SIL-A Advanced

Feeder Relay

Overcurrent & Earth Fault Protection Protection

USER'S MANUAL

1 RECEPTION, HANDLING, INSTALLATION

1.1 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. 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.

1.2 Reception of relays

It is necessary to inspect the device 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.

1.3 Handling electronic equipment

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. This damage may not be detected, but the electronic circuit reliability and life will be reduced. The electronic component in the device is well protected by the metal housing, which should not be removed as the device 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 electrostatic discharges 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 device 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.

1.4 Installation, commissioning and service

The personnel in charge of installing, commissioning and maintaining this device 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.

In order 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 device 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 device is supplied:

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

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

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

1.5 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.

1.6 Recycling

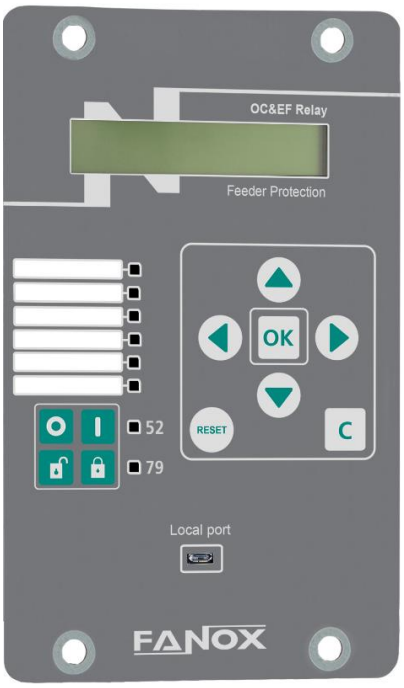
Before recycling the device, capacitors should be discharged through their external terminals. All electrical power sources should be removed before performing this operation to avoid the risk of electrical discharge.

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.

2 DIMENSIONS AND CONNECTION DIAGRAMS

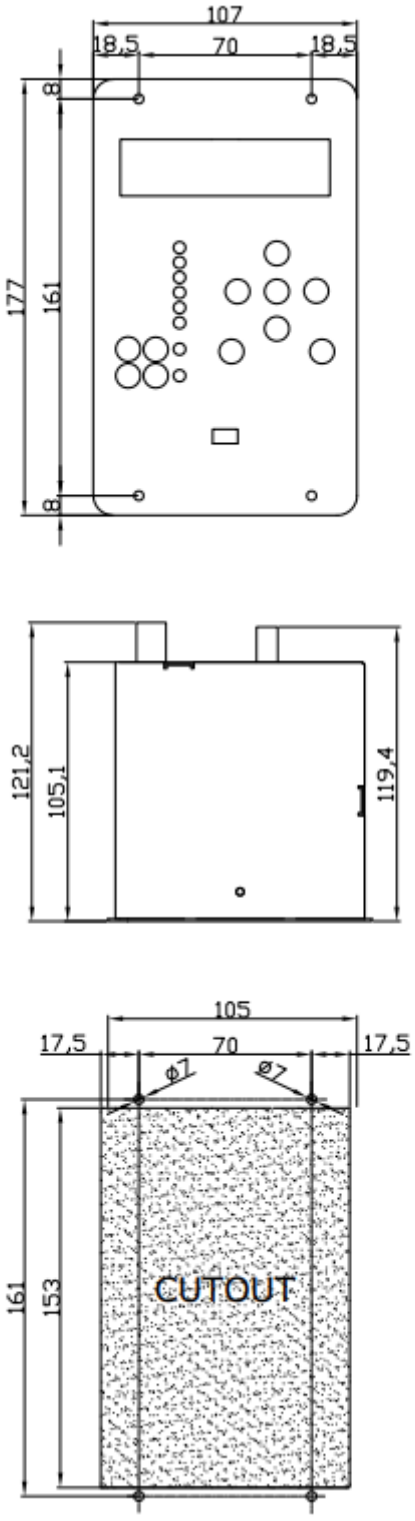
2.1 Front view



2.2 Case dimensions

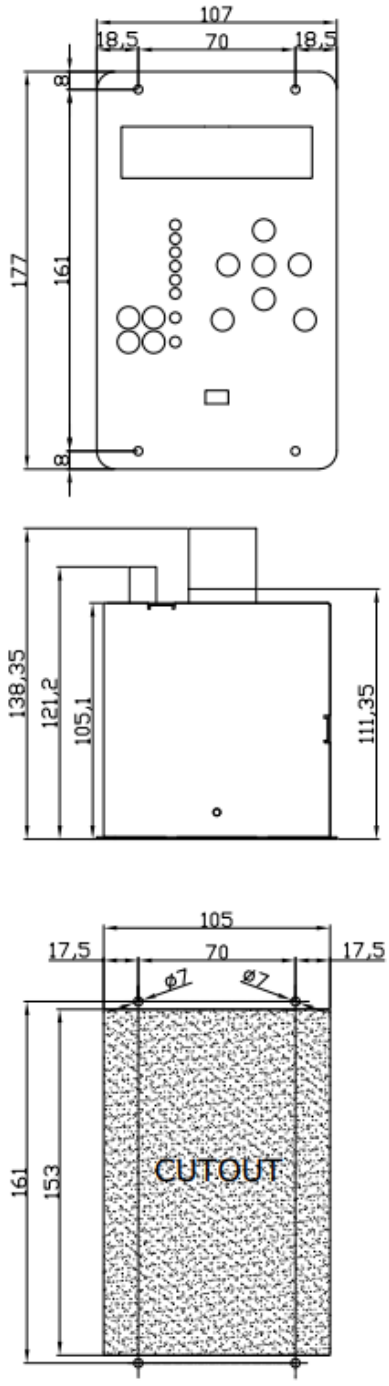
2.2.1 SIL-A with Standard current terminals

The dimensions are in mm:



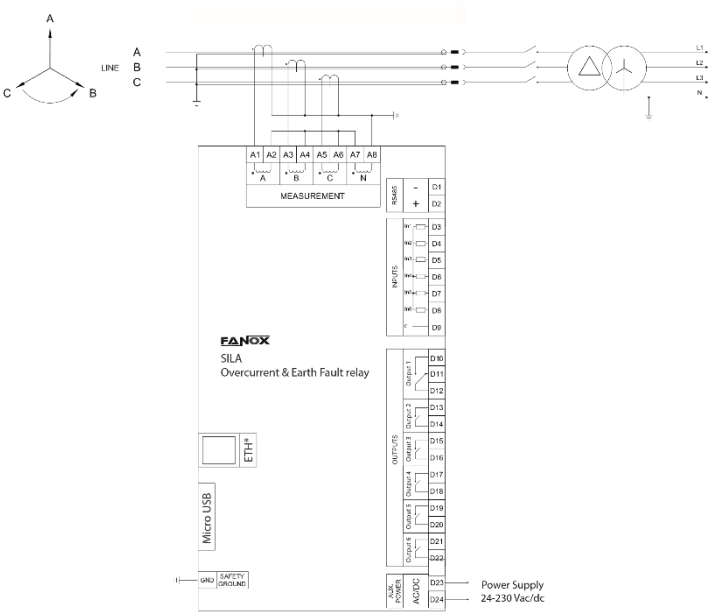
2.2.2 SIL-A with short-circuitable current terminals

The dimensions are in mm

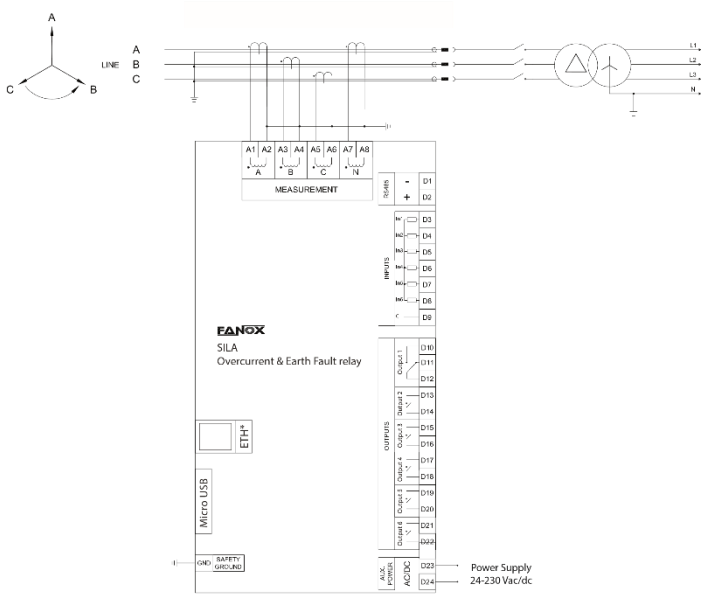


2.3 Connection diagrams

2.3.1 Analog connections

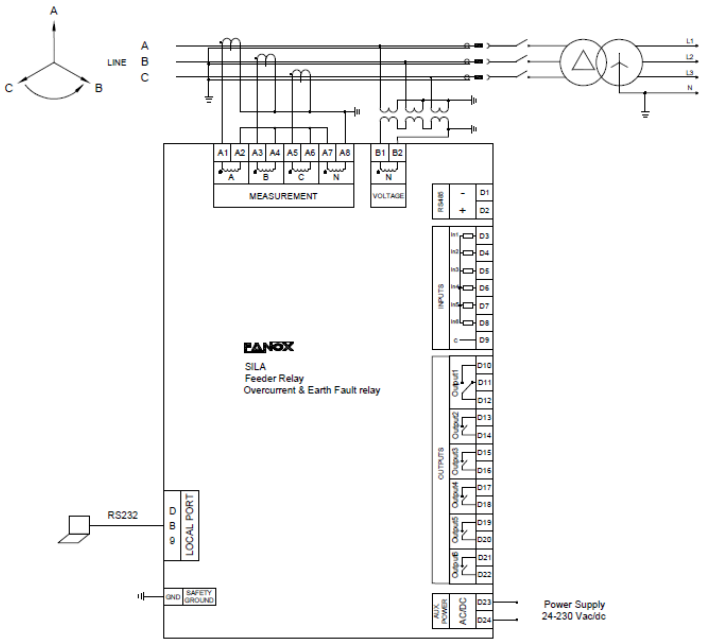


• 3 Standard Current Transformers



• 4 Standard Current Transformers

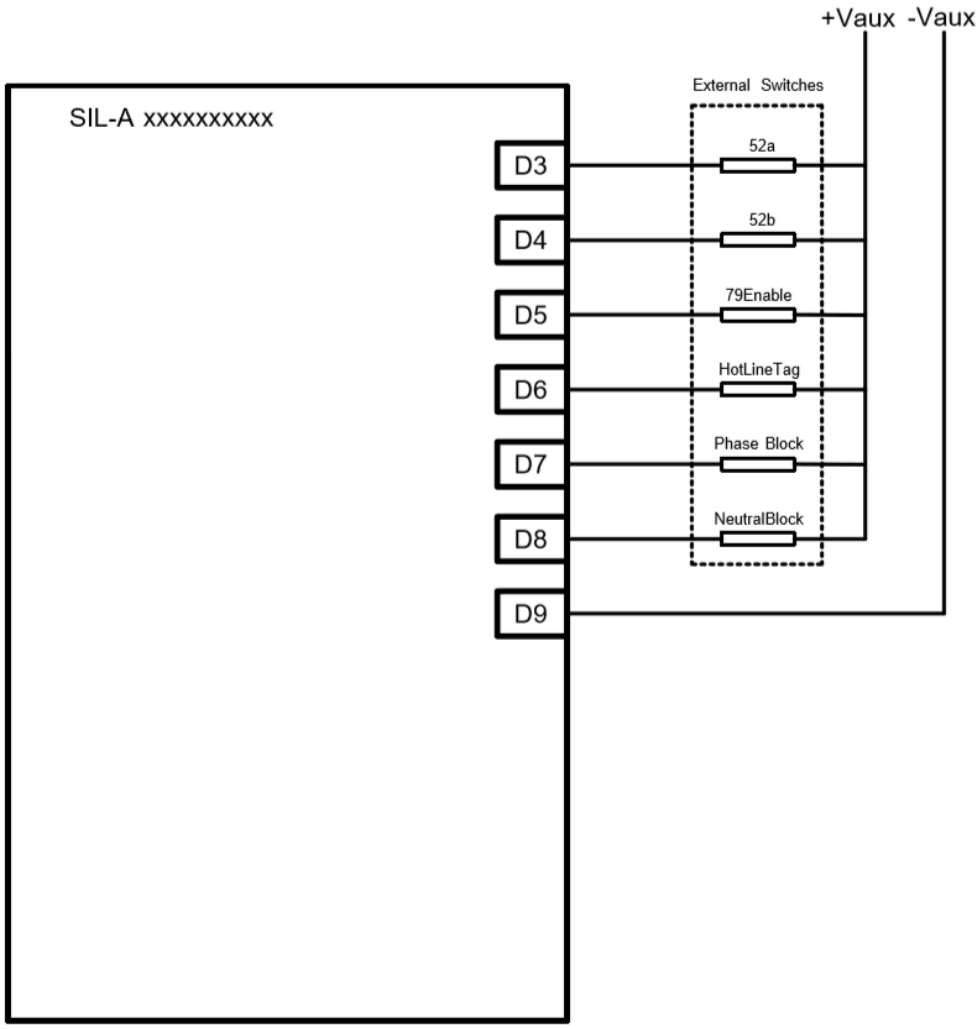
3 Current transformers + voltage transformer



2.3.2 Digital connection

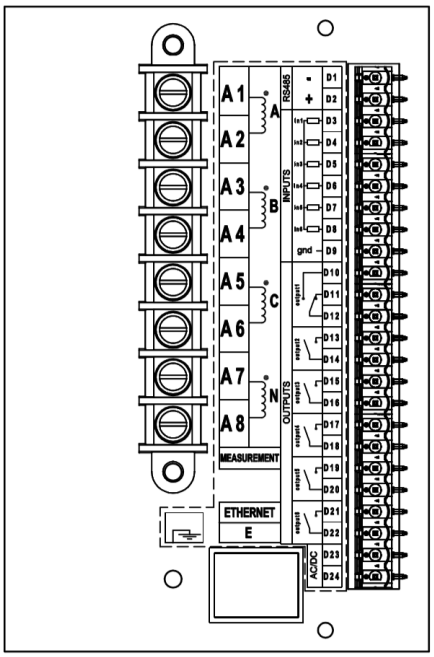
The relay binary inputs need auxiliary power to operate. The minimum voltage difference to detect the activation on the input terminal is 15V.

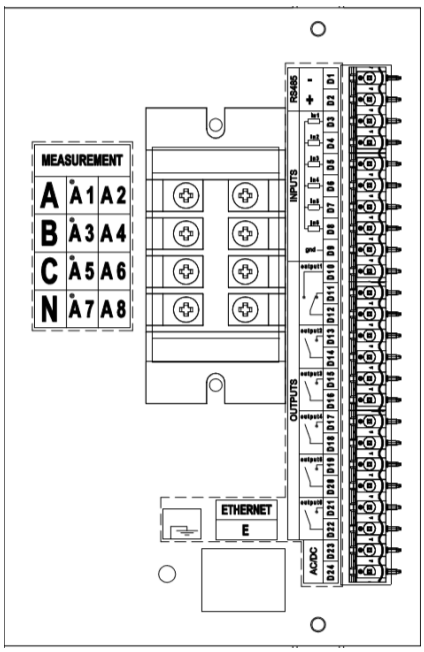
Following connection is an example, the configuration of the showed inputs can be selected by the user.



2.4 Terminals

2.4.1 Current tranformers



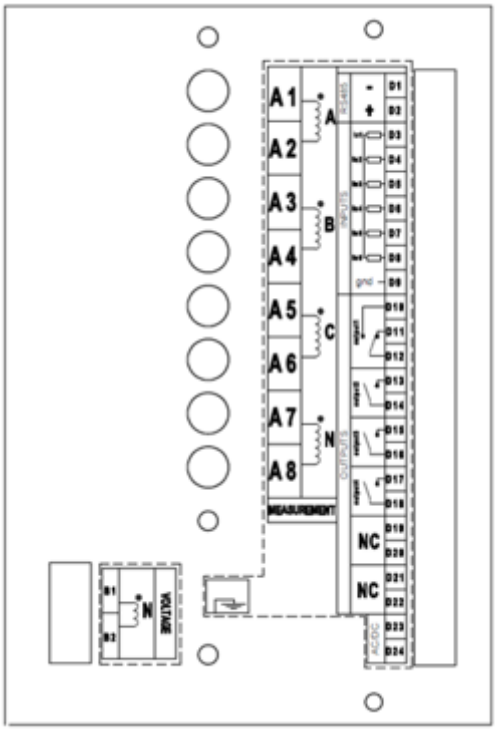


D1	+ RS485 Modbus RTU, DNP3.0 Serial or IEC60870-103 depending on model (*)
D2	– RS485 Modbus RTU, DNP3.0 Serial or IEC60870-103 depending on model (*)
D3	Digital input 1
D4	Digital input 2
D5	Digital input 3
D6	Digital input 4 (*)
D7	Digital input 5 (*)
D8	Digital input 6 (*)
D9	Common digital inputs
D10	NO digital output 1
D11	NC digital output 1
D12	Common digital output 1

D13-D14	NO Digital output 2
D15-D16	NO Digital output 3
D17-D18	NO Digital output 4 (*)
D19-D20	NO Digital output 5 (*)
D21-D22	NO Digital output 6 (*)
D23-D24	Auxiliary Voltage
A1-A2	Phase A current measurement
A3-A4	Phase B current measurement
A5-A6	Phase C current measurement
A7-A8	Neutral current measurement
E	Modbus TCP/IP, DNP3.0 TCP/IP or IEC60870-104 selectable by settings or IEC61850 selectable by model

(*) Model with 5 inputs and 7 outputs available depending on model

2.4.2 Current tranformers + Voltage transformer



D1	+ RS485 Modbus RTU, DNP3.0 Serial or IEC60870-103 depending on model (*)	**D13-D14**	NO Digital output 2
D2	– RS485 Modbus RTU, DNP3.0 Serial or IEC60870-103 depending on model (*)	**D15-D16**	NO Digital output 3
D3	Digital input 1	**D17-D18**	NO Digital output 4 (*)
D4	Digital input 2	**D19-D20**	NO Digital output 5 (*)
D5	Digital input 3	**D21-D22**	NO Digital output 6 (*)
D6	Digital input 4 (*)	**D23-D24**	Auxiliary Voltage
D7	Digital input 5 (*)	**A1-A2**	Phase A current measurement
D8	Digital input 6 (*)	**A3-A4**	Phase B current measurement
D9	Common digital inputs	**A5-A6**	Phase C current measurement
D10	NO digital output 1	**A7-A8**	Neutral current measurement
D11	NC digital output 1	**B1-B2**	Neutral voltage measurement
D12	Common digital output 1	**E**	Modbus TCP/IP, DNP3.0 TCP/IP or IEC60870-104 selectable by settings or IEC61850 selectable by model

(*) Model with 5 inputs and 7 outputs available depending on model

3 DESCRIPTION

3.1 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 family to carry out this function.

The SIL- A relay is designed to protect secondary transformation and distribution centers of electric grids, using current functions. It is intended to work with a circuit breaker as cutting power element.

The protection functions can be activated by using both the front panel and the communications links to the SICom program, allowing a precise coordination with another relay.

Additionally, all the models have been designed to be powered from an external battery. This is aimed at facilitating event management and the commissioning of centers, as well as allowing it to operate properly under adverse conditions.

3.2 Description

SIL-A relays are digital based technology powered with an auxiliary voltage of 24-230 Vac/dc.

Besides the overcurrent line protection functions, instantaneous phase and neutral, with a circuit breaker and protection against phase and neutral inverse time overcurrent, the relay provides phase imbalance and circuit breaker fault functions as well as a thermal image protection.

As this is a line protection, a recloser is fitted. This automated control shall permit closure (up to four attempts) with the possibility of programming each reclosing time. It can be blocked by various means, from the HMI with a separate key to remote communications and inputs.

Further functions have been included which support line protection, such as the cold load pickup or the trip circuit supervision.

Depending on the model different functions are optional:

SILA Adaptation A: 50-1, 51-1, 50G-1, 51G-1, CLP, Second Harmonic Blocking (SHB), 49 and 86+ 49T Optionally, 52, 50BF and trip block for switch disconnector.

SILA Adaptation B: 50-1, 50-2, 51-1, 50G-1, 50G-2, 51G-1, CLP, 46, 52, 50BF, 79, 74TCS, 86 + 49T. Optionally, 49, 60CTS, 37, 46BC and trip block for switch disconnector

SILA Adaptation C: 50-1, 51-1, 50G-1, 51G-1, 52, 79, 74TCS, 86 + 49T. Optionally, SHB, 49 and 46BC.

SILA Adaptation D: (2) 50 + (2) 50N +(2) 50G + (2) 51 + (2) 51N + (2) 51G + SOTF + 64REF + CLP + SHB + 49 + 46 + 52 + 50BF + 79 + 74TCS + 86 + 49T Optionally:

60CTS, 37, 46BC and trip block for switch disconnector

+ 60CTS + 37 + 46BC + Trip block + (2) 59G + (2) 67G/51G + 67GI + 67NI

The SIL-A relay has up to 7 outputs that can be configured by the user and up to 6 configurable inputs, with different combinations depending on model.

The relay has an LCD with two lines and twenty columns and a membrane keyboard with six buttons. These allow the relay status, the current measurements in the primary winding and the events or incidents associated with the relay to be seen, and adjustments to be made to the protection criteria. These events can be saved in a non-volatile memory to keep them when there is no power.

It can store, up to 2048 events, allowing any registered incidents to be analyzed.

To facilitate the analysis of the information recorded in the relay, fault reports are also included in data and COMTRADE format. Event recording consists of more general information, and fault reports will record just the events related with the fault situation, allowing the user to export these fault reports in COMTRADE format (IEEE C37.111-1991) to analyze the graphical representation of fault reports.

The relay can store the fault reports in COMTRADE format - cyclic recording by FIFO method - (resolution 32 samples/cycle):

5 COMTRADE records (260 cycles each record): 1 to 8 pre-fault cycles + 252 to 259 postfault cycles.
25 COMTRADE records (60 cycles each record): 1 to 8 pre-fault cycles + 52 to 59 postfault cycles.
50 COMTRADE records (30 cycles each record): 1 to 8 pre-fault cycles + 22 to 29 postfault cycles.
100 COMTRADE records (15 cycles each record): 1 to 8 pre-fault cycles + 7 to 14 postfault cycles.

Current measurements are performed using the fundamental values, with an accuracy of 2% over a range of ±20% over the nominal current and 4% over the rest of the range. Standard 5 A and 1 A current transformers (CTs) are used depending on model.

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

- 1 RS485 Port: IEC60870-5-103, Modbus RTU or DNP3.0 Serial (selectable by general settings).
- 1 RS485 Port: IEC60870-5-103, Modbus RTU or DNP3.0 Serial (selectable by general settings) + 1 RJ45 Port: Modbus TCP/IP, DNP3.0 TCP/IP or IEC60870-5-104 (selectable by general settings) + SNTP protocol.
- 1 RS485 Port: IEC60870-5-103, Modbus RTU or DNP3.0 Serial (selectable by general settings) + 1 RJ45 Port: IEC61850 + SNTP Protocol.

This micro USB port allows a PC to be connected and the relay to be monitored using the SICom program in WINDOWS 7, WINDOWS 8, WINDOWS 8.1 or WINDOWS 10 (supplied by FANOX).

Setting-up a session allows 4 levels of access to be set up with passwords that can be configured by the user through SICom communication software.

The protection functions, easy-to-use interface, low amount of maintenance and simple integration make the SIL-A a precise and practical solution to protect both industrial and public electrical grids and transformation and distribution centres. The SIL-A protection against earthing faults is sensitive enough to be used on electric systems with low earthing fault currents. It can be adjusted to 0.01 times the rated current and extremely low rated levels can be selected.

The main features of the relay are listed below, and these features will be explained in the rest of the manual:

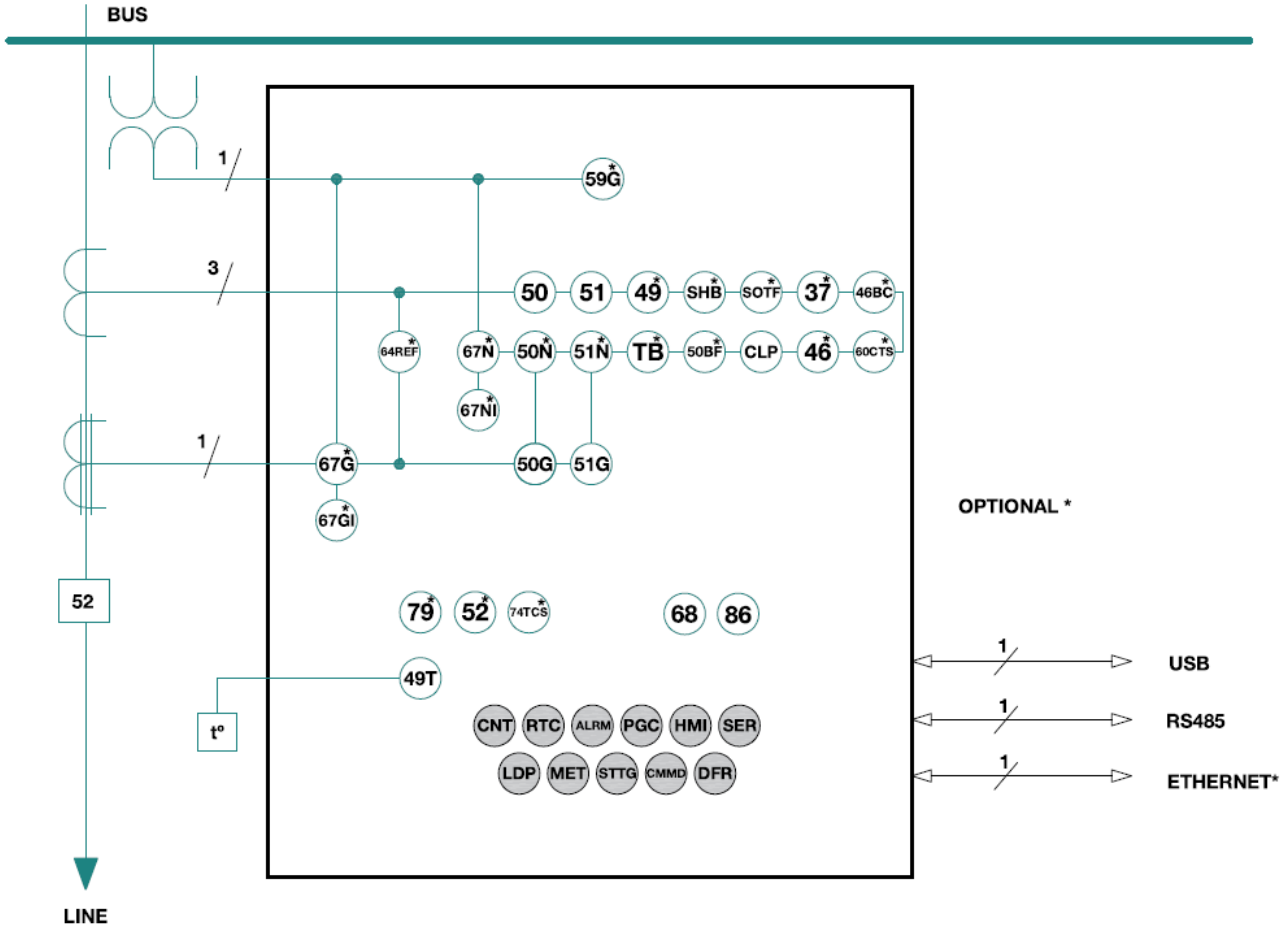
Function	Description	SIL-A
Protection		
50_1	Instantaneous phase overcurrent	1
50_2	Instantaneous phase overcurrent	1 (Optional)
SOTF	Switch On To Fault	1 (Optional)
51_1	Inverse time phase overcurrent	1
51_2	Inverse time phase overcurrent	1 (Optional)
50G_1	Instantaneous measured neutral overcurrent	1
50G_2	Instantaneous measured neutral overcurrent	1 (Optional)
50N_1 **50N_2**	Instantaneous calculated neutral overcurrent	2 (Optional)
51G_1	Inverse time measured neutral overcurrent	1
51G_2	Inverse time measured neutral overcurrent	1 (Optional)
51N_1 **51N_2**	Inverse time calculated neutral overcurrent	2 (Optional)
67G/51G_1 **67G/51G_2**	Inverse Time Directional Measured Neutral Overcurrent	2 (Optional)
67NI	Inverse time directional isolated calculated neutral overcurrent	1 (Optional)
67GI	Inverse time directional isolated measured neutral overcurrent	1 (Optional)
64REF	Restricted earth fault	1 (Optional)
46	Phase balance current protection	1 (Optional)
46BC	Broken conductor detection	1 (Optional)
49	Thermal image	1
49T	External Trip	Available through configurable inputs thanks to the programmable logic
79	AC Reclosing Device	Up to 4 shots (Optional)
50BF	Circuit breaker opening failure	1 (Optional)
74TCS	Trip circuit supervision	1 through configurable inputs (Optional)
86	Trip Output Lockout through PGC	✓
CLP	Cold load pickup	1

60CTS	Phase CT Supervision	1 (Optional)
37	Instantaneous phase undercurrent	1 (Optional)
59G_1 **59G_2**	Instantaneous measured neutral overvoltage	1 (Optional)
TB	Trip block protection for switch disconnector	1 (Optional)
SHB	Second Harmonic Blocking	1
68	Zone Selection Interlocking (ZSI)	1
Circuit Breaker (Optional)		
52	State and control of the circuit breaker	✓
	Number of openings Counter	✓
	Accumulated amperes counter:	✓
	Maximum openings in a time window	✓
Measurements		
	Phase and neutral fundamental values (I-A, I-B, I-C, I-N) with a precision of ±2% or ±5 mA in a band of ±20% when compared to the rated current, and ±4% or ±5 mA (whichever is greater) in the rest of the range.	✓
	Neutral voltage (V-R)	✓ (Optional)
	Zero sequence current (3I-0)	✓
	Positive sequence current (I-1)	✓
	Negative sequence current (I-2)	✓ (Optional)
	Negative/Positive sequence current (I-2/I-1)	✓ (Optional)
	Maximum current (Imax)	✓
	Thermal image (TI)	✓
	Phase A second harmonic current (I-A2H)	✓ (Optional)
	Phase B second harmonic current (I-B2H)	✓ (Optional)
	Phase C second harmonic current (I-C2H)	✓ (Optional)
	Phase A total harmonic distorsion (THD-A)	✓
	Phase B total harmonic distorsion (THD-B)	✓
	Phase C total harmonic distorsion (THD-C)	✓
	Angle In	✓ (Optional)

	Angle 3I-0	✓ (Optional)
	Angle V-R	✓ (Optional)
Inputs and Outputs		
	Configurable Inputs	Up to 6 configurable inputs
	Configurable Outputs	Up to 7 configuracble outputs
Communication		
	LOCAL Communication	✓ 1 Local port MicroUSB: ModBus RTU
	REMOTE Communication	✓ 1 remote port with the following options: 1 Remote port RS485: ModBus RTU or IEC 60870-5-103 or DNP3.0 Serial (by general settings) ✓ 1 additional (optional) remote port with the following options: 1 RJ45: Modbus TCP/IP, DNP3.0 TCP/IP or IEC60870-5-103 + SNTP or IEC61850 + SNTP (depending on model)

HMI		
	SICom programme for Windows	✓
	Setting-up the session: 4 access levels with configurable passwords	✓
	HMI: LCD, 20x2	✓
	6 keys + 1 reset button + 2 keys for CB control + 2 keys for 79 Blocking/Unblocking	✓
	LED Indicators	8 leds: 2 with fixed functions (52 and 79) 6 configurable
Power		
	Auxiliary voltage .	24-230Vac/dc (-20%/+10%)
Monitoring and Recording		
	Sequential Event recording (SER)	2048
	Disturbance Fault Recording (DFR)	5, 25, 50 or 100 depending on the settings with the respective COMTRADE record
	Load Data Profiling	744 records
	Real-Time Clock (RTC 1 millisecond)	✓
	Test menu	✓
	Self-diagnosis	✓
Settings Groups		
	By general settings By inputs	4 setting groups
Mechanical		
	Dimensions	Height x Width: 177 x 107 (mm)
	Weight	1.5 kg

3.3 Functional diagram



3.4 Selection & Ordering Codes

SIL-A	Overcurrent & Earth Fault Protection Relay for Primary & Secondary Distribution										
	0 1										**PHASE CURRENT MEASUREMENT** 1 A or 5 A 1 A (For short-circuitable terminals: Mechanics options 3 and 5)
		0 1									**NEUTRAL CURRENT MEASUREMENT** 1 A or 5 A 1 A (For short-circuitable terminals: Mechanics options 3 and 5)
			0								**NET FREQUENCY** Defined by General Settings
				C							**POWER SUPPLY** 24-230 Vac/dc
					0 2 4 5 6 8						**ADDITIONAL FUNCTIONS** - + 49 + 60CTS + 37 + 46BC + Trip Block (Only for adaptation “B”) + SHB + 49 + 46BC (Only for adaptation “C”) + 52 + 50BF + Trip Block (Only for adaptation “A”) + 60CTS + 37 + 46BC + Trip block (Only for Adaptation “D”) + 60CTS + 37 + 46BC + Trip block + (2) 59G + (2) 67G/51G + 67GI + 67NI (Only for Adaptation “D”)
						E F G					**COMMUNICATIONS** E: USB (Modbus RTU) + RS485: (Modbus RTU, IEC60870-5-103 or DNP3.0 Serial) F: USB (Modbus RTU) + RS485: (Modbus RTU, IEC60870-5-103 or DNP3.0 Serial) + RJ45 (Modbus TCP, DNP3 TCP or IEC 60870-5-104) + Web Server + SNTP protocol G: USB (Modbus RTU) + RS485: (Modbus RTU, IEC60870-5-103 or DNP3.0 Serial) + RJ45 (IEC61850) + SNTP Protocol
							0 1 2 3				**INPUTS AND OUTPUTS** 3 Inputs + 3 Outputs 6 Inputs + 4 Outputs 6 Inputs + 6 Outputs 5 Inputs + 7 Outputs
								2 3 4 5			**MECHANICAL ASSEMBLY** Vertical Assembly Vertical Assembly and short-circuitable current terminals Vertical Assembly with anticorrosive treatment Vertical Assembly with anticorrosive treatment and short-circuitable current terminals
									A E		**LANGUAGE** English, Spanish, German and French English, Spanish, Turkish and Russian
										A B C D	**ADAPTATION** A: Default Functions: 50 + 50G + 51 + 51G + CLP + SHB + 49 + 86 + 49T B: Default functions: (2) 50 + (2) 50G + 51 + 51G + CLP + 46 + 52 + 50BF + 79 + 74TCS + 86 + 49T C: Default functions: 50 + 50G + 51 + 51G + CLP + 46 + 52 + 79 + 74TCS + 86 + 49T D: Default functions: (2) 50 + (2) 50N +(2) 50G + (2) 51 + (2) 51N + (2) 51G + SOTF + 64REF + CLP + SHB + 49 + 46 + 52 + 50BF + 79 + 74TCS + 86 + 49T

Example of ordering code:

SIL-A	0	0	0	C	6	F	2	2	A	D	*SIL A 0 0 0 C 6 F 2 2 A D*

3.5 Phase CT and neutral CT selection

Measurement from 0.01 to 30 times the nominal current:

Model	Phase nominal current	Neutral nominal current	Phase range	Neutral range
SIL-A00	1 A or 5 A	Residual phase connection, 1A or 5A	0.01-30 A or 0.05-150 A	0.01-30 A or 0.05-150 A
SIL-A11	1 A	Residual phase connection, 1A	0.01-30 A	0.01-30 A

To ensure the relay functions correctly, a suitable current transformer must be used. The load of the relay's own measurement circuits and the load on the cables that connect the CTs and the relay must be considered.

Please, check relay values defined on point **9.4 Energizing quantities** to define a suitable CT.

4 PROTECTION AND CONTROL FUNCTIONS

4.1 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

(*) Optional depending on model

The time delay is independent from the operating current flowing through the relay, so if the phase 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 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 the set time delay ±35ms or ±0.5% (whichever is greater).

4.2 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	0.000	300.000	0.001	s	2.000

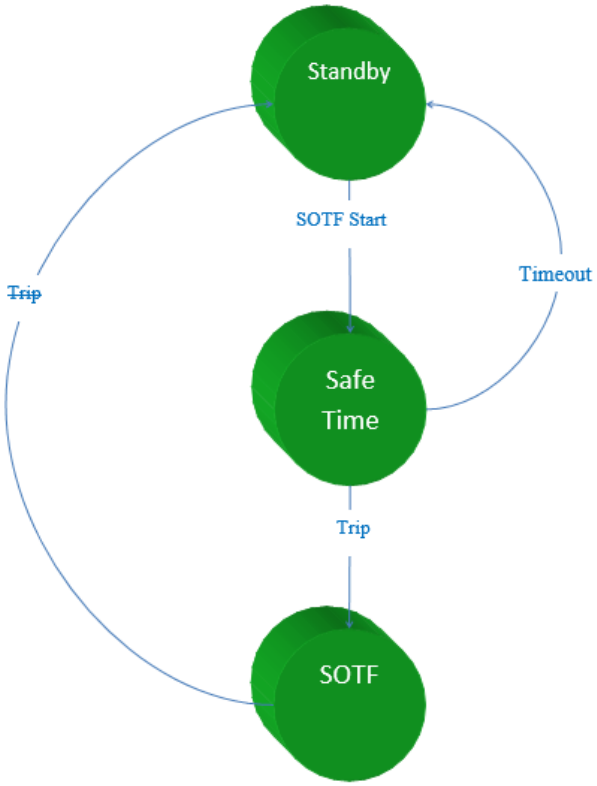
(*) Optional depending on model

When the logic signal '**SOTF Start**' is activated, it starts the pickup of the function. This protection is provided for high speed clearance of detected fault immediately after Manual Closure of Circuit Breaker or any other conditions selectable through the logical signal.

The function is active during the time adjusted in Safe Time and this setting must be coordinated with the Time delay in order to allow the correct behavior of the function. If a fault is detected during Safe Time, but Safe Time ends before the trip, the SOTF function will be deactivated.

The time delay is independent from the operating current flowing through the relay, so if the phase 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 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 the set time delay ±35ms or ±0.5% (whichever is greater).



4.3 Function 51. Inverse time phase overcurrent

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

Function	Description	Minimum	Maximum	Step	Unit	Default
51_1 51_2 (*)	**Inverse time phase overcurrent**					
	Function Enable	-	-	No/Alarm/Trip/SHB Trip	-	No
	Curve Type	-	-	(1)	-	IEC Standard Inverse
	Time Dial (TMS)	0.05	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

(*) Optional depending on model

(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	0.05	1.00	0.01	-	1.00
IEEE	Time Multiplier	0.10	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 (TMS) 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 is instantaneous in both cases.

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.

4.4 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_1 **50G_2 (*)**	**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

(*) Optional depending on model

The time delay is independent from the operating current flowing through the relay, so if the phase 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 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 the set time delay ±35ms or ±0.5% (whichever is greater).

4.5 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_1 (*) **50N_2 (*)**	**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

(*) Optional depending on model

The time delay is independent from the operating current flowing through the relay, so if the phase 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 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 the set time delay ±35 ms or ±0.5% (whichever is greater).

4.6 Function 51G. Inverse time measured neutral overcurrent

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

Function	Description	Minimum	Maximum	Step	Unit	Default
51G_1 51G_2 (*)	**Inverse time measured neutral overcurrent**					
	Function Enable	-	-	No/Alarm/Trip/SHB Trip	-	No
	Curve Type	-	-	(1)	-	IEC Standard Inverse
	Time Dial (TMS)	0.05	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

(*) Optional depending on model

(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	0.05	1.00	0.01	-	1.00
IEEE	Time Multiplier	0.10	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 (TMS) 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 is instantaneous in both cases.

If the unit operates as defined time, the accuracy of the Time Delay is equal to the set time delay ±35 ms 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 ±30 ms or ±5% (whichever is greater).

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

4.7 Function 51N. Inverse time calculated neutral overcurrent

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

Function	Description	Minimum	Maximum	Step	Unit	Default
51N_1 (*) 51N_2 (*)	**Inverse time calculated neutral overcurrent**					
	Function Enable	-	-	No/Alarm/Trip/SHB Trip	-	No
	Curve Type	-	-	(1)	-	IEC Standard Inverse
	Time Dial (TMS)	0.05	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

(*) Optional depending on model

(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	0.05	1.00	0.01	-	1.00
IEEE	Time Multiplier	0.10	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 (TMS) 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 is instantaneous in both cases.

If the unit operates as defined time, the accuracy of the Time Delay is equal to the set time delay ±35 ms 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 ±30 ms or ±5% (whichever is greater).

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

4.8 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)	0.05	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

(*) Optional depending on model

(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	0.05	1.00	0.01	-	1.00
IEEE	Time Multiplier	0.10	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 (TMS) 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 is instantaneous in both cases.

If the unit operates as defined time, the accuracy of the Time Delay is equal to the set time delay ±35 ms 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 ±30 ms or ±5% (whichever is greater).

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

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).

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

If the directionality setting is enable,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 polarization voltage which gives us the maximum torque direction. A cone is drawn, with the half-cone angle adjusted, over this maximum torque direction.

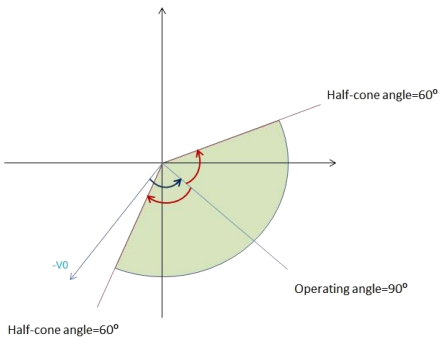
The actuation time starts when the following conditions are met simultaneously:

- Neutral current higher than adjusted.
- Polarization voltage higher than adjusted. To reset this condition a value lower than 95% of adjusted voltage is required.
- The phase shift of neutral current and polarization voltage is such that the neutral current is inside the intervention sector. To reset this condition a displacement higher than 3º of operating area limits is required.

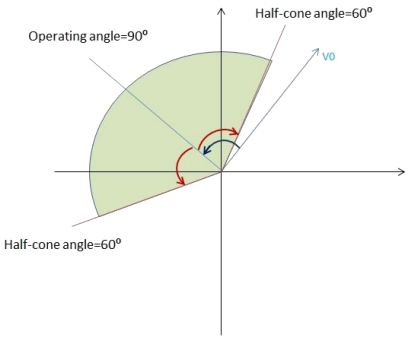
The following table shows the operating and polarization magnitudes used for this function. Those magnitudes are displayed graphically below the table.

Neutral	Operating magnitude	Polarization magnitude
Neutral	In Current	3V0 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



Inverse

4.9 Function 67GI. Inverse time directional isolated measured neutral overcurrent

This protection function can be set by using the following parameters

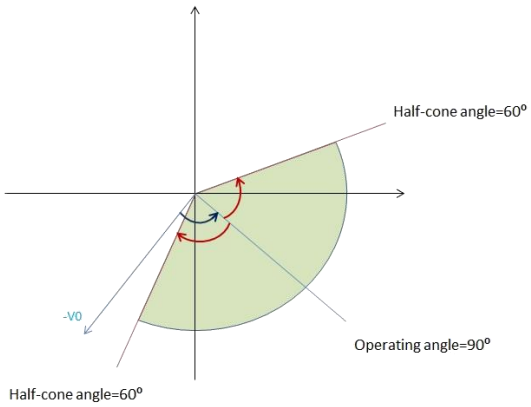
Function	Description	Minimum	Maximum	Step	Unit	Default
67GI (*)	**Inverse time directional isolated measured neutral overcurrent**					
	Function enable	-	-	No/Alarm/Trip	-	No
	Directionality	-	-	(1)	-	No
	Low Current Tap	0.010	30.000	0.001	In	1
	Low Voltage Tap	0.08	2.00	0.01	Un	30
	High Current Tap	0.010	30.000	0.001	In	2
	High Voltage Tap	0.08	2.00	0.01	Un	60
	Time delay	0.000	300.000	0.001	s	0.02
	Operating angle	0	359	1	° (deg)	90
	Halfcone angle	10	170	1	° (deg)	90

(*) Optional depending on model

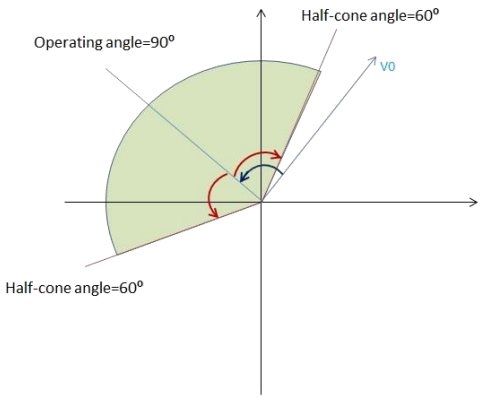
(1) No, Forward, Reverse

To perform the directional detection, the residual voltage is used as polarization magnitude and the residual current as an operating magnitude. The intervention sector in forward direction is defined in the following way: the operating angle is rotated anticlockwise from the negative residual voltage, -V0 which gives us the maximum torque direction. A cone is drawn, with the half-cone angle adjusted, over this maximum torque direction.

In the same way, the intervention sector in reverse direction is defined in the following way: the operating angle is rotated anticlockwise from the positive residual voltage, V0 which gives us the maximum torque direction. A cone is drawn, with the half-cone angle adjusted, over this maximum torque direction.

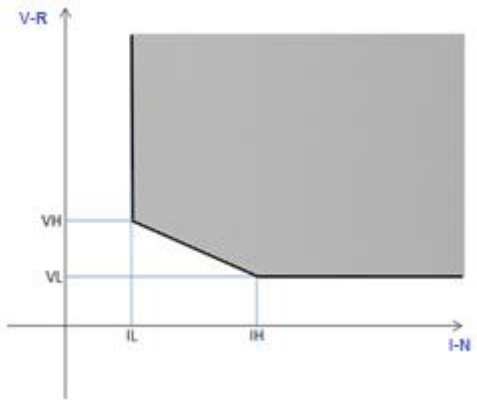


Forward



Inverse

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



Working area characteristic of I-N and V-R

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

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

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

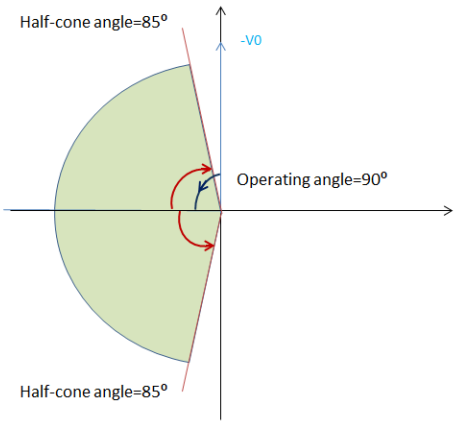
The actuation time is accurate to ±5%, o ±30ms, whichever is higher, of the theoretical actuation time.

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

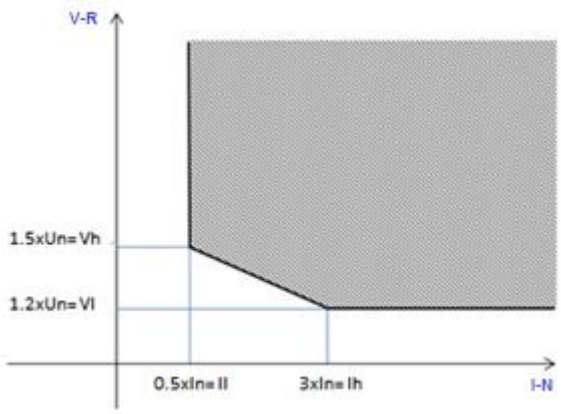
The directional operation area will be defined according the following characteristic:



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	V-R Voltage

The working area will be defined according the following characteristic:



4.10 Function 67NI. Inverse time directional isolated calculated neutral overcurrent

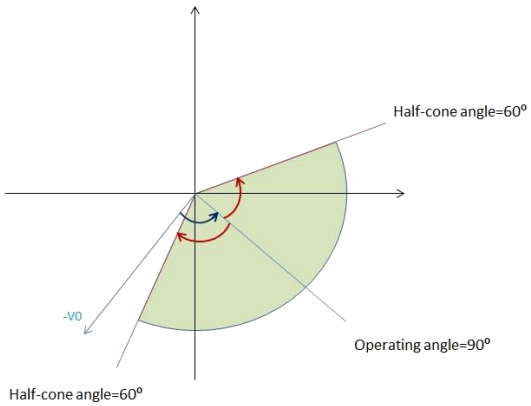
This function is based on two supervisions: The analogue to the one that uses the 67GI to check that the residual current is inside the defined area by the settings of directionality, operation angle and halfcone, and the second supervision of the modules of the residual voltage and current. This protection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

Function	Description	Minimum	Maximum	Step	Unit	Default
67NI (*)	**Inverse time directional isolated calculated neutral overcurrent**					
	Function enable	-	-	No/Alarm/Trip	-	No
	Directionality	-	-	(1)	-	No
	Low current Tap	0.050	30.000	0.001	In	1
	Low Voltage Tap	0.08	2.00	0.01	Un	30
	High Current Tap	0.050	30.000	0.001	In	2
	High Voltage Tap	0.08	2.00	0.01	Un	60
	Time delay	0.000	300.000	0.001	s	0.02
	Operating angle	0	359	1	° (deg)	90
	Halfcone angle	10	170	1	° (deg)	90

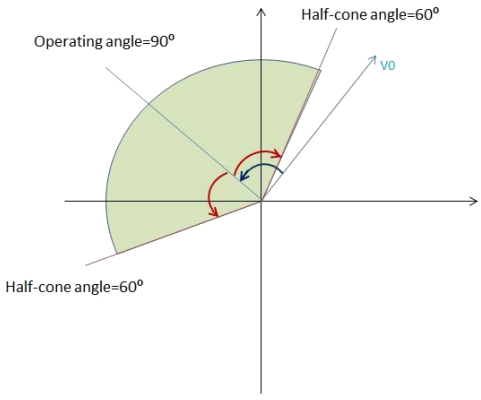
(*) Optional depending on model

(1) No, Forward, Reverse

To perform the directional detection, the residual voltage is used as polarization magnitude and the residual current as an operating magnitude. The intervention sector in forward direction is defined in the following way: the operating angle is rotated anticlockwise from the negative residual voltage,-V0 which gives us the maximum torque direction. A cone is drawn, with the half-cone angle adjusted, over this maximum torque direction. In the same way, the intervention sector in reverse direction is defined in the following way: the operating angle is rotated anticlockwise from the positive residual voltage,V0 which gives us the maximum torque direction. A cone is drawn, with the half-cone angle adjusted, over this maximum torque direction.

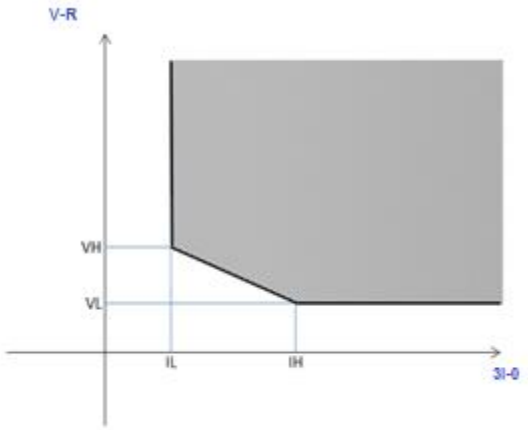


Forward



Inverse

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



Working area characteristic of 3I-0 and V-R

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

The actuation time is accurate to ±5%, o ±30ms, whichever is higher, of the theoretical actuation time.

The following table shows the operating and polarization magnitudes used for this function.

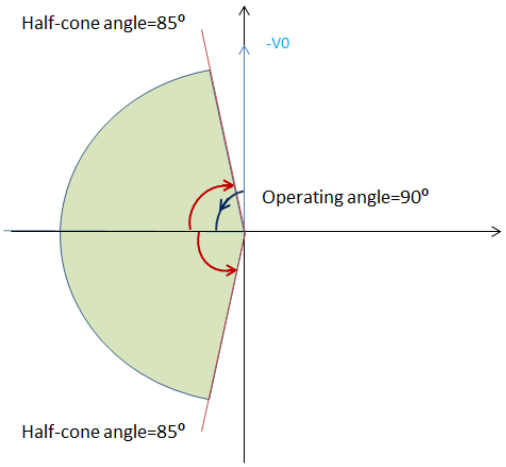
Neutral	Operating magnitude	Polarization magnitude
Neutral	3I-0 Current	V-R Voltage

Application example:

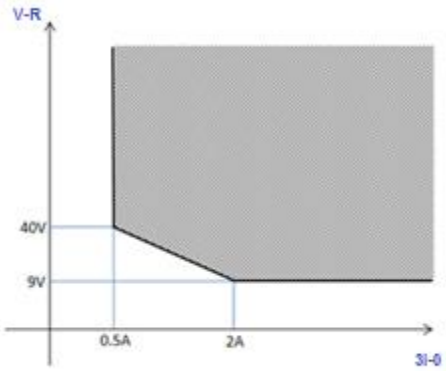
67NI parameters:

- 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 the following characteristic:



The working area will be defined according the following characteristic:



4.11 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 (*)	**Phase balance current protection**					
	Function Enable	-	-	No/Alarm/Trip/SHB Trip	-	No
	Current Tap	0.050	20.000	0.001	xIn	5.000
	Time delay	0.020	300.000	0.001	s	0.200
	Block Threshold	5	50	1	%	20

(*) Optional depending on model

4.12 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)	0.05	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

(*) Optional depending on model

(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	0.05	1.00	0.01	-	1.00
IEEE	Time Multiplier	0.10	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 (TMS) 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 is instantaneous in both cases.

If the unit operates as defined time, the accuracy of the Time Delay is equal to the set time delay ±35 ms 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 ±30 ms or ±5% (whichever is greater). The curves used are IEC 60255-151 and IEEE, which are described in the corresponding section.

4.13 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 protection**					
	Function Enable	-	-	No/Alarm/Trip	-	No
	Current tap	15	100	1	%	50
	Time Delay	0.020	300.000	0.001	s	0.200

(*) Optional depending on model

This protection detects the percentage phase unbalance due to an open phase condition. It considers the measurement I2/I1 in 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 preset input and deactivates at 95%. The reset is instantaneous.

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

4.14 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	ζ heating	1
	Alarm	20	99	1	%	80

(*) Optional depending on model

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

Thermal image is calculated based on 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 next equation:

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

Tripping time accuracy is the 5% over the theorical time.

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

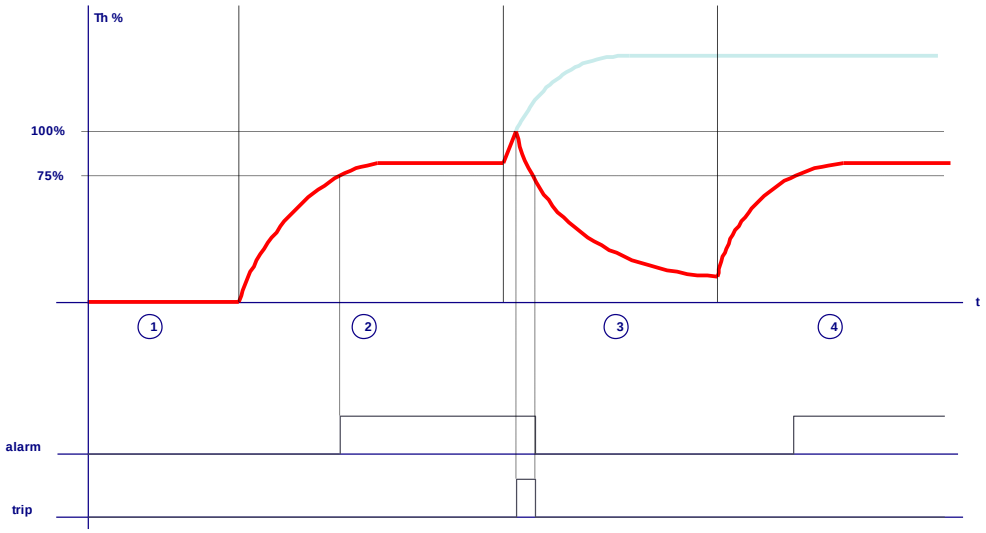
Overload function trips when thermal image reaches the value of 100%. This value is got when the flow current is equal to the adjusted tap for the thermal image.

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

NOTE: Heating constant symbol changes depending on the language selected. The symbols are ζ for language option A and ϕ for language option E.

4.14.1 Thermal overload measurement evolution graphic

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



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

Zone 1: The machine is deenergized for a long time. Thermal image is 0%.

Zone 2: We supply the machine with the nominal current. Thermal image evolutions so as to get the value of the thermal balance corresponding to one time the nominal current Th = $(I/It)^2$ = 82%. The time that it takes in getting the thermal balance depends on the adjusted heating constant.

Zone 3: Once reached the thermal image corresponding to the application of one time the nominal current, we apply 1.2 times the nominal current. Therma image will evolution so as to get the thermal balance corresponding to 1.2 times the nominal current Th = $(I/It)^2$ = 119%. This would occur if we had the permission of the thermal function disabled. If the permission is disabled, 49 protection function performs when the thermal image reaches the value of 100%. Once tripped, current stops and thermal image is getting cool based on the cooling constant.

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

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

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.

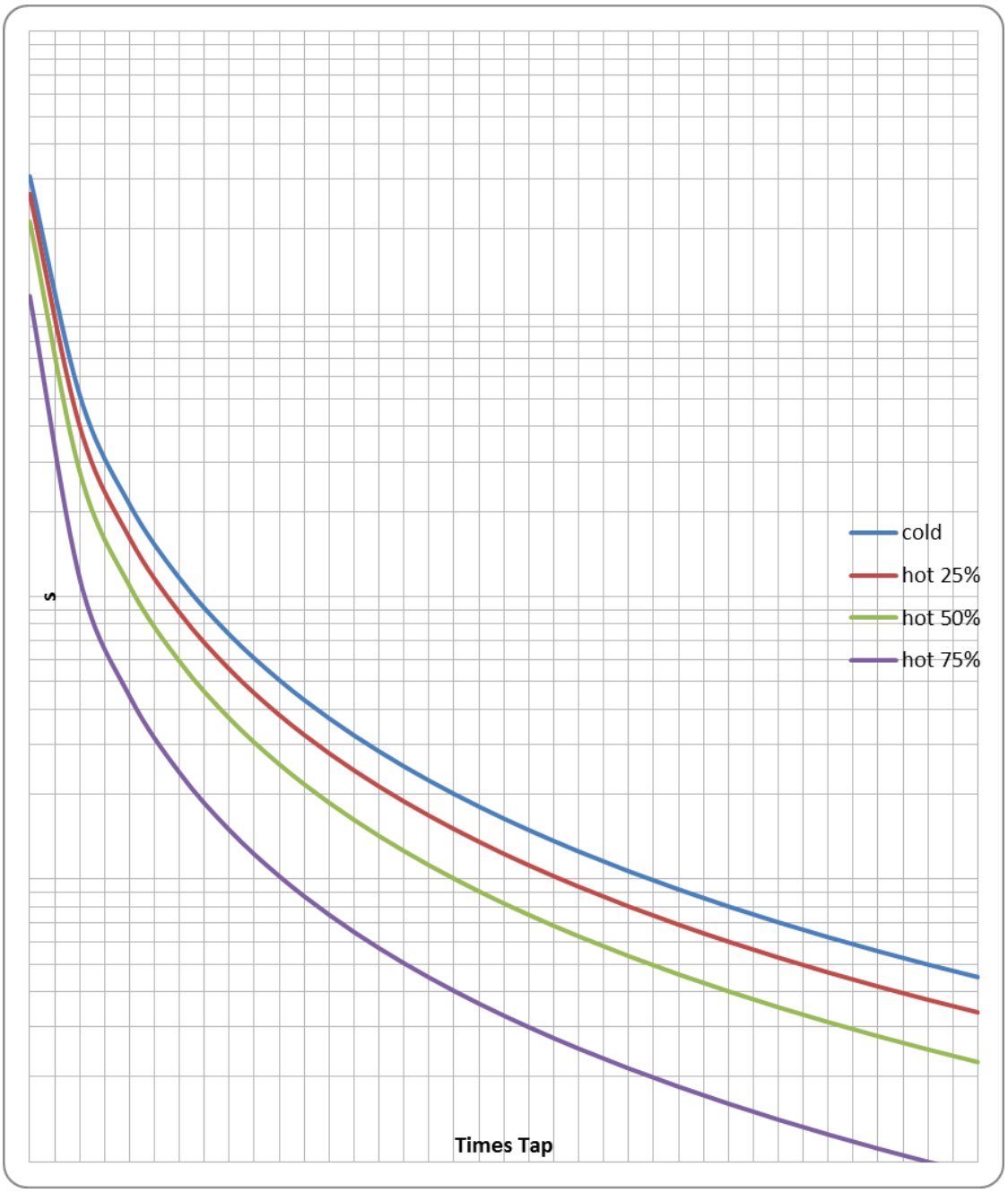
4.14.2 Thermal overload with memory

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

4.14.3 Thermal overload measurement display. Reset.

Thermal image measurement is displayed on Measurement menu. Thermal image value reset is possible in Commands menu or thought communications (Reset TI). This command reset the value of the thermal image to the value set in the alarm level.

4.14.4 Thermal protection curves



This is the thermal curve for ζ = 3 minutes.

4.15 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	0.000
	Time delay	0.060	300.00	0.001	s	0.200

(*) Optional depending on model

The setting “Minimum level” indicates the minimum level of current it 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 from the operating current flowing through the relay, so if the phase current drops below 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 exceeds the point of current pick-up.

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

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

4.16 Function 59G. Instantaneous measured neutral overvoltage

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

Function	Description	Minimum	Maximum	Step	Unit	Default
59G-1 (*) 59G-2 (*)	**Instantaneous calculated neutral overvoltage (Bus bar)**					
	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

(*) Optional depending on model

“Un” will be ***Nominal Voltage P-N*** (available in measurements settings).

The time delay is independent from the measured phase voltage through the relay, if neutral voltage exceeds 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 measured value of the phase voltage drops below the voltage pick-up.

The function activates at 100% of the preset input and deactivates at 95%. The reset time is configurable.

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

4.17 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(A^2)	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	300.000	0.001	s	0.10

(*) Optional depending on model

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

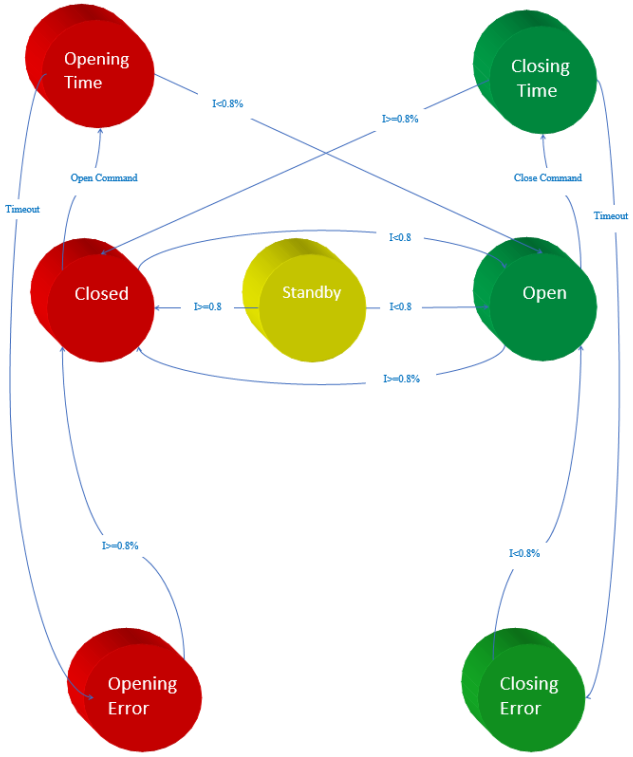
This function allows to monitor the status of the circuit breaker and to perform preventive maintenance.

The following statuses are associated with this function:

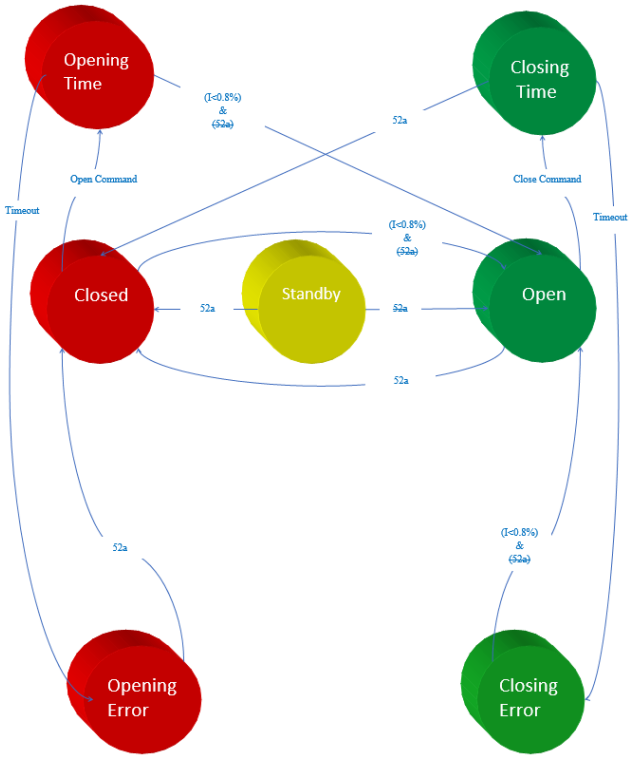
Function	Status	Description
52	Startup	These are the different statuses of the circuit breaker automatic control. The function only is initialized on Start when the relay is switched on. If the relay doesn't lose power supply, the last state is maintained.
	Error	
	Open	
	Opening Time	
	Opening Error	
	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 alarm (I2t 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.

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).

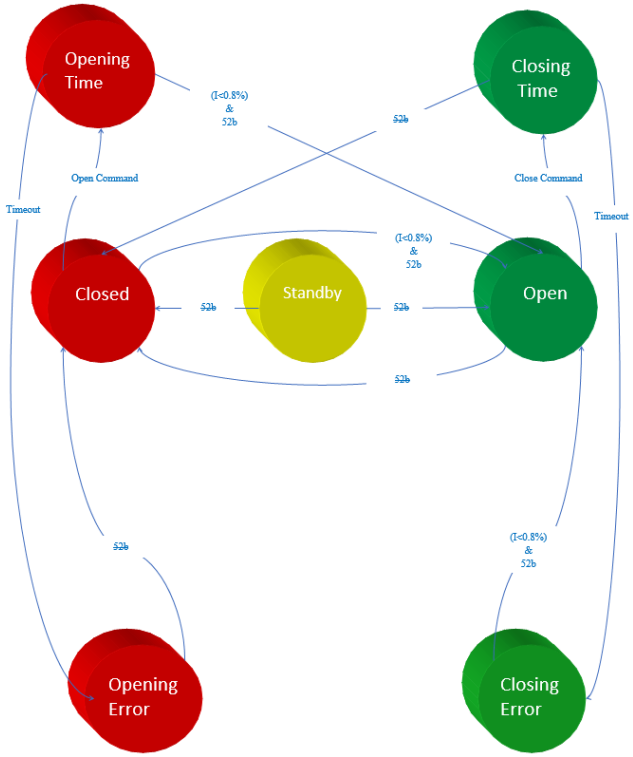
If **no breaker contacts** are used, the monitoring of the circuit breaker is made through the current measurement. This is, if less than 0.8% of rated current is detected it is considered the breaker is open and if more than 0.8% of rated current is available, it is considered the breaker is closed.



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:

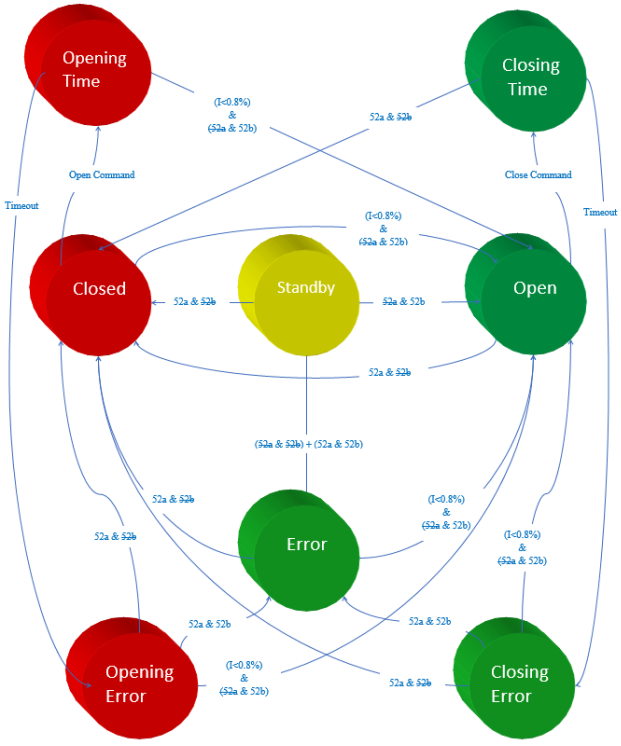


If only the circuit breaker **52b contact** is available, it should be wired to the corresponding physical input. This physical input is then assigned to the "52b Input" logical input. The 52a logical input is calculated internally as the negative of 52b. The circuit breaker performance is shown in the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



4.17.1 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.

4.17.2 'Openings Number' counter.

SILA 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 which was already working.

4.17.3 '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 detected current is lower than nominal current, nominal current is used to calculate the accumulation.

It is used with "Openings Number" counter, as an estimation of aging of circuit breaker.

As primary amperes are accumulated, is indispensable to set correctly 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 adjusted value, state 'Accumulated amperes' 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 which was already working.

4.17.4 Maximum openings in a time frame

As well as counting the number of times the circuit breaker opens, the SILA equipment 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.

4.18 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**					
	Reclose Number	0	4	1	-	0
	Reset Time	0.020	2000.000	0.001	s	5.000
	Reclose 1 time	0.020	2000.000	0.001	s	0.250
	Reclose 2 time	0.020	2000.000	0.001	s	2.00
	Reclose 3 time	0.020	2000.000	0.001	s	2.000
	Reclose 4 time	0.020	2000.000	0.001	s	20.000
	Hold Enable	-	-	No/Yes/No time	-	No
	Hold time	0.000	2000.000	0.001	s	0.200
	Safe time	0.020	2000.000	0.001	s	30.000

(*) Optional depending on model

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**
Unblock Command USB COM	OR
Unblock Command HMI	
Unblock 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.

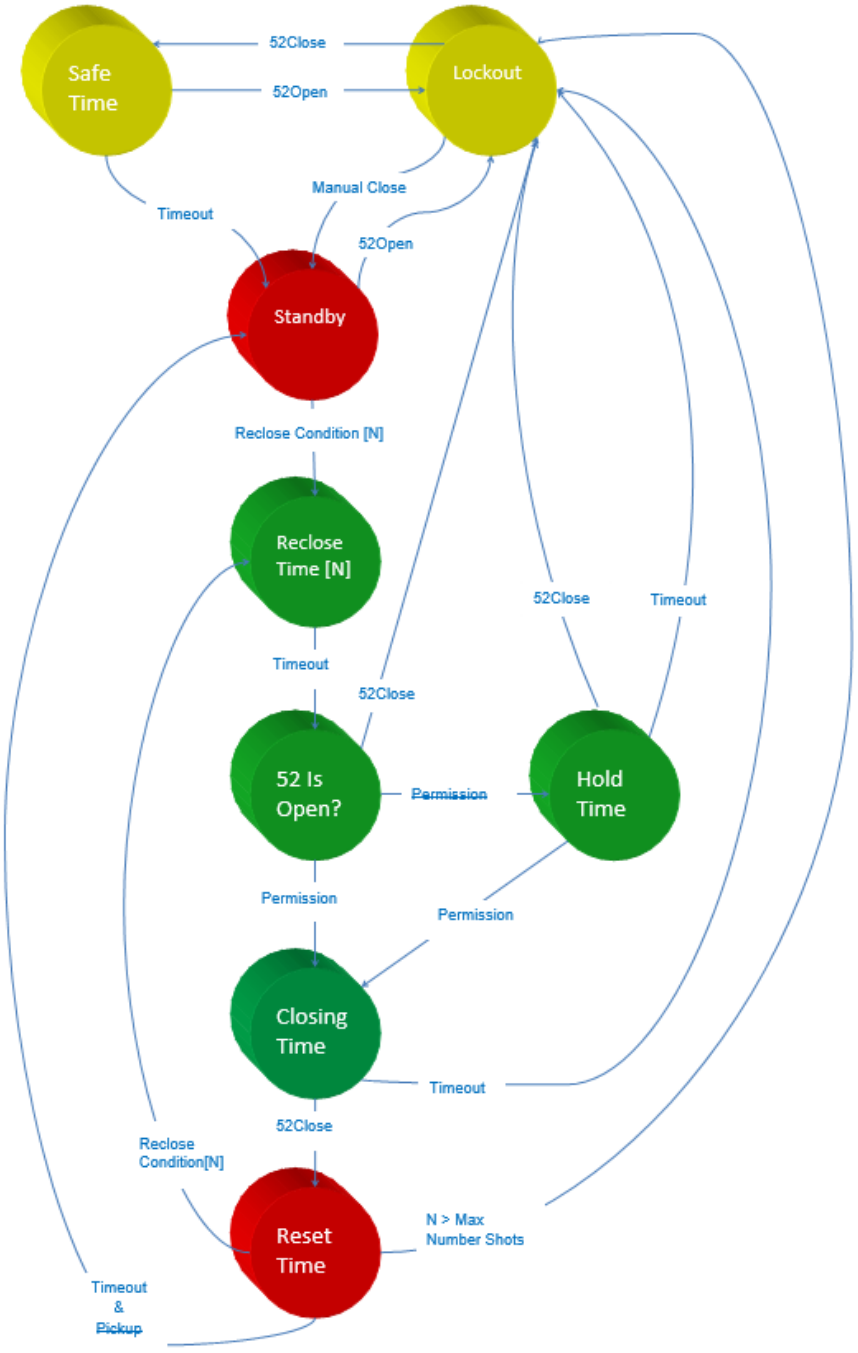
In all these cases, the equipment stores the block situation in the non-volatile memory, as the last command must be known for a possible re-start.

The logic signal **Hot Line Tag** also affects the behaviour of this function. 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.

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

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.

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.

On Lockout, 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 79 Standby
79N2 Start	General Trip AND 79 Reclose Nº 1
79N3 Start	General Trip AND 79 Reclose Nº 2
79N4 Start	General Trip AND 79 Reclose Nº 3

4.18.1 Counter to record the number of recloses

The SIL-A relay is fitted with a counter that records the number of recloses.

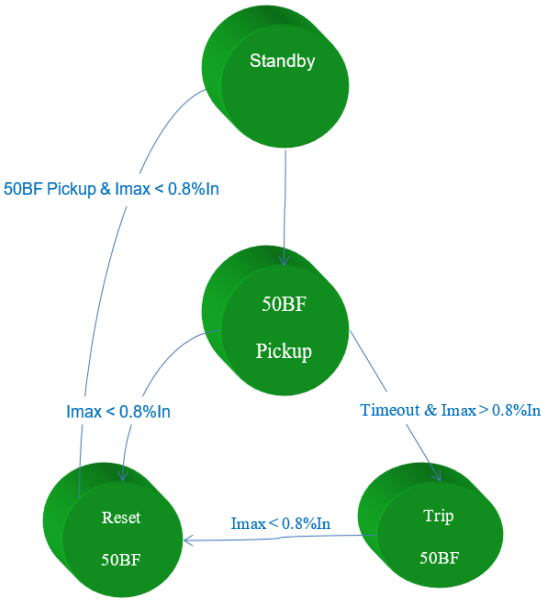
4.19 Function 50BF. Circuit Breaker failure

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

Group	Description	Minimum	Maximum	Step	Unit	Default
50BF (*)	**Circuit breaker failure**					
	Function Enable	-	-	No/Yes	-	No
	Time Delay	0.020	1.000	0.001	s	0.200

(*) Optional depending on model

The following automaton describes the open failure function:



When the logic signal '50BF Star' 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 via 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 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 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.

4.20 Function 74TCS. Trip circuit supervision

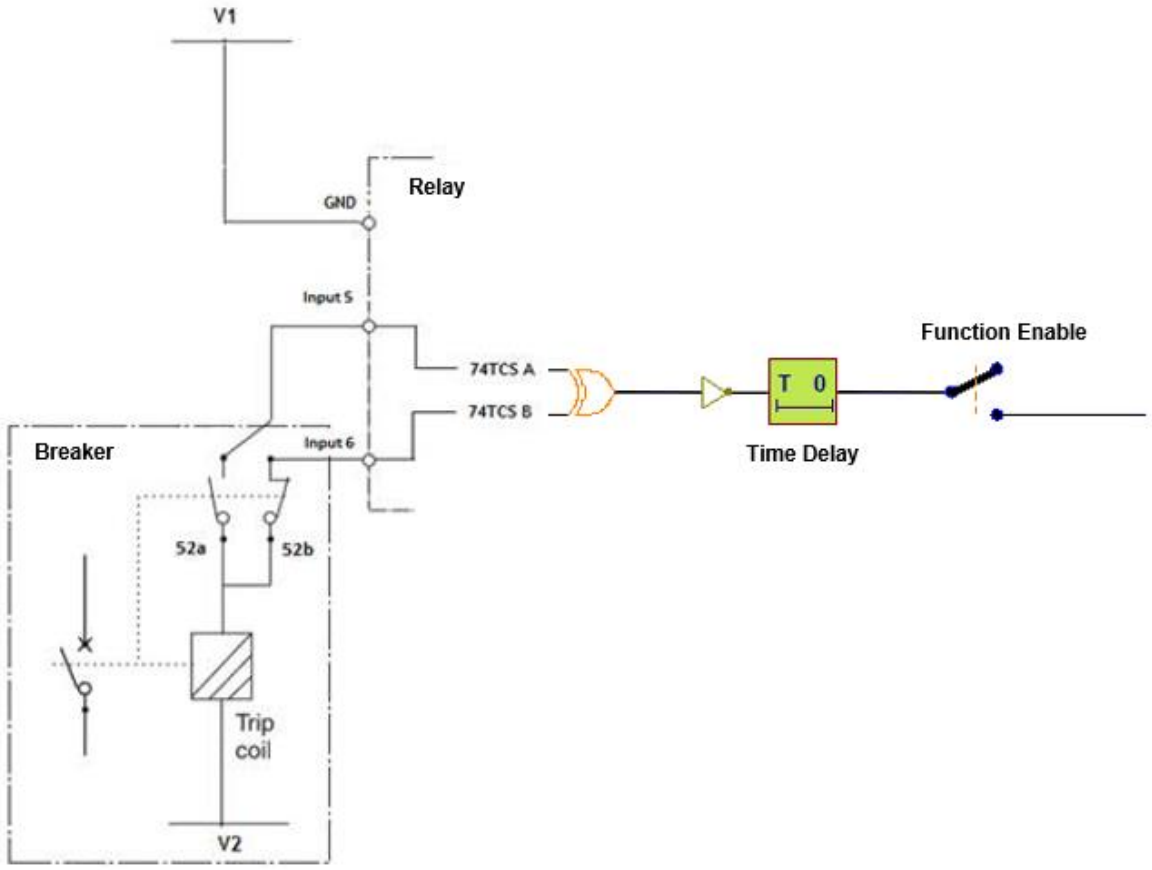
This control function can be set by using the following parameters:

Group	Description	Minimum	Maximum	Step	Unit	Default
74TCS (*)	**Trip circuit supervision**					
	Function Enable	-	-	Yes/No	-	No
	Time Delay	0.020	300.000	0.001	s	0.2

(*) Optional depending on model

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

The schematic for this function is as follows:



The accuracy is equal to the set time delay ±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 to an alarm, logic alarm and outputs through the configuration.

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**'.

4.21 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	1	-	4
	No Load time	0.020	300.000	0.001	s	15.000
	Cold Load Time	0.020	300.000	0.001	s	15.000

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.

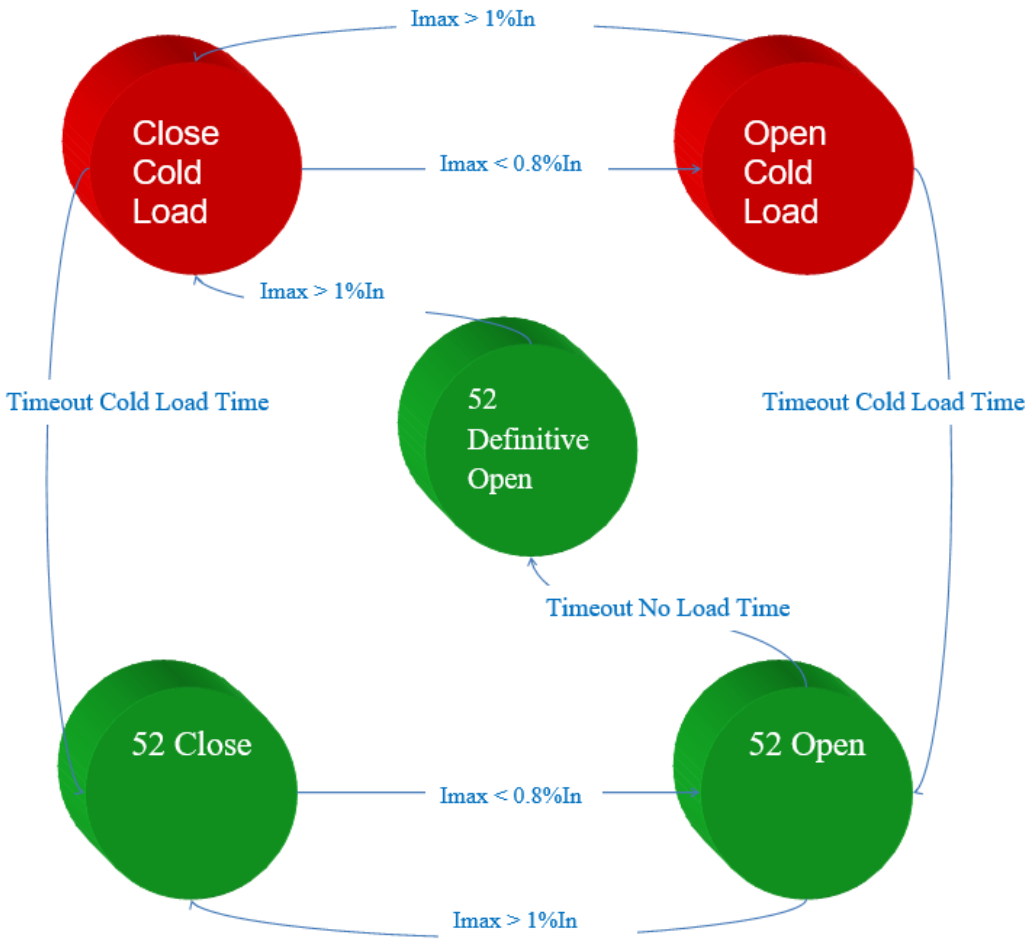
The controller has five states. In three of the states, the green ones on the diagram, the relay works with the usual setting group (the group adjusted in the general settings), and in the other two, the red ones, with the new setting group.

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 level, the line is considered open.

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.

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



4.22 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

(*) Optional depending on model

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 to an alarm, logic alarm and outputs through the configuration.

4.23 Function TB. Trip Block protection for switch disconnector

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

Group	Description	Minimum	Maximum	Step	Unit	Default
TB (*)	**Trip block for switch disconnector**					
	Function Enable	-	-	Yes/No	-	No
	Current Tap	1.500	30.000	0.001	I nominal	7.000

(*) Optional depending on model

Some transformation centers use a combination of switchgear and fuses for cutting out.

Switchgears have a limited opening current, so the fuses are responsible for cutting out the circuit for high current short circuits, as the switchgear would be destroyed if opened in this situation. In order to deal with these situations, tripping is blocked when the phase current exceeds a pre-set value.

4.24 Function SHB. Second Harmonic Blocking

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

(*) Optional depending on model

The second harmonic blocking is used to avoid an undesirable behavior due to inrush current when energizing a machine like a transformer or a generator.

In order to avoid these undesirable trips, if the second harmonic percentage is higher than the pre-set value once it is below the current tap, the trip will be kept blocked during the time set in reset time parameter.

The function picks-up at 100% of the adjusted input and the dropout is at 95%. The reset time will depend on the adjusted reset time setting.

There is also a 2nd harmonic blocking threshold. This setting allows to block this function if the fundamental current exceeds the value specified in the setting.

The SHB will only be applied in functions that have this feature. When the Function Enable of these protection functions is set to ‘SHB Trip’, the second harmonic blocking will supervise the protection function. As a result, tolerances for tripping times could be higher than indicated on the functions.

If the time is set from 0.00 to 0.02 seconds the it should apply +/50 ms respect to the setting. If the time delay setting is higher than 0.02 seconds, the time declared in the manual will apply with or without SHB permission (+/-35 ms).

4.25 Function 68. Zone selection interlocking (ZSI)

The relay is provided with configurable outputs, inputs and logic signals which can be used to implement zone selection interlocking feature.

Configuration:

FEEDER RELAY

Output 1: pickup of function 50 or 51

Output 2: pickup of function 50N/50G or 51N/51G

SUPPLY RELAY

Input 1: block the trip of phase overcurrent functions

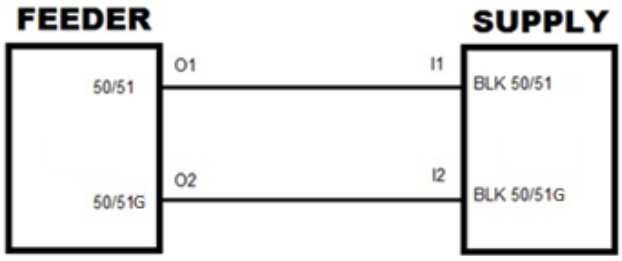
Input 2: block the trip of neutral overcurrent functions

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

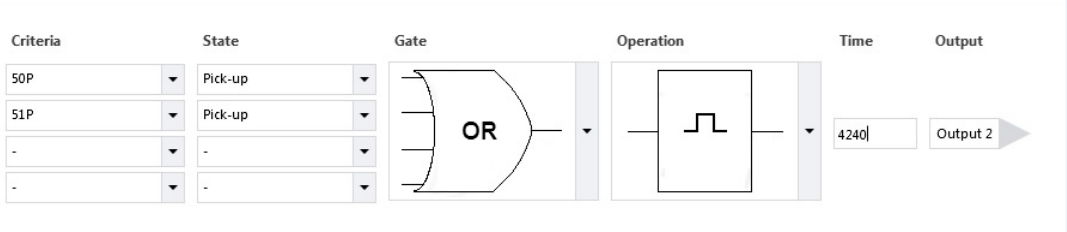
Relays with supply functionality, block the trip of functions 50 and 51 when detect the activation of input 1 and block the trip of functions 50N/50G and 51N/51G when detect the activation of input 2.

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.

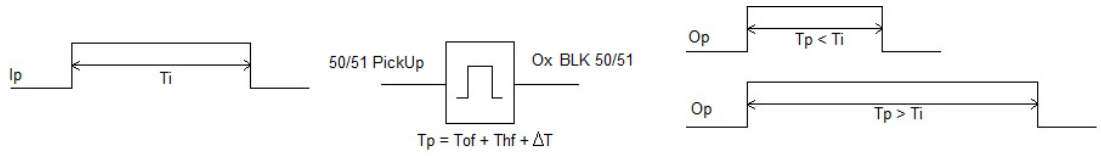
Once the physical connections are made, logical signals must be configured to physical inputs and outputs:



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 feeder's functions (time delay setting), plus the trip holding time (in SIL-A this time is around 200 ms), plus the security time (to ensure the signal has dropped off).

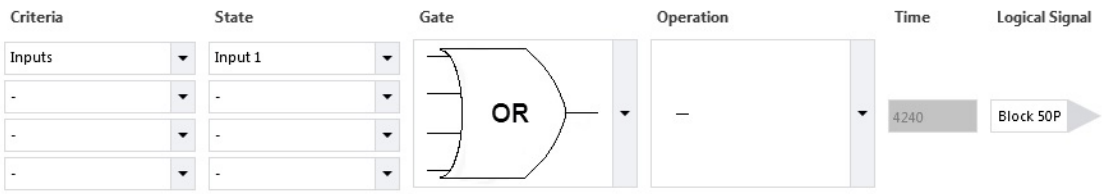


The PULSE operation provides a pulse signal that will block the supply functions enough time to allow the feeder relay to trip, to open its breaker and to make the fault disappear. The pulse operation guarantees that the output of the pulse will be activated the adjusted time, once the input of the pulse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



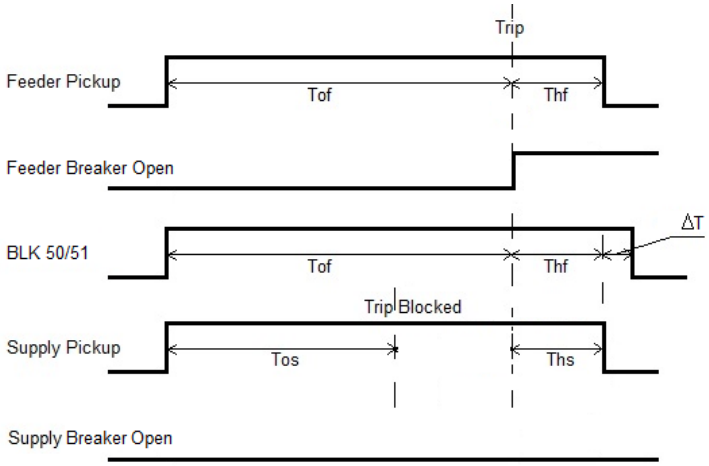
Tp = Time of the pulse (ms)
Tof = Time of operation of the feeder (ms)
Thf = Time of trip holding of the feeder (200ms)
ΔT = Security time (aproximately 40ms)
Tos = Time of operation of the supply (ms)
Ths = Time of trip holding of the supply (200ms)

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

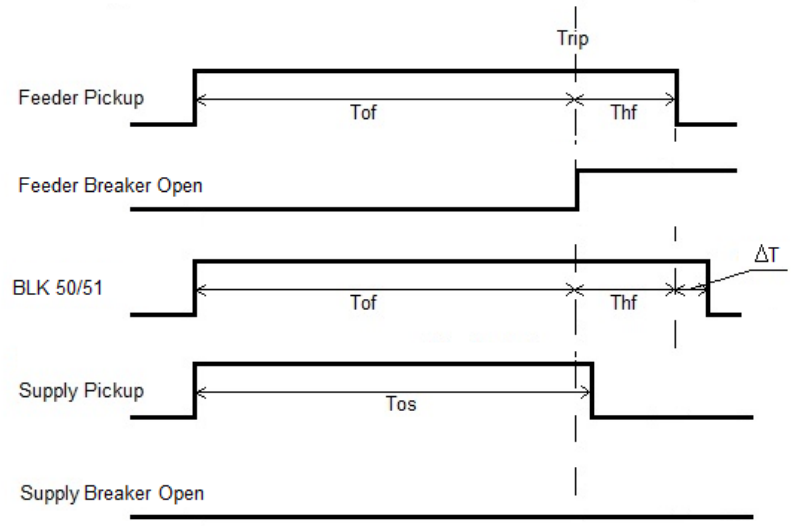


Next, different cases will be described.

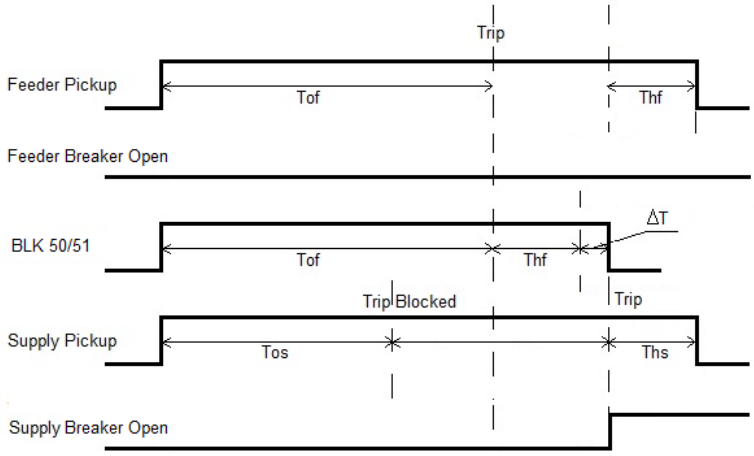
- The feeder and supply will trip their functions as they see the fault. Supply's time of operation is shorter than feeder's time, so the feeder will open its breaker, making the fault disappear, and it will block the supply trip output preventing the opening of the supply's breaker.



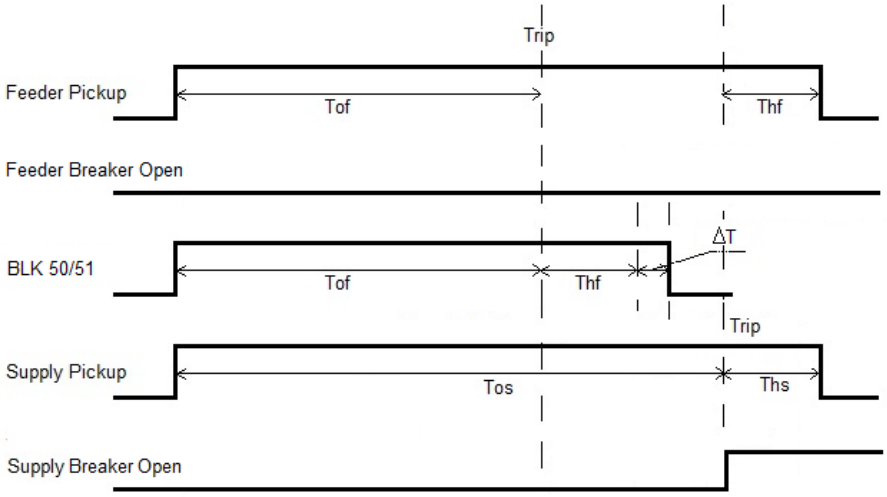
- The feeder and supply will trip their functions as they see the fault. Supply's time of operation is larger than feeder's time, so the feeder will open its breaker, making the fault disappear, and block the supply function. The supply will not trip because the feeder makes the fault disappear before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



5 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 to settings involves resetting the functions, regardless if they are active or not.

5.1 Measurements

Function	Description	Minimum	Maximum	Step	Unit	Default
	Measurements					
	Frequency	50	60	50/60	Hz	50
	Phase Nominal Current	1	5	1/5 (1)	A	1
	Neutral Nominal Current	1	5	1/5 (1)	A	1
	CT Phase Ratio	1.0	3000.0	0.1	-	100.0
	CT Neutral Ratio	1.0	3000.0	0.1	-	100.0
	Nominal Voltage P-P (*)	100.0	130.0	0.1	V	100
	VT Neutral Voltage (*)	1.0	3000.0	0.1	-	100
	IA Deadband	0.03	0.5	0.01	A	0.10
	IB Deadband	0.03	0.5	0.01	A	0.10
	IC Deadband	0.03	0.5	0.01	A	0.10
	IN Deadband	0.03	0.5	0.01	A	0.10

(1) The phase and neutral CT nominal current setting allows to choose between 1A or 5A if model SILA00xxxxxxxx is selected. If the model is SILA11xxxxxxxx, the nominal current is fixed to 1A.

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

The phase and neutral CT transformation ratio setting allows the measurements of the primary values from the protection transformer to be showed.

5.2 DFR

Function	Description	Minimum	Maximum	Step	Unit	Default
	DFR					
	Num. of Records	-	-	25x60, 5x260, 100x15, 50x30	cycles	25x60 cycles
	Cycles Prefault	1	8	1	cycles	8

5.3 LDP

Function	Description	Minimum	Maximum	Step	Unit	Default
	LDP					
	Current Level	0.01	1	0.001	I nominal	0.4
	Interval Time	1	60	1	min	1

5.4 General

Function	Description	Minimum	Maximum	Step	Unit	Default
	General settings					
	Identification	-	-	-	-	my IED
	Serial Number	-	-	-	-	*(*)*
	Language	-	-	-	-	English
	Active Settings Group	1	4	1	-	1

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

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

Language. The SIL-A device has the capacity to 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 groups used by default can be selected with this parameter.

5.5 Inputs

Function	Description	Minimum	Maximum	Step	Unit	Default
	Inputs					
	Debounce time	5	128	1	ms	5 ms

5.6 USB communication

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

5.7 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
	Baudrate	4800	115200	4800, 9600, 19200, 38400, 57600, 115200	bauds	19200
	Serial Setting	-	-	8-N-1, 8-E-1, 8-0-1, 9-N-1, 8-N-2, 8-E-2, 8-0-2, 9-N-2	-	8-N-1

5.7.1 MODBUS RTU

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

5.7.2 DNP3.0 SERIAL

Function	Description	Minimum	Maximum	Step	Unit	Default
	DNP3.0 Communications					
	Slave address	1	247	1	-	3
	Master address	1	247	1	-	1

5.7.3 IEC 60870-5-103

Function	Description	Minimum	Maximum	Step	Unit	Default
	IEC 60870-5-103 Communications					
	Slave address	1	247	1	-	3

5.8 Rear TCP Communication

Function	Description	Minimum	Maximum	Step	Unit	Default
	Rear TCP Communications					
	Protocol	-	-	Modbus TCP, IEC 60870-5-103 or DNP3.0 TCP		Modbus RTU
	IP Address	1.0.0.1	223.255.255.254	-	-	192.168.200.26
	Subnet	255.0.0.0	255.255.255.252	-	-	255.255.255.0
	Gateway	1.0.0.1	223.255.255.254	-	-	192.168.200.1

5.8.1 MODBUS TCP

Function	Description	Minimum	Maximum	Step	Unit	Default
	Modbus TCP Communications					
	Slave address	1	247	1	-	3
	Port	1	65535	1	-	502

5.8.2 DNP3.0 TCP

Function	Description	Minimum	Maximum	Step	Unit	Default
	DNP3.0 TCP Communications					
	Slave address	1	247	1	-	3
	Master address	1	247	1	-	1
	Port	1	65535	1	-	20000

5.8.3 IEC 60870-5-104

Function	Description	Minimum	Maximum	Step	Unit	Default
	IEC 60870-5-104 Communications					
	Slave address	1	247	1	-	3
	Port	1	65535	1	-	2404

6 SETTINGS GROUPS

SIL-A is provided with four settings groups. The settings group which is active at a specific moment can be modified in two ways:

- Changing the active Settings group. In the general settings, inside the general menu, there is a setting which establishes which settings group is active.

- By means of two inputs. Four possibilities are defined.

00	This situation is defined by the active settings group.
01	Settings group 1
10	Settings group 2
11	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.

If the use of both inputs is not required, then one can be used, but depending on which is used, operation can be done with Settings group 1 or Settings group 2.

Settings group 4 can be used just from the active settings group defined in the general menu.

7 AVAILABLE CURVES

7.1 IEC 60255-151 Curves

The SILA relay complies with the curves shown in standard IEC60255-151:

- Standard Inverse
- Very Inverse
- Extremely Inverse
- Long time inverse
- Short Time Inverse

There is a general mathematical equation that defines the time in seconds as a function of the current:

$$t = \frac{A \times D}{V^P - Q} + B \times D + K$$

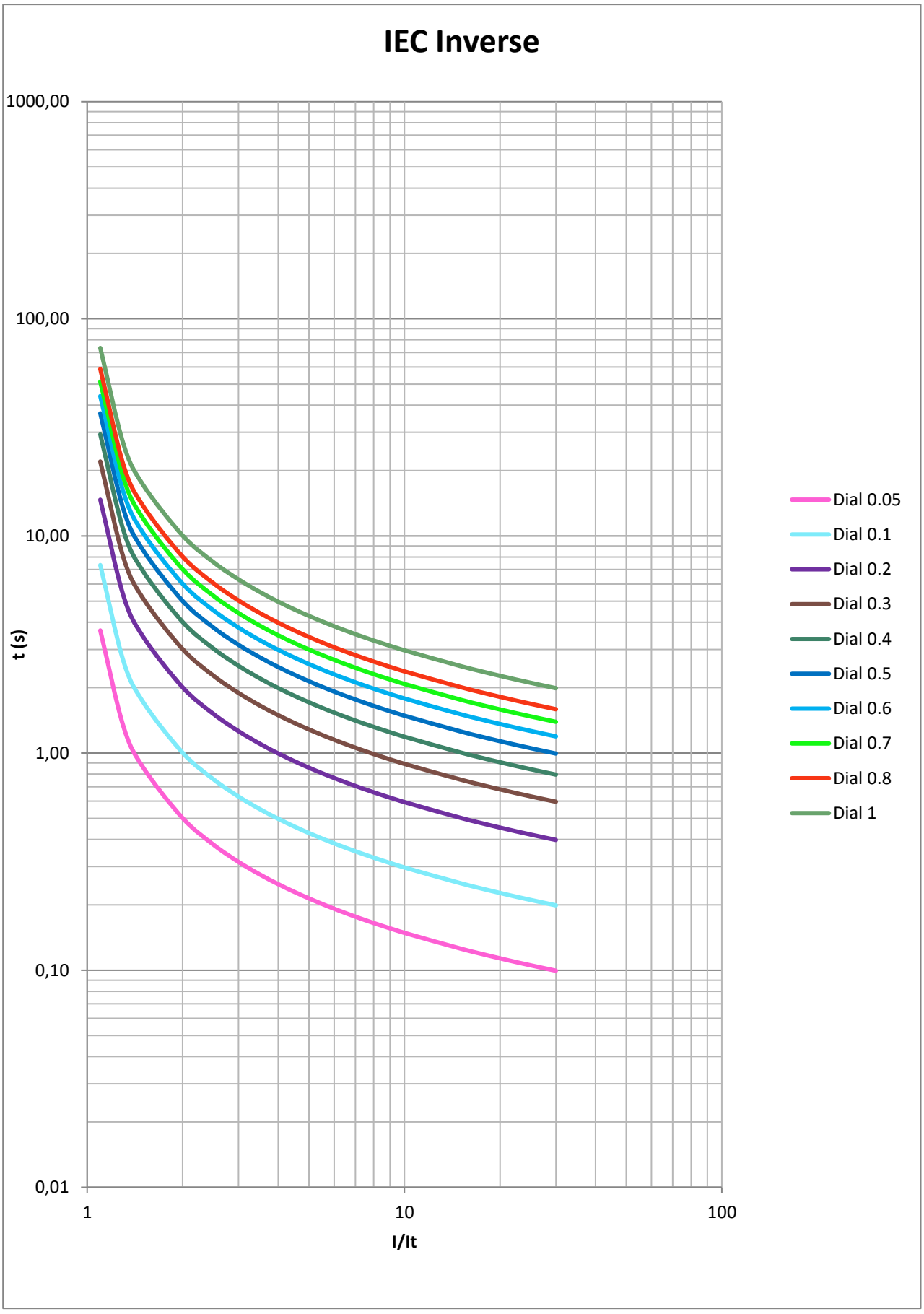
Where:

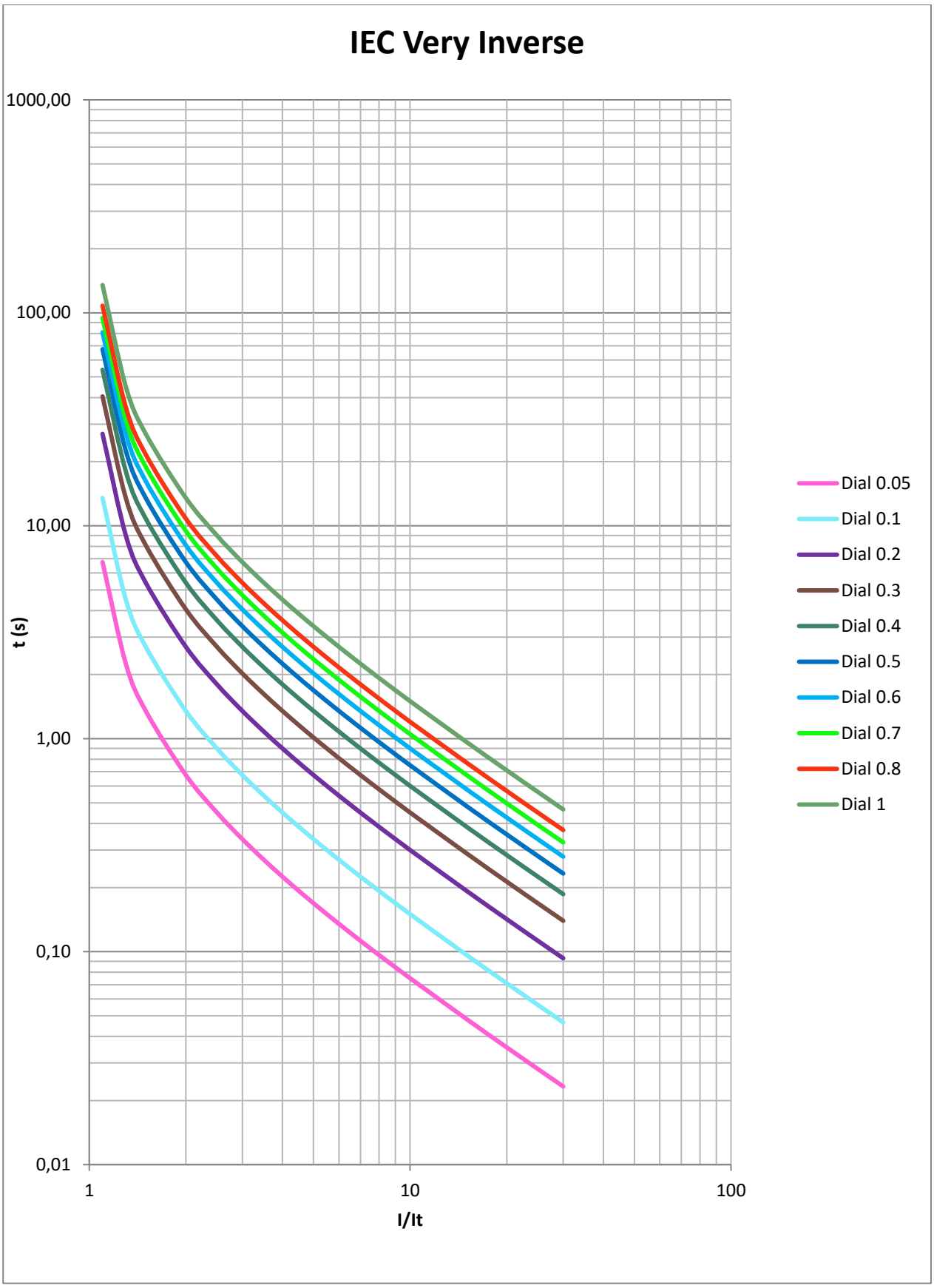
$$V = \frac{I}{I_{adjusted}}$$

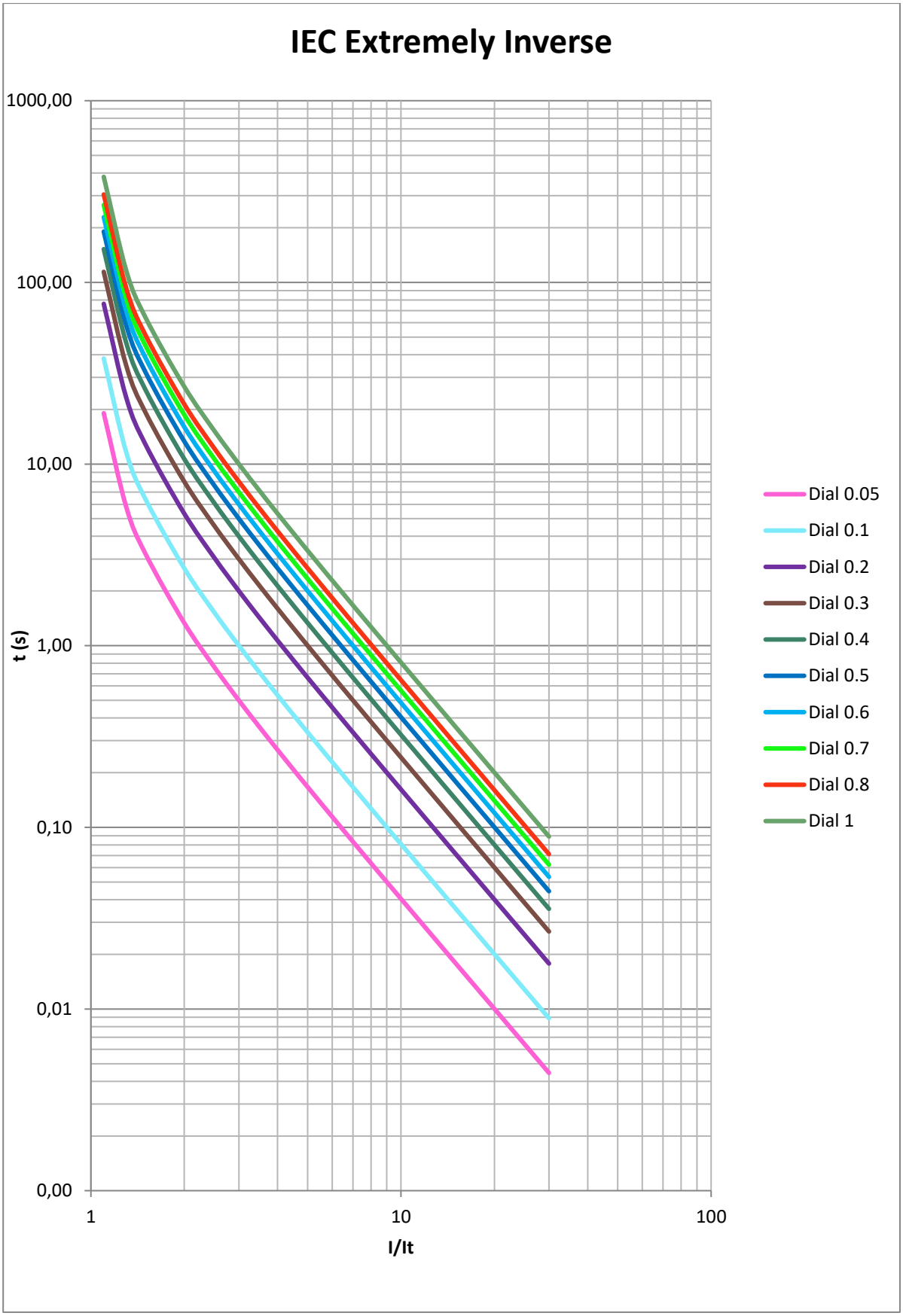
Parameters	A	P	Q	B	K
Long Time Inverse	120	1	1	0	0
Short Time Inverse	0.05	0.04	1	0	0
Ext. Inverse	80	2	1	0	0
Very Inverse	13,5	1	1	0	0
Standard Inverse	0.14	0.02	1	0	0

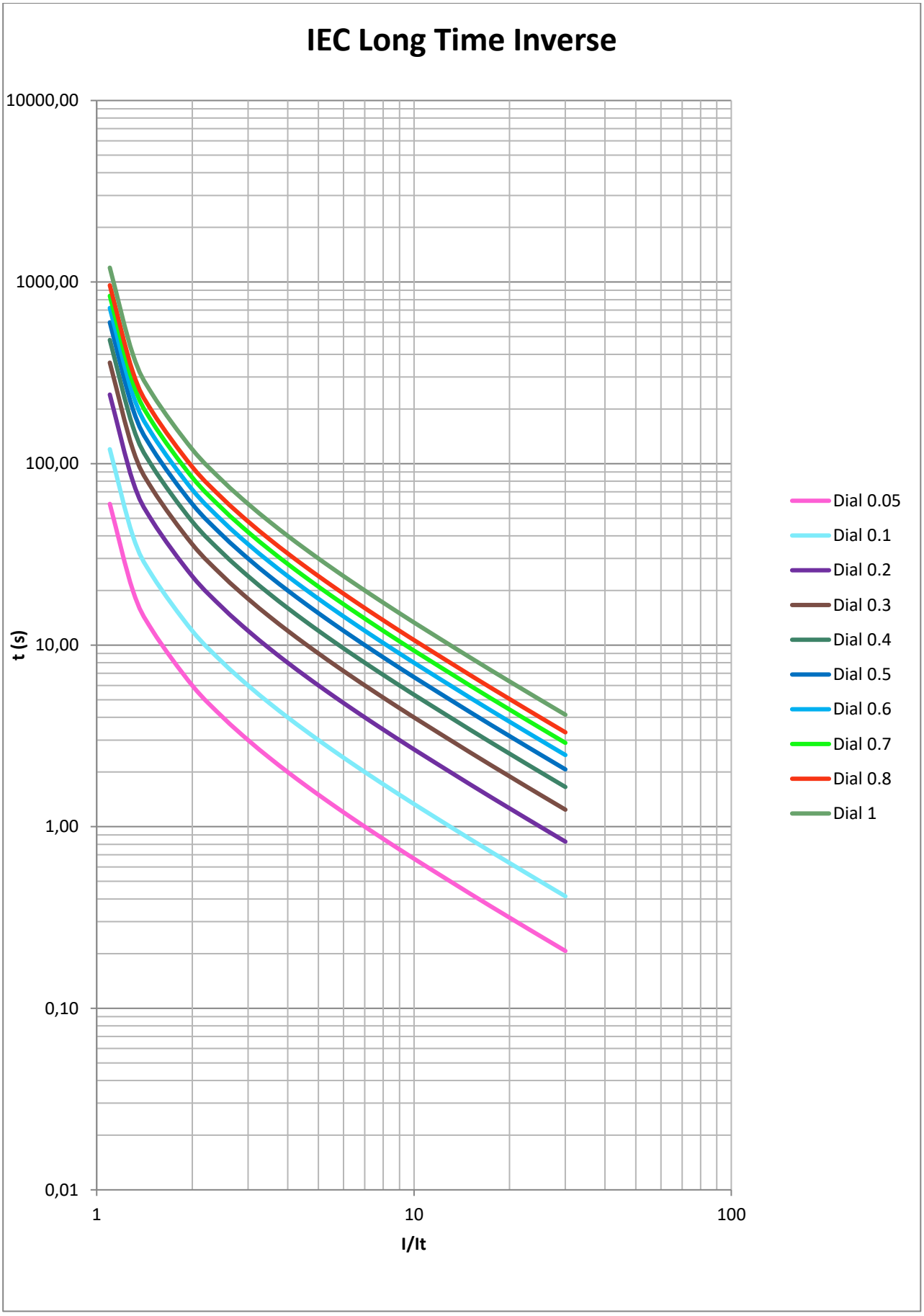
The curve can mode from its axis using the D time selection device, which the user can adjust.

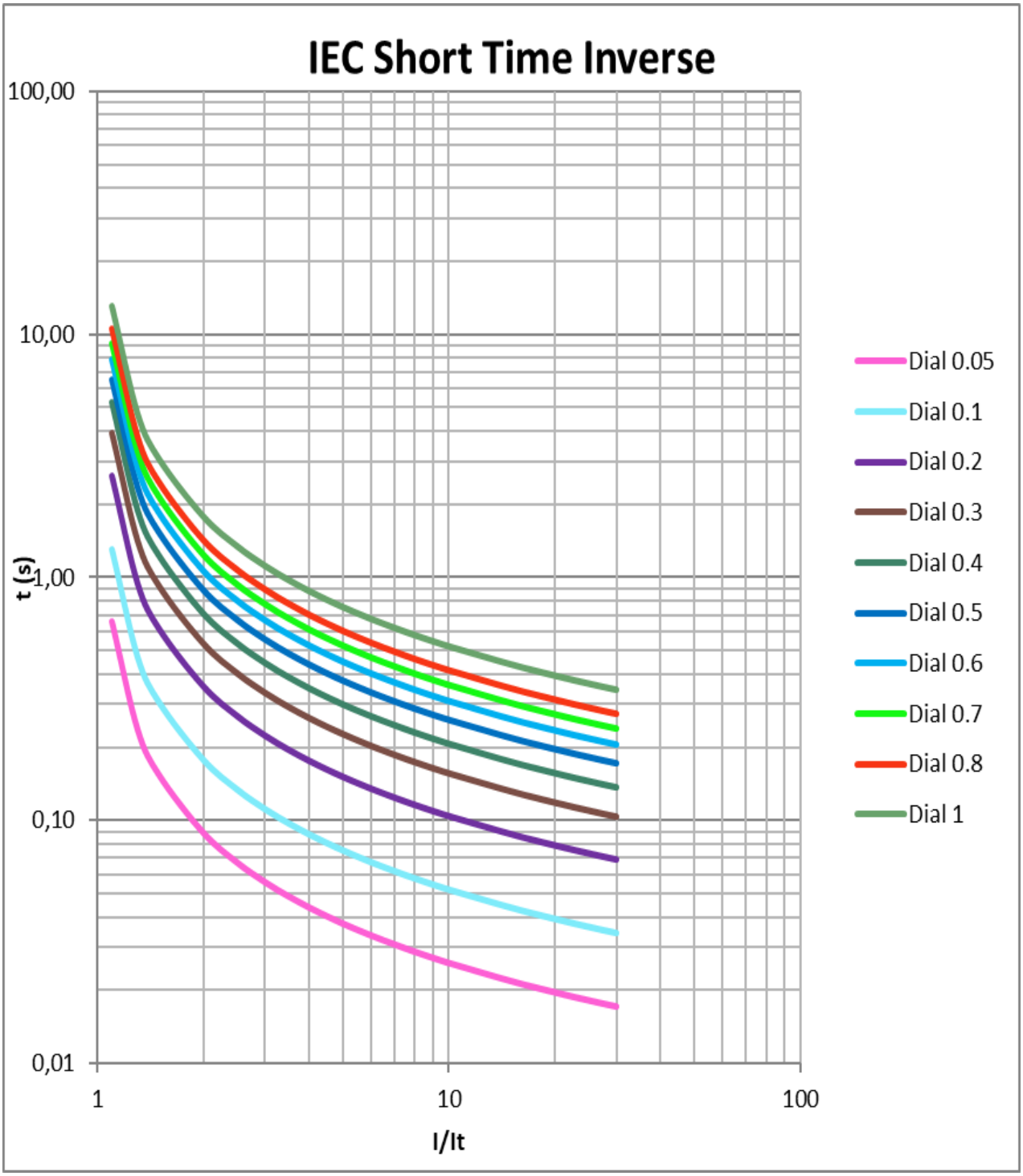
$I_{adjusted}$ is the initial operating current, set by the user.


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

7.2 IEEE Curves

The SILA relay complies with the curves shown in standard IEEE:

- Moderately Inverse
- Very Inverse Curve
- Extremely Inverse Curve

There is a general mathematical equation that defines the time in seconds as a function of the current:

$$t = (TD) \times \left[\left(\frac{A}{V^P - 1} \right) + B \right]$$

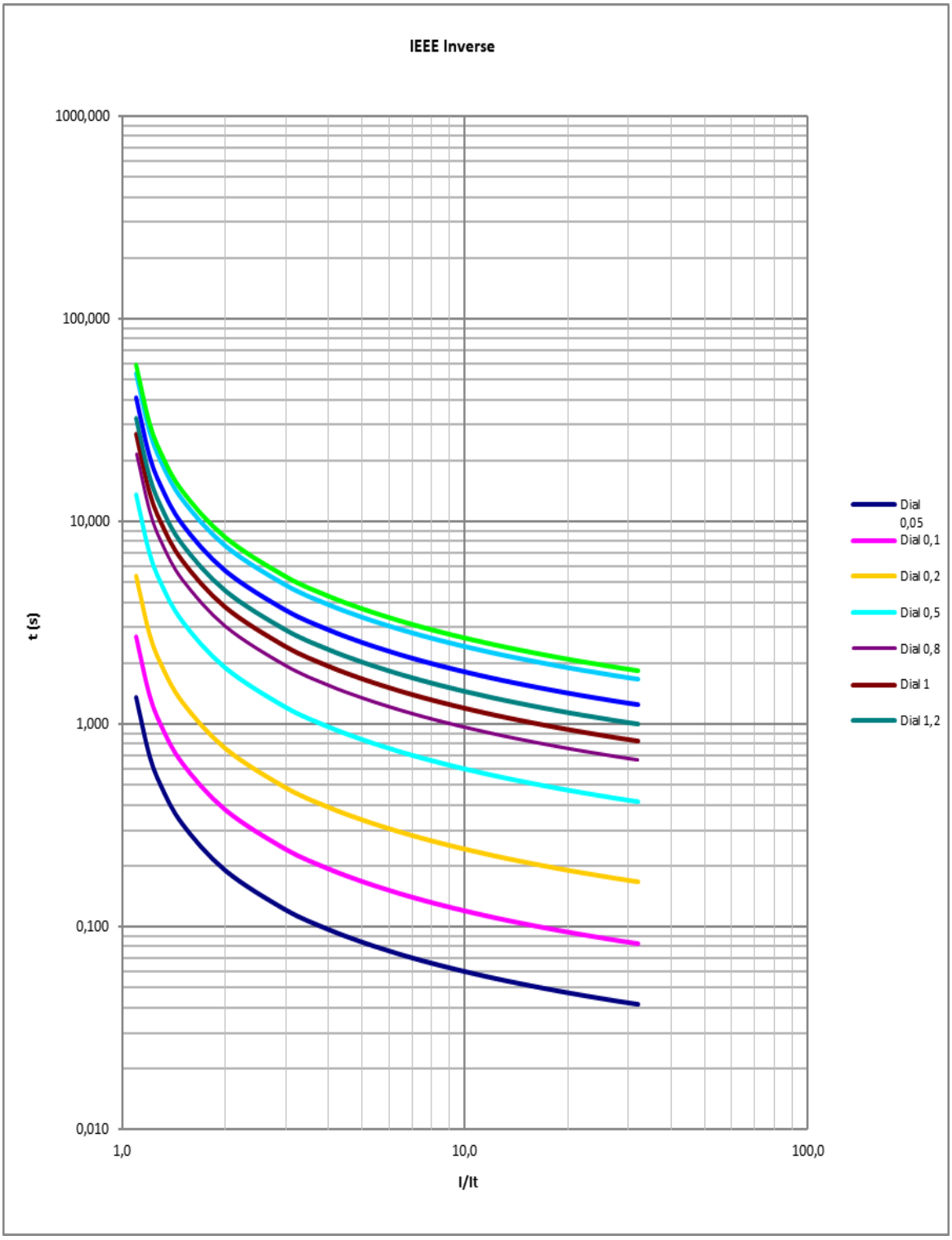
Where:

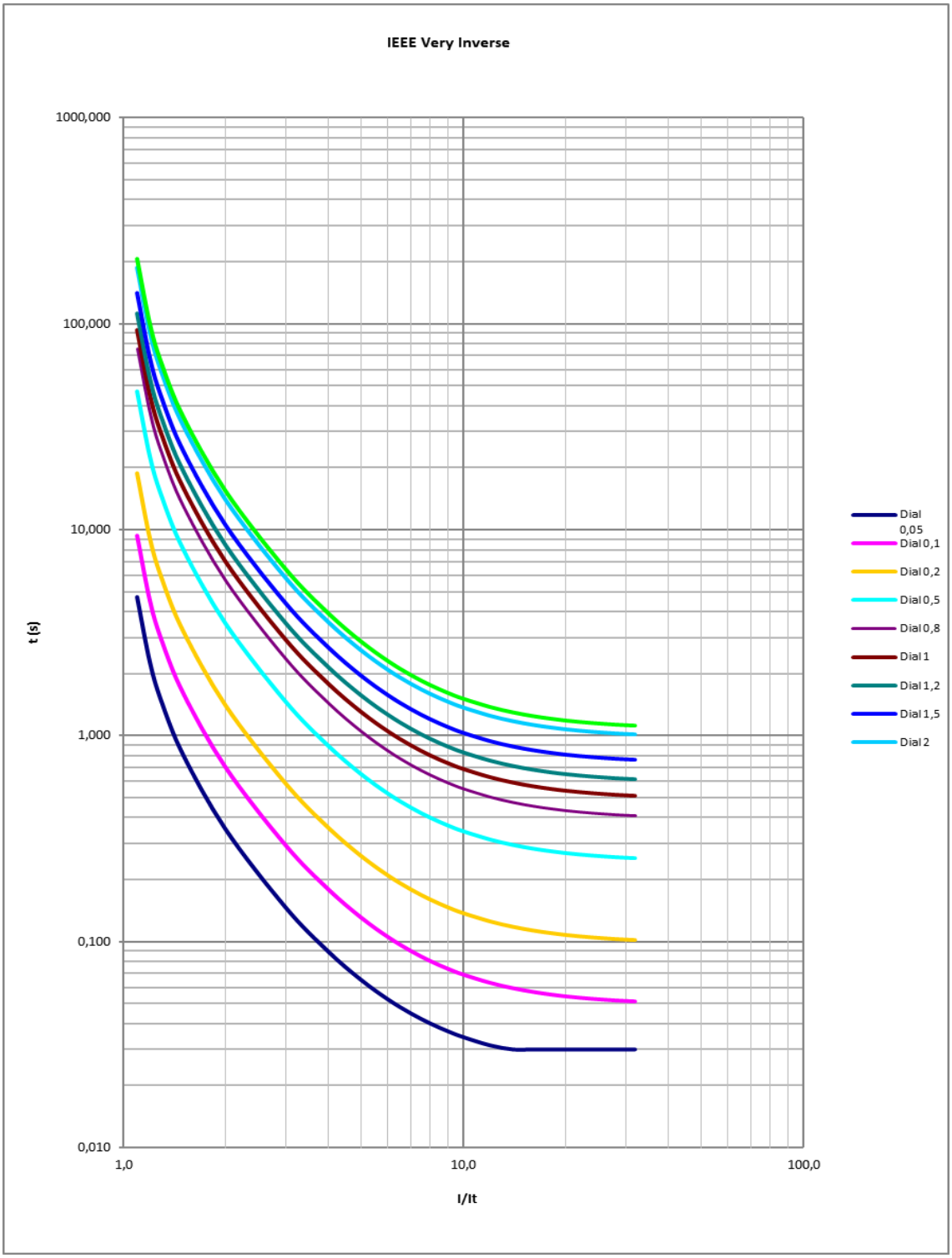
$$V = \frac{I}{I_{adjusted}}$$

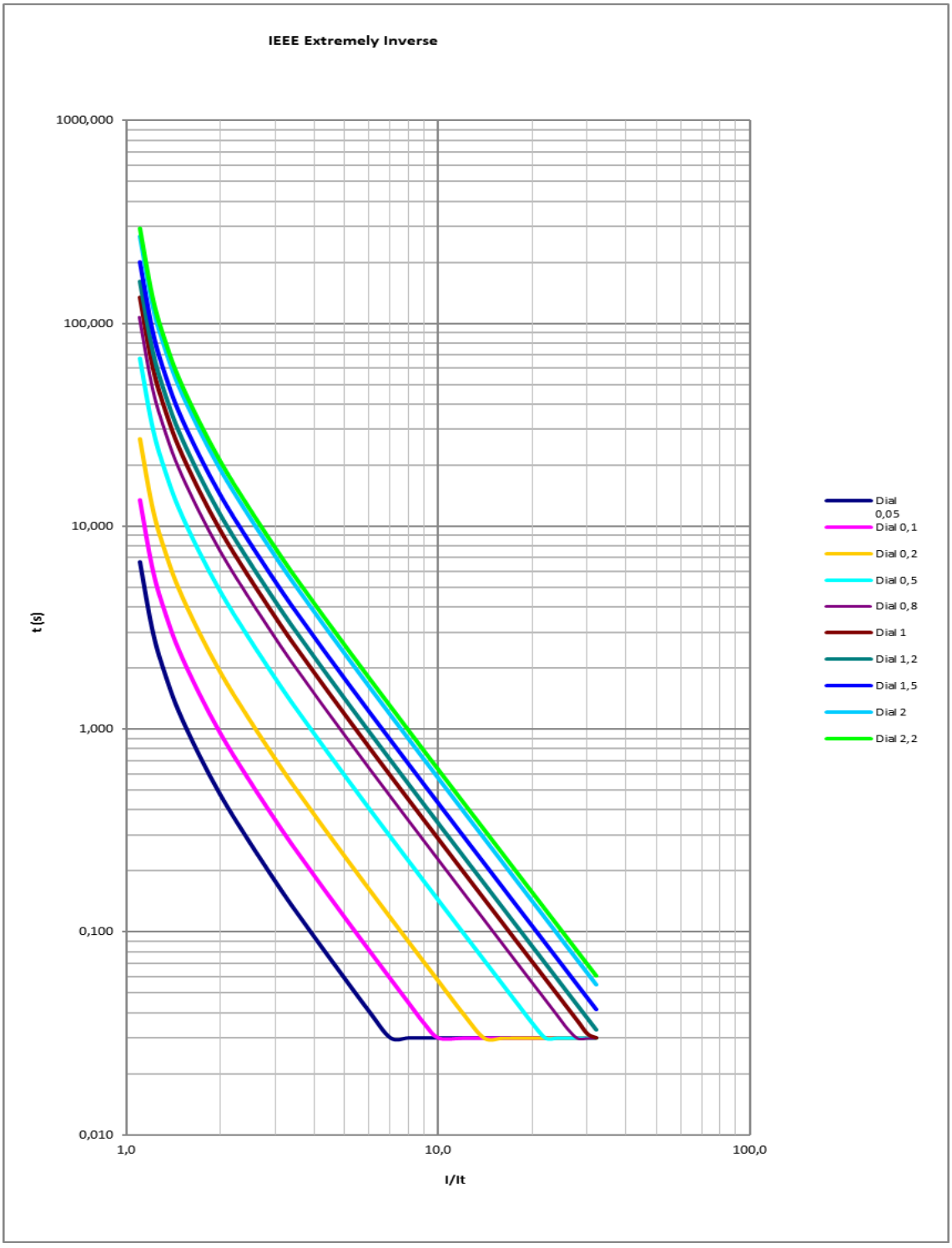
Parameters	A	P	B
Extremely Inverse	28.2	2.00	0.1217
Very Inverse	19.61	2.00	0.491
Moderately Inverse	0.0515	0.02	0.114

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)
1,0
10,0
100,0
I/It
Dial 0,05
Dial 0,1
Dial 0,2
Dial 0,5
Dial 0,8
Dial 1
Dial 1,2


IEEE Very Inverse
1000,000
100,000
10,000
1,000
0,100
0,010
t (s)
1,0
10,0
100,0
I/It
Dial 0,05
Dial 0,1
Dial 0,2
Dial 0,5
Dial 0,8
Dial 1
Dial 1,2
Dial 1,5
Dial 2


IEEE Extremely Inverse
1000,000
100,000
10,000
1,000
0,100
0,010
t (s)
1,0
10,0
100,0
I/It
Dial 0,05
Dial 0,1
Dial 0,2
Dial 0,5
Dial 0,8
Dial 1
Dial 1,2
Dial 1,5
Dial 2
Dial 2,2

7.3 Application examples

It is important to know that if both overcurrent protection functions (50 and 50/51), phase or neutral, are enable, definite time function (function 50) must be more restrictive. So, if overcurrent fault values are low, inverse time overcurrent function (function 50/51) must work, and if overcurrent fault reaches a certain value, definite time overcurrent function will always work. This is because, when overcurrent fault reaches high values (I>>), it is necessary to be sure that trip is going to be instantaneous to get that the element we are protecting, does not be damaged.

Some examples are shown below:

APPLICATION EXAMPLE 1

Starting from the following information:

***Line details**:*

- Transformation ratio of CT =100/1
- Primary current: I_p=100 A

50/51 function settings

- Curve type: IEC Inverse
- Dial: 0.05
- Tap: 1xI_n

50 function settings

- Tap: 11xI_n
- Time delay: 0.05 s

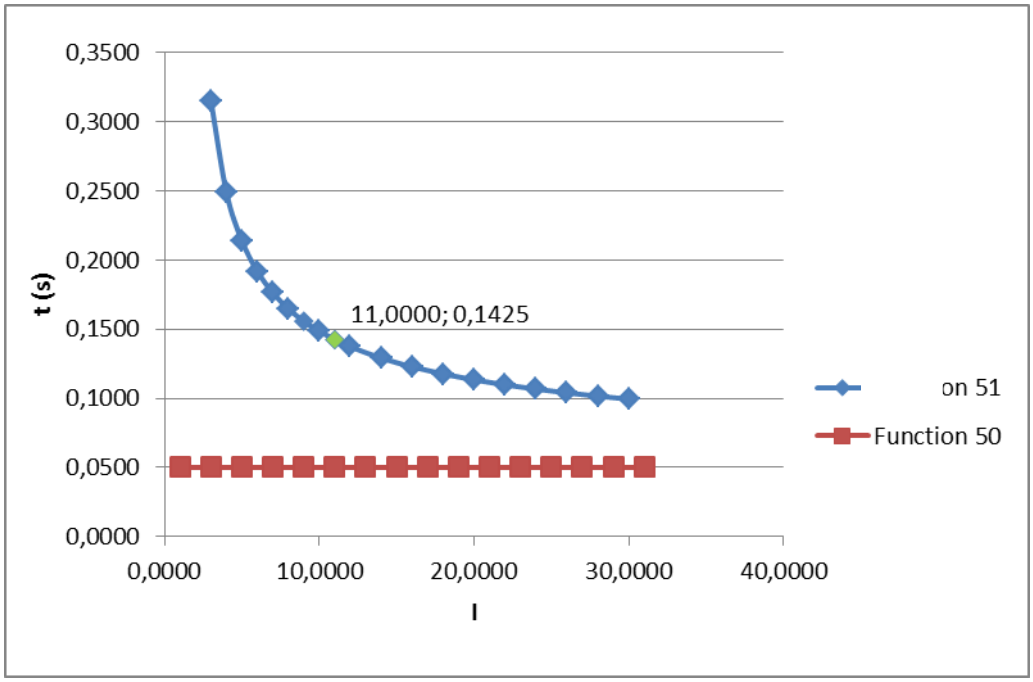


Figure 1. 50 y 50/51 IEC Inverse

If overcurrent fault is 11xI_n=1100 A, IEC inverse curve defines a tripping value of 0.1425s (Figure1) for 50/51 function. It is considered that this time is too high, so when current fault reaches 11xI_n, definite time overcurrent function will be work.

The figure below (Figure 2), shows the tripping curve of the relay:

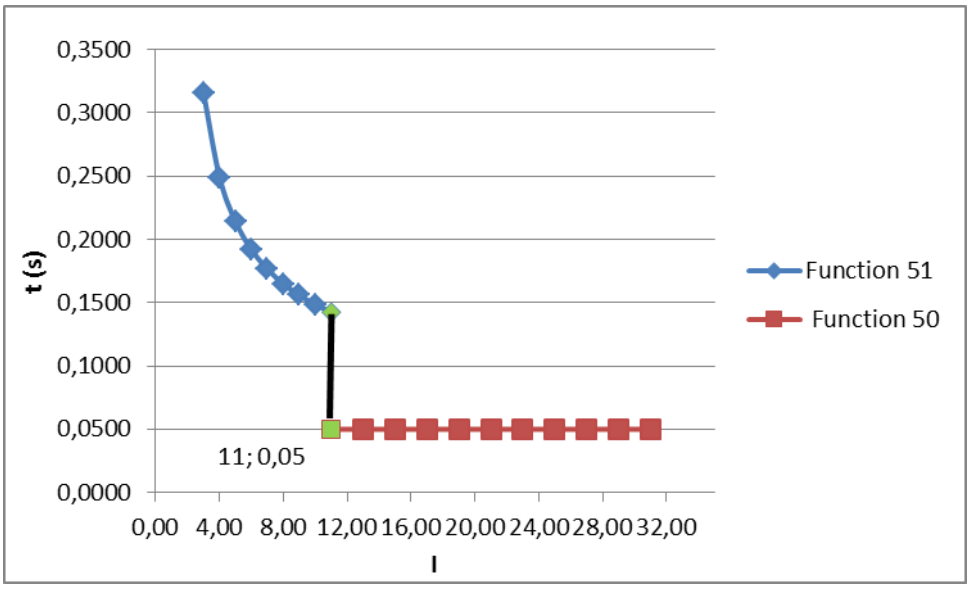


Figure 2. Relay tripping curve

APPLICATION EXAMPLE 2:

Starting from the following information:

***Line details**:*

- Transformation ratio of CT =500/1
- Primary current: I_p=500 A

50/51 function settings

- Curve type: IEEE Extremely Inverse
- Dial: 2.20
- Tap: 1xI_n

50 function settings

- Tap: 14xI_n
- Time delay: 0.1 s

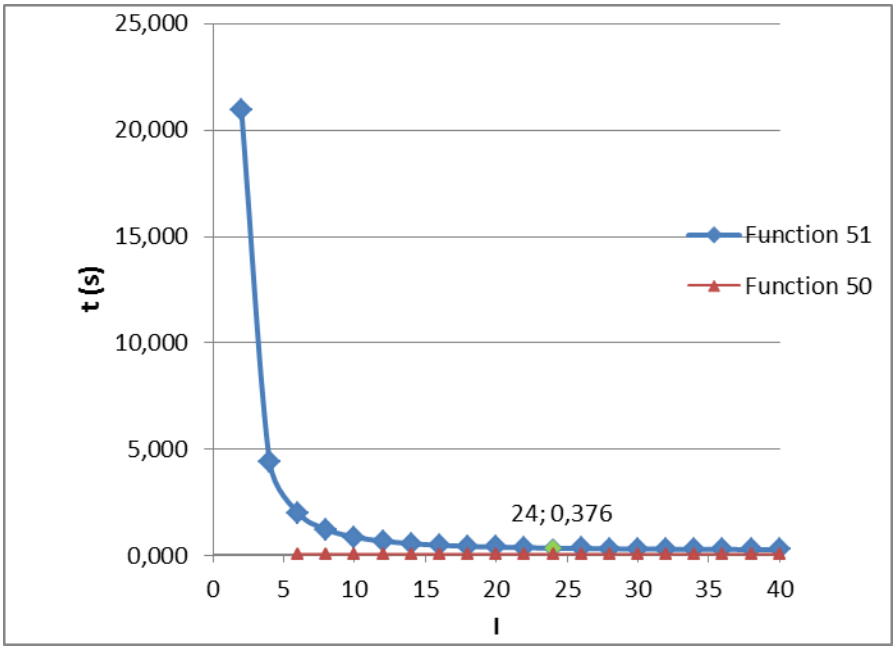


Figure 3. 50 y 50/51 IEEE Extremely Inverse

If overcurrent fault is 24xI_n=12000 Ap, IEEE Extremely inverse curve defines a tripping value of 0.376 s (Figure 3) for 50/51 function. It is considered that this time is too high, so when current fault reaches 24xI_n, definite time overcurrent function will be work. 50 function tap is adjusted at 14xIn so definite time overcurrent function will trip when current fault is higher than 14xIn (50 function does not wait to reach 24xIn)

The figure below (Figure 4), shows the tripping curve of the relay:

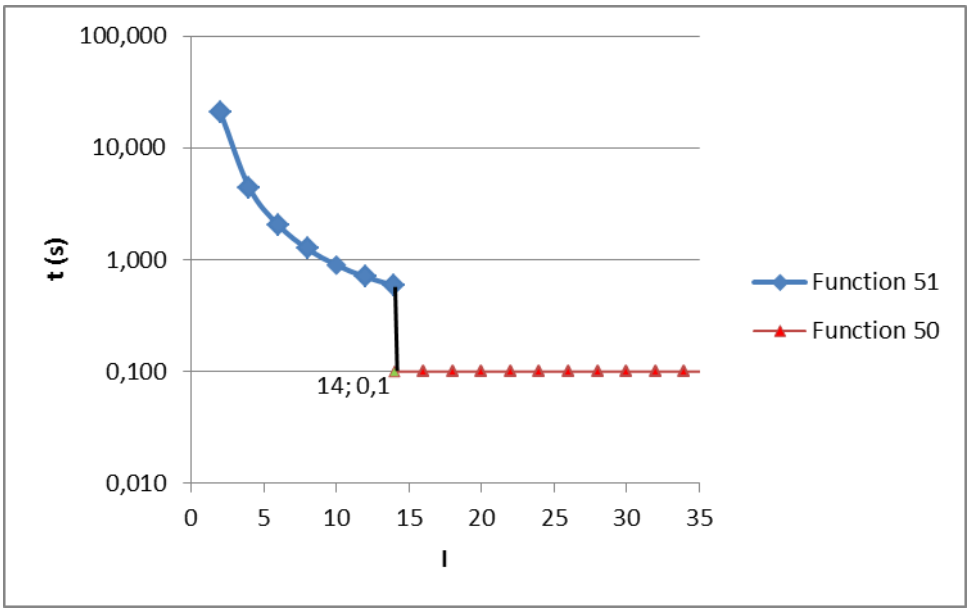


Figure 4. Relay tripping curve

8 MONITORING AND CONTROL

8.1 Measurements

Three-phase currents (I-A, I-B and I-C), neutral current (I-N), neutral voltage (V-R)*, zero sequence current (3I0)*, positive sequence current (I-1)*, negative sequence current (I-2)*, negative/positive sequence current relation (I2/I1)*, maximum current (Imax), second harmonic of each phase (I-A2H, I-B2H and I-C2H)*, total harmonic distortion (THD-A, THD-B, THD-C)*, thermal image (TI)*, angle of neutral current (Ang I-N)*, angle of zero sequence current (Ang 3I-0)* and angle of neutral voltage (V-R)* are given as fundamental values (DFT).

Current: The accuracy of the phases and neutral measurements is ±2% in a band of ± 20% the nominal current and ±4% or ±5 mA (greater of both) in the rest of the band.

Voltage: 1% precision in a band covering ±20% of nominal voltage and 4% in the rest of the range (*)

In case of the second harmonics currents the relay shows the measurements in amperes (although the function is set in percentage).

*Optional depending on model

8.2 Alarms Panel

Once the alarms are activated according to their configurations, they can be all recognized at the same time by holding RESET key from the Alarms Panel main screen.

Accessing to the Alarms Panel, the alarms can be recognized one by one.

Depending on the configuration, after the recognition action, the alarms can be still activated, or they can be deactivated. In alarms panel menu, these features will be shown. Considering this behavior, the possibilities for the alarms are:

ALARMS STATE		ALARM PANEL SYMBOL (LANGUAGE OPTION A)
ACTIVATED	Recognized	R
	Not Recognized	-
DEACTIVATED	Recognized	(*)
	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.

8.3 States and Sequential Events Recording (SER)

The state is given by real-time information generated by the relay. Some states have an event associate 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. These events are registered in a circular memory (buffer) with a capacity for up to 2048 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.

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
Value	Activated / Deactivated: an event is generated for Activation and Deactivation
Associated Meassurement	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: The cause of events shown in the 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.

Group	Status	Event	Cause	Measurement
Measurements				
	Measurement Error	Measurement Error	Activation/Deactivation	-
	Net Frequency 50 Hz	Net Frequency 50 Hz	Activation/Deactivation	-
HMI				
	Open CB	Open CB	-	-
	Close CB	Close CB	-	-
	79 Block	79 Block	-	-
	79 Unblock	79 Unblock	-	-
	Local Control	Local Control	-	-
	Remote Control	Remote Control	-	-
	Reset	Reset	-	-
	Reset TI	Reset TI	-	-

	Set Counter	Set Counter	Activation	-
	Key Reset	Key Reset	Activation	-
	Activity	Activity	Activation	-
	Identification	Identification	Activation	-
	Test State	Test State	Activation/Deactivation	-
Self-Diagnosis				
	Model Error	Model Error	Activation/Deactivation	-
	Hardware Error	Hardware Error	Activation/Deactivation	-
	Communication Error	Communication Error	Activation/Deactivation	-
	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	-

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				
	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	-
	SER error	Error: SER	Activation/Deactivation	-
	SER deleted	SER deleted	Activation	-
	Wrong Access	Wrong Access	Activation	-
	Settings Change	Settings Change	Activation	-
	Configuration Change	Configuration Change	Activation	-
	LDP Deleted	LDP Deleted	Activation	-
	New DFR	New DFR	Activation/Deactivation	-
	Phase Trip	Phase trip	-	Maximum Current
	Trip Block	Trip Block	Activation/Deactivation	Maximum Current
	Pickup	Pickup	Activation/Deactivation	Maximum Current
	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
	Neutral Pickup	Neutral Pickup	Activation/Deactivation	Neutral 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
	Neutral Trip	Neutral Trip	Activation/Deactivation	Neutral Current
	Setttings Group 1	Setttings Group 1	-	-
	Settings Group 2	Settings Group 2	-	-
	Setttings Group 3	Setttings Group 3	-	-
	Settings Group 4	Settings Group 4	-	-
	Set to FALSE	-	-	-
	Set to TRUE	-	-	-

Group	Status	Event	Cause	Measurement
USB COM				
	Open breaker	Open breaker	Activation	-
	Close breaker	Close breaker	Activation	-
	79 Block	79 Block	Activation	-
	79 Unblock	79 Unblock	Activation	-
	Local Control	Local control	Activation	-
	Remote Control	Remote control	Activation	-
	Reset	Reset	-	-
	Reset TI	Thermal I. Reset	-	-
	Set Counter	Set Counter	Activation	-
	Activity	-	Activation/Deactivation	-
	Identification	Identification	Activation	-
DNP3 Serial				
	Open breaker	Open breaker	Activation	-
	Close breaker	Close breaker	Activation	-
	79 Block	79 Block	Activation	-
	79 Unblock	79 Unblock	Activation	-
	Local control	Local control	Activation	-
	Remote control	Remote control	Activation	-
	Reset	Reset	-	-
	Thermal I. Reset	Thermal I. Reset	Activation	-
	Activity	-	Activation/Deactivation	-
IEC60870-103				
	Open breaker	Open breaker	Activation	-
	Close breaker	Close breaker	Activation	-
	79 Block	79 Block	Activation	-
	79 Unblock	79 Unblock	Activation	-
	Local control	Local control	Activation	-
	Remote control	Remote control	Activation	-
	Reset	Reset	-	-
	Thermal I. Reset	Thermal I. Reset	Activation	-
	Activity	-	Activation/Deactivation	-
	Test State	-	-	

Group	Status	Event	Cause	Measurement
MODBUS RTU				
	Open breaker	Open breaker	Activation	-
	Close breaker	Close breaker	Activation	-
	79 Block	79 Block	Activation	-
	79 Unblock	79 Unblock	Activation	-
	Local control	Local control	Activation	-
	Remote control	Remote control	Activation	-
	Reset	Reset	-	-
	Thermal I. Reset	Thermal I. Reset	Activation	-
	Set Counter	Set Counter	Activation	-
	Activity	-	Activation/Deactivation	-
	Identification	Identification	Activation	-
MODBUS TCP (*)				
	Open CB	Open CB	Activation	-
	Close CB	Close CB	Activation	-
	79 Block	79 Block	Activation	-
	79 Unblock	79 Unblock	Activation	-
	Local Control	Local Control	Activation	-
	Remote Control	Remote Control	Activation	-
	Reset	Reset	-	-
	Reset TI	Reset TI	Activation	-
	Set Counter	Set Counter	Activation	-
	Activity		Activation/Deactivation	-
	Identification	Identification	Activation	-
DNP3 TCP (*)				
	Open breaker	Open breaker	Activation	-
	Close breaker	Close breaker	Activation	-
	79 Block	79 Block	Activation	-
	79 Unblock	79 Unblock	Activation	-
	Local control	Local control	Activation	-
	Remote control	Remote control	Activation	-
	Reset	Reset	-	-
	Thermal I. Reset	Thermal I. Reset	Activation	-
	Activity	-	Activation/Deactivation	-
	Test State	-	-	-

Group	Status	Event	Cause	Measurement
IEC 104 (*)				
	Open breaker	Open breaker	Activation	-
	Close breaker	Close breaker	Activation	-
	79 Block	79 Block	Activation	-
	79 Unblock	79 Unblock	Activation	-
	Local control	Local control	Activation	-
	Remote control	Remote control	Activation	-
	Reset	Reset	-	-
	Thermal I. Reset	Thermal I. Reset	Activation	-
	Set Counter	Set Counter	Activation	-
	Activity	-	Activation/Deactivation	-
	Identification	Identification	Activation	-
WEB (*)				
	Open CB	Open CB	Activation	-
	Close CB	Close CB	Activation	-
	79 Block	79 Block	Activation	-
	79 Unblock	79 Unblock	Activation	-
	Local Control	Local Control	Activation	-
	Remote Control	Remote Control	Activation	-
	Reset	Reset	-	-
	Reset TI	Reset TI	Activation	-
	Activity	-	Activation/Deactivation	-
	Test state	-	-	-
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	-
Instantaneous phase overcurrent				
50-1 50-2 (*)	Phase A Pickup	Phase A Pickup	Activation/Deactivation	I-A
	Phase B Pickup	Phase B Pickup	Activation/Deactivation	I-B
	Phase C Pickup	Phase C Pickup	Activation/Deactivation	I-C
	Pickup	Pickup	Activation/Deactivation	I-Max
	Phase A Trip	Phase A Trip	Activation/Deactivation	I-A
	Phase B Trip	Phase B Trip	Activation/Deactivation	I-B
	Phase C Trip	Phase C Trip	Activation/Deactivation	I-C
	Phase Trip	Phase Trip	Activation/Deactivation	I-Max
Instantaneous measured neutral overcurrent				
50G-1 50G-2 (*)	Neutral Pickup	Neutral Pickup	Activation/Deactivation	I-N
	Neutral Trip	Neutral Trip	Activation/Deactivation	I-N
Instantaneous calculated neutral overcurrent (*)				
50N-1 50N-2	Neutral Pickup	Neutral Pickup	Activation/Deactivation	3I-0
	Neutral Trip	Neutral Trip	Activation/Deactivation	3I-0
Inverse time measured neutral overcurrent				
51G-1 51G-2 (*)	Neutral Pickup	Neutral Pickup	Activation/Deactivation	I-N
	Neutral Trip	Neutral Trip	Activation/Deactivation	I-N
Inverse time calculated neutral overcurrent (*)				
51N-1 51N-2	Neutral Pickup	Neutral Pickup	Activation/Deactivation	3I-0
	Neutral Trip	Neutral Trip	Activation/Deactivation	3I-0
Inverse Time Directional* Measured Neutral Overcurrent (*)				
67G/51G-1 67G/51G-2	Neutral Pickup	Neutral Pickup	Activation/Deactivation	I-N
	Neutral Trip	Neutral Trip	Activation/Deactivation	I-N
Inverse time directional isolated calculated neutral overcurrent (*)				
67NI	Neutral Pickup	Neutral Pickup	Activation/Deactivation	3I-0
	Neutral Trip	Neutral Trip	Activation/Deactivation	3I-0
Inverse time directional isolated measured neutral overcurrent (*)				
67GI	Neutral Pickup	Neutral Pickup	Activation/Deactivation	I-N
	Neutral Trip	Neutral Trip	Activation/Deactivation	I-N
Phase balance current protection (*)				
46 (*)	Pickup	Pickup	Activation/Deactivation	I-2
	Trip	Trip	Activation/Deactivation	I-2

Group	Status	Event	Cause	Measurement
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	-
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 08	Logic signal 08	-	-
	Logic signal 09	Logic signal 09	-	-
	Logic signal 10	Logic signal 10	-	-
	Logic signal 11	Logic signal 11	-	-
	Logic signal 12	Logic signal 12	-	-
	Logic signal 13	Logic signal 13	-	-
	Logic signal 14	Logic signal 14	-	-
	Logic signal 15	Logic signal 15	-	-
	Logic signal 16	Logic signal 16	-	-
	Logic signal 17	Logic signal 17	-	-
	Logic signal 18	Logic signal 18	-	-
	Logic signal 19	Logic signal 19	-	-
	Logic signal 20	Logic signal 20	-	-
	Logic signal 21	Logic signal 21	-	-
	Logic signal 22	Logic signal 22	-	-
	Logic signal 23	Logic signal 23	-	-
	Logic signal 24	Logic signal 24	-	-
	Logic signal 25	Logic signal 25	-	-
	Logic signal 26	Logic signal 26	-	-
	Logic signal 27	Logic signal 27	-	-
	Logic signal 28	Logic signal 28	-	-
	Logic signal 29	Logic signal 29	-	-
	Logic signal 30	Logic signal 30	-	-
	Logic signal 31	Logic signal 31	-	-
	Logic signal 32	Logic signal 32	-	-

Group	Status	Event	Cause	Measurement
Instantaneous measured neutral overvoltage (*)				
59G-1 **59G-2**	Neutral Pickup	Neutral Pickup	Activation/Deactivation	V-R
	Neutral Trip	Neutral Trip	Activation/Deactivation	V-R
Breaker wear monitoring				
52 (*)	Startup	Startup	Activation	-
	Error	Error	Activation	-
	Open	Open	Activation	-
	Opening Time	Opening Time	Activation	-
	Opening error	Opening error	Activation	-
	Closed	Closed	Activation	-
	Closing Time	Closing Time	Activation	-
	Closing Error	Closing Error	Activation	-
	Openings Alarm	Openings Alarm	Activation/Deactivation	-
	Excessive accumulated amperes (I2t).	Excessive accumulated amperes (I2t).	Activation/Deactivation	-
	Excessive openings in a time window	Excessive openings in a time window	Activation/Deactivation	-
Thermal overload				
49 (*)	Alarm	Alarm	Activation/Deactivation	Thermal Image
	Trip	Trip	Activation/Deactivation	Thermal Image
Switch onto fault				
SOTF (*)	Phase A Pickup	Phase A Pickup	Activation/Deactivation	I-A
	Phase B Pickup	Phase B Pickup	Activation/Deactivation	I-B
	Phase C PIckup	Phase C PIckup	Activation/Deactivation	I-C
	Phase Pickup	Phase Pickup	Activation/Deactivation	I-Max
	Phase A Trip	Phase A Trip	Activation/Deactivation	I-A
	Phase B Trip	Phase B Trip	Activation/Deactivation	I-B
	Phase C Trip	Phase C Trip	Activation/Deactivation	I-C
	Phase Trip	Phase Trip	Activation/Deactivation	I-Max
	SOTF	SOTF	Activation/Deactivation	I-Max
Inverse time phase overcurrent				
51-1 **51-2 (*)**	Phase A Pickup	Phase A Pickup	Activation/Deactivation	I-A
	Phase B Pickup	Phase B Pickup	Activation/Deactivation	I-B
	Phase C Pickup	Phase C Pickup	Activation/Deactivation	I-C
	Pickup	Pickup	Activation/Deactivation	I-Max
	Phase A Trip	Phase A Trip	Activation/Deactivation	I-A
	Phase B Trip	Phase B Trip	Activation/Deactivation	I-B
	Phase C Trip	Phase C Trip	Activation/Deactivation	I-C
	Phase Trip	Phase Trip	Activation/Deactivation	I-Max
Signalling				
	Close CB	-	-	-
	79 Block	-	-	-

Group	Status	Event	Cause	Measurement
Trip Block				
TB (*)	Phase A Block	Phase A Block	Activation/Deactivation	I-A
	Phase B Block	Phase B Block	Activation/Deactivation	I-B
	Phase C Block	Phase C Block	Activation/Deactivation	I-C
	Phase Block	Phase Block	Activation/Deactivation	I-Max
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 Alarm16	-	-	-
	Logic Alarm17	-	-	-
	Logic Alarm 18	-	-	-
	Logic Alarm 19	-	-	-
	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
Programmable logic control				
PGC	Open CB	Open CB	Activation	-
	Close CB	Close CB	Activation	-
	79 Block (*)	79 Block	Activation	-
	79 Unblock (*)	79 Unblock	Activation	-
	Local Control	Local Control	Activation	-
	Remote Control	Remote Control	Activation	-
	52a (*)	52a	-	-
	52b (*)	52b	-	-
	Sett. Group 1	Sett. Group 1	Activation/Deactivation	-
	Sett. Group 2	Sett. Group 2	Activation/Deactivation	-
	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	-	-
	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	-
	PGC 1	-	-	-
	PGC 2	-	-	-
	PGC 3	-	-	-
	PGC 4	-	-	-
	PGC 5	-	-	-
	PGC 6	-	-	-
	PGC 7	-	-	-

Group	Status	Event	Cause	Measurement
Instantaneous phase undercurrent				
37 (*)	Phase A Pickup	Phase A Pickup	Activation/Deactivation	IA (A)
	Phase B Pickup	Phase B Pickup	Activation/Deactivation	IB (A)
	Phase C Pickup	Phase C Pickup	Activation/Deactivation	IC (A)
	Pickup	Pickup	Activation/Deactivation	Imax (A)
	Phase A Trip	Phase A Trip	Activation/Deactivation	IA (A)
	Phase B Trip	Phase B Trip	Activation/Deactivation	IB (A)
	Phase C Trip	Phase C Trip	Activation/Deactivation	IC (A)
	Trip	Trip	Activation/Deactivation	Imax (A)
Broken conductor detection				
46BC (*)	Pickup	Pickup	Activation/Deactivation	I2/I1
	Trip	Trip	Activation/Deactivation	I2/I1
AC reclosing device				
79 (*)	Stanby	Stanby	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	-
	Blocked	Blocked	Activation/Deactivation	-
	Reclose NO.1	-	-	-
	Reclose NO.2	-	-	-
	Reclose NO.3	-	-	-
	Reclose NO.4	-	-	-
Trip circuit supervision				
74TCS (*)	Pickup	Pickup	Activation/Deactivation	I-Max
	Trip	Trip	Activation/Deactivation	I-Max
Phase CT supervision				
60CTS (*)	Pickup	Pickup	Activation/Deactivation	I-Max
	Trip	Trip	Activation/Deactivation	I-Max
Circuit breaker failure				
50BF (*)	Pickup	Pickup	-	I-Max
	Trip	Trip	-	I-Max

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	-	-
	52 Close	52 Close	-	-
	52 Open	52 Open	-	-
	52 Def. Open	52 Def. Open	Activation/Deactivation	-
	Close CLP	Close CLP	-	-
	Open CLP	Open CLP	-	-
	CLP	CLP	Activation/Deactivation	I-Max (A)

8.4 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	Post-fault cycles
5*260	5	260	1-8	252-259
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

- Digital channels. The digital channels are configurable. By default, the following 96 channels are displayed.

No.	Digital channels
1	50-1 Pickup
2	51-1 Pickup
3	50G-1 Pickup
4	51G-1 Pickup
5	General Pickup
6	Phase A Pickup
7	Phase B Pickup
8	Phase C Pickup
9	Neutral Pickup
10	Trip Block
11	50-1 Trip
12	51-1 Trip
13	50G-1 Trip
14	51G-1 Trip
15	CLP
16	General Trip
17	Phase A Trip
18	Phase B Trip
19	Phase C Trip
20	Neutral Trip

No.	Digital channels
33	PGC-3
34	PGC-4
35	PGC-5
36	PGC-6
37	Output 1
38	Output 2
39	Output 3
40	Input 1
41	Input 2
42	Input 3
43	Set to false
44	Set to false
45	Set to false
46	Set to false
47	Set to false
48	Set to false
49	Set to false
50	Set to false
51	Set to false
52	Set to false

No.	Digital channels
65	Set to false
66	Set to false
67	Set to false
68	Set to false
69	Set to false
70	Set to false
71	Set to false
72	Set to false
73	Set to false
74	Set to false
75	Set to false
76	Set to false
77	Set to false
78	Set to false
79	Set to false
80	Set to false
81	Set to false
82	Set to false
83	Set to false
84	Set to false

21	52 Close command
22	52 Open command
23	Local Control
24	Remote Control
25	Settings group 1
26	Settings group 2
27	DFR Start
28	Neutral block
29	Phase Block
30	External trip
31	PGC-1
32	PGC-2

53	Set to false
54	Set to false
55	Set to false
56	Set to false
57	Set to false
58	Set to false
59	Set to false
60	Set to false
61	Set to false
62	Set to false
63	Set to false
64	Set to false

85	Set to false
86	Set to false
87	Set to false
88	Set to false
89	Set to false
90	Set to false
91	Set to false
92	Set to false
93	Set to false
94	Set to false
95	Set to false
96	Set to false

8.5 Load Data Profiling (LDP)

SIL-A relay provides the demand of current with the following characteristics:

- Number of records: 744
- Recording mode circular
- Sampling rate (interval): configurable through communications: 1 – 60 min
- Record format:

  Date/Time
  IMAX (in interval)
  IMAX (actual)
  IA
  IB
  IC
  IN

NOTE: Once the demand setting is changed, it is necessary to switch the relay off and to switch it on again to ensure that the new setting is recorded correctly.

8.6 Counters

Depending on model, the following counters are provided:

1. Number of openings of the circuit breaker.
2. Amperes accumulated (I2t) during the openings of the circuit breaker.
3. Number of recloses.

8.7 Commands

	HMI	Local Com. ModBus RTU	Remote com: Modbus RTU/Modbus TCP/IP IEC 60870-5-103 IEC61850 DNP 3.0 Serie DNP 3.0 TCP/IP
Open Breaker	✓	✓	✓
Close Breaker	✓	✓	✓
79 Block	✓	✓	✓
79 Unblock	✓	✓	✓
Local Control	✓	✓	-
Remote Control	✓	✓	-
Reset	✓	✓	✓
Reset Thermal Image	✓	✓	✓

To execute commands remotely (ModBus, IEC60870-5-103, 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.

8.8 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.

8.9 Programmable Logic Control (PGC)

Firstly, it is defined the concept of physical input, physical output and logical signal.

Physical inputs are the real inputs of the device. SIL-A device has up to 6 physical inputs. These inputs are translated to internal binary states which later, can be assigned to logical signal to get a specific operation.

SIL-A is provided with up to 7 outputs. Physical outputs are the real outputs of the device. SIL-A has up to 7 physical outputs and the rest of them (up to 32) are logic outputs to be used to configure the relay.

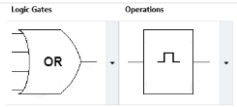
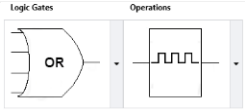
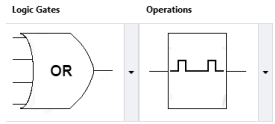
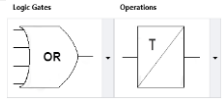
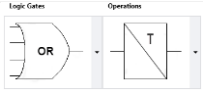
Besides, the relay is provided with 32 alarms. The first 6 alarms correspond to the 6 configurable front LEDs and the rest are logic alarms to be used to configure the relay.

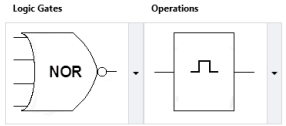
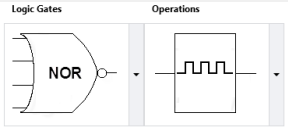
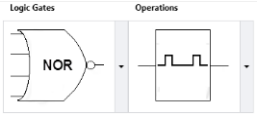
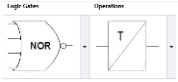
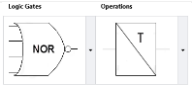
All the outputs (Physical and logic alarms, physical and logic outputs) are the result of a PROGRAMMABLE LOGIC CONTROL which can be configured from HMI or from SICom software.In addition, the following 24 predefined actions and 8 free PGCs are available to be configured by the user in the PGC configuration section.

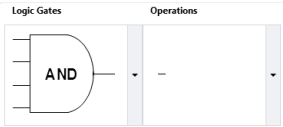
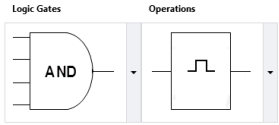
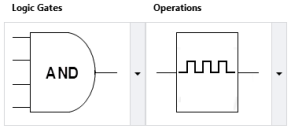
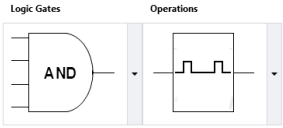
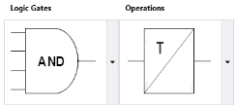
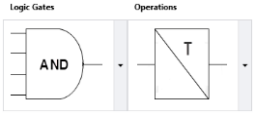
Logical inputs	Description
Open Breaker Command	Conditions to send the open breaker command
Close Breaker Command	Conditions to send the close breaker command
79 Block Command	Conditions to send the 79 Block command
79 Unblock Command	Conditions to send the 79 Unblock command
Local Control Command	Conditions 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
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	Conditions tfot the external trip
PGC 1	Free PGC 1
PGC 2	Free PGC 2
PGC 3	Free PGC 3
PGC 4	Free PGC 4
PGC 5	Free PGC 5
PGC 6	Free PGC 6
PGC 7	Free PGC 7

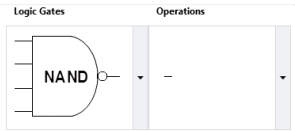
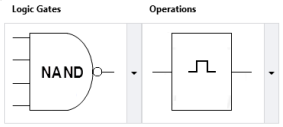
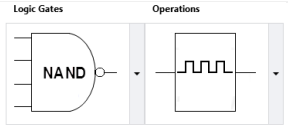
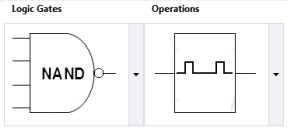
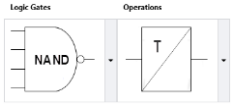
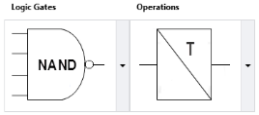
For each output there is a LOGICAL GATE. It can perform a logical operation up to 4 binary states to obtain other binary result.

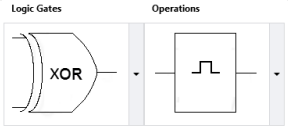
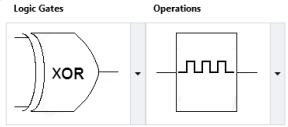
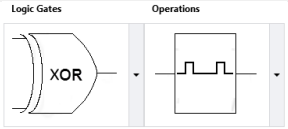
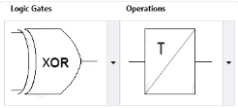
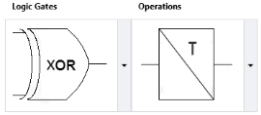
In V3 of the PGC the LOGICAL GATES that are supported by SIL-A are:

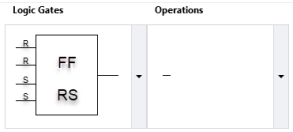
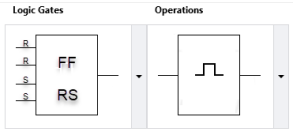
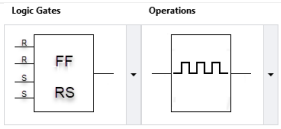
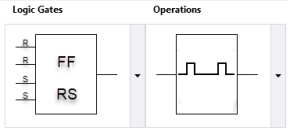
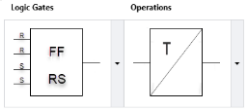
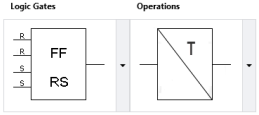
LOGIC GATE	OPERATION	SETTABLE PARAMETERS	HMI SYMBOL	SICOM SYMBOL	APPLICABLE EXTRA PARAMETERS
OR4	-	-	OR		NA
	1 PULSE	Time up: (Time during which the pulse is activated)	OR 1P		Time up The time the pulse lasts
	PULSES	Time up: Time between pulses and duration of each pulse (same for both)	OR PS		Time 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

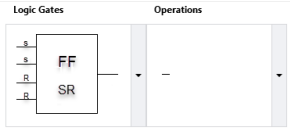
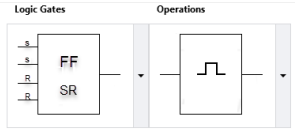
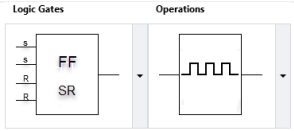
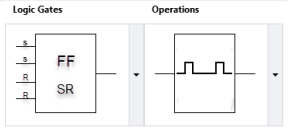
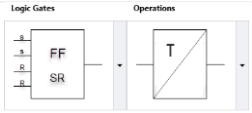
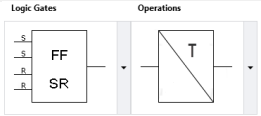
LOGIC GATE	OPERATION	SETTABLE PARAMETERS	HMI SYMBOL	SICOM SYMBOL	APPLICABLE EXTRA PARAMETERS
NOR4	-	-	NOR		NA
	1 PULSE	Time up: (Time during which the pulse is activated)	NOR 1P		Time up The time the pulse lasts
	PULSES	Time up: Time between pulses and duration of each pulse (same for both)	NOR PS		Time 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

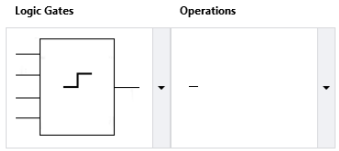
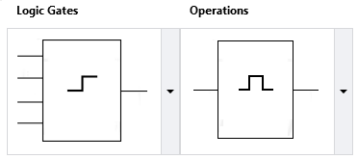
LOGIC GATE	OPERATION	SETTABLE PARAMETERS	HMI SYMBOL	SICOM SYMBOL	APPLICABLE EXTRA PARAMETERS
AND4	-	-	AND		NA
	1 PULSE	Time up: (Time during which the pulse is activated)	AND 1P		Time up The time the pulse lasts
	PULSES	Time up: Time between pulses and duration of each pulse (same for both)	AND PS		Time 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

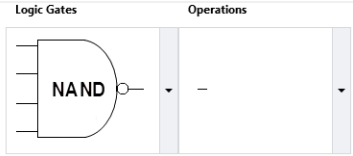
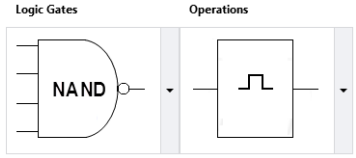
LOGIC GATE	OPERATION	SETTABLE PARAMETERS	HMI SYMBOL	SICOM SYMBOL	APPLICABLE EXTRA PARAMETERS
NAND4	-	-	NAND		NA
	1 PULSE	Time up: (Time during which the pulse is activated)	NAND 1P		Time up The time the pulse lasts
	PULSES	Time up: Time between pulses and duration of each pulse (same for both)	NAND PS		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

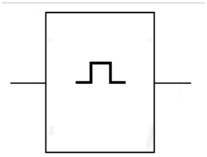
LOGIC GATE	OPERATION	SETTABLE PARAMETERS	HMI SYMBOL	SICOM SYMBOL	APPLICABLE EXTRA PARAMETERS
SRFF **2 for the set + 2 for the reset**	-	-	SRFF		NA
	1 PULSE	Time up: (Time during which the pulse is activated)	SRFF 1P		Time up The time the pulse lasts (in this case the FF. this configuration works as OR_PULSE)
	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

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

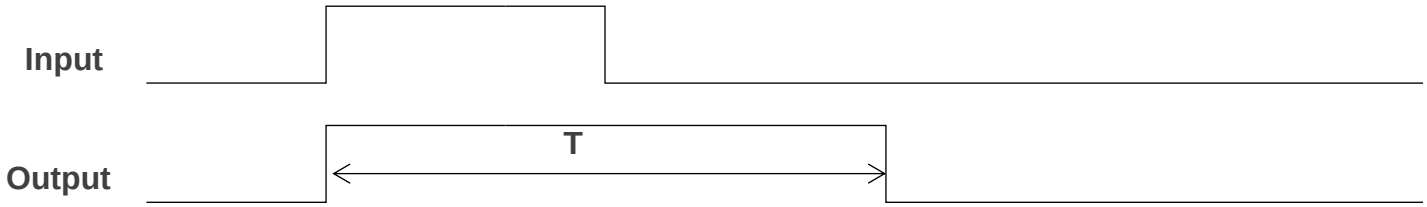
LOGIC GATE	OPERATION	SETTABLE PARAMETERS	HMI SYMBOL	SICOM SYMBOL	APPLICABLE EXTRA PARAMETERS
F_EDGE4	-	-	NAND		NA
	1 PULSE	Time up: (Time during which the pulse is activated)	NAND 1P		Time up The time the pulse lasts

Logical gate selection guide

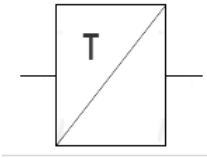
1 PULSE



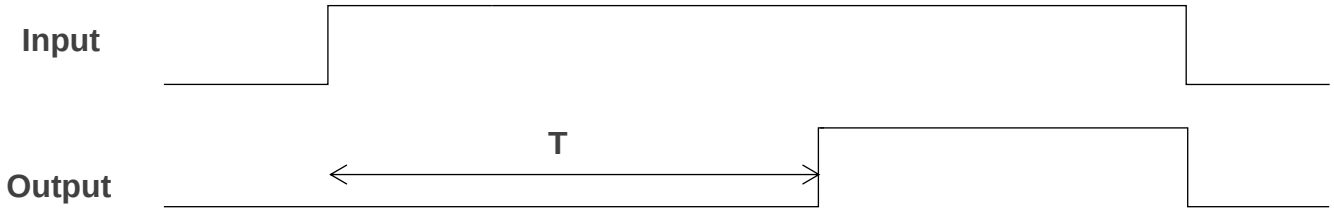
The configured signal will make a pulse of the adjusted time in “time up” parameter once the input signal is activated.



TIMER UP

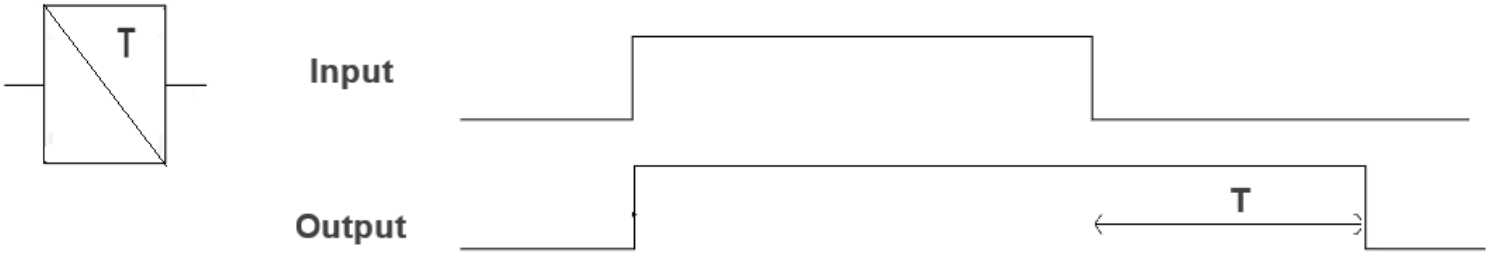


The configured signal waits the adjusted time in “time up” parameter to activate itself once the input signal is activated.

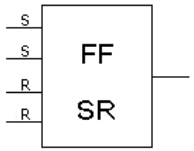


TIMER DOWN

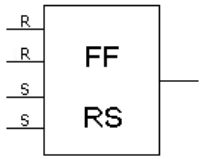
Once the configured signal is activated, it waits the adjusted time in “time up” parameter to deactivate itself.

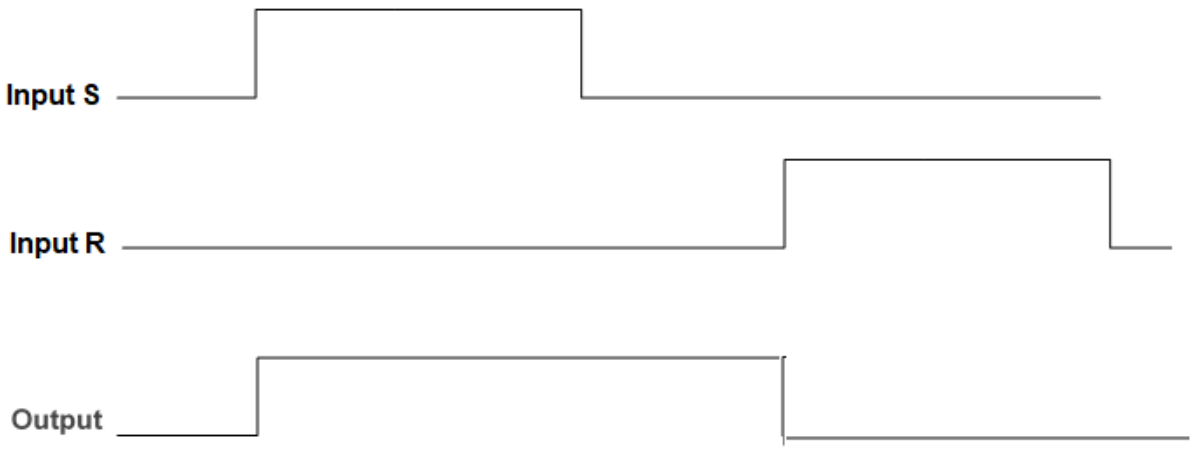


SR FLIP FLOP (priority for set signals) & RS FLIP FLOP (priority for reset signals)



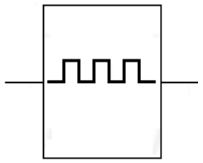
The configured signal will be activated once the bits in “s” position are activated (set position. The signal is maintained activated until the bits configured in “R” position are activated.



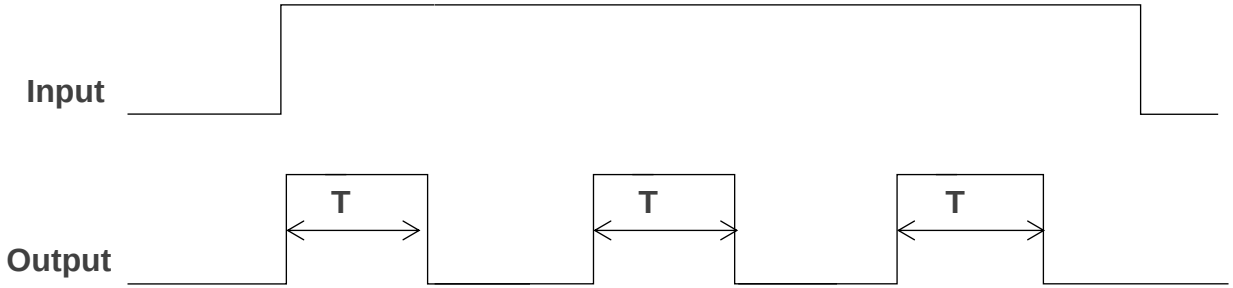


Reset mode is configurable by the user and the option of manual reset is available.

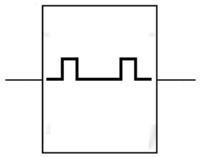
PULSES (Same time on and time off)



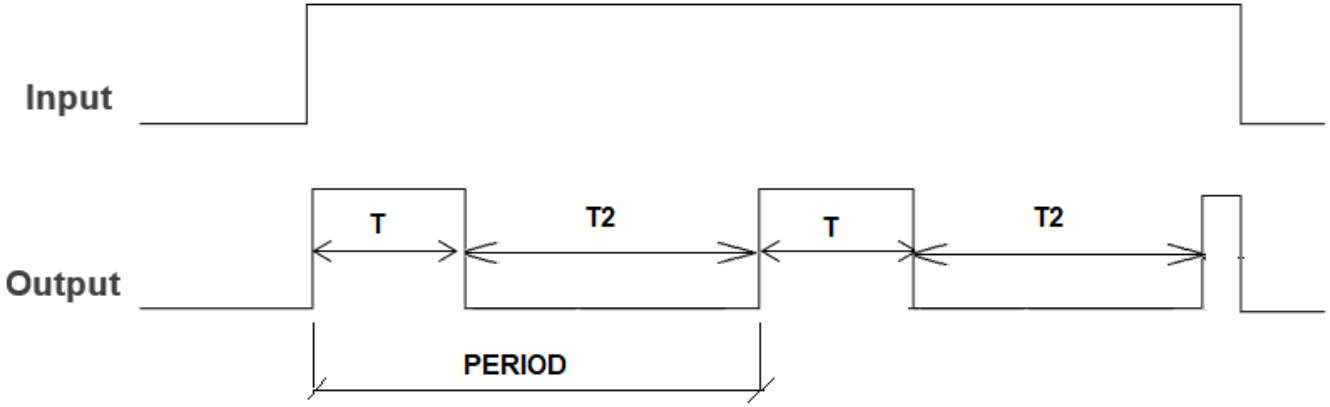
The configured signal will make pulses of the adjusted milliseconds while the input signal is activated.



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 displaying 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 and finally pressing the right key ►, the PGC signals 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

8.10 Configurable Inputs

The SIL-A has different number of digital inputs depending on the model:

Model	Configurable Inputs
SILAxxxxxx0xxx	3 configurable inputs
SILAxxxxxx1xxx, SILAxxxxxx2xxx	6 configurable inputs
SILAxxxxxx3xxx	5 configurable inputs

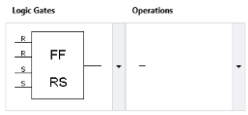
These inputs can be set by the user. They are configured from the HMI or by using the SICom program.

8.11 Configurable outputs

SIL-A is fitted with up to 7 digital outputs. Depending on the model:

Model	Configurable Outputs
SILAxxxxxx0xxx	3 configurable outputs
SILAxxxxxx1xxx	4 configurable outputs
SILAxxxxxx2xxx	6 configurable outputs
SILAxxxxxx3xxx	7 configurable outputs

The outputs can be configured from the HMI or through the SICom program. Default configuration is as follows:

Output	Description	Criteria	States	Logic Gate	Sicom Symbol
OUTPUT 1	Ready	Self-Diagnosis Self-Diagnosis General	Hardware Error Model Error Ready	RRSS	
OUTPUT 2	Close	PGC	Close Breaker	OR	
OUTPUT 3	Open	PGC General	Open Breaker Trip	OR	
OUTPUT 4	-	-	-	-	-
OUTPUT 5	-	-	-	-	-
OUTPUT 6	-	-	-	-	-
OUTPUT 7	-	-	-	-	-

8.12 Function 86. Trip lockout

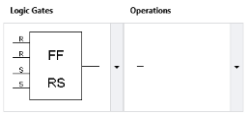
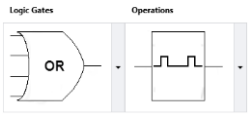
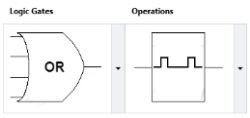
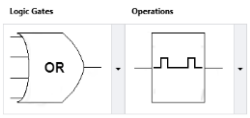
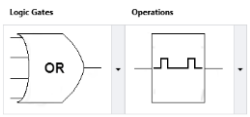
When the trip output is configured like OR_LACTH the programmable logic allows this output to be blocked.

8.13 Configurable LEDs

The device is equipped with 8 LEDs, 6 of them are configurable, while the other two are assigned to fixed purposes:

- Breaker status: LED ON when the circuit breaker is Closed and OFF when it is Open.
- Recloser status: LED ON when the recloser is Operational and OFF when it is Not.

Remaining LEDs can be configured by the user. The default configuration is as follows:

LED	Description	Criteria	States	Logic Gate	Sicom Symbol
ALARM 1	Ready	Self-Diagnosis Self-Diagnosis General	Hardware Error Model Error Ready	RRSS	
ALARM 2	Phase Trip	General	Phase Trip	OR BL	
ALARM 3	Neutral Trip	General	Neutral Trip	OR BL	
ALARM 4	Settings Group 1	General	Settings Group 1	OR BL	
ALARM 5	Settings Group 2	General	Settings Group 2	OR BL	
ALARM 6	Local Control	General	Local Control	OR	

Although the Ready LED is configurable, it is recommended that its default configuration as “Ready” not be modified.

Besides, 26 logic alarms are included in LEDs menu to allow the user a complete configuration of the relay.

8.14 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. Continue 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. Data constituting configuration is confirmed with corresponding checks.
- 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 doesn't match the harware model.
Hardware Error	It is active when there is a defect in the harware.
COM Error	It is active when there is a problem with the communication between the main CPU and the communication CPU.
Test State	This bit is included in this menu despite doesn't indicate an error. 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 inicialization 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 inicialization 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

8.15 Date/time synchronization

The relay can be synchronized from the HMI or by communications. SNTP protocol is included in the models provided with ethernet communications.

8.16 Test menu

The SIL-A relay is equipped with a test menu from where the led and outputs operation can be checked. The following tables show the components that can be tested, along with their status depending on whether they are activated or deactivated:

From standby screen, press ◄,▼,► sequentially and hold OK until the 'Test Menu' appears on the display. The relay will ask for the password '5555' to be entered in the test menu (or other if the customer password by default is '5555' has been modified).

The test menu is accessed by pressing the 'OK' key again, and the '▲' and '▼' keys can be used to navigate through the different menu items. Each item can be activated or deactivated by pressing 'OK' on it (if the item is deactivated, it is activated by pressing OK; if the item is activated, it is deactivated by pressing OK). Press the 'C' key to exit the test menu.

Once the relay is in test menu mode all the LEDs will be activated simultaneously. In case of the outputs, they will be activated or deactivated by pressing OK key:

OUTPUT 1	Deactivated	Output 1 deactivated
	Activated	Output 1 activated
OUTPUT 2	Deactivated	Output 2 deactivated
	Activated	Output 2 activated
OUTPUT 3	Deactivated	Output 3 deactivated
	Activated	Output 3 activated
OUTPUT 4 (*)	Deactivated	Output 4 deactivated
	Activated	Output 4 activated
OUTPUT 5 (*)	Deactivated	Output 5 deactivated
	Activated	Output 5 activated
OUTPUT 6 (*)	Deactivated	Output 6 deactivated
	Activated	Output 6 activated
OUTPUT 7 (*)	Deactivated	Output 7 deactivated
	Activated	Output 7 activated

(*) Depending on model

8.17 Power Supply

SIL-A is designed to be powered with an auxiliary voltage of 24-230 Vac/dc.

The supply guarantees between -20%/+10% of the auxiliary voltage. Outside this range the relay could operate, but it is not guaranteed.

9 TECHNICAL SPECIFICATIONS AND STANDARDS

9.1 Technical Specifications

Function 50-1 **Function 50-2 (*)**	Function enable: No/Alarm/Trip/SHB Trip(1)
	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%
	Instantaneous deactivation
	Timing accuracy: ± 35 ms or ± 0.5% (greater of both)
Function SOTF (*)	Function enable: No/Alarm/Trip/ SHB Trip(1)
	Current tap: 0.010 to 30.000 xIn (step 0.001xIn)
	Time delay: 0.000 to 300.000 s (step 0.001 s)
	Safe Time: 0.000 to 300.000 s (step 0.001 s)
	Activation level: 100%
	Deactivation level: 95%
	Instantaneous deactivation
	Timing accuracy: ± 35 ms or ± 0.5% (greater of both)
Function 50N-1 (*) **Function 50N-2 (*)**	Function enable: No/Alarm/Trip/ SHB Trip(1)
	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%
	Instantaneous deactivation
	Timing accuracy: ± 35 ms or ± 0.5% (greater of both)
Function 50G-1 **Function 50G-2 (*)**	Function enable: No/Alarm/Trip/ SHB Trip(1)
	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%
	Instantaneous deactivation
	Timing accuracy: ± 35 ms or ± 0.5% (greater of both)
Function 51-1 **Function 51-2 (*)**	Function enable: No/Alarm/Trip/ SHB Trip(1)
	Curve Type: IEC 60255-151 and IEEE curves.
	Curve type: IEC Standard Inverse, IEC Very Inverse, IEC Extremely Inverse, IEC Long Time Inverse, IEC Short Time Inverse, IEEE Moderately Inverse, IEEE Very Inverse, IEEE Extremely, Defined Time. Time delay: 0.000 to 300.000 s (step 0.001 s)
	Time Dial (TMS): 0.05 to 25.00 (step 0.01) - If Curve type IEC: 0.05 to 1.00 (step 0.01) - If Curve type IEEE: 0.10 to 25.00 (step 0.01)
	Current Tap: 0.010 to 20.000 xIn (step 0.001 xIn)
	Curve, activation level: 110%
	Curve, deactivation level: 100%
	Defined time, activation level: 100%
	Defined time, deactivation level: 95%
	Instantaneous 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 51N-1 (*)	Function enable: No/Alarm/Trip/ SHB Trip(1)
	Curve Type: IEC 60255-151 and IEEE curves.

Function 51N-2 (*)	Curve type: IEC Standard Inverse, IEC Very Inverse, IEC Extremely Inverse, IEC Long Time Inverse, IEC Short Time Inverse, IEEE Moderately Inverse, IEEE Very Inverse, IEEE Extremely, Defined Time. Time delay: 0.000 to 300.000 s (step 0.001 s)
	Time Dial (TMS): 0.05 to 25.00 (step 0.01) - If Curve type IEC: 0.05 to 1.00 (step 0.01) - If Curve type IEEE: 0.10 to 25.00 (step 0.01)
	Current Tap: 0.050 to 20.000 xIn (step 0.001 xIn)
	Curve, activation level: 110%
	Curve, deactivation level: 100%
	Defined time, activation level: 100%
	Defined time, deactivation level: 95%
	Instantaneous 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 51G-1 **Function 51G-2 (*)**	Function enable: No/Alarm/Trip/ SHB Trip(1)
	Curve Type: IEC 60255-151 and IEEE curves.
	Curve type: IEC Standard Inverse, IEC Very Inverse, IEC Extremely Inverse, IEC Long Time Inverse, IEC Short Time Inverse, IEEE Moderately Inverse, IEEE Very Inverse, IEEE Extremely, Defined Time. Time delay: 0.000 to 300.000 s (step 0.001 s)
	Time Dial (TMS): 0.05 to 25.00 (step 0.01) - If Curve type IEC: 0.05 to 1.00 (step 0.01) - If Curve type IEEE: 0.10 to 25.00 (step 0.01)
	Current Tap: 0.010 to 20.000 xIn (step 0.001 xIn)
	Curve, activation level: 110%
	Curve, deactivation level: 100%
	Defined time, activation level: 100%
	Defined time, deactivation level: 95%
	Instantaneous 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(1)
	Curve Type: IEC 60255-151 and IEEE curves. IEC (Definite time, standard inverse, very inverse, extremely inverse, long time inverse, short time inverse) and IEEE (Moderately inverse, very inverse, extremely inverse). Time delay: 0.000 to 300.000 s (step 0.001 s)
	Time dial (TMS): 0.05 to 25.00 (step 0.01) If Curve type IEC: 0.05 to 1.00 (step 0.01) If Curve type IEEE: 0.10 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%
	Instantaneous 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(1)
	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)
	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%
	Instantaneous deactivation
	Timing accuracy for defined time curve selection: ± 35 ms or ± 0.5% (greater of both)
Function 67GI (*)	Function enable: No/Alarm/Trip/ SHB Trip(1)
	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)
	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%
	Instantaneous deactivation
	Timing accuracy for defined time curve selection: ± 35 ms or ± 0.5% (greater of both)
Function 64REF (*)	Function enable: No/Alarm/Trip/ SHB Trip(1)
	Current tap: 0.050 to 20.000 xIn (step 0.001xIn)
	Time delay: 0.020 to 300.000 s (step 0.001 s)
	Block Threshold: 5 to 50% (step 1%)
	Activation level: 100%
	Deactivation level: 95%
	Instantaneous 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 0.001 xIn)
	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 49T	Available through configurable inputs thanks to the programmable logic
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 0.001 xIn)
	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)
Function 46 (*)	Function enable: No/Alarm/Trip/SHB Trip (1)
	Curve Type: IEC 60255-151 and IEEE curves.
	Curve type: IEC Standard Inverse, IEC Very Inverse, IEC Extremely Inverse, IEC Long Time Inverse, IEC Short Time Inverse, IEEE Moderately Inverse, IEEE Very Inverse, IEEE Extremely, Defined Time. Time delay: 0.000 to 300.000 s (step 0.001 s)
	Time Dial (TMS): 0.05 to 25.00 (step 0.01) - If Curve type IEC: 0.05 to 1.00 (step 0.01) - If Curve type IEEE: 0.10 to 25.00 (step 0.01)
	Current Tap: 0.010 to 20.000 xIn (step 0.001 xIn)
	Curve, activation level: 110%
	Curve, deactivation level: 100%
	Defined time, activation level: 100%
	Defined time, deactivation level: 95%
	Instantaneous 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
	Current 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 0.001 xIn)
	Minimum Level: 0.000 to 1.000 xIn (step 0.001 xIn)
	Time delay: 0.060 to 300.000 s (step 0.001 s)
	Activation level: 100%
	Deactivation level: 105%
	Instantaneous deactivation
	Timing accuracy: ±30 ms or ±0.5% (greater of both)
Function 59G-1 (*) **Function 59G-2 (*)**	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: 100%
	Deactivation level: 95%
	Temporized deactivation
	Timing accuracy: ±0.5% or ±30 ms (greater of both)
	Number of recloses: 0 to 4 (step 1)

Function 79 (*)	Reclose time 1, 2, 3, 4: 0.020 to 2000.000 s (step 0.001 s)
	Hold Enable: No/Yes/No Time
	Hold time: 0.000 to 2000.000 s (step 0.001 s)
	Reset time: 0.000 to 2000.000 s (step 0.001 s)
	Safe time: 0.020 to 2000.000 s (step 0.001 s)
	Locking possibilities: pulse inputs, level inputs, commands.
Function 52 (*)	Maximum number of openings: 1 a 100,000 (step 1)
	Maximum accumulated amperes: 1 to 100,000 M(A2) (step 1 M(A2))
	Repetitive number of openings: 1 to 100,000 (step 1)
	Time for 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)
Function 74TCS (*)	Function enable: No/Yes
	Time delay: 0.020 to 300.000 s (step 0.001 s)
	Continuity in circuits A and B
Function 60CTS (*)	Function enable: No/Yes
	Time delay: 0.020 to 300.000 s (step 0.001 s)
	Open breaker activation and reset threshold: 0.8% In
	Detection of the loss of one phase CT
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
Function TRIP BLOCK (*)	Function enable: No/Yes
	Current Tap: 1.500 to 30.000 xIn (step 0.001 xIn)
Function 86	It allows to latch (lock out) the contact trip due to programmable logic (PGC: OR_LATCH).
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 RSFF, RSFF_1PULSE, RSFF_PULSES, RSFF_BLINKING, RSFF_TIMER UP, RSFF_TIMER DOWN R_EDGE, R_EDGE_1PULSE F_EDGE, F_EDGE_1PULSE
Settings Groups	4 settings groups
	Selectable by input or general setting
Sequential Events Recording (SER)	2048 events
Disturbance fault recording (DFR)	32 samples/cycle
	Fault start configurable
	5 COMTRADE records (260 cycles each record): 1 to 8 pre-fault cycles + 252 to 259 postfault cycles 25 COMTRADE records (60 cycles each record): 1 to 8 pre-fault cycles + 52 to 59 postfault cycles. 50 COMTRADE records (30 cycles each record): 1 to 8 pre-fault cycles + 22 to 29 postfault cycles. 100 COMTRADE records (15 cycles each record): 1 to 8 pre-fault cycles + 7 to 14 postfault cycles.
	COMTRADE IEEE C37.111-1991 - 4 analog channels and 96 digital channels
	Up to 100 fault reports (data format) with 29 events each one
Load Data Profiling (LDP)	Demand of current with the following characteristics: - Number of records: 744 - Recording mode circular

	- Sampling rate (interval): configurable through communications (1-60 min) - Record format: Date/Time IMAX (in interval) Imax (at the moment of the record) IA IB IC IN
Inputs	Up to 6 Configurable inputs: The voltage of the inputs is the same as the auxiliary power supply
Outputs	Up to 7 Configurable outputs: 250 V AC – 8 A 30 V DC – 8 A
	Output 1 (NC + NO) Output 2, Output 3, Output 4(*), Output 5(*) and Output 6(*): NO Model with 7 outputs (*): All the outputs NO
Frequency	50/60Hz
Burden	Burden of current inputs: <0.1 mVA (1 A) & <0.5 mVA (5 A) Burden of power supply unit: 24 Vdc (quiescent): < 4 W 24 Vdc (50% Load): < 7 W 230 Vdc (quiescent): < 5 W 230 Vdc (50% Load): < 6 W 24 Vac (quiescent): < 8 VA 24 Vac (50% Load): < 17 VA 230 Vac (quiescent): < 13 VA 24 Vac (50% Load): < 17 VA Burden for binary inputs: 24 Vdc: <20 mW 230 Vdc: <200 mW 24 Vac: <50 mW 230 Vac: < 500 mW
Measurements	Phase current (I-A, I-B, I-C), neutral (3I0* and IN), neutral voltage (V-R*)positive sequence (I-1*), negative sequence (I-2*), I-2/I-1*, phase second harmonic current (IA-2H, IB-2H and IC-2H) (*), maximum current (Imax), Total Harmonic Distortion (THD-A, THD-B and THD-C) (*), thermal image (TI*), neutral angle (Ang I-N and Ang 3-I0) (*) and neutral voltage angle (Ang V-R*)
	Fundamental values (DFT)
	Sampling: 32 samples/cycle
	Current: ±2% precision in a band covering ±20% of nominal current and ±4% or ± 5 mA in the rest of the range Voltage: 1% precision in a band covering ±20% of nominal voltage and 4% in the rest of the range (*)
	Current: Up to 30 times rated current Voltage: Up to 250 volts (phase to phase) (*)
Communications	Local port (micro USB): Modbus RTU
	1 RS485 Port: IEC60870-5-103, Modbus RTU or DNP3.0 Serial (selectable by general settings). (*)
	1 RS485 Port: IEC60870-5-103, Modbus RTU or DNP3.0 Serial (selectable by general settings) + 1 RJ45 Port: Modbus TCP/IP, DNP3.0 TCP/IP or IEC60870-5-104 Serial (selectable by general settings) + Web Server + SNTP protocol (*)
	1 RS485 Port: IEC60870-5-103, Modbus RTU or DNP3.0 Serial (selectable by general settings) + 1 RJ45 Port: IEC61850 + SNTP protocol (*)
Power supply	24-230 Vdc / Vac -20%/+10%
Environmental conditions	Operating temperature: -40 to 70ºC
	Storage temperature: -40 to 80 ºC
	Relative humidity: 95%
Transformers	Measurement 3 or 4 CT /5 or /1 (depending on model)
Mechanical characteristics	Metallic box
	Panel mounted

	Height x Width: 177 x 107 (mm)
	Depth: 122.1 mm
	IP-54

(*) Optional depending on model
[1] Only for models with SHB function

9.2 Thermal resistance

- 4 times rated current continuously.
- 30 times rated current for 10 s.
- 100 times rated current for 1s.

9.3 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)	IEC60255-27 Clause 10.6.5.2	
• Housing		• 70/80 °C
• Cover		• 70/80 °C
• Terminals		• V-2
• Push buttons		• 55/70 °C
• Display		• 55/70 °C
• PCB boards		• V-2
• (Input) transformers		• V-1
• Opto couplers		• V-1
• Output relays		• V-1

• Wires		• 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 • Overcurrent CT, cont. • Overcurrent CT, 1s	IEC60255-27 Clause 10.6.5.3	• 4xIn • 100xIn
1.10. High Leakage current	IEC60255-27 Clause: 5.1.8	See Standard
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	8 kV cont. 15 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	100 A/m cont. 1000 A/m 1-3 s
2.2.9 D.C. voltage dips	IEC 60255-26 (IEC 61000-4-29) Clause 7.2.11	100%; 5, 10, 20, 50, 100 and 200 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
2.2.17. Slow damped oscillatory wave (100 kHz)	IEC61000-4-18	2.5 kV CM 1.0 kV DM
2.2.18. Main frequency voltage	IEC61000-4-16	50 Hz 30 V; Cont. 300 V; 1 s
2.2.19. Reversal of DC power supply	IEC60255-27 Clause: 10.6.6	1 minute
3. CLIMATIC ENVAIRONMENTAL CONDITIONS		
3.1. Dry heat operational	IEC 60255-1 (IEC 60068-2-2, test Bd) Clause 6.12.3.1	+70°C; 96h

3.2. Cold operational	IEC 60255-1 (IEC 60068-2-1, test Ad) Clause 6.12.3.2	-40°C; 96h
3.3. Dry heat storage	IEC 60255-1 (IEC 60068-2-2, test Bb) Clause 6.12.3.3	+80°C; 96h
3.4. Cold storage	IEC 60255-1 (IEC 60068-2-1, test Ab) Clause 6.12.3.4	-40°C; 96h
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 class 2
4.4. Shock withstand	IEC 60255-1 (IEC 60255-21-2) Clause 6.13.2	class 1 class 2
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 class 2
5. **ENERGIZING QUANTITIES**		
6.1 Burden current transformers	IEC60255-1 Clause: 10.6.2	-
6.2 Burden A.C. power supply **(quiescent, maximum load, inrush current, power-up duration)**	IEC60255-1 Clause: 10.6.3	-
6.3 Burden D.C. power supply **(quiescent, maximum load, inrush current, power-up duration)**	IEC60255-1 Clause: 10.6.4	-
6.4 Burden for binary input	IEC60255-1 Clause: 10.6.5	-
6. CONTACT PERFORMANCE		
Mechanical endurance	IEC60255-1 Clause: 6.11	-
Limiting making capacity	IEC60255-1 Clause: 6.11	-
Short time contact current	IEC60255-1 Clause: 6.11	-
Continuous contact current	IEC60255-1 Clause: 6.11	-

Limiting breaking capacity	IEC60255-1 Clause: 6.11	-

9.4 Energizing quantities

9.4.1 Burden for current measuring inputs

Being the relay set to the secondary nominal current of 1 amp, the burden for current measuring inputs is:

Specified Burden of current inputs:

<0.1 mVA (1 A)

Measured burden of current inputs:

Phase: 0.013 mVA

Neutral: 0.013 mVA

Being the relay set to the secondary nominal current of 5 amperes, the burden for current measuring inputs is:

Specified Burden of current inputs:

<0.5 mVA (5 A)

Measured burden of current inputs:

Phase: 0.324 mVA

Neutral: 0.331 mVA

9.4.2 Burden for power supply unit

Considering the SIL-A relay is provided with universal power supply (24-230 Vac/dc), the burden will be as follows:

Specified Burden of power supply unit:

24 Vdc (quiescent): < 4 W

24 Vdc (50% Load): < 7 W

230 Vdc (quiescent): < 5 W

230 Vdc (50% Load): < 6 W

24 Vac (quiescent): < 8 VA

24 Vac (50% Load): < 17 VA

230 Vac (quiescent): < 13 VA

24 Vac (50% Load): < 17 VA

Measured Burden of power supply unit:

24 Vdc (quiescent): 3.84 W

24 Vdc (50% load): 4.55 W

230 Vdc (quiescent): 3.76 W

230 Vdc (50% load): 4.35 W

24 Vac (quiescent): 6.24 VA

24 Vac (50% load): 8.25 VA

230 Vac (quiescent): 11.94 VA

230 Vac (50% load): 13.63 VA

9.4.3 Burden for binary input

The inputs in SIL-A relay are activated at the same level of the power supply (24-230 Vac/dc). The burden will be as follows:

Specified Burden for binary inputs:

24 Vdc: <20 mW

230 Vdc: <200 mW

24 Vac: <50 mW

230 Vac: < 500 mW

Measured Burden for binary inputs

24 Vdc activation: 9.36 mW

230 Vdc activation: 167.9 mW

24 Vac activation: 33.29 mVA

230 Vac activation: 380.72 mVA

10 COMMUNICATION AND HMI

The SIL-A relay is equipped with the following communications ports:

1	LOCAL (front)	Micro USB	Modbus RTU
2	REMOTE (rear)	RS485	Modbus RTU or IEC 60870-5-103 or DNP3.0 Serial (by general settings)
3 (*)	REMOTE (rear)	RJ45	Modbus TCP/IP or DNP 3.0 TCP/IP or IEC60870-5-104 (by general settings) +SNTP Protocol
4 (*)	REMOTE (rear)	RJ45	IEC 61850 + SNTP Protocol

(*) Port and Protocol available depending on model.

10.1 Local communication port. Micro USB

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 - 8bit – no parity – 1 stop bit).

The PC earth should be connected to the same earth as the relay to avoid communication problems.

The USB communication is fitted with auxiliary voltage insulation, but no insulation with regards to the relay processors. Therefore, the connection cable between the PC and relay must not be very long to prevent possible electromagnetic interferences with the relay.

10.2 Remote communications port

SILA with one RS485 port for ModBus, IEC60870-5-103 or DNP3.0 serial

There is one RS485 port, it is possible to select ModBus RTU protocol or IEC60870-5-103 or DNP3.0 serial protocol 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 program.

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.

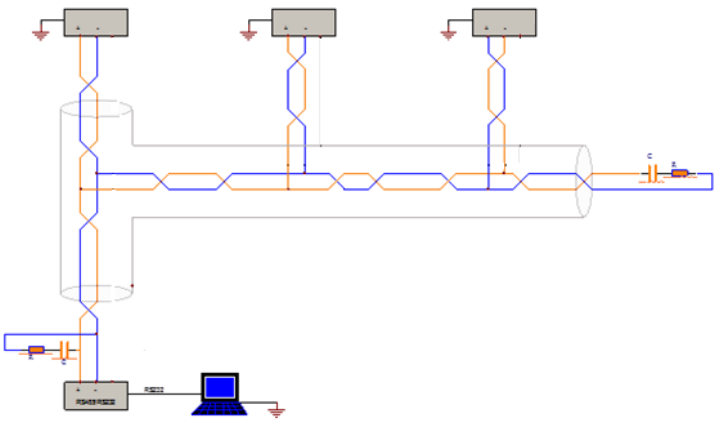
If a 3-wire cable is used, ground terminals (GND) should be connected to ground cable.

If a 2-wire cable is used, ground terminals (GND) should be connected to cable shielding. The shielding should be connected in one just point to ground to avoid circulating currents.

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.

Connection diagram for a RS485 bus:



SILA with one RJ45 port for Modbus TCP/IP or DNP3.0 TCP/IP or IEC60870-5-104

In this case there is one RJ45 port for DNP 3.0 TCP/IP, IEC 60870-5-104 or Modbus TCP/IP protocols, where the protocol can be chosen by general settings.

SILA with one RJ45 port for IEC61850

In this case there is one RJ45 port for IEC61850 the protocol.

10.3 LCD and keypad

The front of the SIL A relay is fitted with an alphanumeric LCD screen, measuring 20x2. This screen provides the user with access to read information about the settings parameters, measurements, status and events. All 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.

This is equipped with two specific keys marked with 79, which permits operation on the recloser, blocking and unblocking it.

It is also equipped with two specific keys marked with 52, which permits operation on the circuit breaker, opening and closing it.

10.4 SICom Communications program

The SICom program, which works with the Windows 7, Windows 8, Windows 8.1 and Windows 10 operating systems is provided, and can be used to gain access to all of 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 program (locally and remotely using Modbus RTU):

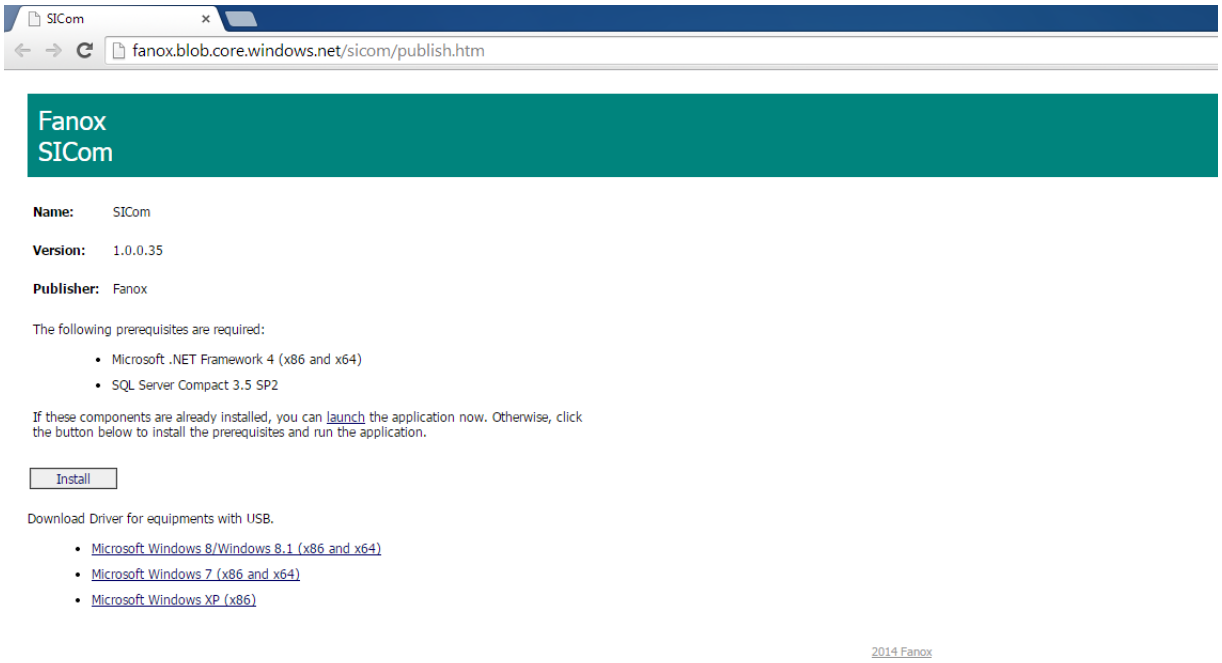
- Status reading
- Measurement reading
- Read, change and save settings
- Read, change and save configuration
- Read and delete events
- Read and delete DFR
- Configure and check the demand (LDP)
- Date-time synchronisation
- Set Counters
- Execute Commands
- Changing the user passwords
- Loading settings files
- Loading configuration files
- Checking the versions of the relay

10.4.1 How to install SICOM Software

To install the SICom it is necessary the following link:

http://fanox.blob.core.windows.net/sicom/publish.htm

The link will open the next screen, where key ‘Install’ 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.

10.5 Setting up the session: Password and access levels

Users must identify themselves with a password in order 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.

Ten (10) passwords and their associated levels of access can be set up using the SICom program. The password can make up of 10 characters as maximum. By default, the equipment is programmed with the following passwords and their associated levels:

HMI

ACCESS LEVEL	PASSWORD	Permission to: Change settings	Permission to: Execute Commands, Set Counters, Delete Events, Delete DFR, Delete LDP	Permission to: Change user´s Configuration, Delete user´s configuration	Permission to: Upgrade the FW (flashing process)	Permission to: Change manufacturer´s Configuration
0	0000	NO	NO	NO	NO	NO
1	1111 2222 3333 6666 7777 8888	YES	NO	NO	NO	NO
2	4444	YES	YES	NO	NO	NO
3	5555	YES	YES	YES	YES	NO

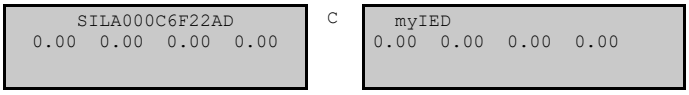
SICOM

ACCESS LEVEL	PASSWORD	Read-only permission: Status and measurements, Settings, Configuration, Events/DFR	Permission to: Change settings	Permission to: Execute Commands, Set Counters, Delete Events, Delete DFR	Permission to: Change user´s Configuration, Delete user´s configuration	Permission to: Upgrade the FW (flashing process)	Permission to: Read and change access levels	Permission to: Change manufacturer´s Configuration
0	Fanox/0000	YES	NO	NO	NO	NO	NO	NO
1	Fanox/1111 Fanox/2222 Fanox/3333 Fanox/6666 Fanox/7777 Fanox/8888	YES	YES	NO	NO	NO	NO	NO
2	Fanox/4444	YES	YES	YES	NO	NO	NO	NO
3	Fanox/5555	YES	YES	YES	YES	YES	YES	NO

10.6 Menus

10.6.1 Standby mode screen

The default screen shows the device model and the currents in phase A, phase B, phase C, and Neutral. Press 'OK' to select a menu: measurements, states, general settings, settings group, alarms panel, events (SER), fault recorder (DFR), Load Data Profiling (LDP), counters, commands and date. If the HMI is left in any state, it will return to the default screen after 5 minutes without any key being pressed.

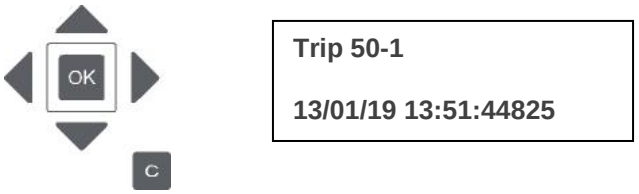


If any error is detected by the self-diagnosis, an error message appears in the second line (instead of the currents) on the main screen, which can show any of the following information: (see inside self-diagnosis section).

- MEASUREMENT ERROR
- EEPROM ERROR
- EVENTS ERROR

10.6.2 Last Trip screen

When a trip occurs, the default screen alternates with the last trip screen, showing the cause of the trip and the time and date of its occurrence.



Even if auxiliary power is lost, when the SIL-A regains power, it will retain information on the last trip. The last trip screen will only disappear when the 'RESET' button is pressed and held down.

10.6.3 Accessing the menus

The keys ▲, ▼, ◄ and ► are used to navigate through the different options and menus. The '**OK**' key is used to accept and to enter a menu or an option. The '**C**' key is used to move up through the menu levels.

It is not necessary to enter any password to read or view the parameters, measurements or settings.

A 4-character password must be entered in order to modify any parameter.

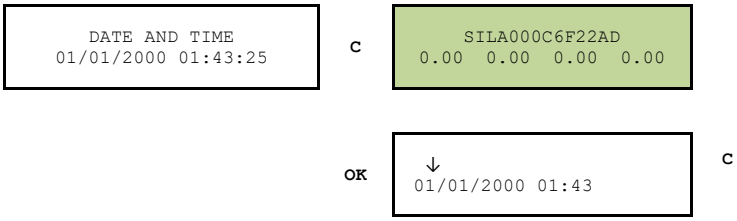
After returning to the main screen, the password must be entered again to make any further modifications.

The keys ◄ and ► are used to navigate from one item to another within a parameter. The keys ▲ and ▼ are used to increase or decrease the value. If an invalid value is entered during the process, the '**C**' key can be used to delete it.

10.6.4 Date-Time Menu

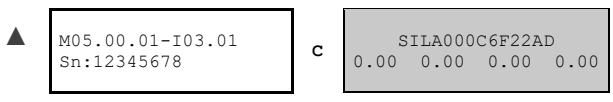
The date-time menu can be accessed by pressing the '►' key from the standby mode screen. From here, press the 'OK' key to access the date-time modification screen. Use the '►' and '◄' keys to position the cursor over the digit that you want to change and assign a value to this digit using the '▲' and '▼' keys. Once the date-time has been entered, press 'OK' to change the relay date. Press the 'C' key to return to the standby mode screen.

The date-time information can be viewed by pressing the '►' key from the main screen.



10.6.5 Versions

From the standby mode screen, hold the '▲' key to access to the relay versions where the microcontrollers software versions are displayed. Pressing 'C' key it is returned to the standby screen.

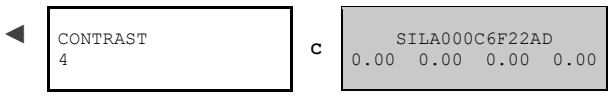


10.6.6 Contrast

From the standby mode screen, hold the '◄' key to visualize contrast menu.

Pressing '▲' and '▼' keys the contrast level can be changed.

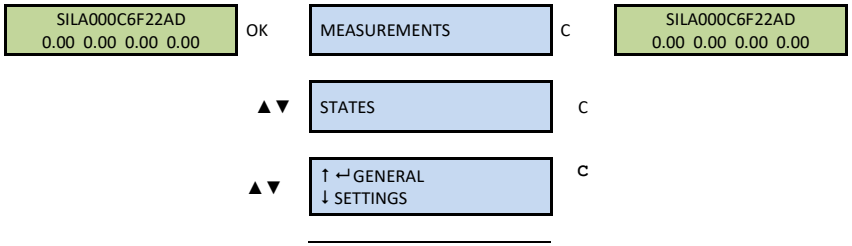
Pressing 'C' key it is returned to the standby screen.

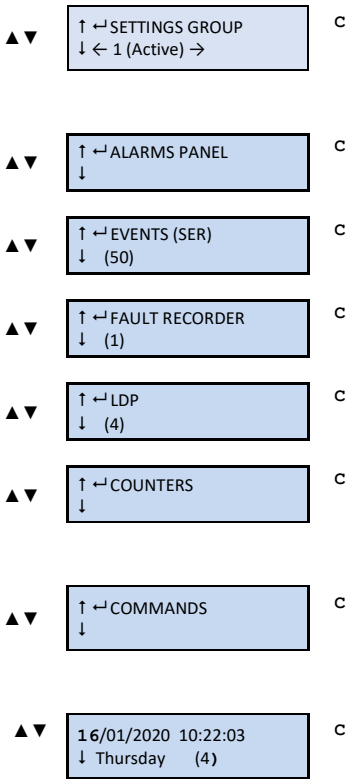


10.6.7 Funcional menu

The SIL-A relay menu is split up into 8 main parts:

- Measurements.
- States.
- General Settings.
- Settings Group.
- Alarms panel.
- Events (SER).
- Fault recorder.
- LDP.
- Counters.
- Commands.
- Date/time.

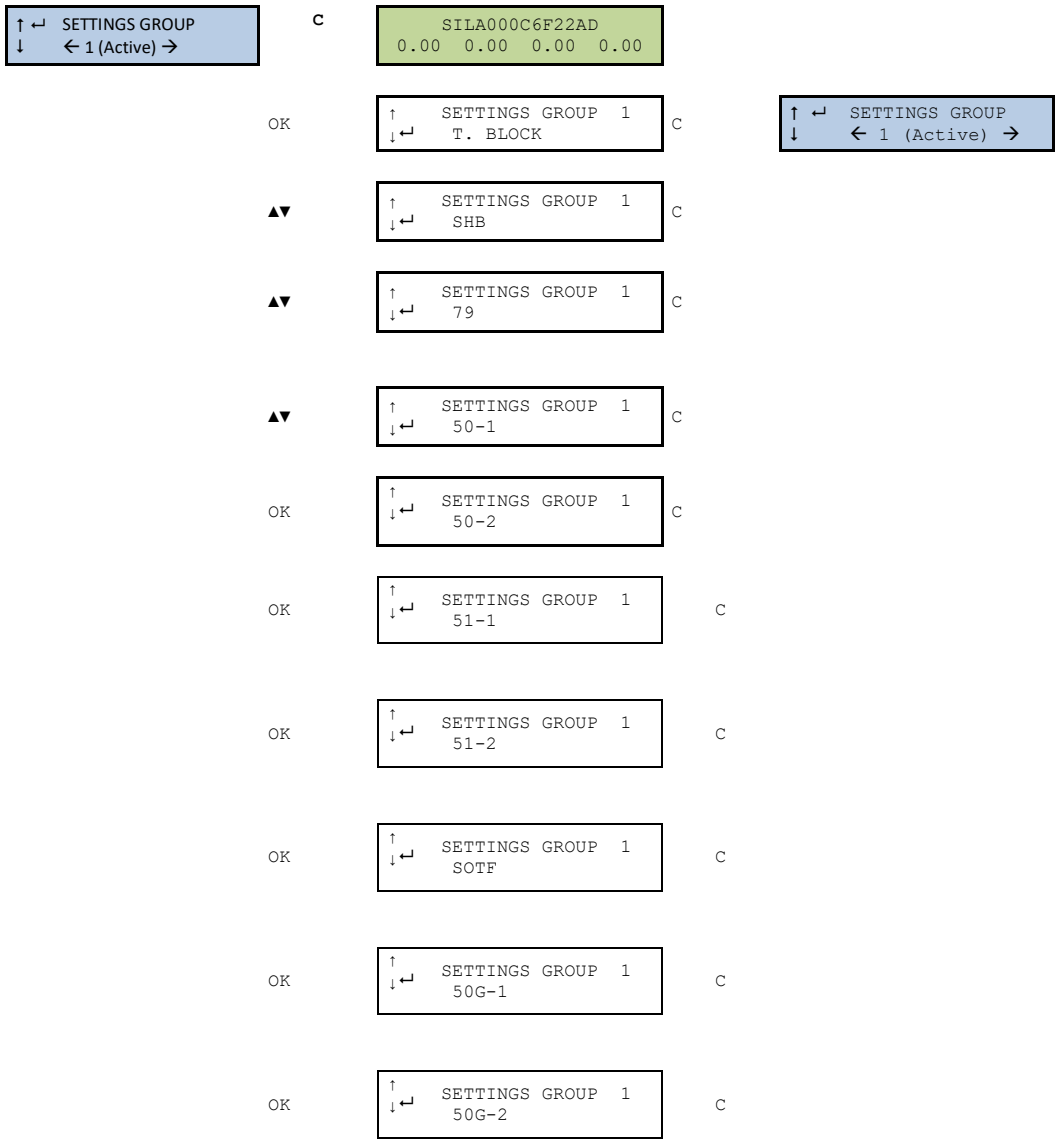


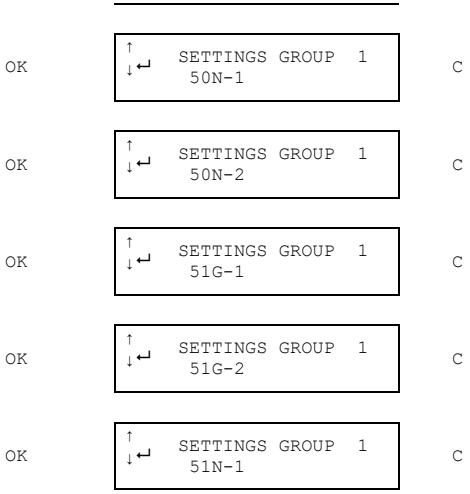


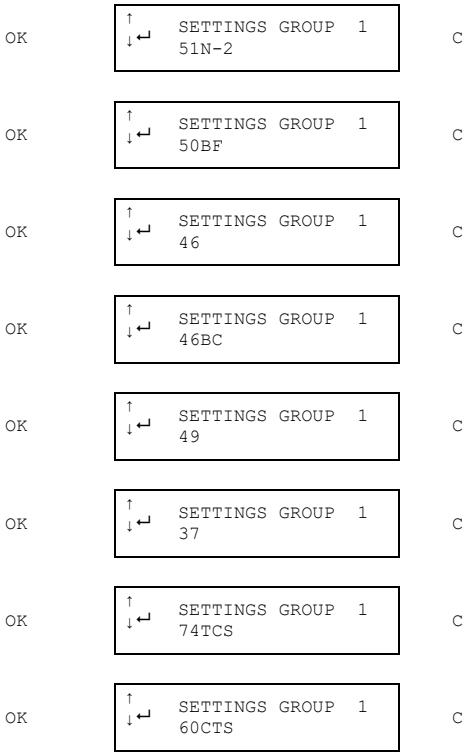
Press the '**OK**' key to access the second level from the main screen. Use the ▲ and ▼ keys to move from one menu section to another in the second level. Use the '**C**' key to return to a higher level.

10.6.8 Settings menu

From the standby mode screen, press the 'OK' key to access the first line of menus. Use the '▲' and '▼' keys to position the cursor over the 'SETTINGS' screen and press 'OK'. This takes you to the settings groups line. Use the '▲' and '▼' keys to position the cursor over a settings group and press the 'OK' key to access the settings that belong to this group. Use the '▲' and '▼' keys to move through the different settings. The information that appears underneath the setting name is its value.


↑ ↵ SETTINGS GROUP
↓ ← 1 (Active) →
C
SILA000C6F22AD
0.00 0.00 0.00 0.00
OK
↑ SETTINGS GROUP 1
↓↵ T. BLOCK
C
↑ ↵ SETTINGS GROUP
↓ ← 1 (Active) →
▲▼
↑ SETTINGS GROUP 1
↓↵ SHB
C
▲▼
↑ SETTINGS GROUP 1
↓↵ 79
C
▲▼
↑ SETTINGS GROUP 1
↓↵ 50-1
C
OK
↑ SETTINGS GROUP 1
↓↵ 50-2
C
OK
↑ SETTINGS GROUP 1
↓↵ 51-1
C
OK
↑ SETTINGS GROUP 1
↓↵ 51-2
C
OK
↑ SETTINGS GROUP 1
↓↵ SOTF
C
OK
↑ SETTINGS GROUP 1
↓↵ 50G-1
C
OK
↑ SETTINGS GROUP 1
↓↵ 50G-2
C


OK
↑
↓↵
SETTINGS GROUP 1
50N-1
C
OK
↑
↓↵
SETTINGS GROUP 1
50N-2
C
OK
↑
↓↵
SETTINGS GROUP 1
51G-1
C
OK
↑
↓↵
SETTINGS GROUP 1
51G-2
C
OK
↑
↓↵
SETTINGS GROUP 1
51N-1
C


OK
↑
↓↵
SETTINGS GROUP 1
51N-2
C
OK
↑
↓↵
SETTINGS GROUP 1
50BF
C
OK
↑
↓↵
SETTINGS GROUP 1
46
C
OK
↑
↓↵
SETTINGS GROUP 1
46BC
C
OK
↑
↓↵
SETTINGS GROUP 1
49
C
OK
↑
↓↵
SETTINGS GROUP 1
37
C
OK
↑
↓↵
SETTINGS GROUP 1
74TCS
C
OK
↑
↓↵
SETTINGS GROUP 1
60CTS
C

11 APPENDIX

NOTES:

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