-
	Input 7	Input 7	Activation/Deactivation	-
	Input 8	Input 8	Activation/Deactivation	-

(*) Only available for models with voltage sensors.

Group	Status	Event	Cause	Measurement
Inputs (Model SILGxxxxxx7xxx)				
Inputs	Input 1	Input 1	Activation/Deactivation	-
	Input 2	Input 2	Activation/Deactivation	-
	Input 3	Input 3	Activation/Deactivation	-
	Input 4	Input 4	Activation/Deactivation	-
	Input 5	Input 5	Activation/Deactivation	-
	Input 6	Input 6	Activation/Deactivation	-
	Input 7	Input 7	Activation/Deactivation	-
	Input 8	Input 8	Activation/Deactivation	-
	Input 9	Input 9	Activation/Deactivation	-
	Input 10	Input 10	Activation/Deactivation	-
	Input 12	Input 12	Activation/Deactivation	-
	Input 13	Input 13	Activation/Deactivation	-
	Input 14	Input 14	Activation/Deactivation	-
	Input 15	Input 15	Activation/Deactivation	-
	Input 16	Input 16	Activation/Deactivation	-
Inputs (Model SILGxxxxxx5xxx)				
Inputs	Input 1	Input 1	Activation/Deactivation	-
	Input 2	Input 2	Activation/Deactivation	-
	Input 3	Input 3	Activation/Deactivation	-
	Input 4	Input 4	Activation/Deactivation	-
	Input 5	Input 5	Activation/Deactivation	-
	Input 6	Input 6	Activation/Deactivation	-

	Input 7	Input 7	Activation/Deactivation	-
	Input 8	Input 8	Activation/Deactivation	-
	Input 9	Input 9	Activation/Deactivation	-
	Input 10	Input 10	Activation/Deactivation	-
	Input 12	Input 12	Activation/Deactivation	-
	Input 13	Input 13	Activation/Deactivation	-
	Input 14	Input 14	Activation/Deactivation	-
	Input 15	Input 15	Activation/Deactivation	-
	Input 16	Input 16	Activation/Deactivation	-
	Input 17	Input 17	Activation/Deactivation	-
	Input 18	Input 18	Activation/Deactivation	-
	Input 19	Input 19	Activation/Deactivation	-
	Input 20	Input 20	Activation/Deactivation	-
	Input 21	Input 21	Activation/Deactivation	-
	Input 22	Input 22	Activation/Deactivation	-
	Input 23	Input 23	Activation/Deactivation	-
	Input 24	Input 24	Activation/Deactivation	-
Group	**Status**	**Event**	**Cause**	**Measurement**
Outputs (Models SILGxxxxxx0xxx, SILGxxxxxx5xxx, SILGxxxxxxAxxx & SILGxxxxxxBxxx)				
Outputs	Output 1	Output 1	Activation/Deactivation	-
	Output 2	Output 2	Activation/Deactivation	-
	Output 3	Output 3	Activation/Deactivation	-
	Output 4	Output 4	Activation/Deactivation	-
	Output 5	Output 5	Activation/Deactivation	-
	Output 6	Output 6	Activation/Deactivation	-
	Output 7	Output 7	Activation/Deactivation	-
	Logic Signal 8	Logic Signal 8	Activation/Deactivation	-
	Logic Signal 9	Logic Signal 9	Activation/Deactivation	-
	Logic Signal 10	Logic Signal 10	Activation/Deactivation	-
	Logic Signal 11	Logic Signal 11	Activation/Deactivation	-
	Logic Signal 12	Logic Signal 12	Activation/Deactivation	-
	Logic Signal 13	Logic Signal 13	Activation/Deactivation	-
	Logic Signal 14	Logic Signal 14	Activation/Deactivation	-
	Logic Signal 15	Logic Signal 15	Activation/Deactivation	-
	Logic Signal 16	Logic Signal 16	Activation/Deactivation	-
	Logic Signal 17	Logic Signal 17	Activation/Deactivation	-
	Logic Signal 18	Logic Signal 18	Activation/Deactivation	-
	Logic Signal 19	Logic Signal 19	Activation/Deactivation	-
	Logic Signal 20	Logic Signal 20	Activation/Deactivation	-

	Logic Signal 21	Logic Signal 21	Activation/Deactivation	-
	Logic Signal 22	Logic Signal 22	Activation/Deactivation	-
	Logic Signal 23	Logic Signal 23	Activation/Deactivation	-
	Logic Signal 24	Logic Signal 24	Activation/Deactivation	-
	Logic Signal 25	Logic Signal 25	Activation/Deactivation	-
	Logic Signal 26	Logic Signal 26	Activation/Deactivation	-
	Logic Signal 27	Logic Signal 27	Activation/Deactivation	-
	Logic Signal 28	Logic Signal 28	Activation/Deactivation	-
	Logic Signal 29	Logic Signal 29	Activation/Deactivation	-
	Logic Signal 30	Logic Signal 30	Activation/Deactivation	-
	Logic Signal 31	Logic Signal 31	Activation/Deactivation	-
	Logic Signal 32	Logic Signal 32	Activation/Deactivation	-

Group	Status	Event	Cause	Measurement
Outputs (Model SILGxxxxxx6xxx)				
Outputs	Output 1	Output 1	Activation/Deactivation	-
	Output 2	Output 2	Activation/Deactivation	-
	Output 3	Output 3	Activation/Deactivation	-
	Output 4	Output 4	Activation/Deactivation	-
	Output 5	Output 5	Activation/Deactivation	-
	Output 6	Output 6	Activation/Deactivation	-
	Output 7	Output 7	Activation/Deactivation	-
	Output 8	Output 8	Activation/Deactivation	-
	Output 9	Output 9	Activation/Deactivation	-
	Output 10	Output 10	Activation/Deactivation	-
	Output 11	Output 11	Activation/Deactivation	-
	Output 12	Output 12	Activation/Deactivation	-
	Output 13	Output 13	Activation/Deactivation	-
	Output 14	Output 14	Activation/Deactivation	-
	Output 15	Output 15	Activation/Deactivation	-
	Output 16	Output 16	Activation/Deactivation	-
	Output 17	Output 17	Activation/Deactivation	-
	Output 18	Output 18	Activation/Deactivation	-
	Logic Signal 19	Logic Signal 19	Activation/Deactivation	-
	Logic Signal 20	Logic Signal 20	Activation/Deactivation	-

	Logic Signal 21	Logic Signal 21	Activation/Deactivation	-
	Logic Signal 22	Logic Signal 22	Activation/Deactivation	-
	Logic Signal 23	Logic Signal 23	Activation/Deactivation	-
	Logic Signal 24	Logic Signal 24	Activation/Deactivation	-
	Logic Signal 25	Logic Signal 25	Activation/Deactivation	-
	Logic Signal 26	Logic Signal 26	Activation/Deactivation	-
	Logic Signal 27	Logic Signal 27	Activation/Deactivation	-
	Logic Signal 28	Logic Signal 28	Activation/Deactivation	-
	Logic Signal 29	Logic Signal 29	Activation/Deactivation	-
	Logic Signal 30	Logic Signal 30	Activation/Deactivation	-
	Logic Signal 31	Logic Signal 31	Activation/Deactivation	-
	Logic Signal 32	Logic Signal 32	Activation/Deactivation	-

Group	Status	Event	Cause	Measurement
Outputs (Model SILGxxxxxx7xxx)				
Outputs	Output 1	Output 1	Activation/Deactivation	-
	Output 2	Output 2	Activation/Deactivation	-
	Output 3	Output 3	Activation/Deactivation	-
	Output 4	Output 4	Activation/Deactivation	-
	Output 5	Output 5	Activation/Deactivation	-
	Output 6	Output 6	Activation/Deactivation	-
	Output 7	Output 7	Activation/Deactivation	-
	Output 8	Output 8	Activation/Deactivation	-
	Output 9	Output 9	Activation/Deactivation	-
	Output 10	Output 10	Activation/Deactivation	-
	Output 11	Output 11	Activation/Deactivation	-
	Logic Signal 12	Logic Signal 12	Activation/Deactivation	-
	Logic Signal 13	Logic Signal 13	Activation/Deactivation	-
	Logic Signal 14	Logic Signal 14	Activation/Deactivation	-
	Logic Signal 15	Logic Signal 15	Activation/Deactivation	-
	Logic Signal 16	Logic Signal 16	Activation/Deactivation	-
	Logic Signal 17	Logic Signal 17	Activation/Deactivation	-
	Logic Signal 18	Logic Signal 18	Activation/Deactivation	-

	Logic Signal 19	Logic Signal 19	Activation/Deactivation	-
	Logic Signal 20	Logic Signal 20	Activation/Deactivation	-
	Logic Signal 21	Logic Signal 21	Activation/Deactivation	-
	Logic Signal 22	Logic Signal 22	Activation/Deactivation	-
	Logic Signal 23	Logic Signal 23	Activation/Deactivation	-
	Logic Signal 24	Logic Signal 24	Activation/Deactivation	-
	Logic Signal 25	Logic Signal 25	Activation/Deactivation	-
	Logic Signal 26	Logic Signal 26	Activation/Deactivation	-
	Logic Signal 27	Logic Signal 27	Activation/Deactivation	-
	Logic Signal 28	Logic Signal 28	Activation/Deactivation	-
	Logic Signal 29	Logic Signal 29	Activation/Deactivation	-
	Logic Signal 30	Logic Signal 30	Activation/Deactivation	-
	Logic Signal 31	Logic Signal 31	Activation/Deactivation	-
	Logic Signal 32	Logic Signal 32	Activation/Deactivation	-

Group	Status	Event	Cause	Measurement
PGC (Programmable Logic Control)				
PGC	Open Breaker	Open Breaker Command	Activation	-
	Close Breaker	Close Breaker Command	Activation	-
	79 Block	79 Block Command	Activation	-
	79 Unblock	79 Unblock Command	Activation	-
	Local Control	Local Control Command	Activation	-
	Remote Control	Remote Control Command	Activation	-
	52a	52a	-	-
	52b	52b	-	-
	SettingsG1	SettingsG1	Activation/Deactivation	-
	SettingsG2	SettingsG2	Activation/Deactivation	-
	Settings Group x4(*)	Settings Group x4	Activation/Deactivation	-
	SZM Start(*)	SZM Start	Activation	-
	Hot Line Tag	Hot Line Tag	Activation/Deactivation	-
	79 Enable	79 Enable	Activation/Deactivation	-
	79N1 Start	79N1 Start	Activation	-
	79N2 Start	79N2 Start	Activation	-
	79N3 Start	79N3 Start	Activation	-
	79N4 Start	79N4 Start	Activation	-
	DFR Start	DFR Start	-	-
	50BF Start	50BF Start	Activation	-
	SOTF Start	SOTF Start	Activation	-

	Thermal I. Reset	Thermal I. Reset	Activation	-
	74TCS Coil A	74TCS Coil A	Activation/Deactivation	-
	74TCS Coil B	74TCS Coil B	Activation/Deactivation	-
	Neutral Block	Neutral Block	Activation/Deactivation	-
	Phase Block	Phase Block	Activation/Deactivation	-
	External Trip	External Trip	Activation	-
	Reset	Reset	Activation/Deactivation	-
	Opening Blk	Opening Blk	Activation/Deactivation	-
	Closing Blk	Closing Blk	Activation/Deactivation	-
	PGC 1	PGC 1	-	-
	PGC 2	PGC 2	-	-
	PGC 3	PGC 3	-	-

(*) Only available for models with voltage sensors.

Group	Status	Event	Cause	Measurement
Alarm LEDs				
Alarm LEDs	Alarm 1	-	-	-
	Alarm 2	-	-	-
	Alarm 3	-	-	-
	Alarm 4	-	-	-
	Alarm 5	-	-	-
	Alarm 6	-	-	-
	Alarm 7	-	-	-
	Alarm 8	-	-	-
	Logic Alarm 9	-	-	-
	Logic Alarm 10	-	-	-
	Logic Alarm 11	-	-	-
	Logic Alarm 12	-	-	-
	Logic Alarm 13	-	-	-
	Logic Alarm 14	-	-	-
	Logic Alarm 15	-	-	-
	Logic Alarm 16	-	-	-
	Logic Alarm 17	-	-	-
	Logic Alarm 18	-	-	-

	Logic Alarm 19	-	-	-
	Logic Alarm 20	-	-	-
	Logic Alarm 20	-	-	-
	Logic Alarm 21	-	-	-
	Logic Alarm 22	-	-	-
	Logic Alarm 23	-	-	-
	Logic Alarm 24	-	-	-
	Logic Alarm 25	-	-	-
	Logic Alarm 26	-	-	-
	Logic Alarm 27	-	-	-
	Logic Alarm 28	-	-	-
	Logic Alarm 29	-	-	-
	Logic Alarm 30	-	-	-
	Logic Alarm 31	-	-	-
	Logic Alarm 32	-	-	-

Group	Status	Event	Cause	Measurement
Arc Flash Detection (Model SILGxxxxxxAxxx & SILGxxxxxxBxxx)				
AFD	AFD Output 1	AFD Output 1	Activation/Deactivation	-
	AFD Output 2	AFD Output 2	Activation/Deactivation	-
	AFD Output 3	AFD Output 3	Activation/Deactivation	-
	AFD Output 4	AFD Output 4	Activation/Deactivation	-
	AFD Input 1	AFD Input 1	Activation/Deactivation	-
	AFD Input 2	AFD Input 2	Activation/Deactivation	-
	AFD Input 3	AFD Input 3	Activation/Deactivation	-
	AFD Input 4	AFD Input 4	Activation/Deactivation	-
	AFD Test OK 1	AFD Test OK 1	Activation/Deactivation	-
	AFD Test OK 2	AFD Test OK 2	Activation/Deactivation	-
	AFD Test OK 3	AFD Test OK 3	Activation/Deactivation	-
	AFD Test OK 4	AFD Test OK 4	Activation/Deactivation	-
	AFD Phase Overcurrent	AFD Phase Overcurrent	Activation/Deactivation	-
	AFD Neutral Overcurrent	AFD Neutral Overcurrent	Activation/Deactivation	-
	AFD Overcurrent	AFD Overcurrent	Activation/Deactivation	-
Level 1 Instantaneous Phase Overcurrent				
50-1	50-1 Phase A Pickup	50-1 Phase A Pickup	Activation/Deactivation	Phase A Current
	50-1 Phase B Pickup	50-1 Phase B Pickup	Activation/Deactivation	Phase B Current
	50-1 Phase C Pickup	50-1 Phase C Pickup	Activation/Deactivation	Phase C Current

	50-1 Pickup	50-1 Pickup	Activation/Deactivation	Maximum Current
	50-1 Phase A Trip	50-1 Phase A Trip	Activation/Deactivation	Phase A Current
	50-1 Phase B Trip	50-1 Phase B Trip	Activation/Deactivation	Phase B Current
	50-1 Phase C Trip	50-1 Phase C Trip	Activation/Deactivation	Phase C Current
	50-1 Trip	50-1 Trip	Activation/Deactivation	Maximum Current
Level 2 Instantaneous Phase Overcurrent				
50-2	50-2 Phase A Pickup	50-2 Phase A Pickup	Activation/Deactivation	Phase A current
	50-2 Phase B Pickup	50-2 Phase B Pickup	Activation/Deactivation	Phase B current
	50-2 Phase C Pickup	50-2 Phase C Pickup	Activation/Deactivation	Phase C current
	50-2 Pickup	50-2 Pickup	Activation/Deactivation	Maximum Current
	50-2 Phase A Trip	50-2 Phase A Trip	Activation/Deactivation	Phase A current
	50-2 Phase B Trip	50-2 Phase B Trip	Activation/Deactivation	Phase B current
	50-2 Phase C Trip	50-2 Phase C Trip	Activation/Deactivation	Phase C current
	50-2 Trip	50-2 Trip	Activation/Deactivation	Maximum Current

Group	Status	Event	Cause	Measurement
Switch On To Fault (SOTF)				
SOTF	Phase A Pickup	Phase A Pickup	Activation/Deactivation	Phase A current
	Phase B Pickup	Phase B Pickup	Activation/Deactivation	Phase B current
	Phase C Pickup	Phase C Pickup	Activation/Deactivation	Phase C current
	Pickup	Pickup	Activation/Deactivation	Maximum current
	Phase A Trip	Phase A Trip	Activation/Deactivation	Phase A current
	Phase B Trip	Phase B Trip	Activation/Deactivation	Phase B current
	Phase C Trip	Phase C Trip	Activation/Deactivation	Phase C current
	Trip	Trip	Activation/Deactivation	Maximum current
	SOTF	SOTF	Activation/Deactivation	Maximum current
Level 1: Inverse Time Directional Phase Overcurrent				
67/51-1	67-1 Phase A Pickup	67-1 Phase A Pickup	Activation/Deactivation	Phase A current
	67-1 Phase B Pickup	67-1 Phase B Pickup	Activation/Deactivation	Phase B current
	67-1 Phase C Pickup	67-1 Phase C Pickup	Activation/Deactivation	Phase C current
	67-1 Pickup	67-1 Pickup	Activation/Deactivation	Maximum current
	67-1 Phase A Trip	67-1 Phase A Trip	Activation/Deactivation	Phase A current
	67-1 Phase B Trip	67-1 Phase B Trip	Activation/Deactivation	Phase B current
	67-1 Phase C Trip	67-1 Phase C Trip	Activation/Deactivation	Phase C current
	67-1 Trip	67-1 Trip	Activation/Deactivation	Maximum current
	67-1 Directionality A	67-1 Directionality A	Activation/Deactivation	BC voltage
	67-1 Directionality B	67-1 Directionality B	Activation/Deactivation	CA voltage
	67-1 Directionality C	67-1 Directionality C	Activation/Deactivation	AB voltage

Level 2: Inverse Time Directional Phase Overcurrent				
67/51-2	67-2 Phase A Pickup	67-2 Phase A Pickup	Activation/Deactivation	Phase A current
	67-2 Phase B Pickup	67-2 Phase B Pickup	Activation/Deactivation	Phase B current
	67-2 Phase C Pickup	67-2 Phase C Pickup	Activation/Deactivation	Phase C current
	67-2 Pickup	67-2 Pickup	Activation/Deactivation	Maximum current
	67-2 Phase A Trip	67-2 Phase A Trip	Activation/Deactivation	Phase A current
	67-2 Phase B Trip	67-2 Phase B Trip	Activation/Deactivation	Phase B current
	67-2 Phase C Trip	67-2 Phase C Trip	Activation/Deactivation	Phase C current
	67-2 Trip	67-2 Trip	Activation/Deactivation	Maximum current
	67-2 Directionality A	67-2 Directionality A	Activation/Deactivation	BC voltage
	67-2 Directionality B	67-2 Directionality B	Activation/Deactivation	CA voltage
	67-2 Directionality C	67-2 Directionality C	Activation/Deactivation	AB voltage

Group	Status	Event	Cause	Measurement
Level 3: Inverse Time Directional Phase Overcurrent				
67/51-3	67-3 Phase A Pickup	67-3 Phase A Pickup	Activation/Deactivation	Phase A current
	67-3 Phase B Pickup	67-3 Phase B Pickup	Activation/Deactivation	Phase B current
	67-3 Phase C Pickup	67-3 Phase C Pickup	Activation/Deactivation	Phase C current
	67-3 Pickup	67-3 Pickup	Activation/Deactivation	Maximum current
	67-3 Phase A Trip	67-3 Phase A Trip	Activation/Deactivation	Phase A current
	67-3 Phase B Trip	67-3 Phase B Trip	Activation/Deactivation	Phase B current
	67-3 Phase C Trip	67-3 Phase C Trip	Activation/Deactivation	Phase C current
	67-3 Trip	67-3 Trip	Activation/Deactivation	Maximum current
	67-3 Directionality A	67-3 Directionality A	Activation/Deactivation	BC voltage
	67-3 Directionality B	67-3 Directionality B	Activation/Deactivation	CA voltage
	67-3 Directionality C	67-3 Directionality C	Activation/Deactivation	AB voltage
Level 4: Inverse Time Directional Phase Overcurrent				
67/51-4	67-4 Phase A Pickup	67-4 Phase A Pickup	Activation/Deactivation	Phase A current
	67-4 Phase B Pickup	67-4 Phase B Pickup	Activation/Deactivation	Phase B current
	67-4 Phase C Pickup	67-4 Phase C Pickup	Activation/Deactivation	Phase C current
	67-4 Pickup	67-4 Pickup	Activation/Deactivation	Maximum current
	67-4 Phase A Trip	67-4 Phase A Trip	Activation/Deactivation	Phase A current
	67-4 Phase B Trip	67-4 Phase B Trip	Activation/Deactivation	Phase B current
	67-4 Phase C Trip	67-4 Phase C Trip	Activation/Deactivation	Phase C current
	67-4 Trip	67-4 Trip	Activation/Deactivation	Maximum current
	67-4 Directionality A	67-4 Directionality A	Activation/Deactivation	BC voltage

	67-4 Directionality B	67-4 Directionality B	Activation/Deactivation	CA voltage
	67-4 Directionality C	67-4 Directionality C	Activation/Deactivation	AB voltage
Instantaneous Measured Neutral Overcurrent				
50G	50G Ground Pickup	50G Ground Pickup	Activation/Deactivation	Neutral Current
	50G Ground Trip	50G Ground Trip	Activation/Deactivation	Neutral Current
Instantaneous Calculated Neutral Overcurrent				
50N	50N Neutral Pickup	50N Neutral Pickup	Activation/Deactivation	Neutral Current
	50N Neutral Trip	50N Neutral Trip	Activation/Deactivation	Neutral Current
Level 1: Inverse Time Directional Measured Neutral Overcurrent				
67G/51G-1	67G-1 Neutral Pickup	67G-1 Neutral Pickup	Activation/Deactivation	Neutral Current
	67G-1 Neutral Trip	67G-1 Neutral Trip	Activation/Deactivation	Neutral Current
	67G-1 Directionality	67G-1 Directionality	Activation/Deactivation	Neutral Voltage

Group	Status	Event	Cause	Measurement
Level 2: Inverse Time Directional Measured Neutral Overcurrent				
67G/51G-2	67G-2 Neutral Pickup	67G-2 Neutral Pickup	Activation/Deactivation	Neutral Current
	67G-2 Neutral Trip	67G-2 Neutral Trip	Activation/Deactivation	Neutral Current
	67G-2 Directionality	67G-2 Directionality	Activation/Deactivation	Neutral Voltage
Level 1: Inverse Time Directional Calculated Neutral Overcurrent				
67N/51N-1	67N-1 Neutral Pickup	67N-1 Neutral Pickup	Activation/Deactivation	Neutral Current
	67N-1 Neutral Trip	67N-1 Neutral Trip	Activation/Deactivation	Neutral Current
	67N-1 Directionality	67N-1 Directionality	Activation/Deactivation	Neutral Voltage
Level 2: Inverse Time Directional Calculated Neutral Overcurrent				
67N/51N-2	67N-1 Neutral Pickup	67N-1 Neutral Pickup	Activation/Deactivation	Neutral Current
	67N-1 Neutral Trip	67N-1 Neutral Trip	Activation/Deactivation	Neutral Current
	67N-1 Directionality	67N-1 Directionality	Activation/Deactivation	Neutral Voltage
Phase Balance Current Protection				
46	46 Pickup	46 Pickup	Activation/Deactivation	Negative sequence current
	46 Trip	46 Trip	Activation/Deactivation	Negative sequence current
Incipient fault detection				
50INC (**)	Phase A Pickup	Phase A Pickup	Activation/Deactivation	NO. Peaks Phase A
	Phase B Pickup	Phase B Pickup	Activation/Deactivation	NO. Peaks Phase B
	Phase C Pickup	Phase C Pickup	Activation/Deactivation	NO. Peaks Phase C
	Phase Pickup	Phase Pickup	Activation/Deactivation	-
	Phase A Trip	Phase A Trip	Activation/Deactivation	NO. Peaks Phase A

	Phase B Trip	Phase B Trip	Activation/Deactivation	NO. Peaks Phase B
	Phase C Trip	Phase C Trip	Activation/Deactivation	NO. Peaks Phase C
	Phase Trip	Phase Trip	Activation/Deactivation	-
	50INC Fault Locator	50INC Fault Locator	Activation/Deactivation	Km – Dist.
	50INC Block	50INC Block	Activation/Deactivation	-
	50IINC Reset	50IINC Reset	Activation/Deactivation	-
Restricted Earth Fault				
64REF	64REF Pickup	64REF Pickup	Activation/Deactivation	-
	64REF Trip	64REF Trip	Activation/Deactivation	-
	64Ref In2hBlock	64Ref In2hBlock	Activation/Deactivation	-
Directional Measured Neutral Overcurrent				
67GI	67GI Ground Pickup	67GI Ground Pickup	Activation/Deactivation	-
	67GI Ground Trip	67GI Ground Trip	Activation/Deactivation	-
	67GI Directionality	67GI Directionality	Activation/Deactivation	-

(**) Optional depending on the model.

Group	Status	Event	Cause	Measurement
Directional Calculated Neutral Overcurrent				
67NI	67NI Neutral Pickup	67NI Neutral Pickup	Activation/Deactivation	-
	67NI Neutral Trip	67NI Neutral Trip	Activation/Deactivation	-
	67NI Directionality	67NI Directionality	Activation/Deactivation	-
Broken Conductor Detection				
46BC	46BC Pickup	46BC Pickup	Activation/Deactivation	I2/I1
	46BC Trip	46BC Trip	Activation/Deactivation	I2/I1
Thermal Overload				
49	49 Alarm	49 Alarm	Activation/Deactivation	Thermal image
	49 Trip	49 Trip	Activation/Deactivation	Thermal image
Instantaneous Phase Undercurrent				
37	37 Phase A Pickup	37 Phase A Pickup	Activation/Deactivation	Phase A current
	37 Phase B Pickup	37 Phase B Pickup	Activation/Deactivation	Phase B current
	37 Phase C Pickup	37 Phase C Pickup	Activation/Deactivation	Phase C current
	37 Phase Pickup	37 Phase Pickup	Activation/Deactivation	Maximum current
	37 Phase A Trip	37 Phase A Trip	Activation/Deactivation	Phase A current
	37 Phase B Trip	37 Phase B Trip	Activation/Deactivation	Phase B current
	37 Phase C Trip	37 Phase C Trip	Activation/Deactivation	Phase C current
	37 Trip	37 Trip	Activation/Deactivation	Maximum current
Level 1: Instantaneous Phase Undervoltage				
27-1	27-1 Phase A Pickup	27-1 Phase A Pickup	Activation/Deactivation	Phase A voltage
	27-1 Phase B Pickup	27-1 Phase B Pickup	Activation/Deactivation	Phase B voltage
	27-1 Phase C Pickup	27-1 Phase C Pickup	Activation/Deactivation	Phase C voltage
	27-1 Phase Pickup	27-1 Phase Pickup	Activation/Deactivation	Maximum voltage
	27-1 AB Pickup	27-1 AB Pickup	Activation/Deactivation	AB voltage
	27-1 BC Pickup	27-1 BC Pickup	Activation/Deactivation	BC voltage
	27-1 CA Pickup	27-1 CA Pickup	Activation/Deactivation	CA voltage
	27-1 Phase A Trip	27-1 Phase A Trip	Activation/Deactivation	Phase A voltage
	27-1 Phase B Trip	27-1 Phase B Trip	Activation/Deactivation	Phase B voltage
	27-1 Phase C Trip	27-1 Phase C Trip	Activation/Deactivation	Phase C voltage
	27-1 Phase Trip	27-1 Phase Trip	Activation/Deactivation	Maximum voltage
	27-1 AB Trip	27-1 AB Trip	Activation/Deactivation	AB voltage
	27-1 BC Trip	27-1 BC Trip	Activation/Deactivation	BC voltage
	27-1 CA Trip	27-1 CA Trip	Activation/Deactivation	CA voltage

Group	Status	Event	Cause	Measurement
Level 2: Instantaneous Phase Undervoltage				
27-2	27-2 Phase A Pickup	27-2 Phase A Pickup	Activation/Deactivation	Phase A voltage
	27-2 Phase B Pickup	27-2 Phase B Pickup	Activation/Deactivation	Phase B voltage
	27-2 Phase C Pickup	27-2 Phase C Pickup	Activation/Deactivation	Phase C voltage
	27-2 Phase Pickup	27-2 Phase Pickup	Activation/Deactivation	Maximum voltage
	27-2 AB Pickup	27-2 AB Pickup	Activation/Deactivation	AB voltage
	27-2 BC Pickup	27-2 BC Pickup	Activation/Deactivation	BC voltage
	27-2 CA Pickup	27-2 CA Pickup	Activation/Deactivation	CA voltage
	27-2 Phase A Trip	27-2 Phase A Trip	Activation/Deactivation	Phase A voltage
	27-2 Phase B Trip	27-2 Phase B Trip	Activation/Deactivation	Phase B voltage
	27-2 Phase C Trip	27-2 Phase C Trip	Activation/Deactivation	Phase C voltage
	27-2 Phase Trip	27-2 Phase Trip	Activation/Deactivation	Maximum voltage
	27-2 AB Trip	27-2 AB Trip	Activation/Deactivation	AB voltage
	27-2 BC Trip	27-2 BC Trip	Activation/Deactivation	BC voltage
	27-2 CA Trip	27-2 CA Trip	Activation/Deactivation	CA voltage
Instantaneous Positive Sequence Undervoltage				
27V1	27V1 Pickup	27V1 Pickup	Activation/Deactivation	Positive sequence voltage
	27V1 Trip	27V1 Trip	Activation/Deactivation	Positive sequence voltage
Instantaneous Phase Undervoltage (**)				
27-L (**)	27-L Pickup	27-L Pickup	Activation/Deactivation	Line voltage
	27-L Trip	27-L Trip	Activation/Deactivation	Line voltage
Level 1: Instantaneous Phase Overvoltage				
59-1	59-1 Phase A Pickup	59-1 Phase A Pickup	Activation/Deactivation	Phase A voltage
	59-1 Phase B Pickup	59-1 Phase B Pickup	Activation/Deactivation	Phase B voltage
	59-1 Phase C Pickup	59-1 Phase C Pickup	Activation/Deactivation	Phase C voltage
	59-1 Phase Pickup	59-1 Phase Pickup	Activation/Deactivation	Maximum voltage
	59-1 AB Pickup	59-1 AB Pickup	Activation/Deactivation	AB voltage
	59-1 BC Pickup	59-1 BC Pickup	Activation/Deactivation	BC voltage
	59-1 CA Pickup	59-1 CA Pickup	Activation/Deactivation	CA voltage
	59-1 Phase A Trip	59-1 Phase A Trip	Activation/Deactivation	Phase A voltage
	59-1 Phase B Trip	59-1 Phase B Trip	Activation/Deactivation	Phase B voltage
	59-1 Phase C Trip	59-1 Phase C Trip	Activation/Deactivation	Phase C voltage
	59-1 Phase Trip	59-1 Phase Trip	Activation/Deactivation	Maximum voltage
	59-1 AB Trip	59-1 AB Trip	Activation/Deactivation	AB voltage
	59-1 BC Trip	59-1 BC Trip	Activation/Deactivation	BC voltage
	59-1 CA Trip	59-1 CA Trip	Activation/Deactivation	CA voltage

Group	Status	Event	Cause	Measurement
Level 2: Instantaneous Phase Overvoltage				
59-2	59-2 Phase A Pickup	59-2 Phase A Pickup	Activation/Deactivation	Phase A voltage
	59-2 Phase B Pickup	59-2 Phase B Pickup	Activation/Deactivation	Phase B voltage
	59-2 Phase C Pickup	59-2 Phase C Pickup	Activation/Deactivation	Phase C voltage
	59-2 Phase Pickup	59-2 Phase Pickup	Activation/Deactivation	Maximum voltage
	59-2 AB Pickup	59-2 AB Pickup	Activation/Deactivation	AB voltage
	59-2 BC Pickup	59-2 BC Pickup	Activation/Deactivation	BC voltage
	59-2 CA Pickup	59-2 CA Pickup	Activation/Deactivation	CA voltage
	59-2 Phase A Trip	59-2 Phase A Trip	Activation/Deactivation	Phase A voltage
	59-2 Phase B Trip	59-2 Phase B Trip	Activation/Deactivation	Phase B voltage
	59-2 Phase C Trip	59-2 Phase C Trip	Activation/Deactivation	Phase C voltage
	59-2 Phase Trip	59-2 Phase Trip	Activation/Deactivation	Maximum voltage
	59-2 AB Trip	59-2 AB Trip	Activation/Deactivation	AB voltage
	59-2 BC Trip	59-2 BC Trip	Activation/Deactivation	BC voltage
	59-2 CA Trip	59-2 CA Trip	Activation/Deactivation	CA voltage
Level 1: Instantaneous Calculated/Measured Neutral Overvoltage(***)				
59N/G-1(***)	59N/G-1 Neutral Pickup	59N/G-1 Neutral Pickup	Activation/Deactivation	Neutral voltage
	59N/G-1 Neutral Trip	59N/G-1 Neutral Trip	Activation/Deactivation	Neutral voltage
Level 2: Instantaneous Calculated/Measured Neutral Overvoltage(***)				
59N/G-2(***)	59N/G-2 Neutral Pickup	59N/G-2 Neutral Pickup	Activation/Deactivation	Neutral voltage
	59N/G-2 Neutral Trip	59N/G-2 Neutral Trip	Activation/Deactivation	Neutral voltage
Phase Balance Voltage Protection				
47	47 Pickup	47 Pickup	Activation/Deactivation	Negative sequence voltage
	47 Trip	47 Trip	Activation/Deactivation	Negative sequence voltage
Instantaneous Phase Overvoltage (**)				
59-L (**)	59-L Phase Pickup	59-L Phase Pickup	Activation/Deactivation	Line voltage
	59-L Phase Trip	59-L Phase Trip	Activation/Deactivation	Line voltage
Level 1: Directional Overpower				
32-1	32-1 Phase A Pickup	32-1 Phase A Pickup	Activation/Deactivation	S-A (VA)
	32-1 Phase B Pickup	32-1 Phase B Pickup	Activation/Deactivation	S-B (VA)
	32-1 Phase C Pickup	32-1 Phase C Pickup	Activation/Deactivation	S-C (VA)
	32-1 Phase Pickup	32-1 Phase Pickup	Activation/Deactivation	S-3P (VA)
	32-1 Phase A Trip	32-1 Phase A Trip	Activation/Deactivation	S-A (VA)
	32-1 Phase B Trip	32-1 Phase B Trip	Activation/Deactivation	S-B (VA)
	32-1 Phase C Trip	32-1 Phase C Trip	Activation/Deactivation	S-C (VA)
	32-1 Phase Trip	32-1 Phase Trip	Activation/Deactivation	S-3P (VA)

Group	Status	Event	Cause	Measurement
Level 2: Directional Overpower				
32-2	32-2 Phase A Pickup	32-2 Phase A Pickup	Activation/Deactivation	S-A (VA)
	32-2 Phase B Pickup	32-2 Phase B Pickup	Activation/Deactivation	S-B (VA)
	32-2 Phase C Pickup	32-2 Phase C Pickup	Activation/Deactivation	S-C (VA)
	32-2 Phase Pickup	32-2 Phase Pickup	Activation/Deactivation	S-3P (VA)
	32-2 Phase A Trip	32-2 Phase A Trip	Activation/Deactivation	S-A (VA)
	32-2 Phase B Trip	32-2 Phase B Trip	Activation/Deactivation	S-B (VA)
	32-2 Phase C Trip	32-2 Phase C Trip	Activation/Deactivation	S-C (VA)
	32-2 Phase Trip	32-2 Phase Trip	Activation/Deactivation	S-3P (VA)
Level 3: Directional Overpower				
32-3	32-3 Phase A Pickup	32-3 Phase A Pickup	Activation/Deactivation	S-A (VA)
	32-3 Phase B Pickup	32-3 Phase B Pickup	Activation/Deactivation	S-B (VA)
	32-3 Phase C Pickup	32-3 Phase C Pickup	Activation/Deactivation	S-C (VA)
	32-3 Phase Pickup	32-3 Phase Pickup	Activation/Deactivation	S-3P (VA)
	32-3 Phase A Trip	32-3 Phase A Trip	Activation/Deactivation	S-A (VA)
	32-3 Phase B Trip	32-3 Phase B Trip	Activation/Deactivation	S-B (VA)
	32-3 Phase C Trip	32-3 Phase C Trip	Activation/Deactivation	S-C (VA)
	32-3 Phase Trip	32-3 Phase Trip	Activation/Deactivation	S-3P (VA)
Level 4: Directional Overpower				
32-4	32-4 Phase A Pickup	32-4 Phase A Pickup	Activation/Deactivation	S-A (VA)
	32-4 Phase B Pickup	32-4 Phase B Pickup	Activation/Deactivation	S-B (VA)
	32-4 Phase C Pickup	32-4 Phase C Pickup	Activation/Deactivation	S-C (VA)
	32-4 Phase Pickup	32-4 Phase Pickup	Activation/Deactivation	S-3P (VA)
	32-4 Phase A Trip	32-4 Phase A Trip	Activation/Deactivation	S-A (VA)
	32-4 Phase B Trip	32-4 Phase B Trip	Activation/Deactivation	S-B (VA)
	32-4 Phase C Trip	32-4 Phase C Trip	Activation/Deactivation	S-C (VA)
	32-4 Phase Trip	32-4 Phase Trip	Activation/Deactivation	S-3P (VA)

Group	Status	Event	Cause	Measurement
Level 1: Under / Overfrecuency				
81-1	81-1 Pickup	81-1 Pickup	Activation/Deactivation	Frequency
	81-1 Trip	81-1 Trip	Activation/Deactivation	Frequency
Level 2: Under / Overfrecuency				
81-2	81-2 Pickup	81-2 Pickup	Activation/Deactivation	Frequency
	81-2 Trip	81-2 Trip	Activation/Deactivation	Frequency
Level 3: Under / Overfrecuency				
81-3	81-3 Pickup	81-3 Pickup	Activation/Deactivation	Frequency
	81-3 Trip	81-3 Trip	Activation/Deactivation	Frequency
Level 4: Under / Overfrecuency				
81-4	81-4 Pickup	81-4 Pickup	Activation/Deactivation	Frequency
	81-4 Trip	81-4 Trip	Activation/Deactivation	Frequency
Level 5: Under / Overfrecuency(*)				
81-5	81-5 Pickup	81-5 Pickup	Activation/Deactivation	Frequency
	81-5 Trip	81-5 Trip	Activation/Deactivation	Frequency
Level 6: Under / Overfrecuency(*)				
81-6	81-6 Pickup	81-6 Pickup	Activation/Deactivation	Frequency
	81-6 Trip	81-6 Trip	Activation/Deactivation	Frequency

(*) Only available for models with voltage sensors.81-5 available for models with VTs too from fw version 3.01.00 onwards.

(**) Optional depending on the model.

(***) Functions 59G not available for models with voltage sensors (only 59N).

Group	Status	Event	Cause	Measurement
Level 1: Rate Of Change Of Frequency (ROCOF)				
81R-1	81R-1 Pickup	81R-1 Pickup	Activation/Deactivation	Frequency variation (Hz/s)
	81R-1 Trip	81R-1 Trip	Activation/Deactivation	Frequency variation (Hz/s)
Level 2: Rate Of Change Of Frequency (ROCOF)				
81R-2	81R-2 Pickup	81R-2 Pickup	Activation/Deactivation	Frequency variation (Hz/s)
	81R-2 Trip	81R-2 Trip	Activation/Deactivation	Frequency variation (Hz/s)
Level 3: Rate Of Change Of Frequency (ROCOF) (****)				
81R-3 (****)	81R-3 Pickup	81R-3 Pickup	Activation/Deactivation	Frequency variation (Hz/s)
	81R-3 Trip	81R-3 Trip	Activation/Deactivation	Frequency variation (Hz/s)
Level 4: Rate Of Change Of Frequency (ROCOF) (****)				
81R-4 (****)	81R-4 Pickup	81R-4 Pickup	Activation/Deactivation	Frequency variation (Hz/s)
	81R-4 Trip	81R-4 Trip	Activation/Deactivation	Frequency variation (Hz/s)
Out Of Step (Vector Shift)				
78	78 Trip	78 Trip	Activation/Deactivation	-
Level 1: Overfluxing (****)				
24-1 (****)	24-1 Pickup	24-1 Pickup	Activation/Deactivation	Un/Fn (V/Hz)
	24-1 Trip	24-1 Trip	Activation/Deactivation	Un/Fn (V/Hz)
Level 2: Overfluxing (****)				
24-2 (****)	24-2 Pickup	24-2 Pickup	Activation/Deactivation	Un/Fn (V/Hz)
	24-2 Trip	24-2 Trip	Activation/Deactivation	Un/Fn (V/Hz)
AC Reclosing Device				
79	Standby	Standby	Activation	-
	Reclose Time	Reclose Time	Activation	-
	Is 52 Open?	Is 52 Open?	Activation	-
	Hold Time	Hold Time	Activation	-
	Closing Time	Closing Time	Activation	-
	Reset Time	Reset Time	Activation	-
	Lockout	Lockout	Activation	-
	Safe Time	Safe Time	Activation	-
	79 Blocked	79 Blocked	Activation/Deactivation	-
	Reclose No. 1	Reclose No. 1	-	-
	Reclose No. 2	Reclose No. 2	-	-
	Reclose No. 3	Reclose No. 3	-	-
	Reclose No. 4	Reclose No. 4	-	-
	79 In Progress	79 In Progress	Activation	-

(****) Only available for models with conventional VTs.

Group	Status	Event	Cause	Measurement
Synchrocheck (**)				
25 (**)	Synchrocheck	Synchrocheck	Activation/Deactivation	-
	Dad L & Dead B	Dad L & Dead B	-	-
	Dead L & Live B	Dead L & Live B	-	-
	Live L & Dead B	Live L & Dead B	-	-
	Live L & Live B	Live L & Live B	-	-
	Voltage Difference	Voltage Difference	Activation/Deactivation	V-B Voltage (V)
	Frequency difference	Frequency difference	Activation/Deactivation	Frequency (Hz)
	Phase difference	Phase difference	Activation/Deactivation	Ang V-B (deg)
Sectionalizer Mode (SZM)(*)				
SZM(*)	Standby	Standby	Activation	-
	Wait to Open	Wait to Open	Activation	-
	Wait to Close	Wait to Close	Activation	-
	Reset Time	Reset Time	Activation	-
	Open	Open	Activation	-
	Lockout	Lockout	Activation	-
Sequence Coordination Mode (SCM)(*)				
SCM(*)	Standby	Standby	Activation	-
	Wait to Open	Wait to Open	Activation	-
	Lockout	Lockout	Activation	-
	Wait to 79	Wait to 79	Activation	-
	Reset Time	Reset Time	Activation	-
Trip Circuit Supervision				
74TCS	74TCS Pickup	74TCS Pickup	Activation/Deactivation	I-Max (A)
	74TCS Alarm	74TCS Alarm	Activation/Deactivation	I-Max (A)
Phase CT Supervision				
60CTS	60CTS Pickup	60CTS Pickup	Activation/Deactivation	I-Max (A)
	60CTS Alarm	60CTS Alarm	Activation/Deactivation	I-Max (A)
Phase VT/VS(*) Supervision				
60VTS/VSS(*)	60VTS/VSS Phase Pickup	60VTS/VSS Phase Pickup	Activation/Deactivation	V-2 (V)
	60VTS/VSS Phase A Alarm	60VTS/VSS Phase A Alarm	Activation/Deactivation	V-A (V)
	60VTS/VSS Phase B Alarm	60VTS/VSS Phase B Alarm	Activation/Deactivation	V-B (V)
	60VTS/VSS Phase C Alarm	60VTS/VSS Phase C Alarm	Activation/Deactivation	V-C (V)
	60VTS/VSS Phase Alarm	60VTS/VSS Phase Alarm	Activation/Deactivation	V-2 (V)
Circuit Breaker Failure				
50BF	50BF Pickup	50BF Pickup	Activation/Deactivation	I-Max (A)
	50BF Alarm	50BF Alarm	Activation/Deactivation	I-Max (A)

Group	Status	Event	Cause	Measurement
Second Harmonic Blocking				
SHB	Phase A Block	Phase A Block	Activation/Deactivation	I-A2H (A)
	Phase B Block	Phase B Block	Activation/Deactivation	I-B2H (A)
	Phase C Block	Phase C Block	Activation/Deactivation	I-C2H (A)
	Phase Block	Phase Block	Activation/Deactivation	-
Cold Load Pickup				
CLP	CLP Disable	CLP Disable	-	I-Max (A)
	52 Close	52 Close	-	I-Max (A)
	52 Open	52 Open	-	I-Max (A)
	52 Def. Open	52 Def. Open	-	I-Max (A)
	Close CLP	Close CLP	-	I-Max (A)
	Open CLP	Open CLP	-	I-Max (A)
	CLP	CLP	Activation/Deactivation	I-Max (A)
Fault Locator				
21FL	Fault Locator	Fault Locator	Activation/Deactivation	Km – Dist.
	Fault AG	Fault AG	Activation/Deactivation	-
	Fault BG	Fault BG	Activation/Deactivation	-
	Fault CG	Fault CG	Activation/Deactivation	-
	Fault ABG	Fault ABG	Activation/Deactivation	-
	Fault BCG	Fault BCG	Activation/Deactivation	-
	Fault CAG	Fault CAG	Activation/Deactivation	-
	Fault AB	Fault AB	Activation/Deactivation	-
	Fault BC	Fault BC	Activation/Deactivation	-
	Fault CA	Fault CA	Activation/Deactivation	-
	Fault ABC	Fault ABC	Activation/Deactivation	-
Load Management System (**)				
LMS (**)	Standby	Standby	Activation	I-MAX (A)
	Check Peak Period	Check Peak Period	Activation	I-MAX (A)
	Check Peak Tap	Check Peak Tap	Activation	I-MAX (A)
	Peak Alarm	Peak Alarm	Activation	Reclosing Number
	Peak Interval	Peak Interval	Activation	I-MAX (A)
	Peak: 52 Open?	Peak: 52 Open?	Activation	I-MAX (A)
	Peak Close Time	Peak Close Time	Activation	I-MAX (A)
	Peak Reset Time	Peak Reset Time	Activation	I-MAX (A)
	Lockout	Lockout	Activation	I-MAX (A)
	Check No Peak Tap	Check No Peak Tap	Activation	I-MAX (A)
	No Peak Alarm	No Peak Alarm	Activation	Reclosing Number
	No Peak Interval	No Peak Interval	Activation	I-MAX (A)
	No Peak: 52 Open?	No Peak: 52 Open?	Activation	I-MAX (A)
	No Peak Close Time	No Peak Close Time	Activation	I-MAX (A)
	No Peak Reset Time	No Peak Reset Time	Activation	I-MAX (A)

	Peak Period	Peak Period	Activation / Deactivation	Reclosing Number
	Pickup	Pickup	Activation / Deactivation	Reclosing Number
	Trip	Trip	Activation / Deactivation	Reclosing Number
	Peak Max Alarm	Peak Max Alarm	Activation / Deactivation	Reclosing Number
	No Peak Max Alarm	No Peak Max Alarm	Activation / Deactivation	Reclosing Number
	LMS Bypass	LMS Bypass	Activation / Deactivation	-

(*) Only available for models with voltage sensors.

(**) Optional depending on the model.

Group	Status	Event	Cause	Measurement
HMI				
HMI	Open Breaker	Opening Command	Activation	Command identifier
	Close Breaker	Closing Command	Activation	Command identifier
	79 Block	79Bolck Command	Activation	Command identifier
	79 Unblock	79Unblock Command	Activation	Command identifier
	Local Control	Local Command	Activation	Command identifier
	Remote Control	Remote Command	Activation	Command identifier
	Reset	Reset	Activation	Command identifier
	Thermal I. Reset	Thermal I. Reset	Activation	Command identifier
	Hot Line Tag ON	Hot Line Tag ON	Activation	Command identifier
	Hot Line Tag OFF	Hot Line Tag OFF	Activation	Command identifier
	User Command 1	User Command 1	-	Command identifier
	User Command 2	User Command 2	-	Command identifier
	User Command 3	User Command 3	-	Command identifier
	User Command 4	User Command 4	-	Command identifier
	User Command 5	User Command 5	-	Command identifier
	User Command 6	User Command 6	-	Command identifier
	Set Counter	Set Counter	Activation	Command identifier
	Key Reset	Key Reset	Activation	Command identifier
	HMI Activity	HMI Activity	Activation/Deactivation	Command identifier
	Identification	Identification	Activation/Deactivation	Command identifier
	Test State	Test State	Activation/Deactivation	Command identifier
USB COM				
USB COM	Open Breaker	Opening Command	Activation	Command identifier
	Close Breaker	Closing Command	Activation	Command identifier
	79 Block	79Block Command	Activation	Command identifier
	79 Unblock	79Unblock Command	Activation	Command identifier
	Local Control	Local Command	Activation	Command identifier
	Remote Control	Remote Command	Activation	Command identifier
	Reset	Reset	Activation	Command identifier
	Thermal I. Reset	Thermal I. Reset	Activation	Command identifier
	Hot Line Tag ON	Hot Line Tag ON	-	Command identifier
	Hot Line Tag OFF	Hot Line Tag OFF	-	Command identifier
	User Command 1	User Command 1	-	Command identifier
	User Command 2	User Command 2	-	Command identifier
	User Command 3	User Command 3	-	Command identifier
	User Command 4	User Command 4	-	Command identifier
	User Command 5	User Command 5	-	Command identifier
	User Command 6	User Command 6	-	Command identifier
	Set Counter	Set Counter	Activation	Command identifier
	Activity	-	-	-
	Identification	Identification	Activation/Deactivation	Command identifier

Group	Status	Event	Cause	Measurement
WIFI COM (**)				
WIFI COM (**)	Open Breaker	Opening Command	Activation	Command identifier
	Close Breaker	Closing Command	Activation	Command identifier
	79 Block	79Block Command	Activation	Command identifier
	79 Unblock	79Unblock Command	Activation	Command identifier
	Local Control	Local Command	Activation	Command identifier
	Remote Control	Remote Command	Activation	Command identifier
	Reset	Reset Command	Activation	Command identifier
	Thermal I. Reset	Thermal I. Reset	Activation	Command identifier
	Hot Line Tag ON	Hot Line Tag ON	-	Command identifier
	Hot Line Tag OFF	Hot Line Tag OFF	-	Command identifier
	User Command 1	User Command 1	-	Command identifier
	User Command 2	User Command 2	-	Command identifier
	User Command 3	User Command 3	-	Command identifier
	User Command 4	User Command 4	-	Command identifier
	User Command 5	User Command 5	-	Command identifier
	User Command 6	User Command 6	-	Command identifier
	WIFI ON	WIFI ON	-	Command identifier
	Set Counter	Set Counter	Activation	Command identifier
	Link	Link	Activation	Command identifier
	Activity	Activity	-	-
	Identification	Identification	Activation/Deactivation	Command identifier
MODBUS RTU (**)				
MODBUS RTU (**)	Opening Command	Opening Command	Activation	Command identifier
	Closing Command	Closing Command	Activation	Command identifier
	79Block Command	79Block Command	Activation	Command identifier
	79Unblock Command	79Unblock Command	Activation	Command identifier
	Local Command	Local Command	Activation	Command identifier
	Remote Command	Remote Command	Activation	Command identifier
	Reset	Reset	Activation	Command identifier
	Thermal I. Reset	Thermal I. Reset	Activation	Command identifier
	Hot Line Tag ON	Hot Line Tag ON	-	Command identifier
	Hot Line Tag OFF	Hot Line Tag OFF	-	Command identifier
	User Command 1	User Command 1	-	Command identifier
	User Command 2	User Command 2	-	Command identifier
	User Command 3	User Command 3	-	Command identifier
	User Command 4	User Command 4	-	Command identifier
	User Command 5	User Command 5	-	Command identifier
	User Command 6	User Command 6	-	Command identifier
	Set Counter	Set Counter	Activation	Command identifier
	Activity	-	-	-
	Identification	Identification	Activation/Deactivation	Command identifier

(**) Optional depending on the model.

Group	Status	Event	Cause	Measurement
DNP3 (**)				
DNP3 (**)	Opening Command	Opening Command	Activation	Command identifier
	Closing Command	Closing Command	Activation	Command identifier
	79Block Command	79Block Command	Activation	Command identifier
	79Unblock Command	79Unblock Command	Activation	Command identifier
	Local Command	Local Command	Activation	Command identifier
	Remote Command	Remote Command	Activation	Command identifier
	Reset	Reset	Activation	Command identifier
	Thermal I. Reset	Thermal I. Reset	Activation	Command identifier
	Hot Line Tag ON	Hot Line Tag ON	-	Command identifier
	Hot Line Tag OFF	Hot Line Tag OFF	-	Command identifier
	User Command 1	User Command 1	-	Command identifier
	User Command 2	User Command 2	-	Command identifier
	User Command 3	User Command 3	-	Command identifier
	User Command 4	User Command 4	-	Command identifier
	User Command 5	User Command 5	-	Command identifier
	User Command 6	User Command 6	-	Command identifier
	Activity	-	-	-
IEC-103 (**)				
IEC-103 (**)	Opening Command	Opening Command	Activation	Command identifier
	Closing Command	Closing Command	Activation	Command identifier
	79Block Command	79Block Command	Activation	Command identifier
	79Unblock Command	79Unblock Command	Activation	Command identifier
	Local Command	Local Command	Activation	Command identifier
	Remote Command	Remote Command	Activation	Command identifier
	Reset	Reset	Activation	Command identifier
	Thermal I. Reset	Thermal I. Reset	Activation	Command identifier
	Activity	-	-	-
MODBUS TCP (**)				
MODBUS TCP (**)	Opening Command	Opening Command	Activation	Command identifier
	Closing Command	Closing Command	Activation	Command identifier
	79Block Command	79Block Command	Activation	Command identifier
	79Unblock Command	79Unblock Command	Activation	Command identifier
	Local Command	Local Command	Activation	Command identifier
	Remote Command	Remote Command	Activation	Command identifier
	Reset	Reset	Activation	Command identifier
	Thermal I. Reset	Thermal I. Reset	Activation	Command identifier
	Hot Line Tag ON	Hot Line Tag ON	-	Command identifier
	Hot Line Tag OFF	Hot Line Tag OFF	-	Command identifier
	User Command 1	User Command 1	-	Command identifier
	User Command 2	User Command 2	-	Command identifier
	User Command 3	User Command 3	-	Command identifier
	User Command 4	User Command 4	-	Command identifier
	User Command 5	User Command 5	-	Command identifier
	User Command 6	User Command 6	-	Command identifier
	Activity	-	-	-
	Identification	Identification	Activation/Deactivation	Command identifier

(**) Optional depending on the model.

Group	Status	Event	Cause	Measurement
DNP3 TCP (**)				
DNP3 TCP (**)	Opening Command	Opening Command	Activation	Command identifier
	Closing Command	Closing Command	Activation	Command identifier
	79Block Command	79Block Command	Activation	Command identifier
	79Unblock Command	79Unblock Command	Activation	Command identifier
	Local Command	Local Command	Activation	Command identifier
	Remote Command	Remote Command	Activation	Command identifier
	Thermal I. Reset	Thermal I. Reset	Activation	Command identifier
	Hot Line Tag ON	Hot Line Tag ON	-	Command identifier
	Hot Line Tag OFF	Hot Line Tag OFF	-	Command identifier
	User Command 1	User Command 1	-	Command identifier
	User Command 2	User Command 2	-	Command identifier
	User Command 3	User Command 3	-	Command identifier
	User Command 4	User Command 4	-	Command identifier
	User Command 5	User Command 5	-	Command identifier
	User Command 6	User Command 6	-	Command identifier
	Activity	-	-	-
IEC-104 (**)				
IEC-104 (**)	Opening Command	Opening Command	Activation	Command identifier
	Closing Command	Closing Command	Activation	Command identifier
	79Block Command	79Block Command	Activation	Command identifier
	79Unblock Command	79Unblock Command	Activation	Command identifier
	Local Command	Local Command	Activation	Command identifier
	Remote Command	Remote Command	Activation	Command identifier
	Thermal I. Reset	Thermal I. Reset	Activation	Command identifier
	Hot Line Tag ON	Hot Line Tag ON	-	Command identifier
	Hot Line Tag OFF	Hot Line Tag OFF	-	Command identifier
	User Command 1	User Command 1	-	Command identifier
	User Command 2	User Command 2	-	Command identifier
	User Command 3	User Command 3	-	Command identifier
	User Command 4	User Command 4	-	Command identifier
	User Command 5	User Command 5	-	Command identifier
	User Command 6	User Command 6	-	Command identifier
	Activity	-	-	-
WEB (**)				
WEB (**)	Opening Command	Opening Command	Activation	Command identifier
	Closing Command	Closing Command	Activation	Command identifier
	79Block Command	79Block Command	Activation	Command identifier
	79Unblock Command	79Unblock Command	Activation	Command identifier
	Local Command	Local Command	Activation	Command identifier
	Remote Command	Remote Command	Activation	Command identifier
	Reset	Reset	Activation	Command identifier
	Thermal I. Reset	Thermal I. Reset	Activation	Command identifier
	Hot Line Tag ON	Hot Line Tag ON	-	Command identifier
	Hot Line Tag OFF	Hot Line Tag OFF	-	Command identifier

(**) Optional depending on the model.

Group	Status	Event	Cause	Measurement
WEB (**)	User Command 1	User Command 1	-	Command identifier
	User Command 2	User Command 2	-	Command identifier
	User Command 3	User Command 3	-	Command identifier
	User Command 4	User Command 4	-	Command identifier
	User Command 5	User Command 5	-	Command identifier
	User Command 6	User Command 6	-	Command identifier
	Activity	-	-	-
IEC 61850 (**)				
IEC 61850 (**)	Opening Command	Opening Command	Activation	Command identifier
	Closing Command	Closing Command	Activation	Command identifier
	79Block Command	79Block Command	Activation	Command identifier
	79Unblock Command	79Unblock Command	Activation	Command identifier
	Local Command	Local Command	Activation	Command identifier
	Remote Command	Remote Command	Activation	Command identifier
	Reset	Reset	Activation	Command identifier
	Thermal I. Reset	Thermal I. Reset	Activation	Command identifier
	Hot Line Tag ON	Hot Line Tag ON	-	Command identifier
	Hot Line Tag OFF	Hot Line Tag OFF	-	Command identifier
	User Command 1	User Command 1	-	Command identifier
	User Command 2	User Command 2	-	Command identifier
	User Command 3	User Command 3	-	Command identifier
	User Command 4	User Command 4	-	Command identifier
	User Command 5	User Command 5	-	Command identifier
	User Command 6	User Command 6	-	Command identifier
	Activity	-	-	-

(**) Optional depending on the model.

Group	Status	Event	Cause	Measurement
GOOSE (**)				
	GOOSE output-1	GOOSE output-1	Activation/Deactivation	-
	GOOSE output -2	GOOSE output -2	Activation/Deactivation	-
	GOOSE output -3	GOOSE output -3	Activation/Deactivation	-
	GOOSE output -4	GOOSE output -4	Activation/Deactivation	-
	GOOSE output -5	GOOSE output -5	Activation/Deactivation	-
	GOOSE output -6	GOOSE output -6	Activation/Deactivation	-
	GOOSE input-1	GOOSE input-1	Activation/Deactivation	-
	GOOSE input -2	GOOSE input -2	Activation/Deactivation	-
	GOOSE input -3	GOOSE input -3	Activation/Deactivation	-
	GOOSE input -4	GOOSE input -4	Activation/Deactivation	-
	GOOSE input -5	GOOSE input -5	Activation/Deactivation	-
	GOOSE input -6	GOOSE input -6	Activation/Deactivation	-
	GOOSE input -7	GOOSE input -7	Activation/Deactivation	-
	GOOSE input -8	GOOSE input -8	Activation/Deactivation	-
	GOOSE input -9	GOOSE input -9	Activation/Deactivation	-
	GOOSE input -10	GOOSE input -10	Activation/Deactivation	-
	GOOSE input -11	GOOSE input -11	Activation/Deactivation	-
	GOOSE input -12	GOOSE input -12	Activation/Deactivation	-
	GOOSE input -13	GOOSE input -13	Activation/Deactivation	-
	GOOSE input -14	GOOSE input -14	Activation/Deactivation	-
	GOOSE input -15	GOOSE input -15	Activation/Deactivation	-
	GOOSE input -16	GOOSE input -16	Activation/Deactivation	-

(**) Optional depending on the model.

Control LEDs				
Control LEDs	LED Local	-	-	-
	LED 79	-	-	-
	LED 52	-	-	-
	Virtual LED 1	-	-	-
	Virtual LED 2	-	-	-
	Virtual LED 3	-	-	-

15.5 Disturbance fault recording (DFR)

Disturbance fault recording includes the disturbance records in COMTRADE format and the data of each COMTRADE (fault reports). The relay can store, in FRAM memory. From the standby mode screen, press 'OK' key to access the first line of menus. Use the '▲' and '▼' keys to position the cursor over the 'FAULTS' screen. They are also accessible by pressing '◄' from the standby menu. The next information can be checked:

- Date-time at which the fault started.
- List of all events occurred in the relay during the fault.

To delete the fault reports buffer, position the cursor over the fault report menu and press and hold the 'RESET' key, until there are no fault reports. There will be an event 'Fault reports erased'.

Besides, the relay can store the fault reports in COMTRADE format - cyclic recording by FIFO method - (resolution 32 samples/cycle):

The number of oscillography records can be set. Depending on the number of records chosen, the cycles for each record will vary as follows:

Num of records*cycles	Records	Cycles per record	Pre-fault cycles	Postfault cycles
5*300	5	300	1-8	292-299
25*60	25	60		52-59
50*30	50	30		22-29
100*15	100	15		7-14

The records will be register in data and COMTRADE format. The oscillography can be viewed and downloaded with the SICom, which allows to save it in COMTRADE format (IEEE C37.111-1991).

The records maintain date & time thanks to the relays internal RTC (Real Time Clock).

It is possible to configure the reason of the start of the fault report through the "DFR Start" configuration in the PGC. It must be considered that if there is no trip of a protection function, the fault report will show a "0" on the trip reason and the reason of the start of the fault report it will not be shown. For this reason, Fanox recommends configuring the "DFR Start" PGC signal to "General Trip" in order to record all the information of the fault.

Once the COMTRADE is saved 3 files are generated:

- File '.dat': The information of the COMTRADE record in data format.
- File '.cfg' The information of the COMTRADE record in graphic format (this is the file to open to analyze the waves and the signals involved in the DFR).
- File '.hdr': This is the COMTRADE header file that includes: date-time of the record, number of COMTRADE record, pre-fault and post-fault cycles and analog/digital channels.

The following information is included in each oscillography record:

- Analog channels:

Number	Analog channels
1	Phase A current
2	Phase B current
3	Phase C current
4	Neutral current
5	Phase A voltage
6	Phase B voltage
7	Phase C voltage
8	Neutral voltage
9	Line voltage
10	Bar Frequency

- Digital channels. The digital channels are configurable. By default, the following 96 channels are displayed.

No.	Digital channels
1	50-1 Trip
2	50-2 Trip
3	SOTF
4	67/51-1 Trip
5	67/51-2 Trip
6	67/51-3 Trip
7	67/51-4 Trip
8	50G Trip
9	50N Trip
10	67G/51G-1 Trip
11	67G/51G-2 Trip
12	67N/51N-1 Trip
13	67N/51N-2 Trip
14	46 Trip
15	46BC Trip
16	49 Trip
17	37 Trip
18	27-1 Trip
19	27-2 Trip
20	27V1 Trip
21	59-1 Trip
22	59-2 Trip
23	59N/G-1 Trip
24	59N/G-2 Trip

No.	Digital channels
33	81-4 Trip
34	81R-1 Trip
35	81R-2 Trip
36	81R-3 Trip
37	81R-4 Trip
38	78 Trip
39	24-1 Trip
40	24-2 Trip
41	79 Closing Time
42	79 Blocked
43	79 Lockout
44	52 Closed
45	74TCS Alarm
46	60CTS Alarm
47	60VTS Alarm
48	50BF Alarm
49	SHB Block
50	CLP
51	General Trip
52	50-1 Pickup
53	50-2 Pickup
54	67/51-1 Pickup
55	67/51-2 Pickup
56	67/51-3 Pickup

No.	Digital channels
65	46BC Pickup
66	37 Pickup
67	27-1 Pickup
68	27-2 Pickup
69	27V1 Pickup
70	59-1 Pickup
71	59-2 Pickup
72	59N/G-1 Pickup
73	59N/G-2 Pickup
74	47 Pickup
75	32-1 Pickup
76	32-2 Pickup
77	32-3 Pickup
78	32-4 Pickup
79	81-1 Pickup
80	81-2 Pickup
81	81-3 Pickup
82	81-4 Pickup
83	81R-1 Pickup
84	81R-2 Pickup
85	81R-3 Pickup
86	81R-4 Pickup
87	24-1 Pickup
88	24-2 Pickup

25	47 Trip
26	32-1 Trip
27	32-2 Trip
28	32-3 Trip
29	32-4 Trip
30	81-1 Trip
31	81-2 Trip
32	81-3 Trip

57	67/51-4 Pickup
58	50G Pickup
59	50N Pickup
60	67G/51G-1 Pickup
61	67G/51G-2 Pickup
62	67N/51N-1 Pickup
63	67N/51N-2 Pickup
64	46 Pickup

89	General Pickup
90	Output 1
91	Output 2
92	Output 3
93	Output 4
94	Output 5
95	Output 6
96	Output 7

15.6 Load Data Profiling (LDP)

SIL-G relay provides the demand of current with the following characteristics:

- Number of records: 2160.
- Recording mode circular.
- Sampling rate (interval): 1 min, configurable through communications up to 60 min.
- Activation current level: from 0.01 to 2 times the nominal current.
- Record format:

  Date/Time.
  S (3-phase).
  P (3-phase).
  Q (3-phase).
  IMAX (during the interval) *.
  IMAX (actual)*.
  VMAX (actual)*.

NOTE: The measurements marked with an asterisk are only visible through the SICom, not from the HMI. Once the demand setting is changed, it is necessary to restart the relay to ensure that the new setting is recorded correctly.

15.7 Counters

The following counters are provided:

1. Number of openings of the circuit breaker.
2. Recloses number.
3. Amperes accumulated (I^2t) during the openings of the circuit breaker.
4. Positive Active Energy (AE+).
5. Negative Active Energy (AE-).
6. Positive Reactive Energy (RE+).
7. Negative Reactive Energy (RE-).

15.8 Commands

	HMI	Local Com. Modbus RTU	Remote com: Modbus RTU Modbus TCP/IP IEC 60870-5-103/104 IEC61850 DNP 3.0 Serial DNP 3.0 TCP/IP
Open Breaker	✓	✓	✓
Close Breaker	✓	✓	✓
79 Block	✓	✓	✓
79 Unblock	✓	✓	✓
Local Control	✓	✓	✓
Remote Control	✓	✓	✓
Reset	✓	✓	✓
Reset Thermal Image	✓	✓	✓
Hot Line Tag ON	✓	✓	✓
Hot Line Tag OFF	✓	✓	✓
User command 1	✓	✓	✓
User command 2	✓	✓	✓
User command 3	✓	✓	-
User command 4	✓	✓	-
User command 5	✓	✓	✓
User command 6	✓	✓	✓
Set Counter	(*)	✓	✓ (only Modbus)

(*) Counters have a specific menu in HMI where they can be set.

To execute commands remotely (Modbus, IEC60870-5-103/104, IEC 61850 or DNP 3.0) the device must be operating in REMOTE CONTROL mode.

Operations can be performed from the HMI or from local communications (Modbus), regardless of whether the relay is in remote control or not.

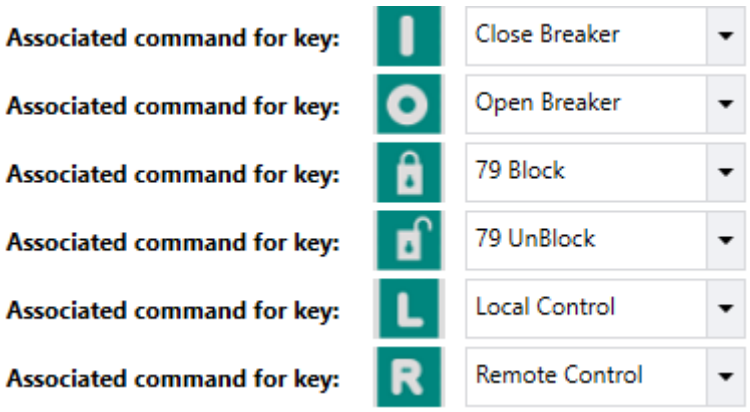
15.8.1 User Commands

User commands can be configured from the HMI with the desired logic. For example, a user command can be configured to an output. When that command is activated from a communication, the output will activate.

15.8.2 Configuration of HMI Command Keys

Depending on the version, it is possible to configure some of the keys of the relay to execute different commands. The operation time for the command is also configurable, from immediate action (0 seconds) to 179 seconds of delay.

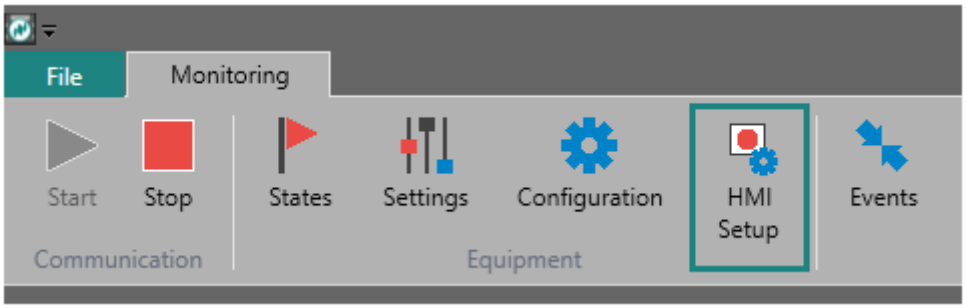
By default, keys are configured as follows:



And the associated default operation times are:

Command	Time
Open Breaker	3s
Close Breaker	10s
79 Block	1s
79 Unblock	1s
Local Control	1s
Remote Control	1s
Reset	2s
Reset Thermal Image	2s
Hot Line Tag ON	2s
Hot Line Tag OFF	2s
User command 1	2s
User command 2	2s
User command 3	2s
User command 4	2s
User command 5	0s
User command 6	0s

The configuration can be done from the “HMI Setup” Menu on the menu bar of the SICom software. It is not possible to configure it from the HMI.



15.9 Real Time Clock (RTC)

The relay is provided with an internal Real Time Clock (RTC), with a precision of 1 millisecond, that allows to maintain date & time.

The RTC is backed up by a supercapacitor. When the device is unpowered, the supercapacitor gradually discharges and once depleted, the RTC resets. As a guideline, the RTC date/time is typically retained without power for about 2 months at 25ºC and 10 days at 70ºC (*). After an RTC reset, the relay can be resynchronized via the HMI, through SICOM software, or by remote communication.

(*) Tests performed after being the relay connected to the auxiliary supply for 60h.

15.10 Programmable Logic Control (PGC)

Firstly, the concepts of physical input, physical output and logical signal are defined.

Physical inputs are the real inputs of the device. SIL-G device has 8, 16 or 24 physical inputs, depending on model. These inputs are translated to internal binary states which later, can be assigned to logical signal to get a specific operation.

SIL-G is provided with 32 outputs. Physical outputs are the real outputs of the device. SIL-G has up to 18 physical outputs, (7, 11 or 18 outputs depending on model) and the rest of them are logic outputs to configure the relay.

Besides, the relay is provided with 32 alarms. The first 8 alarms correspond to the 8 configurable front LEDs and the rest are logic alarms to configure the relay.

All the outputs (physical and logic alarms, physical and logic outputs) are the result of a PROGRAMMABLE LOGIC CONTROL which can be configured from HMI or from SICom software.

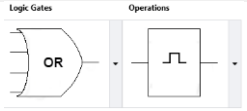
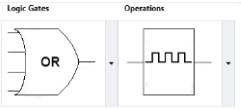
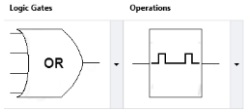
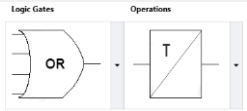
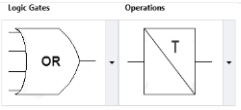
In addition, the following 24 predefined actions and 8 free PGCs are available to be configured by the user in the PGC configuration section.

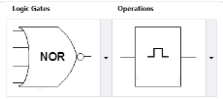
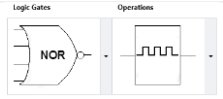
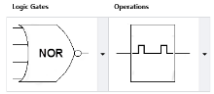
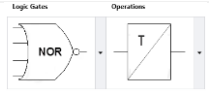
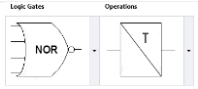
Logical inputs	Description
Open Breaker Command	Conditions to send the open breaker command
Close Breaker Command	Conditions to send the close breaker command
79 Block Command	Conditions to send the 79 Block command
79 Unblock Command	Conditions to send the 79 Unblock command
Local Control Command	Conditions to send the Local Control command
Remote Control Command	Conditions to send the Remote Control command
52a	Circuit breaker contact a
52b	Circuit breaker contact b
Settings Group 1	Active Settings Group assignment
Settings Group 2	Active Settings Group assignment
Settings Group 4(*)	Active Settings Group assignment
SZM Start(*)	Sectionalize function start
Hot Line Tag	Conditions to activate the Hot Line Tag. When it is activated, the function 79 is blocked and reclosing is not permitted.
79 Enable	Conditions to activate auto reclosing
79N1 Start	Start of first cycle of 79 protection function
79N2 Start	Start of second cycle of 79 protection function
79N3 Start	Start of third cycle of 79 protection function
79N4 Start	Start of fourth cycle of 79 protection function
DFR Start	Disturbance Fault Report Start
50BF Start	Start of circuit breaker failure protection
SOTF Start	Conditions to start the switch on to fault function
Reset Thermal Image	Conditions to reset the thermal image
74TCS Coil A Continuity	Trip circuit supervision input for coil A
74TCS Coil B Continuity	Trip circuit supervision input for coil B
Neutral Block	Conditions to block neutral trip
Phase Block	Conditions to block phase trip
External trip	External Trip
Reset	Reset
Opening Blk	Conditions to block opening
Closing Blk	Conditions to block closing
PGC 1	Free PGC 1
PGC 2	Free PGC 2
PGC 3	Free PGC 3

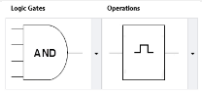
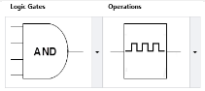
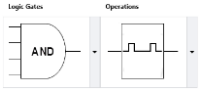
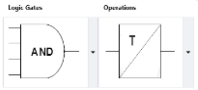
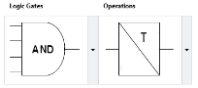
(*) Only available for models with voltage sensors.

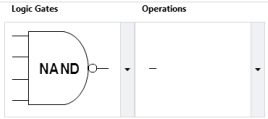
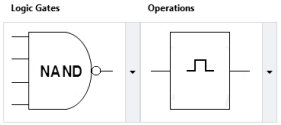
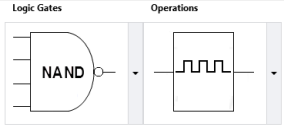
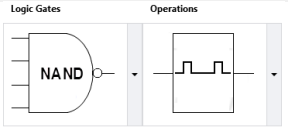
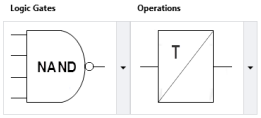
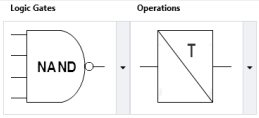
For each output there is a LOGICAL GATE that can perform a logical operation with up to 4 binary states to obtain a binary result.

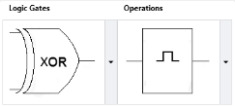
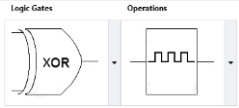
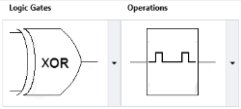
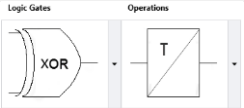
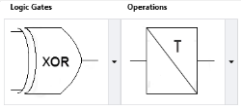
In V3 of the PGC the LOGICAL GATES that are supported by SIL-G are:

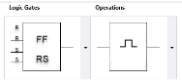
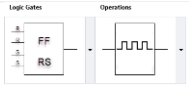
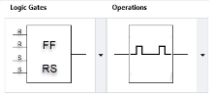
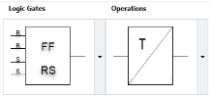
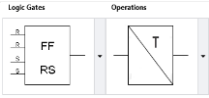
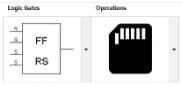
LOGIC GATE	OPERATION	SETTABLE PARAMETERS	HMI SYMBOL	SICom SYMBOL	APPLICABLE EXTRA PARAMETERS
OR4	-	-	OR		NA
	1 PULSE	Time up: Time during which the pulse is activated	OR 1P		Time up The time the pulse lasts
	PULSES	Time up: Time between pulses and duration of each pulse (same for both)	OR PS		Time up The time the pulses are activated and deactivated (same time on/off)
	BLINKING	Period & Time up: Period: Repetitive time between each pulse Tme up: Time during which each pulse is activated	OR BL		Period and Time up Period: It is the period of the square wave Time up: it is the time the pulse is activated
	TIMER UP	Time up: Delay time to activate the configured signal	OR TU		Time up It is the delay until the configured signal is activated
	TIMER DOWN	Time up: Delay time to deactivate the configured signal	OR TD		Time up It is the delay until the configured signal is deactivated

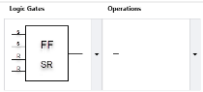
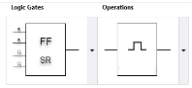
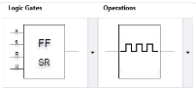
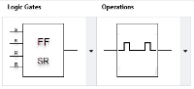
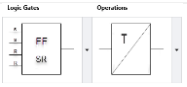
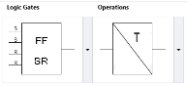
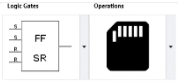
LOGIC GATE	OPERATION	SETTABLE PARAMETERS	HMI SYMBOL	SICom SYMBOL	APPLICABLE EXTRA PARAMETERS
NOR4	-	-	NOR		NA
	1 PULSE	Time up: Time during which the pulse is activated	NOR 1P		Time up The time the pulse lasts
	PULSES	Time up: Time between pulses and duration of each pulse (same for both)	NOR PS		Time up The time the pulses are activated and deactivated (same time on/off)
	BLINKING	Period & time up: Period: Repetitive time between each pulse Tme up: Time during which each pulse is activated	NOR BL		Period and Time up Period: It is the period of the square wave Time up: it is the time the pulse is activated
	TIMER UP	Time up: Delay time to activate the configured signal	NOR TU		Time up It is the delay until the configured signal is deactivated
	TIMER DOWN	Time up: Delay time to deactivate the configured signal	NOR TD		Time up It is the delay until the configured signal is activated

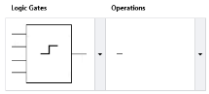
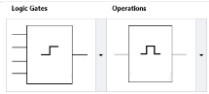
LOGIC GATE	OPERATION	SETTABLE PARAMETERS	HMI SYMBOL	SICom SYMBOL	APPLICABLE EXTRA PARAMETERS
AND4	-	-	AND		NA
	1 PULSE	Time up: Time during which the pulse is activated	AND 1P		Time up The time the pulse lasts
	PULSES	Time up: Time between pulses and duration of each pulse (same for both)	AND PS		Time up The time the pulses are activated and deactivated (same time on/off)
	BLINKING	Period & time up: Period: Repetitive time between each pulse Tme up: Time during which each pulse is activated	AND BL		Period and Time up Period: It is the period of the square wave Time up: it is the time the pulse is activated
	TIMER UP	Time up: Delay time to activate the configured signal	AND TU		Time up It is the delay until the configured signal is activated
	TIMER DOWN	Time up: Delay time to deactivate the configured signal	AND TD		Time up It is the delay until the configured signal is deactivated

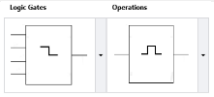
LOGIC GATE	OPERATION	SETTABLE PARAMETERS	HMI SYMBOL	SICom SYMBOL	APPLICABLE EXTRA PARAMETERS
NAND4	-	-	NAND		NA
	1 PULSE	Time up: Time during which the pulse is activated	NAND 1P		Time up The time the pulse lasts
	PULSES	Time up: Time between pulses and duration of each pulse (same for both)	NAND PS		Time up The time the pulses are activated and deactivated (same time on/off)
	BLINKING	Period & time up: Period: Repetitive time between each pulse Tme up: Time during which each pulse is activated	NAND BL		Period and Time up Period: It is the period of the square wave Time up: it is the time the pulse is activated
	TIMER UP	Time up: Delay time to activate the configured signal	NAND TU		Time up It is the delay until the configured signal is deactivated
	TIMER DOWN	Time up: Delay time to deactivate the configured signal	NAND TD		Time up It is the delay until the configured signal is activated

LOGIC GATE	OPERATION	SETTABLE PARAMETERS	HMI SYMBOL	SICom SYMBOL	APPLICABLE EXTRA PARAMETERS
XOR2	-	-	XOR		NA
	1 PULSE	Time up: Time during which the pulse is activated	XOR 1P		Time up The time the pulse lasts
	PULSES	Time up: Time between pulses and duration of each pulse (same for both)	XOR PS		Time up The time the pulses are activated and deactivated (same time on/off)
	BLINKING	Period & time up: Period: Repetitive time between each pulse Tme up: Time during which each pulse is activated	XOR BL		Period and Time up Period: It is the period of the square wave Time up: it is the time the pulse is activated
	TIMER UP	Time up: Delay time to activate the configured signal	XOR TU		Time up It is the delay until the configured signal is activated
	TIMER DOWN	Time up: Delay time to deactivate the configured signal	XOR TD		Time up It is the delay until the configured signal is deactivated

LOGIC GATE	OPERATION	SETTABLE PARAMETERS	HMI SYMBOL	SICom SYMBOL	APPLICABLE EXTRA PARAMETERS
RSFF **2 for the reset + 2 for the set**	-	-	RSFF		NA
	1 PULSE	Time up: Time during which the pulse is activated	RSFF 1P		Time up The time the pulse lasts (in this case the FF. this configuration works as OR_PULSE)
	PULSES	Time up: Time between pulses and duration of each pulse (same for both)	RSFF PS		Time up The time the pulses are activated and deactivated (same time on/off)
	BLINKING	Period & time up: Period: Repetitive time between each pulse Tme up: Time during which each pulse is activated	RSFF BL		Period and Time up Period: It is the period of the square wave Time up: it is the time the pulse is activated
	TIMER UP	Time up: Delay time to activate the configured signal	RSFF TU		Time up: It is the delay until the configured signal is activated
	TIMER DOWN	Time up: Delay time to deactivate the configured signal	RSFF TD		Time up: It is the delay until the configured signal is deactivated
	NO VOLÁTIL	Time up: The location in the non-volatile memory where it is saved (adjustable **from 1 to 32, each location must be used only once**)	RSFF		-

LOGIC GATE	OPERATION	SETTABLE PARAMETERS	HMI SYMBOL	SICom SYMBOL	APPLICABLE EXTRA PARAMETERS
SRFF **2 for the set +** **2 for the reset**	-	-	SRFF		NA
	1 PULSE	Time up: Time during which the pulse is activated	SRFF 1P		Time up The time the pulse lasts (in this case the FF. this configuration works as OR_PULSE)
	PULSES	Time up: Time between pulses and duration of each pulse (same for both)	SRFF PS		Time up The time the pulses are activated and deactivated (same time on/off)
	BLINKING	Period & time up: Period: Repetitive time between each pulse Tme up: Time during which each pulse is activated	SRFF BL		Period and Time up Period: It is the period of the square wave Time up: it is the time the pulse is activated
	TIMER UP	Time up: Delay time to activate the configured signal	SRFF TU		Time up It is the delay until the configured signal is activated
	TIMER DOWN	Time up: Delay time to deactivate the configured signal	SRFF TD		Time up It is the delay until the configured signal is deactivated
	NO VOLÁTIL	Time up: The location in the non-volatile memory where it is saved (adjustable **from 1 to 32, each location must be used only once**)	SRFF 		-

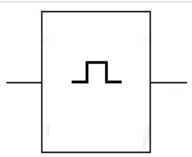
LOGIC GATE	OPERATION	SETTABLE PARAMETERS	HMI SYMBOL	SICom SYMBOL	APPLICABLE EXTRA PARAMETERS
R_EDGE4	-	-	R EDGE		NA
	1 PULSE	Time up: Time during which the pulse is activated	R EDGE 1P		Time up The time the pulse lasts

LOGIC GATE	OPERATION	SETTABLE PARAMETERS	HMI SYMBOL	SICom SYMBOL	APPLICABLE EXTRA PARAMETERS
F_EDGE4	-	-	F EDGE		NA
	1 PULSE	Time up: Time during which the pulse is activated	F EDGE 1P		Time up The time the pulse lasts

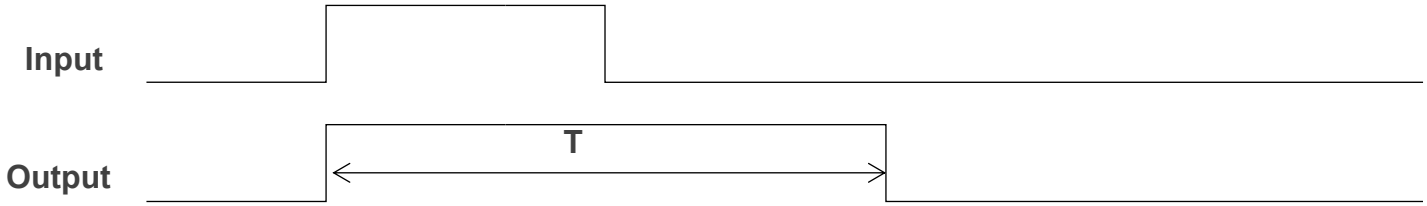
NOTE: After using RS or SR flip flops, please reset the relay before changing the configuration.

Logical gate selection guide

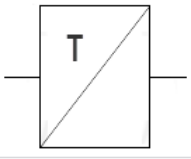
1 PULSE



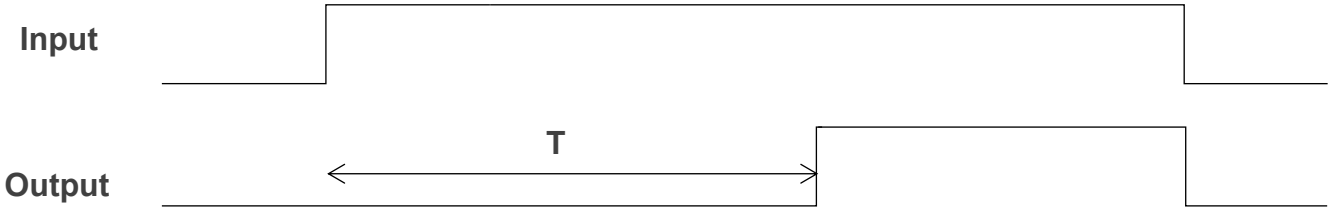
The configured signal will make a pulse of the adjusted time in “time up” parameter once the input signal is activated.



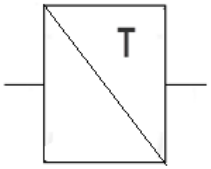
TIMER UP



The configured signal waits the adjusted time in “time up” parameter to activate itself once the input signal is activated.



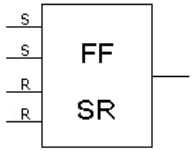
TIMER DOWN

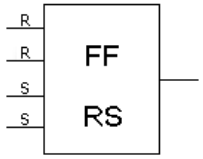


Once the configured signal is activated, it waits the adjusted time in “time up” parameter to deactivate itself.

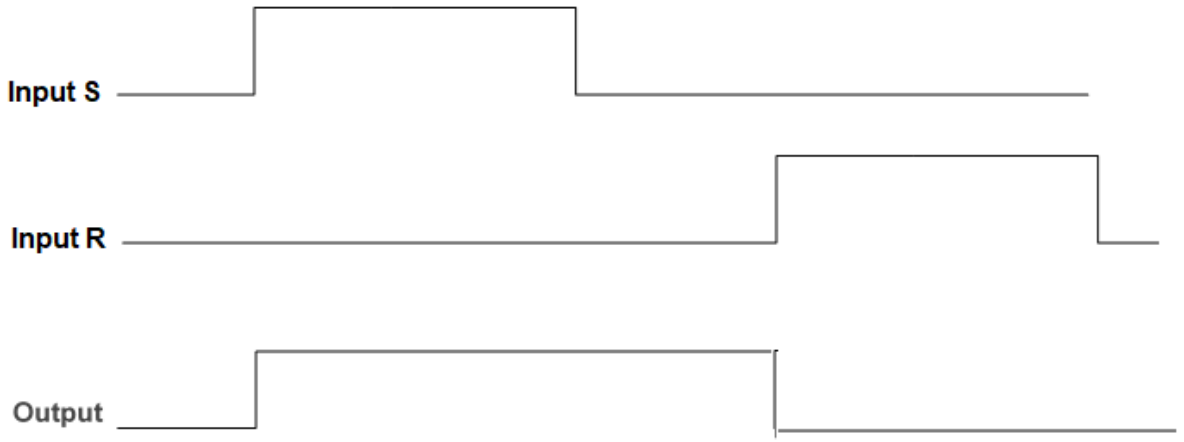


SR FLIP FLOP (priority for set signals) & RS FLIP FLOP (priority for reset signals)

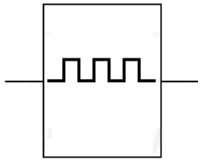




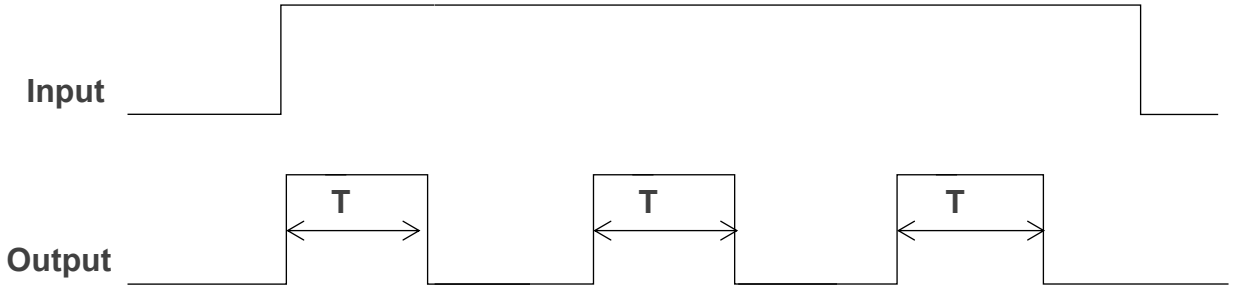
The configured signal will be activated once the bits in “s” position are activated (set position. The signal is maintained activated until the bits configured in “R” position are activated.



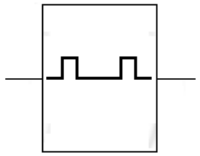
PULSES (Same time on and time off)



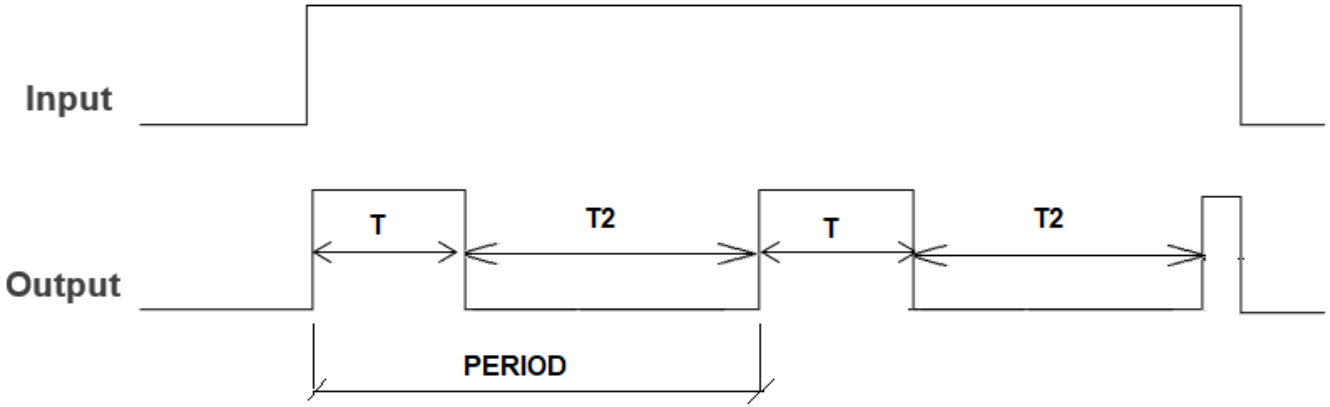
The configured signal will make pulses of the adjusted milliseconds while the input signal is activated.



BLINKING (different time on (T) and time off (T2)



The configured signal will be activated the time set in “time up” parameter and will be switched off the time set in “period” parameter less the set in “time up” parameter:



To delete the configuration, SICom or HMI can be used. Through SICom it is necessary to remove the configured signals and send the new configuration to the relay.

Through HMI, it is necessary to access to the output, PGC or LED that is configured and press OK to visualize the configured signals. Being displayed the configured options, hold reset key to delete them. After inserting the password, by pressing OK the action of removing the configured options is confirmed. It is necessary to press RESET key as many times as signals are configured.

Once the signal is empty, it is possible to configure it. First find the signal which will be configured to an output, LED or PGC (i.e., “General Trip”). Press “right arrow” an enter the password, in the first column the outputs are placed (pressing “up” or “down” keys find the output), pressing the “right” key LEDs (alarms) will appear, pressing the “right” key again Signalling LED will appear, and finally, pressing again right key PGC will be placed. Once the output is found, press “left” key to find the correct operation, press OK to assign the operation. Then the configuration is finished.

15.11 Configurable inputs

The SIL-G has up to 24 digital inputs that can be set by the user. Depending on the model:

Model	Configurable Inputs
SILGxxxxxx0xxx, SILGxxxxxx6xxx	8 configurable inputs
SILGxxxxxxAxxx, SILGxxxxxxBxxx	8 configurable inputs + 4 AFD inputs
SILGxxxxxx7xxx	16 configurable inputs
SILGxxxxxx5xxx	24 configurable inputs

The voltage to activate the inputs is the same as the power supply.

The inputs can be configured from the HMI or through the SICom Software. A single input can be assigned to more than one logical input.

15.12 Configurable outputs

The SIL-G has up to 18 digital outputs that can be set by the user. Depending on the model:

Model	Configurable Inputs
SILGxxxxxx0xxx, SILGxxxxxx5xxx	7 configurable outputs
SILGxxxxxxAxxx, SILGxxxxxxBxxx	7 configurable outputs + 4 High Speed outputs (high breaking capacity at 24-48Vdc for model B)
SILGxxxxxx7xxx	11 configurable outputs
SILGxxxxxx6xxx	18 configurable outputs

The outputs can be configured from the HMI or through the SICom software.

These outputs have a carry current of 8A of continuous, except the outputs E23-E24 and E25-E26 of the models SILGxxxxxx6xxx and SILGxxxxxx7xxx that are outputs which can withstand 16A at 250 VAC and 16A at 30 VDC.

At 24-230Vdc/ac (24-220 Vdc (±20%) / 100-230 Vac (±15%)) HSO withstand:

- 1A continuously
- 4A for 10s
- 8A for 1s

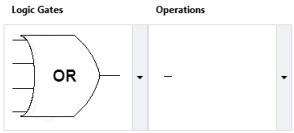
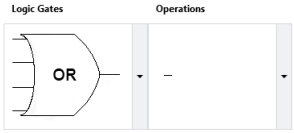
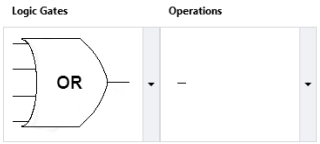
With a maximum breaking capacity of 8A.

At 24-48Vdc (-20%/+10%), HSO with a high breaking capacity withstand:

- 4A continuously
- 15A for 10s
- 25A for 1s

With a maximum breaking capacity of 25A.

By default, the outputs configuration is as follows:

OUTPUTS	Description	Criteria	Status	Logic Gate	SICom Symbol
OUTPUT 1	Ready	General	Ready	OR	
OUTPUT 2	Close	PGC	Close Breaker	OR	
OUTPUT 3	Trip	PGC General	Open breaker Trip	OR	

The rest of the physical and logic outputs are not configured by default.

15.13 Function 86. Trip output lockout

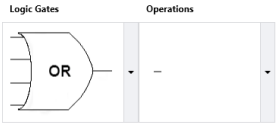
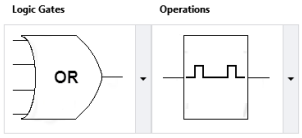
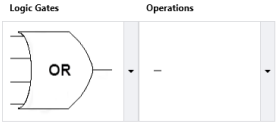
When the trip output is configured as a RS (reset-Set) or SR (Set-Reset) Flip Flop this output is locked thanks to programmable logic.

15.14 Configurable Leds

The device is equipped with 11 configurable LEDs, 8 belong to alarm LEDs menu and the other three belong to control LEDs menu. These three LEDs correspond to the three front special keys. The configuration is shown in the table below:

Although the READY LED is configurable, it is recommended not to modify its default configuration.

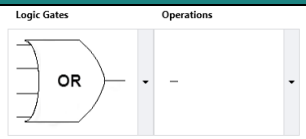
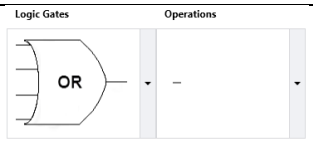
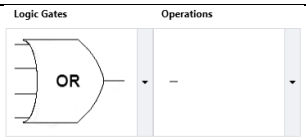
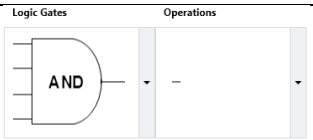
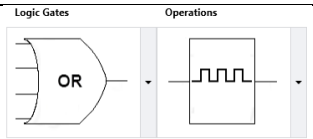
Besides, 24 logic alarms are included in ALARM LEDs menu to allow the user a complete configuration of the relay.

Alarm LEDs	Description	Criteria	Status	Logic Gate	SICom Symbol
ALARM 1	Ready	General	Ready	OR	
ALARM 2	79 Cycle	79 79 79 79	79 Reclose Time 79 Hold Time 79 Closing Time 79 Reset Time	OR BL	
ALARM 3	Hot Line tag	PGC	Hot Line Tag	OR	
ALARM 4	O/C Trip	Alarm Leds Alarm Leds PGC	Logic Alarm 16 Logic Alarm 17 PGC-7	SSRR	
ALARM 5	EF Trip	Alarm Leds Alarm Leds PGC	Logic Alarm 14 Logic Alarm 15 PGC-7	SSRR	
ALARM 6	O/V Trip	Alarm Leds Alarm Leds PGC	Logic Alarm 9 Logic Alarm 10 PGC-7	SSRR	
ALARM 7	Overpower Trip	Alarm Leds PGC	Logic Alarm 12 PGC-7	SSRR	
ALARM 8	Frequency Trip	Alarm Leds Alarm Leds PGC	Logic Alarm 11 Logic Alarm 13 PGC-7	SSRR	

Alarm LEDs	Description	Criteria	Status	Logic Gate	SICom Symbol
LOGIC ALARM 9	OV Trip	59-1 59-2 59N/G-1 59N/G-2	Trip Trip Neutral Trip Neutral Trip	OR	
LOGIC ALARM 10	UV Trip	27-1 27-2 27V1	Trip Trip Trip	OR	
LOGIC ALARM 11	ROCOF Trip	81R-1 81R-2 81R-3 81R-4	Trip Trip Trip Trip	OR	
LOGIC ALARM 12	Power Trip	32-1 32-2 32-3 32-4	Trip Trip Trip Trip	OR	
LOGIC ALARM 13	Frequency Trip	81-1 81-2 81-3 81-4	Trip Trip Trip Trip	OR	
LOGIC ALARM 14	50N/G Trip	50G 50N	Ground Trip Neutral Trip	OR	
LOGIC ALARM 15	67N/G Trip	67G/51G-1 67G/51G-2 67N/51N-1 67N/51N-2	Ground Trip Ground Trip Neutral Trip Neutral Trip	OR	
LOGIC ALARM 16	67P Trip	67/51-1 67//51-2 67/51-3 67/51-4	Trip Trip Trip Trip	OR	
LOGIC ALARM 17	OC Trip OR	50-1 50-2 46 SOTF	Trip Trip Trip Trip	OR	

Alarm LEDs	Description	Criteria	Status	Logic Gate	SICom Symbol
LOGIC ALARM 18…32	-	-	-	-	-

Apart from the physical control LEDs there are three virtual LEDs.

Control LEDs	Description	Criteria	Status	Logic Gate	SICom Symbol
Local Led	Local	General	Local Control	OR	
Led 79	79 Blocked	79	Blocked	OR	
Led 52	52 Closed	Control LEDs Control LEDs	Virtual Led-2 Virtual Led-3	OR	
Virtual Led 1	-	-	-	-	-
Virtual Led 2	52 Without Error	52 52	Closed Error (NOT)	AND	
Virtual Led 3	52 Error	52	Error	OR	

15.15 Self-diagnosis

Diagnostic algorithms are run on device switch on and continuously during operation of the relay. These diagnostics guarantee the correct working of the device, as a preventive process.

The following general considerations apply:

- Communications between different CPUs are confirmed with corresponding integrity checks. Continuing anomalies will lead to the restarting of the device.
- Data constituting settings are confirmed with corresponding checks. Furthermore, all tables of settings are stored in two copies. The relay can work with a corrupted table, but not if both tables are corrupted.
- A Watchdog mechanism exists, both between and within the different main CPUs. Loss of activity in any CPU will lead to the restarting of the device, which will be logged as an event.

The state flag bits associated with this process are as follows:

Model Error	It is active when the firmware version does not match the hardware model.
Hardware Error	It is active when there is a defect in the hardware.
Slot 3 Empty	It is active when the third hardware slot is detected as empty
Slot 4 Empty	It is active when the fourth hardware slot is detected as empty
Slot 5 Empty	It is active when the fifth hardware slot is detected as empty
COM Error	It is active when there is a problem with the communication between the main CPU and the communication CPU.
Test State	It is active when the user enters in the Test Menu
Settings Error	It is active when there is corrupted data on the settings page of the memory. It is performed on initialization and on each change.
Configuration Error	It is active when there is corrupted data on the configuration page of the memory. It is performed on initialization and on each change.
Measurement Error (*)	It is active when there is a problem with the communication between the main CPU and the measurement CPU.

(*) This bit is included in the Measurements State

There are also other bits on this menu that are active when a factory restoration is applied and generate an event registered on the SER.

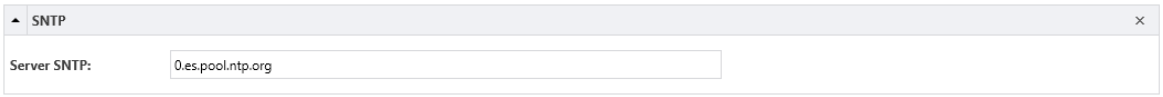
Settings by default	Default settings are applied
Default configuration	Default configuration is applied

15.16 Date-Time synchronization

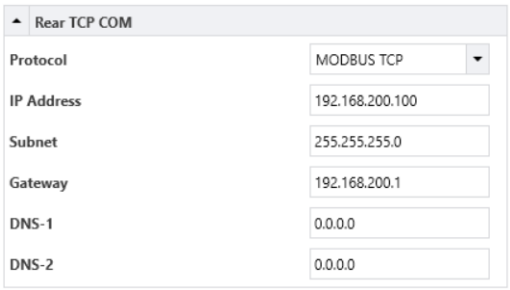
The relay can be synchronized from the HMI or by communications. SNTP protocol is included in the models provided with ethernet.

The SNTP version available in the relay is version 3. To allow the relay to identify the server to which it must connect, it is necessary to give the relay the IP address or domain name where the SNTP server is located. To do this, from the configuration menu in SICom, in the "Rear TCP Com" section, it is possible to indicate the domain or IP of the server.





Since the SNTP server could be inside or outside the LAN network where the relay is located, it may also be necessary to indicate the Gateway IP and a DNS address. If the SNTP server is outside the relays LAN network, it is necessary to indicate the Gateway of the network. And if the SNTP server is given with a domain name, it is necessary to indicate a DNS where that domain name is related to its IP address. These settings are available in the "Rear TCP Com" section of the settings menu.



As a summary:

- If the SNTP server is on your LAN network:
  - Configuration: IP of the SNTP server.
  - Settings: Nothing.

- If the SNTP server is on the internet and you know its IP:
  - Configuration: IP of the SNTP server.
  - Settings: IP of the Gateway.

- If the SNTP server is on the internet and you know its domain name:
  - Configuration: Domine Name of the SNTP server.
  - Settings: IP of the Gateway or IP of a DNS (8.8.8.8 Google DNS).

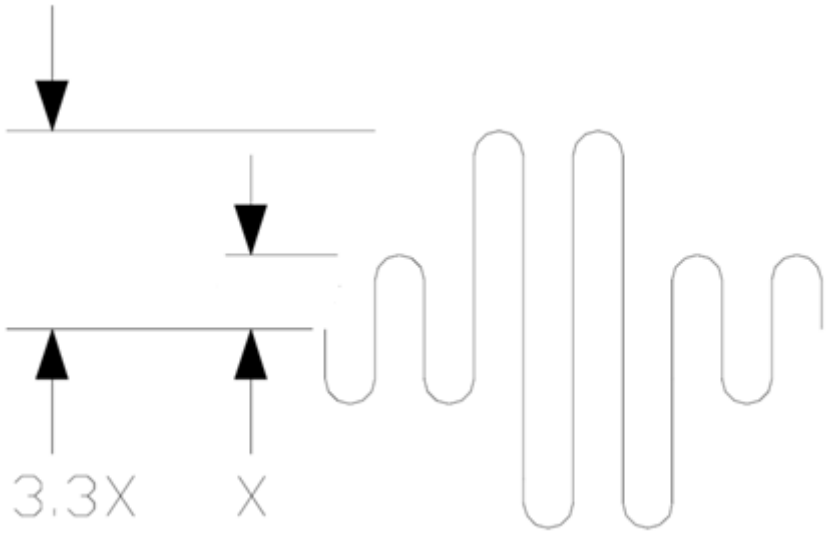
Depending on the model it is also available synchronization through modular IRIG-B.

The IRIG-B is B12X, this means:

First letter: Rate Designation → B → 100 PPS (Pulse Per Second).
1st Digit: Form Designation → 1 → Sine wave carrier, amplitude modulated.
2nd Digit: Carrier Resolution → 2 → 1 kHz / 1 millisecond resolution.
3rd Digit: Coded Expressions → X → Type BCD_Year.

IRIG-B connector impedance: 50 Ohms.

The amplitude of the modulated wave must be at the high level, 3.3 times the low level. And the low level must be less than 600mV. So:



Lower Level Vp < 600mV.

Higher level Vp = 3.3* Lower Level Vp.

15.17 Test menu

The device features a test menu for use to verify the LEDs and outputs. Please note that while using the test menu the protection will be disabled.

2 key sequences are available to access to this test mode:

From the main menu enter the key sequence “◄”, “▼”, “►” and hold “OK” until “Test menu” is displayed, indicating that while the test menu is active, protection is deactivated.

From the main menu hold “C” key until “Test menu” is displayed, indicating that while the test menu is active, protection is deactivated.

Pressing “OK” bring up the password introduction menu; if the correct password is inserted, the text menu is accessed by pressing “OK” again (by default, the password is 5555). Navigate the menu using the “up” ▲ and “down” ▼ keys. Press “OK” to toggle the state of each menu item (to activate it if it is deactivated, and to deactivate it if it is activated). Press “C” to leave the test menu.

Once the relay is in test menu all the LEDs will be activated simultaneously. In case of the outputs, they can be activated or deactivated by pressing OK key.

15.18 Power Supply

Depending on the model this relay is designed to be powered with an auxiliary voltage of:

- 24-48 Vdc (±20%).
- 48-230 Vac/dc (48-220 Vdc (±20%) / 48-230 Vac (±15%)).
- 24-230 Vdc/ac (24-220 Vdc (±20%) / 100-230 Vac (±15%)).

Front power supply is designed for fine tuning, or situations where the auxiliary voltage is not guaranteed. In these cases, it is not guaranteed that the relay be totally operative, particularly the outputs.

The unit's power consumption is variable depending on the auxiliary voltage:

- SILGxxxAxxxxxx & SILGxxxBxxxxxx 24-48 Vdc and 48-230 Vac/dc → less than 20VA.
- SILGxxxCxxxxxx 24-230 Vac/dc → less than 12VA.

For more information on consumption, see the 16.4 Energizing Quantities section.

Models with 11 or more outputs and communication redundancy, when powered at 24 Vdc, the auxiliary supply tolerance is –10% instead of ±20%.

16 TECHNICAL SPECIFICATIONS AND STANDARDS

16.1 Technical specifications

Function 50-1 **Function 50-2**	Function enable: No/Alarm/Trip/SHB Trip
	Current tap: 0.010 to 30.000 xIn (step 0.001xIn)
	Time delay: 0.000 to 300.000 s (step 0.001 s)
	Activation level: 100%
	Deactivation level: 95%
	Temporized deactivation
	Timing accuracy: ± 35 ms or ± 0.5% (greater of both)
Function 50N	Function enable: No/Alarm/Trip/SHB Trip
	Current tap: 0.050 to 30.000 xIn (step 0.001xIn)
	Time delay: 0.000 to 300.000 s (step 0.001 s)
	Activation level: 100%
	Deactivation level: 95%
	Temporized deactivation
	Timing accuracy: ± 35 ms or ± 0.5% (greater of both)
Function 50G	Function enable: No/Alarm/Trip/SHB Trip
	Current tap: 0.010 to 30.000 xIn (step 0.001xIn)
	Time delay: 0.000 to 300.000 s (step 0.001 s)
	Activation level: 100%
	Deactivation level: 95%
	Temporized deactivation
	Timing accuracy: ± 35 ms or ± 0.5% (greater of both)
Function 67/51-1 **Function 67/51-2** **Function 67/51-3** **Function 67/51-4**	Function enable: No/Alarm/Trip/SHB Trip
	Curve Type: IEC 60255-151 (Definite time, standard inverse, very inverse, extremely inverse, long time inverse, short time inverse) and IEEE (Moderately inverse, very inverse, extremely inverse)
	For IEC Definite time curve, time delay: 0.000 to 300.000 s (step 0.001 s)
	Time dial (TMS): 0.01 to 25.00 (step 0.01) If Curve type IEC: 0.01 to 1.00 (step 0.01) If Curve type IEEE: 0.01 to 25.00 (step 0.01)
	Current tap: 0.010 to 20.000 xIn (step 0.001xIn)
	Directionality: No/Forward/Reverse
	Polarization voltage: 0.08 to 2.00 xUn (step 0.01xUn)
	Operating angle: 0 to 359º (step 1º)
	Halfcone angle: 10 to 170º (step 1º)
	Curve, current activation level: 110%
	Curve, current deactivation level: 100%
	Defined time, current activation level: 100%
	Defined time, current deactivation level: 95%
	Voltage activation level: 100%
	Voltage deactivation level: 95%
	Temporized deactivation
	Timing accuracy for IEC and IEEE curves selection: ± 30 ms or ± 5% (greater of both) Timing accuracy for defined time curve selection: ± 35 ms or ± 0.5% (greater of both)
Function 67N/51N-1 **Function 67N/51N-2**	Function enable: No/Alarm/Trip/SHB Trip
	Curve Type: IEC 60255-151 (Definite time, standard inverse, very inverse, extremely inverse, long time inverse, short time inverse) and IEEE (Moderately inverse, very inverse, extremely inverse)
	For IEC Definite time curve, time delay: 0.000 to 300.000 s (step 0.001 s)
	Time dial (TMS): 0.01 to 25.00 (step 0.01) If Curve type IEC: 0.01 to 1.00 (step 0.01) If Curve type IEEE: 0.01 to 25.00 (step 0.01)

	Current tap: 0.050 to 20.000 xIn (step 0.001xIn)
	Directionality: No/Forward/Reverse
	Polarization voltage: 0.08 to 2.00 xUn (step 0.01xUn)
	Operating angle: 0 to 359º (step 1º)
	Halfcone angle: 10 to 170º (step 1º)
	Curve, current activation level: 110%
	Curve, current deactivation level: 100%
	Defined time, current activation level: 100%
	Defined time, current deactivation level: 95%
	Voltage activation level: 100%
	Voltage deactivation level: 95%
	Temporized deactivation
	Timing accuracy for IEC and IEEE curves selection: ± 30 ms or ± 5% (greater of both) Timing accuracy for defined time curve selection: ± 35 ms or ± 0.5% (greater of both)
Function 67G/51G-1 **Function 67G/51G-2**	Function enable: No/Alarm/Trip/SHB Trip
	Curve Type: IEC 60255-151 (Definite time, standard inverse, very inverse, extremely inverse, long time inverse, short time inverse) and IEEE (Moderately inverse, very inverse, extremely inverse)
	For IEC Definite time curve, time delay: 0.000 to 300.000 s (step 0.001 s)
	Time dial (TMS): 0.01 to 25.00 (step 0.01) If Curve type IEC: 0.01 to 1.00 (step 0.01) If Curve type IEEE: 0.01 to 25.00 (step 0.01)
	Current tap: 0.010 to 20.000 xIn (step 0.001xIn)
	Directionality: No/Forward/Reverse
	Polarization voltage: 0.08 to 2.00 xUn (step 0.01xUn)
	Operating angle: 0 to 359º (step 1º)
	Halfcone angle: 10 to 170º (step 1º)
	Curve, current activation level: 110%
	Curve, current deactivation level: 100%
	Defined time, current activation level: 100%
	Defined time, current deactivation level: 95%
	Voltage activation level: 100%
	Voltage deactivation level: 95%
	Temporized deactivation
	Timing accuracy for IEC and IEEE curves selection: ± 30 ms or ± 5% (greater of both) Timing accuracy for defined time curve selection: ± 35 ms or ± 0.5% (greater of both)
Function 67NI	Function enable: No/Alarm/Trip/SHB Trip
	Directionality: No/Forward/Reverse
	Low Current Tap: 0.050 to 30.000 xIn (step 0.001xIn)
	High Current Tap: 0.050 to 30.000 xIn (step 0.001xIn)
	Low Voltage Tap: 0.08 to 2.00 xUn (step 0.01xUn)
	High Voltage tap: 0.08 to 2.00 xUn (step 0.01xUn)
	Time delay: 0.000 to 300.000 s (step 0.001 s)
	Operating angle: 0 to 359º (step 1º)
	Halfcone angle: 10 to 170º (step 1º)
	Activation level: 100%
	Deactivation level: 95%
	Temporized deactivation
	Timing accuracy: ± 30 ms or ± 5% (greater of both)
Function 67GI	Function enable: No/Alarm/Trip/SHB Trip
	Directionality: No/Forward/Reverse
	Low Current Tap: 0.010 to 30.000 xIn (step 0.001xIn)

	High Current Tap: 0.010 to 30.000 xIn (step 0.001xIn)
	Low Voltage Tap: 0.08 to 2.00 xUn (step 0.01xUn)
	High Voltage tap: 0.08 to 2.00 xUn (step 0.01xUn)
	Time delay: 0.000 to 300.000 s (step 0.001 s)
	Operating angle: 0 to 359º (step 1º)
	Halfcone angle: 10 to 170º (step 1º)
	Activation level: 100%
	Deactivation level: 95%
	Temporized deactivation
	Timing accuracy: ± 30 ms or ± 5% (greater of both)
Function 50INC (*)	Function enable: No/Alarm/Trip
	Phase Current Tap: 0.500 to 20.000 xIn (step 0.001xIn)
	Pickup Peaks number; 1 to 10 (step 1)
	Trip Peak number: 1 to 10 (step 1)
Function 64REF	Function enable: No/Alarm/Trip/ SHB Trip
	Current tap: 0.050 to 20.000 xIn (step 0.001xIn)
	Time delay: 0.020 to 300.000 s (step 0.001 s)
	Neutral SHB Tap: 5 to 50% (step 1%)
	Activation level: 100%
	Deactivation level: 90%
	Temporized deactivation
	Timing accuracy: ± 35 ms or ± 5% (greater of both)
Function SOTF	Function enable: No/Alarm/Trip/SHB Trip
	Current tap: 0.010 to 30.000 xIn (step 0.001xIn)
	Time delay: 0.000 to 295.000 s (step 0.001 s)
	Safe Time: 0.020 to 300.000 s (step 0.001 s)
	Activation level: 100%
	Deactivation level: 95%
	Temporized deactivation
	Timing accuracy: ± 35 ms or ± 0.5% (greater of both)
Function 49	Function enable: No/Alarm/Trip
	Current tap: 0.100 to 2.400 In (step 0.001xIn)
	ζ heating: 3 to 600 min (step 1 min)
	ζ cooling: 1 to 6 xζ heating (step 1)
	Alarm: 20 to 99% (step 1%)
	Trip level: 100%
	Deactivation level: 95% of alarm level
	Timing accuracy: ± 5% respect of theorical value.
Function SHB	Function enable: No/Yes
	Current Tap: 5 to 50% (step 1%)
	Reset Time: 0.000 to 300.000 (step 0.001 s)
	Block Threshold: 0.010 to 30.000xIn (step 0.001xIn)
	Activation level: 100%
	Deactivation level: 95%
	Temporized deactivation
Function CLP	Function enable: Yes/No
	Settings group: 1 to 4 (step 1)
	No load time: 0.020 to 300.000 s (step 0.001 s)
	Cold load time: 0.020 to 300.000 s (step 0.001 s)
	Open breaker activation 0.8% In and reset threshold: 1% In
Function 46	Function enable: No/Alarm/Trip/SHB Trip
	Curve Type: IEC 60255-151 (Definite time, standard inverse, very inverse, extremely inverse, long time inverse, short time inverse) and IEEE (Moderately inverse, very inverse, extremely inverse)
	For IEC Definite time curve, time delay: 0.000 to 300.000 s (step 0.001 s)

	Time dial (TMS): 0.01 to 25.00 (step 0.01) If Curve type IEC: 0.01 to 1.00 (step 0.01) If Curve type IEEE: 0.01 to 25.00 (step 0.01)
	Current tap: 0.050 to 20.000 xIn (step 0.001xIn)
	Curve, current activation level: 110%
	Curve, current deactivation level: 100%
	Defined time, current activation level: 100%
	Defined time, current deactivation level: 95%
	Temporized deactivation
	Timing accuracy for IEC and IEEE curves selection: ± 30 ms or ± 5% (greater of both) Timing accuracy for defined time curve selection: ± 35 ms or ± 0.5% (greater of both)
Function 46BC	Function enable: No/Alarm/Trip/
	Tap: 15 to 100 % (step 1%)
	Time delay: 0.030 to 300.000 s (step 0.001 s)
	Activation level: 100%
	Deactivation level: 95%
	Timing accuracy: ± 30 ms or ± 0.5% (greater of both)
Function 37	Function enable: No/Alarm/Trip
	Current tap: 0.010 to 30.000 xIn (step 0.001xIn)
	Minimum level: 0.000 to 1.000 xIn (step 0.001xIn)
	Time delay: 0.060 to 300.000 s (step 0.001 s)
	Activation level: 100%
	Deactivation level: 105%
	Temporized deactivation
	Timing accuracy: ± 30 ms or ± 0.5% (greater of both)
Function 27-1[3] **Function 27-2**[3]	Function enable: No/Alarm/Trip
	Voltage tap: 0.08 to 2.00 xUn (step 0.01xUn)
	Minimum level: 0.00 to 1.00 xUn (step 0.01xUn)
	Time delay: 0.060 to 300.000 s (step 0.001 s)
	Reset time: 0.020 to 300.000 s (step 0.001 s)
	Activation level: 99%
	Deactivation level: 101%
	Temporized deactivation
	Timing accuracy: ± 30 ms or ± 0.5% (greater of both)
Function 27L (*)[3]	Function enable: No/Alarm/Trip
	Voltage tap: 0.08 to 2.00 xUn (step 0.01xUn)
	Minimum level: 0.00 to 1.00 xUn (step 0.01xUn)
	Time delay: 0.060 to 300.000 s (step 0.001 s)
	Reset time: 0.020 to 300.000 s (step 0.001 s)
	Activation level: 99%
	Deactivation level: 101%
	Temporized deactivation
	Timing accuracy: ± 30 ms or ± 0.5% (greater of both)
Function 27V1	Function enable: No/Alarm/Trip
	Voltage tap: 0.15 to 2.00 xUn (step 0.01xUn)
	Minimum level: 0.00 to 1.00 xUn (step 0.01xUn)
	Time delay: 0.060 to 300.000 s (step 0.001 s)
	Reset time: 0.020 to 300.000 s (step 0.001 s)
	Activation level: 99%
	Deactivation level: 101%
	Temporized deactivation
	Timing accuracy: ± 30 ms or ± 0.5% (greater of both)
	Function enable: No/Alarm/Trip

Function 59-1[3] **Function 59-2**[3]	Voltage tap: 0.08 to 2.00 xUn (step 0.01xUn)
	Time delay: 0.045 to 300.000 s (step 0.001 s)
	Reset time: 0.020 to 300.000 s (step 0.001 s)
	Activation level: 101%
	Deactivation level: 99%
	Temporized deactivation
	Timing accuracy: ± 30 ms or ± 0.5% (greater of both)
Function 59L (*)[3]	Function enable: No/Alarm/Trip
	Voltage tap: 0.08 to 2.00 xUn (step 0.01xUn)
	Time delay: 0.045 to 300.000 s (step 0.001 s)
	Reset time: 0.020 to 300.000 s (step 0.001 s)
	Activation level: 101%
	Deactivation level: 99%
	Temporized deactivation
	Timing accuracy: ± 30 ms or ± 0.5% (greater of both)
Function 59N/G[1]**-1**[3] **Function 59N/G**[1]**-2**[3]	Function enable: No/Alarm/Trip
	Voltage tap: 0.08 to 2.00 xUn (step 0.01xUn)
	Time delay: 0.045 to 300.000 s (step 0.001 s)
	Reset time: 0.020 to 300.000 s (step 0.001 s)
	Activation level: 101%
	Deactivation level: 99%
	Temporized deactivation
	Timing accuracy: ± 30 ms or ± 0.5% (greater of both)
Function 47[3]	Function enable: No/Alarm/Trip
	Voltage tap: 0.08 to 2.00 xUn (step 0.01xUn)
	Time delay: 0.045 to 300.000 s (step 0.001 s)
	Reset time: 0.020 to 300.000 s (step 0.001 s)
	Activation level: 101%
	Deactivation level: 99%
	Temporized deactivation
	Timing accuracy: ± 30 ms or ± 0.5% (greater of both)
Function 32-1 **Function 32-2** **Function 32-3** **Function 32-4**	Function enable: No/Alarm/Trip
	Activation level: 0.02 to 2.00 xSn (step 0.01xSn)
	Operating angle: 0 to 359º (step 1º)
	Time delay: 0.020 to 300.000 s (step 0.001 s)
	Activation level: 100%
	Deactivation level: 95%
	Instantaneous deactivation
	Timing accuracy: ± 30 ms or ± 0.5% (greater of both)
Function 81-1 **Function 81-2** **Function 81-3** **Function 81-4** **Function 81-5**[2] **Function 81-6**[2]	Function enable: No/Alarm/Trip
	Type: Underfrequency or Overfrequency
	Activation level: 45.000 to 65.000 Hz (step 0.001 Hz)
	Time delay: 0.020 to 300.000 s (step 0.001 s)
	Reset time: 0.020 to 300.000 s (step 0.001 s)
	Function blocked if phase B voltage is lower than 20 volts P-N (35 volts P-P)
	Activation level: 100%
	Underfrequency reset level: activation level + 50mHz Overfrequency reset level: activation level - 50 mHz
	Temporized deactivation
	The frequency measurement is an average value of the frequency measured during 8 cycles. The accuracy of the Time Delay is the adjusted value plus the necessary time to achieve the measurement during 8 cycles.
Function 81R-1	Function enable: No/Alarm/Trip
	Type: Increase/Decrease
	Activation level: 0.100 to 5.000 Hz/s (step 0.001 Hz/s)

Function 81R-2 **Function 81R-3**[1] **Function 81R-4**[1]	Time delay: 0.060 to 40.000 s (step 0.001 s)
	Reset time: 0.020 to 300.000 s (step 0.001 s)
	Function blocked if phase B voltage is lower than 20 volts P-N (35 volts P-P)
	Activation level: 100%
	Temporized deactivation
	The frequency measurement is an average value of the frequency measured during 8 cycles. The accuracy of the Time Delay is the adjusted value plus the necessary time to achieve the measurement during 8 cycles.
Function 78	Function enable: No/Alarm/Trip
	Activation level: 1 to 25º (step 1º)
	Reset time: 0.020 to 300.000 s (step 0.001 s)
	Function blocked if phase B voltage is lower than 20 volts P-N (35 volts P-P)
	Temporized deactivation
	Measurement accuracy: ±1º or ±10% (greater of both)
Function 24-1[1] **Function 24-2**[1]	Function enable: No/Alarm/Trip
	Curve Type: Inverse A, Inverse B, Inverse C, and Defined Time. Time delay: 0.020 to 300.000 s (step 0.001 s)
	Time dial (TMS): 0.05 to 300.00 (step 0.01)
	Activation level: 0.50 to 2.00 xUn/Fn (step 0.01 xUn/Fn)
	Time delay: 0.020 to 300.000 s (step 0.01 s)
	Reset Time: 0.000 to 300.000 s (step 0.01 s)
	Curve, activation level: 110%
	Curve, deactivation level: 100%
	Defined time, activation level: 100%
	Defined time, deactivation level: 95%
	Temporized deactivation
	Timing accuracy for curves selection: ± 30 ms or ± 5% (greater of both) Timing accuracy for defined time curve selection: ± 30 ms or ± 0.5% (greater of both)
Function 25 (*)	Dead tap: 0.08 to 2.00 xUn (step 0.01xUn)
	Live tap: 0.08 to 2.00 xUn (step 0.01xUn)
	Voltage supervision time: 0.060 to 300.000 s (step 0.001 s)
	Voltage difference: 0.05 to 2.00 xUn (step 0.01xUn)
	Phase difference: 2 to 90 º (step 1º)
	Frequency difference: 0.060 to 10.000 Hz (step 0.001 Hz)
	Synchro check time: 0.020 to 300.000 s (step 0.001 s)
Function 79	Number of recloses: 0 to 4 (step 1)
	Reclose time 1, 2, 3, 4: 0.020 to 2000.000 s (step 0.01 s)
	Hold Enable: No/Yes/No Time
	Hold time: 0.02 to 2000.000 s (step 0.01 s)
	Reset time: 0.02 to 2000.000 s (step 0.01 s)
	Safe time: 0.020 to 2000.000 s (step 0.01 s)
	Locking possibilities: pulse inputs, level inputs, commands.
Function SCM[2]	Number of shots: 0 to 4 (step 1)
	Reset time: 0.020 to 2000.000 s (step 0.001 s)
Function SZM[2]	Number of shots: 0 to 4 (step 1)
	Reset time: 0.020 to 2000.000 s (step 0.001 s)
	Max open time: 0.020 to 2000.000 s (step 0.001 s)
	Max close time: 0.020 to 2000.000 s (step 0.001 s)
	Fault current: 0.010 to 20.000 s (step 0.001 xIn)
	Voltage supervision time: 0.000 to 300.000 s (step 0.001 s)
	Dead tap: 0.04 to 2.00 xUn (step 0.01 xUn)
Function 52	Maximum number of openings: 1 to 100,000 (step 1)
	Maximum accumulated amperes: 1 to 100,000 M(A2) (step 1)

	Repetitive number of openings: 1 to 100,000 (step 1)
	Time for a repetitive number of openings: 1 to 300 min (step 1 min)
	Maximum opening time: 0.020 to 300.000 s (step 0.001 s)
	Maximum closing time: 0.020 to 300.000 s (step 0.001 s)
	Circuit breaker status monitoring: Current measurements: Open breaker activation and reset threshold: 0.8% In (Without using contacts) Using contacts: 52a or 52b and 52a and 52b
Function 74TCS	Function enable: No/Yes
	Time delay: 0.020 to 300.000 s (step 0.001 s)
	Continuity in coils A and B through configurable inputs
Function 60CTS	Function enable: No/Yes
	Time delay: 0.020 to 300.000 s (step 0.001 s)
	Timing accuracy: ± 30 ms or ± 0.5% (greater of both)
	Open breaker activation and reset threshold: 0.8% In
	Detection of the loss of one phase CT
Function 60VTS **Function 60VSS²**	Function enable: No/Yes
	Time delay: 0.020 to 300.000 s (step 0.001 s)
	V1, V2 and VP Tap: 0.08 to 2.00 xUn (step 0.01xUn)
	I1, I2 and 3I0 Tap: 0.010 to 20.000 xIn (step 0.001xIn)
	Timing accuracy: ± 30 ms or ± 0.5% (greater of both)
Function 50BF	Function enable: No/Yes
	Time delay: 0.020 to 1.000 s (step 0.001 s)
	Open breaker activation and reset threshold: 0.8% In
	From fw version 3.01.00 onwards: Phase Current Tap: 0.008 to 30 xIn (step 0.001xIn) Neutral Current Tap: 0.008 to 30 xIn (step 0.001xIn) Time Delay: 0.020 to 1.000 s (step 0.001 s) Back Period: 0.020 to 1.000 s (step 0.001 s) 50BF Start PGC
Function 21FL (*)	Function enable: No/Yes
	Line length 0.1 to 100.0 km (step 01 km)
	Z1 line magnitude: 0.001 to 5.000 (step 0.001 Ω/km)
	Z1 line angle: 0 to 90º (step 1º)
	Z0 line magnitude: 0.001 to 5.000 (step 0.001 Ω/km)
	Z0 line angle: 0 to 90º (step 1º)
Function AFD (*)	Function enable: No/Alarm/Trip
	Current tap:1 to 20xIn (step 1xIn)
	Time delay: 1 to 4 samples (step 1 sample)
LMS (*)	Function enable: No/Yes
	No Peak Mode: Alarm/Trip
	Peak mode: Alarm/Trip
	Peak period starting month: January to December
	Peak period starting day: 1 to 31 (step 1)
	Peak period ending month: January to December
	Peak period ending day: 1 to 31 (step 1)
	Peak period starting hour: 0 to 23 (step 1 hour)
	Peak period starting minute: 0 to 59 (step 1 minute)
	Peak period ending hour: 0 to 23 (step 1 hour)
	Peak period ending minute: 0 to 59 (step 1 minute)
	Peak period starting day of week: Monday to Sunday
	Peak period ending day of week: Monday to Sunday
	Reset Time: 0 to 18000 s (step 1 s)
	Peak period Tap: 0.010 to 30.000 xIn (step 0.001xIn)
	Peak trip Time 1: 0 to 18000 s (step 1 s)
	Peak trip Time 2: 0 to 18000 s (step 1 s)

	Peak trip Time 3: 0 to 18000 s (step 1 s)
	Peak trip Time 4+: 0 to 18000 s (step 1 s)
	Peak Number of recloses: 0 to 247 (Step 1)
	Peak Interval Time 1: 0 to 18000 s (Step 1 s)
	Peak Interval Time 2: 0 to 18000 s (Step 1 s)
	Peak Interval Time 3: 0 to 18000 s (Step 1 s)
	Peak Interval Time 4+: 0 to 18000 s (Step 1 s)
	No Peak period Tap: 0.010 to 30.000 xIn (step 0.001xIn)
	No Peak trip Time 1: 0 to 18000 s (step 1 s)
	No Peak trip Time 2: 0 to 18000 s (step 1 s)
	No Peak trip Time 3: 0 to 18000 s (step 1 s)
	Peak trip Time 4+: 0 to 18000 s (step 1 s)
	No Peak Number of recloses: 0 to 247 (Step 1)
	No Peak Interval Time 1: 0 to 18000 s (Step 1 s)
	No Peak Interval Time 2: 0 to 18000 s (Step 1 s)
	No Peak Interval Time 3: 0 to 18000 s (Step 1 s)
	No Peak Interval Time 4+: 0 to 18000 s (Step 1 s)
Power supply control[2]	Function enable: No/Yes
	V supply alarm 1: 19 to 220 Vdc (step 1 V)
	V supply alarm 2: 19 to 220 Vdc (step 1 V)
Function 49T	Available through configurable inputs thanks to the programmable logic
Function 86	It allows latching (lockout) the contact trip due to programmable logic (PGC: RSFF or SRFF).
Function 68	Available through configurable inputs and outputs thanks to the programmable logic (PGC).
Programmable logic control (PGC)	OR, OR_1PULSE, OR_PULSES, OR_BLINKING, OR_TIMER UP, OR_TIMER DOWN NOR, NOR_1PULSE, NOR_PULSES, NOR_BLINKING, NOR_TIMER UP, NOR_TIMER DOWN AND, AND_1PULSE, AND_PULSES, AND_BLINKING, AND_TIMER UP, AND_TIMER DOWN NAND, NAND_1PULSE, NAND_PULSES, NAND_BLINKING, NAND_TIMER UP, NAND_TIMER DOWN XOR, OR_1PULSE, XOR_PULSES, XOR_BLINKING, XOR_TIMER UP, XOR_TIMER DOWN SRFF, SRFF_1PULSE, SRFF_PULSES, SRFF_BLINKING, SRFF_TIMER UP, SRFF_TIMER DOWN and NON-VOLATILE FF. RSFF, RSFF_1PULSE, RSFF_PULSES, RSFF_BLINKING, RSFF_TIMER UP, RSFF_TIMER DOWN and NON-VOLATILE FF R_EDGE, R_EDGE_1PULSE F_EDGE, F_EDGE_1PULSE
Settings tables	4 settings groups 6 settings groups[2]
	Selectable by input, communications, user commands or general setting.
SER	3072 events
Disturbance fault recording (DFR)	32 samples/cycle
	10 analog channels and 96 configurable digital channels
	Configurable DFR start
	The configurable number of records depending on the size: 5 records in data and COMTRADE format (300 cycles each record): 1 to 8 pre-fault cycles + 292 to 299 post-fault cycles. 25 records in data and COMTRADE format (60 cycles each record): 1 to 8 pre-fault cycles + 52 to 59 post-fault cycles. 50 records in data and COMTRADE format (30 cycles each record): 1 to 8 pre-fault cycles + 22 to 29 post-fault cycles. 100 records in data and COMTRADE format (15 cycles each record): 1 to 8 pre-fault cycles + 7 to 14 post-fault cycles.)
	COMTRADE IEEE C37.111-1991
	Up to 100 fault reports (data format) with a maximum 29 events, each one
Load Data Profiling (LDP)	Demand of power with the following characteristics: - Number of records: 2160

	- Circular recording mode - Sampling rate (interval): configurable through communications (1-60 min)
Inputs (*)	Depending on Model: - 8 configurable inputs - 24 configurable inputs - 8 configurable inputs + 4 AFD inputs - 16 configurable inputs The voltage of the inputs is the same as the auxiliary power supply Burden: 24 Vdc: <20 mW 220 Vdc: <200 mW 24 Vac: <50 mW 230 Vac: < 500 mW
Outputs (*)	Depending on Model: - 7 configurable outputs - 18 configurable outputs - 11 configurable outputs - 7 configurable outputs + 4 High-Speed Outputs - 7 configurable outputs + 4 High-Speed Outputs with high breaking capacity at 24-48Vdc Model with 7 outputs: 250 V AC – 8 A; 30 V DC – 8 A Model with 11 outputs: Outputs 1 … Output 9: 250 V AC – 8 A; 30 V DC – 8 A Output 10 and 11: 250 V AC – 16 A; 30 V DC – 16 A Model with 18 outputs: Outputs 1 … Output 16: 250 V AC – 8 A; 30 V DC – 8 A Output 17 and 18: 250 V AC – 16 A; 30 V DC – 16 A Contact current short duration: 30A – 200ms
Frequency	50/60Hz
Energizing Quantities	Burden of current inputs: <0.015 VA (1 A) & <0.375 VA (5 A) Burden of voltage inputs: < 70 mVA Burden of power supply unit: SILGxxxAxxxxxx & SILGxxxBxxxxxx 24-48 Vdc/48-230 Vac/dc: < 20 VA SILGxxxCxxxxxx 24-230 Vdc/Vac: < 12 VA Burden for binary inputs: 24 Vdc: <20 mW 220 Vdc: <200 mW 24 Vac: <50 mW 230 Vac: < 500 mW
Current measurements	Phase currents (IA, IB, IC), neutral (IN, 3I0), positive sequence (I1) and negative sequence (I2), I2/I1, maximum current (Imax), thermal image (TI), second harmonic (IA2H, IB2H IC2H), current total harmonic distortion (THD-A, THD-B, and THD-C).
	Fundamental values (DFT)
	Sampling: 32 samples/cycle
	Phase and Neutral (1 A or 5 A): ±2% precision in a band covering ±20% of nominal current and ±4% or ±5 mA in the rest of the range Neutral (0.1 A): ±2% precision in a band covering ±20% of nominal current and ±4% or ±0.5 mA in the rest of the range
	Current measurement range: From 0.01 to 30 times the nominal current
Voltage measurements	Phase voltage (V-A, V-B, V-C), line voltage (VL)*, phase-phase voltage (UAB, UBC, UCA), neutral voltage (VR, 3-V0), positive sequence voltage (V-1) and negative sequence voltage (V-2), maximum voltage (VMAX) and V/f[1].
	Fundamental values (DFT)
	Sampling: 32 samples/cycle
	Conventional VTs: Measured voltage: 1% precision in a band covering ±20% of nominal voltage and 4% in the rest of the range (ambient temperature) Calculated voltage: 2% precision in a band covering ±20% of nominal voltage and 4% in the rest of the range (ambient temperature) Range: With VTs: 3-250 V measured voltage (6-250 V calculated voltage). Direct connection: From 12 to 1000 V
	Voltage sensors (LEAs):

	1% precision in a band covering ±20% of nominal voltage and 4% in the rest of the range. Voltage sensors: LEA of 2.8Vrms LEA of 8Vrms, LEA of 5.2Vrms or LEA of 16Vrms. Range: Measured voltage: From (0.01282 x LEA Maximum voltage x Ratio) to 2.4xUn. Calculated voltage: From (0.013 x LEA Maximum voltage x Ratio) to 2.4xUn.
Angle measurements	Current Angles: IA, IB, IC, IN and 3I0. Voltage Angles: VA, VB, VC, VR, VL*, 3V0, UAB, UBC and UCA. Power factor: Cos PHI-A, Cos-PHI-B, and Total Cos-PHI-C
	Accuracy: ±2º
	Angle measurement range: From 0 to 359º
Power measurements	Total and per-phase active power
	Total and per-phase reactive power
	Total and per phase apparent power
	2% accuracy in rated values with power factor between 1 and 0.7 (phase shift from 0 to ±45º).
Energy measurement	Positive and negative active energy
	Positive and negative reactive energy
Frequency measurements	Busbar Frequency, Line Frequency, df/dt, V/Hz
	Minimum required voltage: 20V P-N (35 P-P)
	Accuracy: ±0.005 Hz
	Frequency measurement range: From 45 to 65 Hz
Communications	Local port (micro-USB): Modbus RTU
	Wireless communication (Wi-Fi) (*)
	Rear Serial Port (RS485)
	IRIG-B (*)
	Remote Ethernet Port (*): RJ45 (10/100 Base-Tx) FO-LC (10/100 Base-Fx) SFP Cage HSR/PRP SFP Cages
	Protocols: WiFi: Modbus RTU RS485: Modbus RTU, DNP3.0 and IEC60870-5-103 (selectable by general settings) RJ45, FO-LC, SFP Cage: Modbus TCP/IP, DNP3.0 TCP/IP, IEC60870-5-104 or IEC61850 (selectable by general settings) + SNTP Protocol
Power supply (*)	24-48 Vdc (Tolerance: -20%/+10%) 48-230 Vac/dc (Tolerance: -20%/+10%) 24-230 Vac/dc (24-220 Vdc (±20%) / 100-230 Vac (±15%)) Burden: SILGxxxAxxxxxx & SILGxxxBxxxxxx 24-48 Vdc/48-230 Vac/dc: < 20 VA. SILGxxxCxxxxxx 24-230 Vdc/Vac: < 12 VA.
Environmental conditions	Operating temperature: -40 to 70ºC
	Storage temperature: -40 to 80ºC
	Relative humidity: 95%
Mechanical characteristics	Metallic box
	Panel mounted
	HxWxD: 198x187x153.15 (mm)
	Depth: 153.15 mm
	IP-54
	The required screws to fix the relay should be M4

(*) Optional depending on model

NOTE: ANSI 67, ANSI 67G, and ANSI 67N can be converted into ANSI 51, ANSI51G, and ANSI 51N respectively by setting the “Directionality” parameter to NO.

NOTE: ANSI 50G, ANSI 67G and ANSI 67GI will be converted into ANSI 50GS, ANSI 67GS and ANSI 67GSI in the model with neutral current measurement digit 1 (IN = 0.1A or 1A)

[1]Available in models with conventional VTs (50G not available for voltage sensors).

[2] Available only in models with voltage sensors. 81-5 available for models with VTs too from fw version 3.01.00 onwards.

[3] Voltage setting from 0.04 instead of 0.08 for models with voltage sensors.

For communication digits E, J, U and V SFP transceivers will be installed by the user, and the following specifications must be complied:

Supply: 3.3v.

Speed: 100BASE-FX, Fast Ethernet.

The SFP module must support SerDes

16.2 Thermal resistance

Current:

- 4xIn continuously.
- 30xIn for 20 seconds.
- 100xIn for 1 second.

Voltage:

- 2xUn continuously.
- 2.4xUn for 10 seconds.

16.3 Energizing quantities

16.3.1 Burden for current measuring inputs

Being the relay set to the secondary nominal current of 1 amp, the burden for current measuring inputs is less than 0.015 VA (1 A).

Being the relay set to the secondary nominal current of 5 amperes, the burden for current measuring inputs is less than 0.375 VA (5 A).

16.3.2 Burden for voltage measuring inputs

The maximum consumption of the voltage inputs will be less than 70 mVA for models with conventional VTs.

For models with voltage sensors, depending on the model:

SIL001 (8 Vrms – 1 MOhm)→ Burden= $\frac{V^2}{Impedance} = (8 * 8)/(1 * 10^6)$= 0.064 mVA.

SIL002 (5.2 Vrms – 2 MOhms)→ Burden= $\frac{V^2}{Impedance} = (5.2 * 5.2)/(2 * 10^6)$=0.01352 mVA.

SIL003 (16 Vrms – 2 MOhms)→ Burden= $\frac{V^2}{Impedance} = (16 * 16)/(2 * 10^6)$=0.128 mVA.

SIL004 (2.8 Vrms – 20 MOhms)→ Burden= $\frac{V^2}{Impedance} = (2.8 * 2.8)/(20 * 10^6)$=0.000392 mVA.

16.3.3 Burden for power supply unit

Considering the relay power supply options, the burden will be as follows:

SILGxxxAxxxxxx & SILGxxxBxxxxxx 24-48 Vdc/48-230 Vac/dc: < 20 VA.

SILGxxxCxxxxxx 24-230 Vdc/Vac: < 12 VA.

16.4 Standards

TEST	TEST STANDARD	LEVEL
1. PRODUCT SAFETY REQUIREMENTS		
1.1. Clearance and creepage	IEC60255-27 Clause 10.6.3	see standard
1.2.1. Accessible parts test	IEC60255-27 Clause 10.6.2.5	IP2X
1.2.2. IP rating	IEC 60255-1, Clause 6.3 IEC60255-27 Clause 10.6.2.6	IP54 (front)
1.3. Impulse voltage	IEC60255-27 Clause 10.6.4.2	5 kV 1 kV
1.4. Dielectric voltage	IEC60255-27 Clause 10.6.4.3	2 kV 0,5 kV
1.5. Insulation resistance	IEC60255-27 Clause 10.6.4.4	500 VDC
1.6. Protective bonding	IEC60255-27 Clause 10.6.4.5	≤ 0,1 Ω
1.7. Flammability (visual inspection) • Housing • Cover • Terminals • Push buttons • Display • PCB boards • (Input) transformers • Opto couplers • Output relays • Wires	IEC60255-27 Clause 10.6.5.2	• 70/80 °C • 70/80 °C • V-2 • 55/70 °C • 55/70 °C • V-2 • V-1 • V-1 • V-1 • V-1
1.8. Single fault condition • **Power supply circuit**	IEC60255-27 Clause 10.6.5.5	no fire risk
1.9. Thermal short-time test • Overvoltage VT, cont. • Overvoltage VT, 10s. • Overcurrent CT, cont. • Overcurrent CT, 1s	IEC60255-27 Clause 10.6.5.3	• 2xUn • 2,4xUn • 4xIn • 100xIn
2. ELECTROMAGNETIC COMPATIBILITY (EMC) tests		
2.1. EMISSION		
2.1.1. Radiated emission	IEC 60255-26 CISPR11 CISPR22 table 1 table 6 table 7	class A class A
2.1.2. Conducted emission	IEC 60255-26 CISPR22 table 2 table 2/4	class A
2.2. IMMUNITY		
2.2.1. Slow damped oscillatory wave (1 MHz)	IEC 60255-26 (IEC 61000-4-18) Clause 7.2.6	2,5 kV CM 1,0 kV DM 1 kV CM 0 kV DM

2.2.2. Electrostatic discharges	IEC 60255-26 (IEC 61000-4-2) Clause 7.2.3	6 kV cont. 8 kV air
2.2.3. Radiated radio frequency magnetic field	IEC 60255-26 (IEC 61000-4-3) Clause 7.2.4	80 - 1000 MHz 10 V/m 1,4 – 2,7 GHz 10 V/m 80, 160, 380, 450, 900, 1850, 2150 MHz 10 V/m
2.2.4. Fast transient/burst	IEC 60255-26 (IEC 61000-4-4) Clause 7.2.5	☒ Zone A 4 kV CM 2 kV CM ☐ Zone B 2 kV CM 1 kV CM
2.2.5. Surge	IEC 60255-26 (IEC 61000-4-5) Clause 7.2.7	☒ Zone A to 4 kV LE to 2 kV LL ☐ Zone B to 2 kV LE to 1 kV LL
2.2.6. Conducted disturbance induced by RF fields	IEC 60255-26 (IEC 61000-4-6) Clause 7.2.8	0,15 - 80 MHz 10 V 27, 68 MHz 10 V
2.2.7. Power frequency voltage	IEC 60255-26 (IEC 61000-4-16) Clause 7.2.9	☒ Zone A 150 V DM 300 V CM ☐ Zone B 100 V DM 300 V CM
2.2.8. Power frequency H- field	IEC 60255-26 (IEC 61000-4-8) Clause 7.2.10	30 A/m cont. 300 A/m 1-3 s
2.2.9 D.C. voltage dips	IEC 60255-26 (IEC 61000-4-29) Clause 7.2.11	100%; 10 – 1000 ms 60%; 200 ms 30%; 500 ms
2.2.10. A.C. voltage dips	IEC 60255-26 (IEC 61000-4-11) Clause 7.2.11	100%; 0,5 – 25 c. 60%; 10/12 c. 30%; 25/30 c.
2.2.11. D.C. voltage interruptions	IEC 60255-26 (IEC 61000-4-29) Clause 7.2.11	100%; 5 s
2.2.12. A.C. voltage interruptions	IEC 60255-26 (IEC 61000-4-11) Clause 7.2.11	100%; 250/300 c
2.2.13. D.C. ripple	IEC 60255-26 (IEC 61000-4-17) Clause 7.2.12	15% Ur_dc 100/120 Hz
2.2.14. D.C. gradual shut- down / start-up	IEC 60255-26 Clause 7.2.13	Shut d. ramp 60 s 5 min off St up ramp 60s
2.2.15. Damped oscillatory magnetic field (100 kHz and 1 MHz)	IEC 61000-4-10	100 A/m (peak)
2.2.16. Pulse magnetic field	IEC 61000-4-9	1000 A/m
3. CLIMATIC ENVAIRONMENTAL CONDITIONS		
3.1. Dry heat operational	IEC 60255-1 (IEC 60068-2-2, test Bd)	+70°C; 72h

	Clause 6.12.3.1	
3.2. Cold operational	IEC 60255-1 (IEC 60068-2-1, test Ad) Clause 6.12.3.2	-40°C; 72h
3.3. Dry heat storage	IEC 60255-1 (IEC 60068-2-2, test Bb) Clause 6.12.3.3	+80°C; 72h
3.4. Cold storage	IEC 60255-1 (IEC 60068-2-1, test Ab) Clause 6.12.3.4	-40°C; 72h
3.5. Change of temperature	IEC 60255-1 (IEC 60068-2-14, test Nb) Clause 6.12.3.5	-40°C; +70°C 3 hours; 5 cycles
3.6. Damp heat, steady state	IEC 60255-1 (IEC 60068-2-78, test Cab) Clause 6.12.3.6	+40°C; 93% 10 days
3.7. Damp heat, cyclic	IEC 60255-1 (IEC 60068-2-30, test Db) Clause 6.12.3.7	+25°C; 40°C 97%; 93% 6 cycles
4. MECHANICAL ENVIRONMENTAL CONDITIONS		
4.1. Vibration response	IEC 60255-1 (IEC 60255-21-1) Clause 6.13.1	class 1
4.2. Vibration endurance	IEC 60255-1 (IEC 60255-21-1) Clause 6.13.1	class 1
4.3 Shock response	IEC 60255-1 (IEC 60255-21-2) Clause 6.13.2	class 1
4.4. Shock withstand	IEC 60255-1 (IEC 60255-21-2) Clause 6.13.2	class 1
4.5 Bump	IEC 60255-1 (IEC 60255-21-2) Clause 6.13.2	class 1
4.6 Seismic (single axis sweep)	IEC 60255-1 (IEC 60255-21-3) Clause 6.13.3	class 1

17 COMMUNICATION AND HMI

17.1 Local communication port

USB front port

The USB communications port is installed on the front of the relay. The connector that is used is a micro-USB. The used protocol is Modbus RTU (115200 – 8 bit – no parity – 1 bit stop).

The ground from the PC should be connected to the same ground as the relay to prevent communication problems.

The USB communication system is insulated from the auxiliary voltage, but not from the relay processors. For this reason, the cable connecting the PC to the relay should not be excessively long to avoid potential electromagnetic interference with the device.

WIFI communication

Depending on model, the relay is provided with wireless communication.

By default, the password to connect the relay to the laptop through this communication type is: Fanox/W1f1.

When the relays are provided with WIFI, a symbol informing about it will be displayed. Depending on the display type the symbol can be w or

OPTION 1	w
OPTION 2	

From version M1.03.00 onwards, it is necessary an external antenna to ensure enough wireless signal:



17.2 Remote communications ports

RS485 port for Modbus RTU, DNP3.0 serial or IEC60870-5-103

There is one RS485 port, it is possible to select Modbus RTU protocol, DNP3.0 serial protocol or IEC60870-5-103 thanks to the general settings. The RS485 port output has two terminals (+, -), located on the rear of the relay.

This port can be used to continuously monitor the relay from a remote PC or SCADA system. Up to 32 relays can be connected to one bus: each device with a different Modbus address. The relay Modbus address can be configured using the SICom Software.

To minimize communication errors as a result of noise, the use of a stranded and shielded cable is recommended for the physical connection. All of the + terminals on one side, and all of the - terminals on the other must be connected together in order to make the connection.

In this case, the RS485 is provided with 2 terminals: +, -. In case of having a shield cable, it will be connected to the ground screw.

Resistors should be used at each end if very long cables are used. The best solution for avoiding reflection is to install resistors at both ends of the cable. The ohm value of these resistors must be equal to the cable impedance value.

The RS485 communications are fitted with auxiliary voltage insulation, but no insulation between the various RS485 communication connectors. Fiber optics can be used in very aggressive environments, and they are connected by using the corresponding converters.

With one RJ45 or two independent or redundant HSR/PRP ports for Modbus TCP/IP, DNP3.0 TCP/IP, IEC 60870-5-104 or IEC61850

In this case there is one RJ45 port for Modbus TCP/IP, DNP 3.0 TCP/IP, IEC 60870-5-104 or IEC61850 protocols, where the protocol can be chosen by general settings.

With one FO-LC port for Modbus TCP/IP, DNP3.0 TCP/IP, IEC 60870-5-104 or IEC61850

In this case there are one or two (PRP) FO-LC ports for Modbus TCP/IP, DNP 3.0 TCP/IP, IEC 60870-5-104 or IEC61850 protocols, where the protocol can be chosen by general settings.

The specifications of the fiber optic port are listed below:

Connector: LC Type.

Speed: 100BASE-FX, Fast Ethernet.

Mode: Multimode, compatible with 50/125 µm and 62.5/125 µm.

Wavelength: 1310 nm.

Maximum theoretical Length: 2 km

With two independent or redundant HSR/PRP SFP Cages for Modbus TCP/IP, DNP 3.0 TCP/IP, IEC 60870-5-104 or IEC61850 protocols.

The transceivers will be connected by the user and they must comply with the below requirements:

Supply: 3.3v.

Speed: 100BASE-FX, Fast Ethernet.

The SFP module must support SerDes.

17.3 LCD and keypad

The front of the relay is fitted with an alphanumeric 20x4 (20 columns and 4 rows) LCD screen. This screen provides the user with access to read information about the settings parameters, measurements, status and events. All of this information is arranged in a system of menus.

A keypad is fitted to the relay front panel, which can be used to access the information shown on the LCD screen and to navigate through the menu system.

This membrane keyboard has 6 keys that can be used to navigate through the different menus and to change the setting parameters. The ▲ ▼ and ◄ ► keys can be used to navigate through the different menus, the different options in each menu and the different values for the settings parameters.

The "**OK**" key is used to access the menus and the different options, as well as to approve changes to values. The "**C**" key is used to delete and to go back through the menu levels.

As well as the 6 keys, there is also a '**Reset**' key. When '**Reset**' is pressed, the LEDs indicators return to their initial position. The '**Reset**' key can also be used to delete all the events in the 'Events' menu, the Fault Reports and the LDP from each menu.

In addition to these keys used to navigate through the menus, there are some special keys that are also configurable from the PC software. By default:

- I/O of the circuit breaker. Used to close and open the circuit breaker.
- Block/Unblock 79. Used to block and unblock the recloser.
- Local/Remote Control. Used to forbid/allow remote communications.

17.4 SICom Communications Software

The SICom software, which works with the Windows 8, Windows 8.1, Windows 10 and Windows 11 operating systems is provided, and can be used to gain access to all the relay information, to modify the settings and to save events using a graphic user interface.

The following operations can be carried out using the SICom software:

- Status reading.
- Measurement reading.
- Read and change settings.
- Read and change configuration.
- Read and delete events.
- Read and delete DFR.
- Configure and check the demand (LDP).
- Date-time synchronization.
- Set Counters.
- Execute Commands.

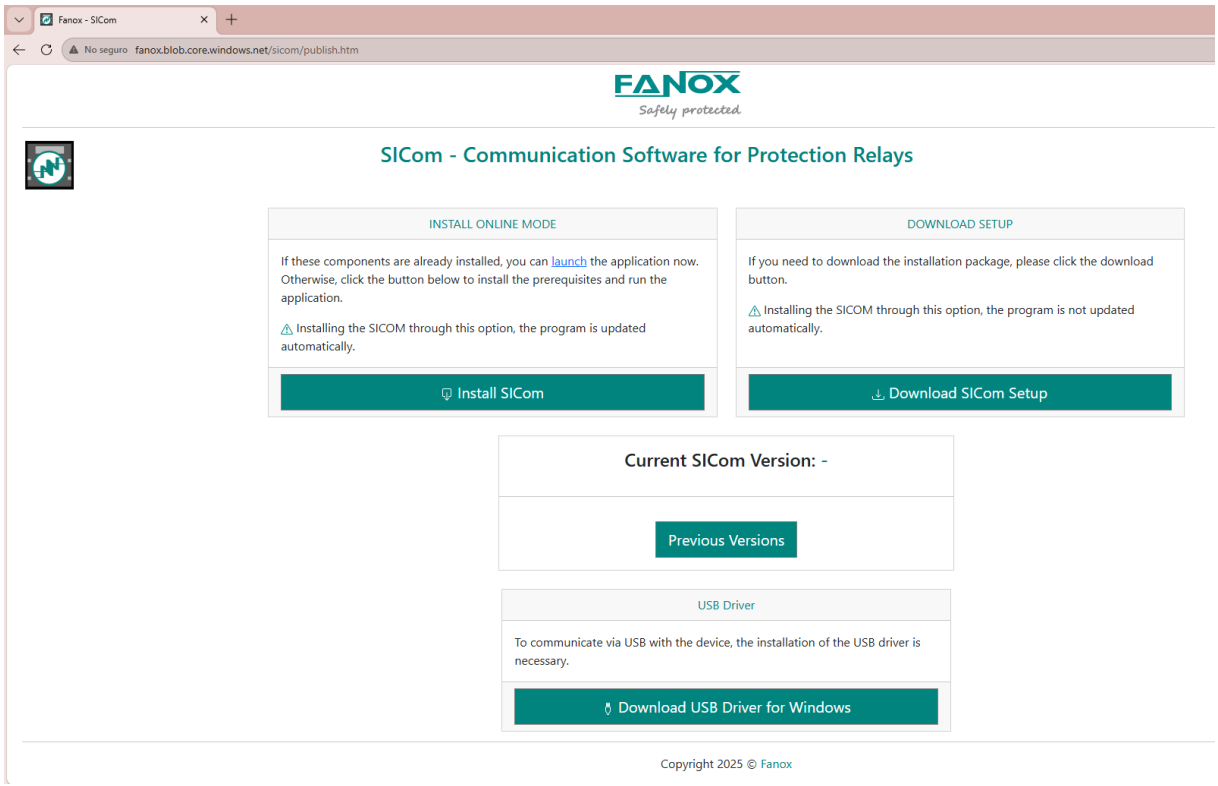
- Changing the user passwords.
- Loading settings files.
- Loading configuration files.
- Checking the versions of the relay.
- Configure Communication address.

17.5 How to install SICom Software

To install the SICom it is necessary to use the following link:

http://fanox.blob.core.windows.net/sicom/publish.htm

The link will open the next screen, where key 'Install SICom' must be pressed:



The necessary drivers depending on the operative system can be downloaded from this page.

The update of the software does not require any user's action, this is, if the computer is connected to Internet, SICom updates itself when it is started.

17.6 Setting-up the session: Passwords and access levels

Users must identify themselves with a password to start communications and to change the relay settings or configuration using the HMI. Depending on the access level, it may or may not be possible to perform the operations shown on the table below.

FANOX
Safely protected

HMI

ACCESS LEVEL	PASSWORD	Read permission: Status and measurements Settings Configuration Events/DFR	Permission to: Change settings Set date/Time	Permission to: Execute Commands Set Counters Delete Events Delete DFR Delete LDP	Permission to: Change user´s configuration Delete user´s configuration
0	NA	YES	NO	NO	NO
1	1111 2222 3333 6666 7777 8888	YES	YES	NO	NO
2	4444 1010	YES	YES	YES	NO
3	5555 9999	YES	YES	YES	YES

NOTE: The reading permission does not require any password.

COMMUNICATION SOFTWARE: SICom

ACCESS LEVEL	PASSWORD	Read permission: Status and measurements Settings Configuration Events/DFR	Permission to: Change settings	Permission to: Execute Commands Set Counters Delete LDP Delete Events Delete DFR Set Date/Time	Permission to: Change user´s configuration Delete user´s configuration	Permission to: Read and change access levels
1	Fanox/0000	YES	NO	NO	NO	NO
2	Fanox/1111 Fanox/2222 Fanox/3333 Fanox/6666 Fanox/7777 Fanox/8888	YES	YES	NO	NO	NO
3	Fanox/4444	YES	YES	YES	NO	NO
4	Fanox/5555 Fanox/9999	YES	YES	YES	YES	YES

(*) if the access level allows the user to check the passwords, only the passwords from a lower level than the one is using will be shown. However, all the passwords can be changed if the used access level allows it.

10 passwords and their associated levels of access can be set up using the SICom software.

The password can make up of 10 characters as maximum for SICom and up to 4 characters if HMI is used.

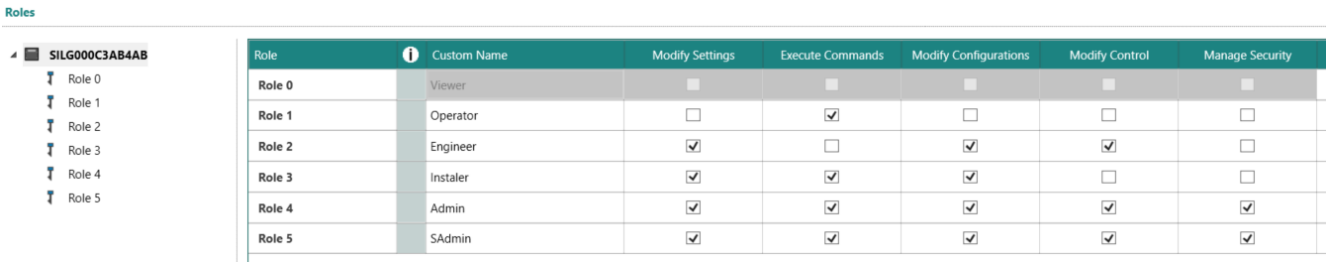
By default, the relay is parametrized with the following passwords and their associated levels:

HMI PASSWORDS	SICom PASSWORDS	ACCESS LEVEL
-	Fanox/0000	0
1111 2222 3333 6666 7777 8888	Fanox/1111 Fanox/2222 Fanox/3333 Fanox/6666 Fanox/7777 Fanox/8888	1
4444 1010	Fanox/4444	2
5555 9999	Fanox/5555 Fanox/9999	3

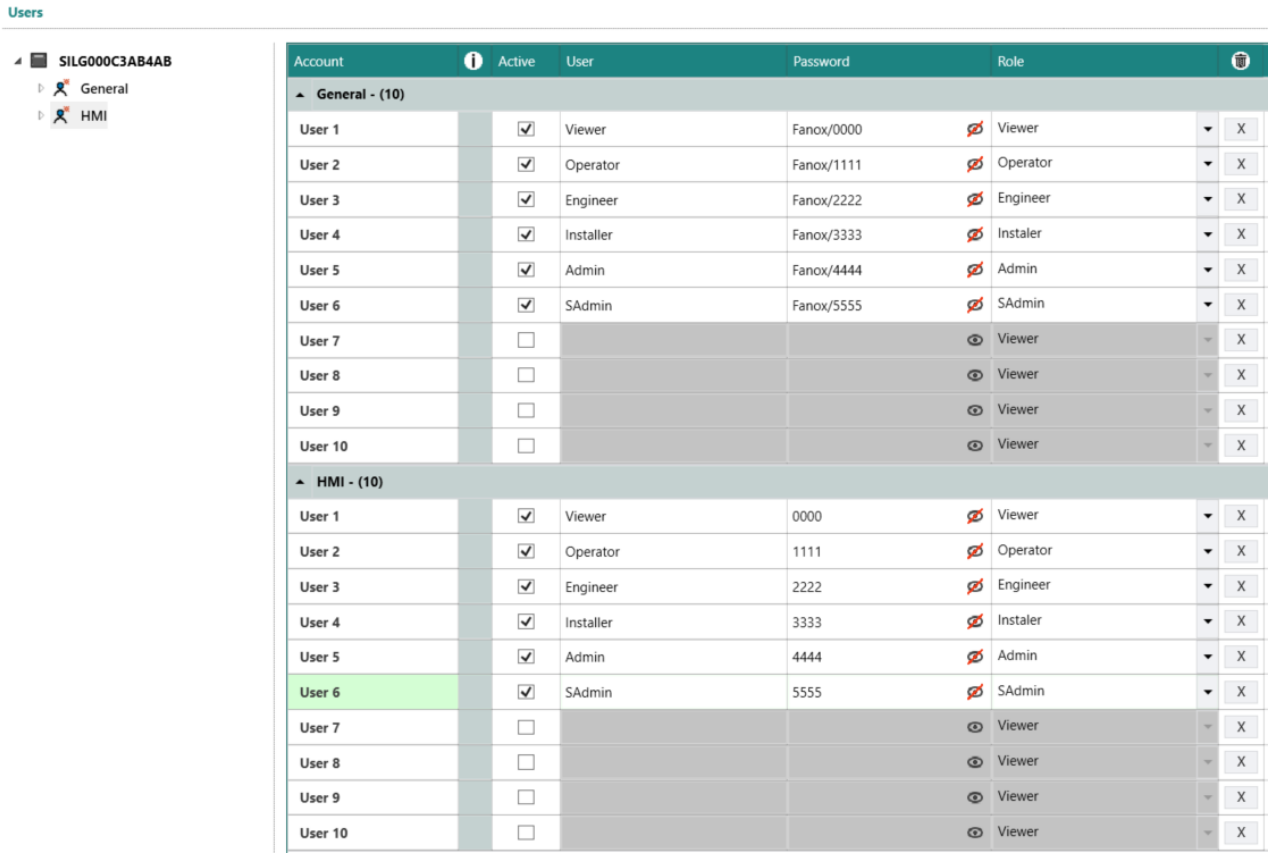
From fw version 3.00.00 onwards the relay enables the creation of local user accounts to give the authorized individual different permissions.

Every user account can be assigned different roles, and the user roles can be changed as needed.

ROLES:



USERS:



Account	Active	User	Password	Role
General - (10)				
User 1	☑	Viewer	Fanox/0000	Viewer
User 2	☑	Operator	Fanox/1111	Operator
User 3	☑	Engineer	Fanox/2222	Engineer
User 4	☑	Installer	Fanox/3333	Instaler
User 5	☑	Admin	Fanox/4444	Admin
User 6	☑	SAdmin	Fanox/5555	SAdmin
User 7	☐			Viewer
User 8	☐			Viewer
User 9	☐			Viewer
User 10	☐			Viewer
HMI - (10)				
User 1	☑	Viewer	0000	Viewer
User 2	☑	Operator	1111	Operator
User 3	☑	Engineer	2222	Engineer
User 4	☑	Installer	3333	Instaler
User 5	☑	Admin	4444	Admin
User 6	☑	SAdmin	5555	SAdmin
User 7	☐			Viewer
User 8	☐			Viewer
User 9	☐			Viewer
User 10	☐			Viewer

There are up to 10 configurable users where it is possible to associate the corresponding password and the applicable role.

The password can be customized by following the next specifications:

Minimum number of characters: 8

Maximum number of characters: 10

Use a lower case

Use an upper case

Use a special character

NOTES:



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