FANOX
Safely protected

SIA-C Standard CT´s

Self & Dual Powered Overcurrent & Earth Fault Protection Relay

SELF-POWERED TECHNOLOGY

KEMA Labs

USER´S MANUAL

1. INTRODUCTION

Scope:

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

The right to make technical improvements without notice is reserved.

Conformity:

This product is design according IEC60255-1 Standard and it is provided with CE marking.

Technical support: Contact Fanox technical Service:

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

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

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

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

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

The SIA-C is identified with the following quality label:

2. RECEPTION, HANDLING & INSTALLATION

2.1 Unpacking

Relays must only be handled by qualified personnel and special care must be taken to protect all of their parts from any damage while they are being unpacked and installed. The use of good illumination is recommended to facilitate the relay visual inspection.
The facility must be clean and dry, and relays should not be stored in places that are exposed to dust or humidity. Special care must be taken if construction work is taking place.

2.2 Reception of relays

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

If any defect is found, the transport company and FANOX should be informed immediately.
If the relays are not for immediate use, they should be returned to their original packaging.

2.3 Handling electronic relay

Relays contain an electronic component that is sensitive to electrostatic discharges.
Just by moving, a person can build up an electrostatic potential of several thousand volts. Discharging this energy into electronic components can cause serious damage to electronic circuits. It is possible that this damage may not be detected straight away, but the electronic circuit reliability and life will be reduced. This electronic component in the relay is well protected by the metal housing, which should not be removed as the relay cannot be adjusted internally.
If it is necessary to disassemble the electronic component, this must be carried out with care and contact with electronic components, printed circuits and connections must be avoided to prevent an electrostatic discharge that could damage one of the components. If the electronic components are stored outside the metal housing, they must be placed in an antistatic conductive bag.
If it is necessary to open a module, care must be taken to preserve the relay reliability and the duration of the life cycle as designed by the manufacturer by taking the following actions:

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

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

2.4 Installation, commissioning and service

The personnel in charge of installing, commissioning and maintaining this relay must be qualified and must be aware of the procedures for handling it. The product documentation should be read before installing, commissioning or carrying out maintenance work on the relay.
Personnel should take specific protection measures to avoid the risk of electronic discharge when access is unlocked on the rear part of the relay.
In order to guarantee safety, the crimp terminal and a suitable group tool must be used to meet isolation requirements on the terminal strip. Crimped terminations must be used for the voltage and current connections.
It is necessary to connect the relay to earth through the corresponding terminal, using the shortest possible cable. As well as guaranteeing safety for the personnel, this connection allows high frequency noise to be evacuated directly to earth.
The following checks must be performed before the relay is supplied:

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

The relay must be used within the stipulated electrical and environmental limits (Surrounding air temperature of 70 ºC). Suitable for mounting in a flat surface of type 1 enclosure.

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

The user shall be responsible for ensuring the integrity of any protective conductor connections before carrying out any other actions.

The user shall also be responsible for checking equipment ratings, operating instructions and installation instructions before commissioning or maintenance.

It is the responsibility of the user to ensure that the equipment is installed, operated, and used for its intended function in the manner specified by Fanox.

During the commissioning process any external fuse or protective device required for safe operation of the equipment shall be installed if necessary.

In case of any failure, contact Fanox.

2.5 Storage

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

2.6 Recycling

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

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

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

3. IDENTIFICATION OF THE RELAY

3.1 Ratings / Characteristics of the relay

Rated current I_N	1 A or 5 A
Rated frequency	50/60 Hz
Rated auxiliary voltage:	Self-powered
	24-230 Vdc/Vac (Vdc (±20%) / Vac (±15%))
	Commissioning battery
Binary input voltage	Without auxiliary voltage (activated by short-circuiting the terminals)
Output contact continuous current	5 A
Maximum operating temperature	+70 ºC
Minimum operating temperature	-40 ºC
Maximum storage temperature	+80 ºC
Minimum storage temperature	-40 ºC

Classification

IP-Class:	
Mechanics G and H	
	IP 54 (Front)
	IP 40 (Top, bottom, left, right and back)
	IP 20 (Terminals)*
Mechanics F	
	IP 40 (Front)
	IP 40 (Top, bottom, left, right and back)
	IP 10 (Terminals)*
Mechanical class	1
EMC emission class	A
EMC immunity zone	A
Overvoltage category	III
Pollution degree	2
Insulation type	Functional

*Declared IP for mechanics G and H when the relay is wired.

4. SUMMARY OF THE MAIN CHARACTERISTICS

- The SIA-C is an OC&EF protection relay with self-powered and dual powered (self-powering + auxiliary power) options.
- The relay is self-powered using the operating current through /5 (2.5VA) or /1 (2.5VA) standard current transformers fitted on the lines. These transformers are also used to obtain current measurements. Besides, SIA-C can be used with auxiliary power supply (24-230 Vac/dc). The relay can be also supplied by a USB cable connected to the laptop or with a standard power bank.
- Internal commissioning battery included (Lithium battery: 20 years lifetime).
- Metallic box with high electromagnetic compatibility level (EMC) and wide range of operating temperature.
- Really low start-up levels in self-powered mode: 0.075xIn in three phase system / 0.16xIn in single phase system.
- Test menu allows the trip circuit to be tested before the transformation centre is powered up.
- The front part of the SIA-C relays is provided with a navigation keypad made of 7 keys (including the RESET key) and a hot key to open the CB. Besides, there are up to 7 configurable LEDs and 1 bistable magnetic indicator (flag) which indicates the trip, maintaining their position even though the relay loses the supply.
- Self-diagnosis of the relay status (WATCHDOG) through the configurable LEDs and outputs.
- Low power consumption.
- To allow communication, relays are provided with a front Micro USB Port and with an optional remote communication on the rear side: RS485 port (Modbus RTU (DNP3 and IEC60870-5-103 protocols upcoming)) and ethernet RJ45 port (Modbus TCP protocol).
- The SIA-C is provided with trip output for a low-power coil (24 Vdc – 135 mJ). Depending on the model, a single-phase trip or single/triple-phase trip is available by means of a switch.
- The SIA-C is provided with (depending on model):
    - » 2 outputs + 4 inputs
    - » 4 outputs + 4 inputs
    - » 7 outputs + 10 inputs
- The SIA-C is fitted with the demand of current (Load Data Profiling) with the following characteristics:
    - » Number of records: 168.
    - » Recording mode circular.
    - » Sampling rate (interval): configurable through communications 1-60min.
- The SIA-C is provided with non-volatile RAM memory in order to store up to 1.024 events and disturbance fault recording (DFR- 20 fault reports and 10 oscillographic records in COMTRADE format), maintaining date & time thanks to its internal RTC (Real Time Clock) even without power supply.
- Each oscillographic record contains 4 analogue channels and up to 32 digital channels. The oscillography is downloaded by communications port. The SICom communications program

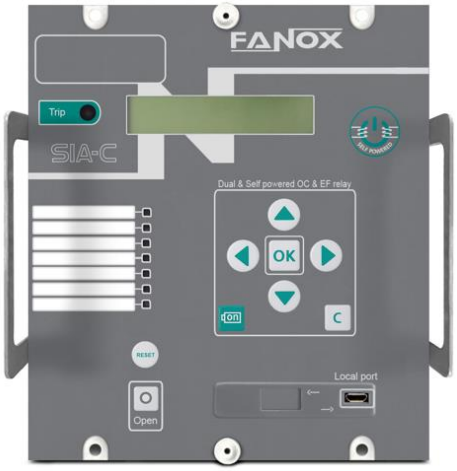
allows the oscillography record to be downloaded and saved in COMTRADE format (IEEE C37.111-1991).

- The installation and subsequent maintenance of external batteries is eliminated. The operating costs of the center are reduced.
- Withdrawable and non-withdrawable mechanics are available by model list to fulfil all our customers' needs and make the installation easier.

5. DIMENSIONS AND CONNECTION DIAGRAMS

5.1 Front view

Non-withdrawable model

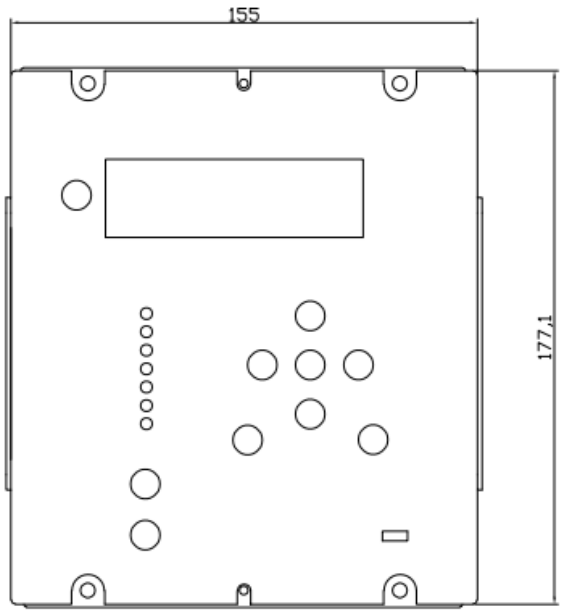


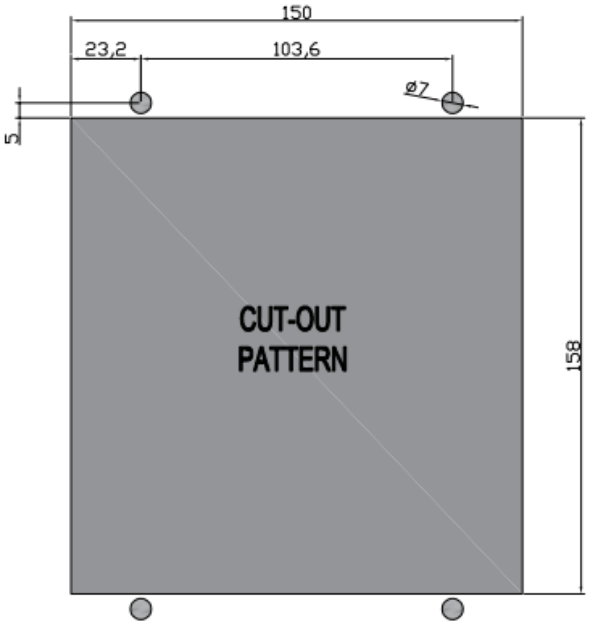
Withdrawable model

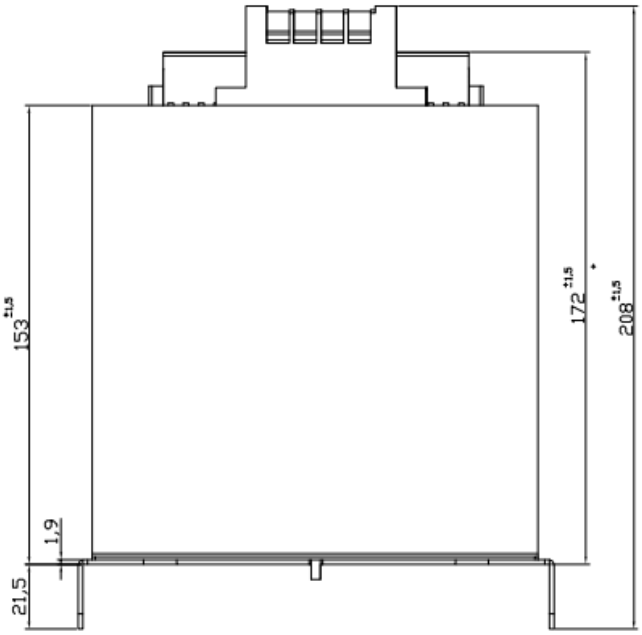
5.2 Case dimensions

The dimensions are in mm:

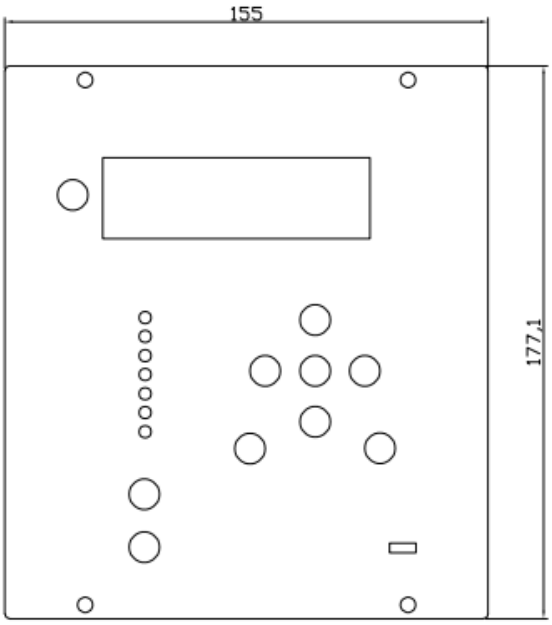
Option 1: Withdrawable vertical assembly:

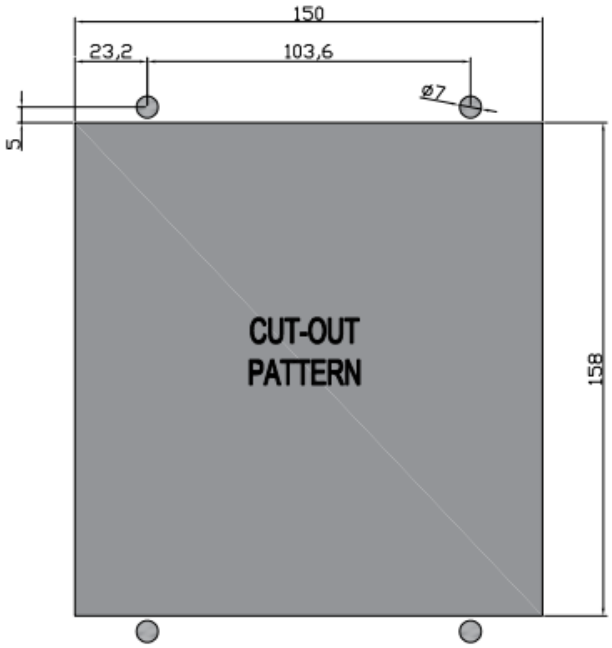


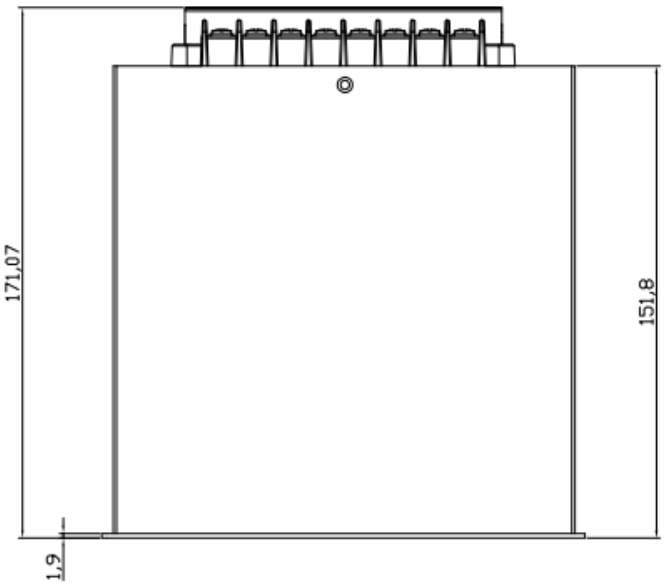




Option 2: Non-withdrawable vertical assembly:



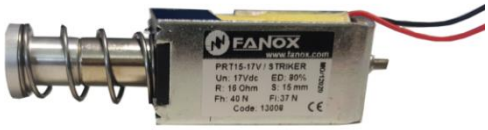


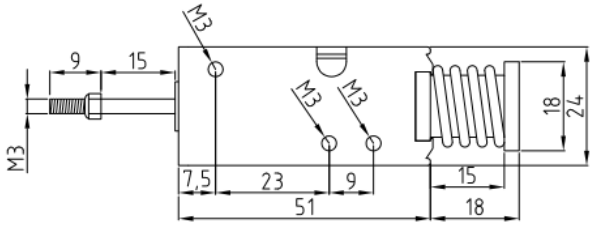


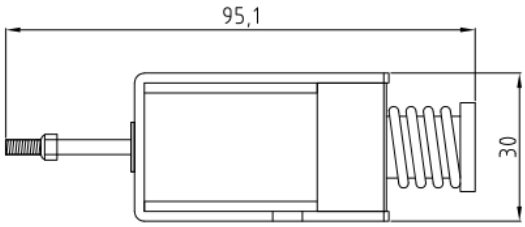
*Values without tolerances according to DIN7168m

5.3 Striker dimensions

5.3.1 PRT-15

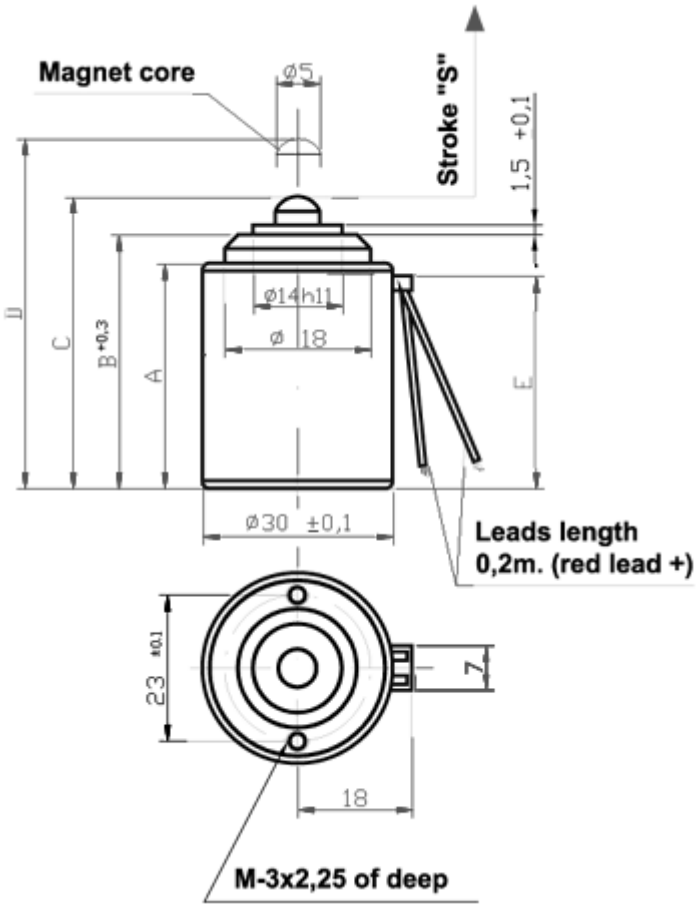






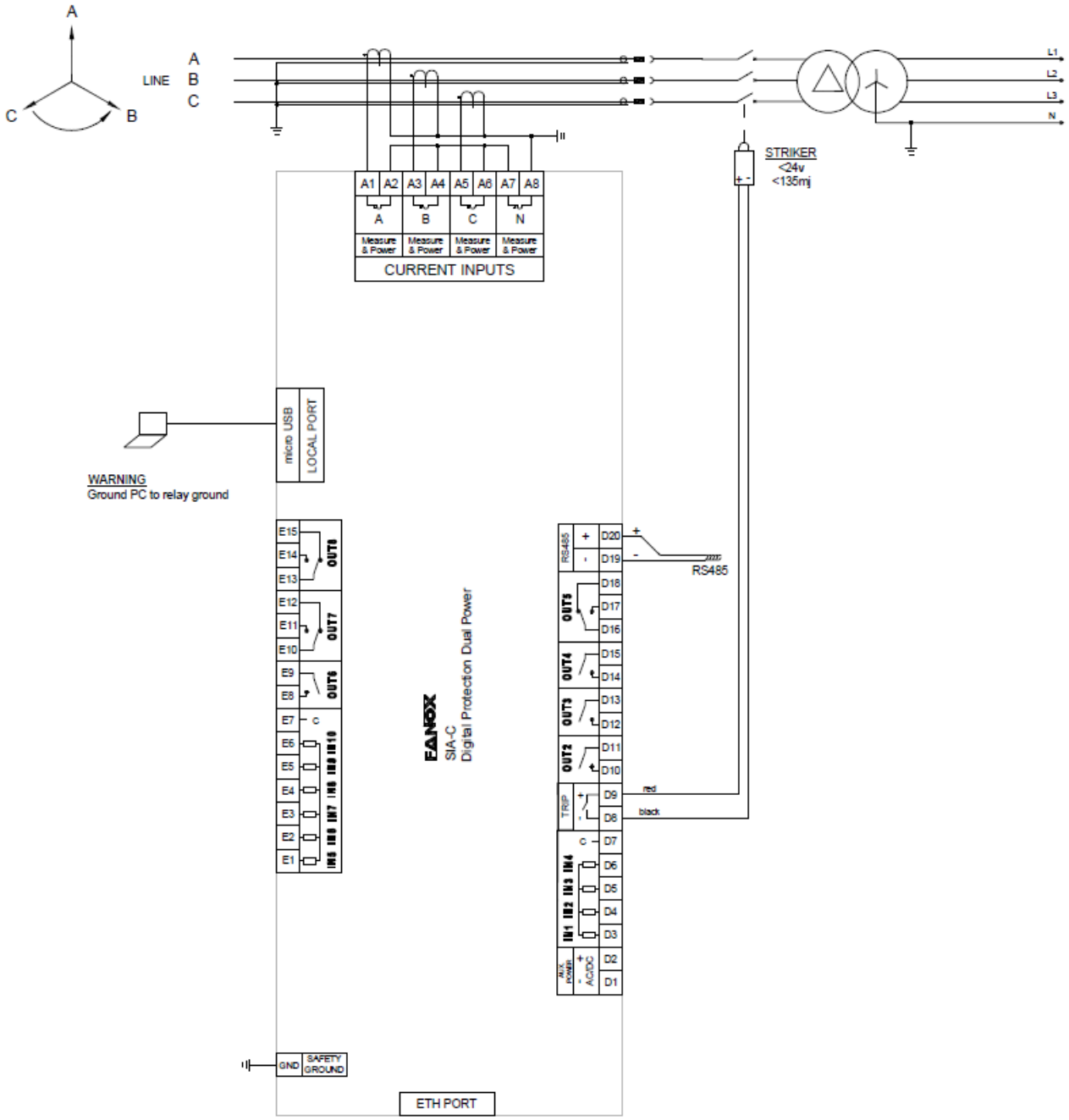
5.3.2 PRT

A	44,5
B	49,5
C	56,5
D	64,5
E	42,5

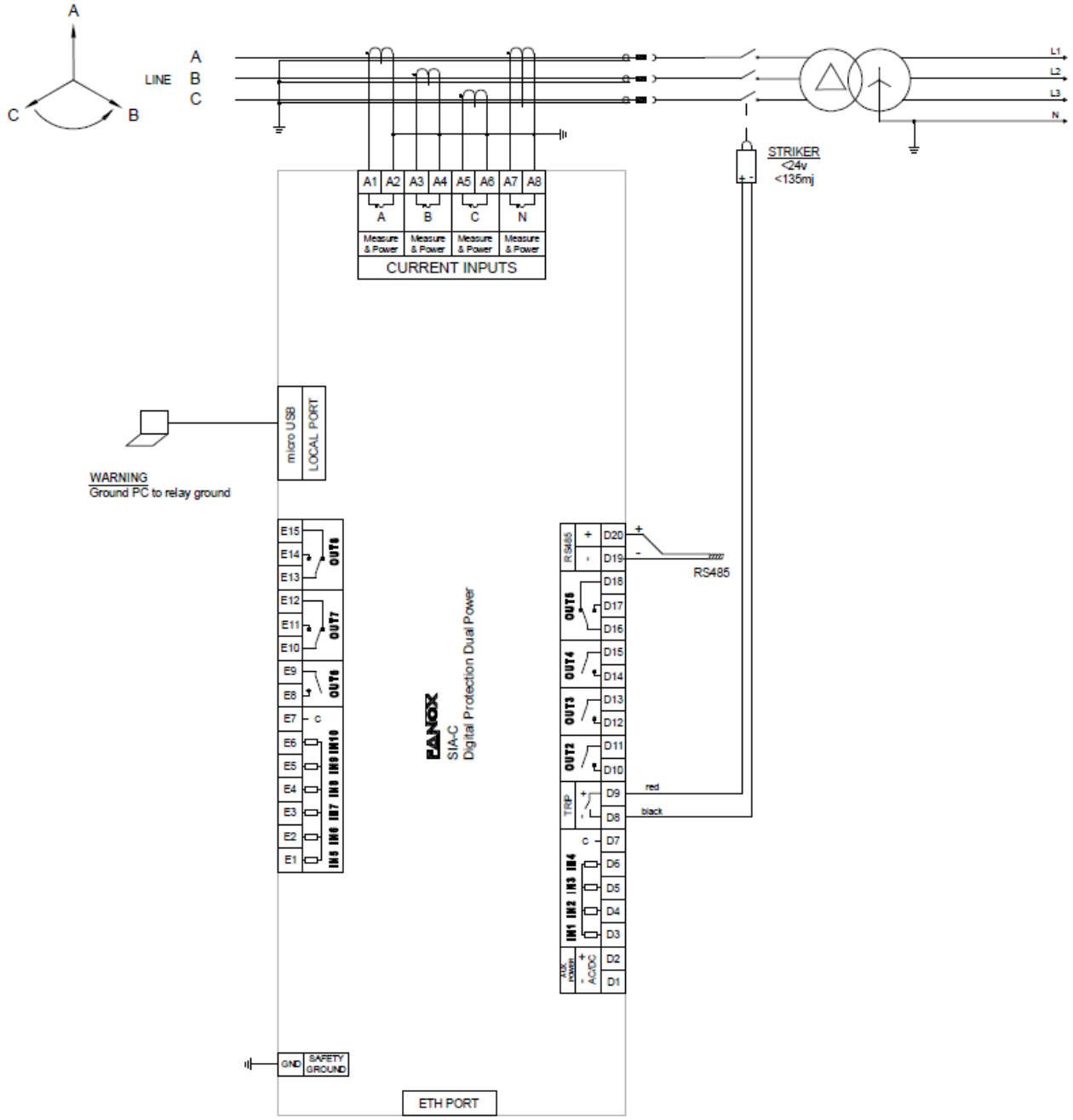

Magnet core
ø5
Stroke "S"
1,5 +0,1
ø14h11
ø 18
D
C
B+0,3
A
E
ø30 ±0,1
Leads length
0,2m. (red lead +)
23 ±0,1
7
18
M-3x2,25 of deep

5.4 Connection diagram

3 Standard Current transformers



4 Standard Current transformers



NOTE! STRIKER: 6 – 24 Vdc & <= 0.135 W·s

(*) Other options for inputs, outputs and communications available depending on model.

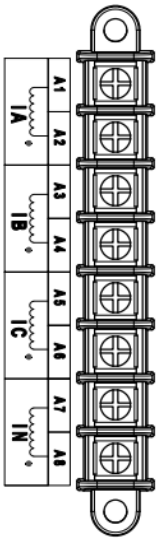
5.5 Terminals

Use copper conductors only, rated 75 ºC minimum.

5.5.1 Current terminals

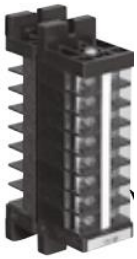
5.5.1.1 Non-withdrawable model

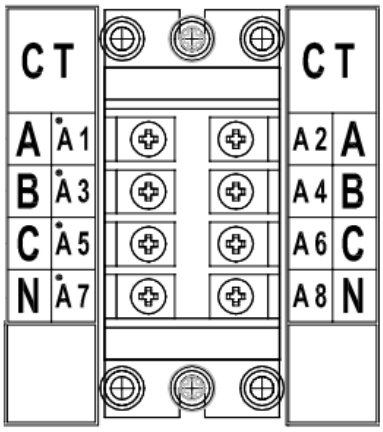
	Terminals	Reference	Features	Picture
CT current inputs	A1-A8	0387416608 (Molex)	24 AWG – 10 AWG: 0.2 – 4 mm^2 cable with a torque of 13 in-lbs	



A1	Phase A current input for Measurement & power supply
A2	Phase A current output for Measurement & power supply
A3	Phase B current input for Measurement & power supply
A4	Phase B current output for Measurement & power supply
A5	Phase C current input for Measurement & power supply
A6	Phase C current output for Measurement & power supply
A7	Neutral current input for Measurement
A8	Neutral current output for Measurement

5.5.1.2 Withdrawable model

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



A1	Phase A current input for Measurement & power supply
A2	Phase A current output for Measurement & power supply
A3	Phase B current input for Measurement & power supply
A4	Phase B current output for Measurement & power supply
A5	Phase C current input for Measurement & power supply
A6	Phase C current output for Measurement & power supply
A7	Neutral current input for Measurement
A8	Neutral current output for Measurement

5.5.2 Inputs/outputs/communication/power supply terminals

Terminals D1-D20 available for all the models.

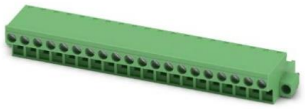
Terminals E1-E16 available only for “inputs and outputs” digit 4

5.5.2.1 Non-withdrawable model

Terminals	Reference	Features	
D1-D20 E1-E15 (*)	1777468 (Phoenix contact) (different numbers of poles are included, but all the pins have the same reference)	24 AWG – 12 AWG: 0.2 – 2.5 mm2 cable with a torque of 0.5-0.6 Nm	
E16 (*)	094635206 (Molex)	10/100 Base-T	

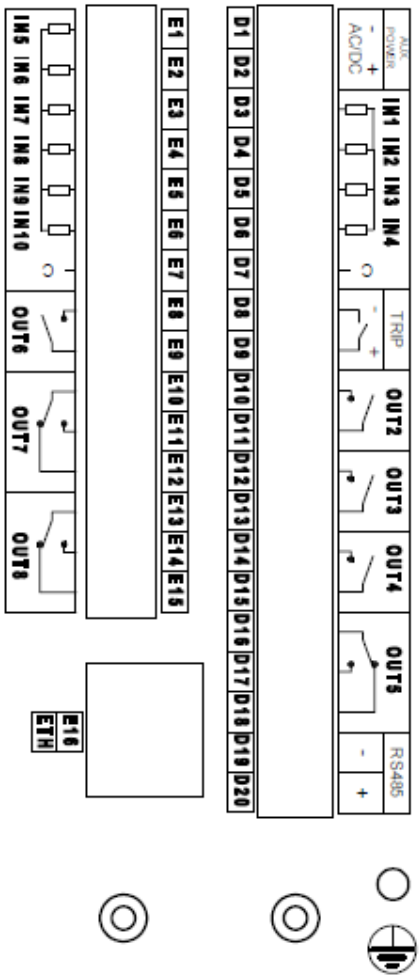
(*) Optional depending on model

5.5.2.2 Withdrawable model

Terminals	Reference	Features	
D1-D20 E1-E15 (*)	1777976 (Phoenix Contact) (different numbers of poles are included, but all the pins have the same reference)	24 AWG – 12 AWG: 0.2 – 2.5 mm2 cable with a torque of 0.5-0.6 Nm	
E16 (*)	094635206 (Molex)	10/100 Base-T	

(*) Optional depending on model

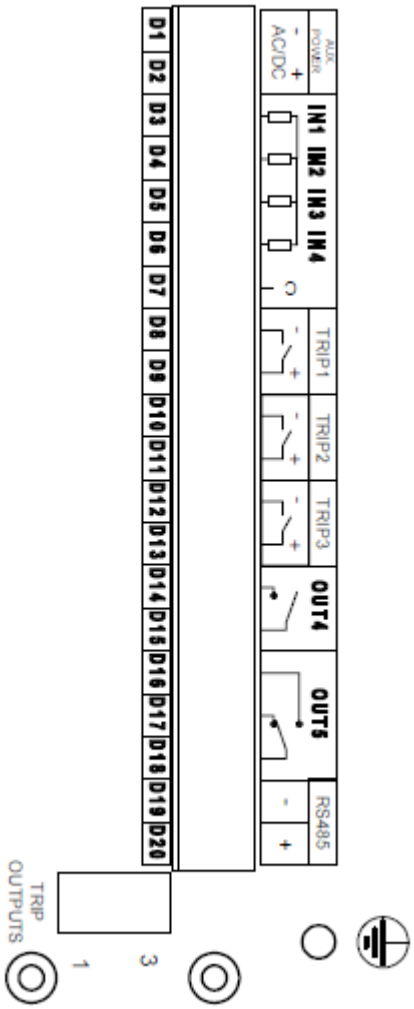
One trip output model



D1	Auxiliary Voltage -	E1	Digital input 5 (*)
D2	Auxiliary Voltage +	E2	Digital input 6 (*)
D3	Digital input 1	E3	Digital input 7 (*)
D4	Digital input 2	E4	Digital input 8 (*)
D5	Digital input 3	E5	Digital input 9 (*)
D6	Digital input 4	E6	Digital input 10 (*)
D7	Common for the inputs 1, 2, 3, 4	E7	Common for the inputs 5, 6, 7, 8, 9, 10 (*)
D8	Output 1: Trip output negative contact	E8-E9	Digital output 6 NO (*)
D9	Output 1: Trip output positive contact	E10	Digital output 7 common (*)
D10-D11	Digital output 2 NO	E11	Digital output 7 NO (*)
D12-D13	Digital output 3 NO	E12	Digital output 7 NC (*)
D14-D15	Digital output 4 NO	E13	Digital output 8 common (*)
D16	Digital output 5 common	E14	Digital output 8 NO (*)
D17	Digital output 5 NO	E15	Digital output 8 NC
D18	Digital output 5 NC	E16	Ethernet RJ45 port (*)
D19	RS485 -	(*) Optional depending on model	
D20	RS485 +		

⏚ **Earthing screw (protective earth) connection should not be removed when the equipment is energized.*

3 trip outputs model



D1	Auxiliary Voltage -
D2	Auxiliary Voltage +
D3	Digital input 1
D4	Digital input 2
D5	Digital input 3
D6	Digital input 4
D7	Common for the inputs 1, 2, 3, 4
D8	Output 1: Trip output 1 negative contact
D9	Output 1: Trip output 1 positive contact
D10	Output 2: Trip output 2 negative contact
D11	Output 2: Trip output 2 positive contact
D12	Output 3: Trip output 3 negative contact
D13	Output 3: Trip output 3 positive contact
D14-D15	Digital output 4 NO
D16	Digital output 5 common
D17	Digital output 5 NO
D18	Digital output 5 NC
D19	RS485 -
D20	RS485 +

**Earthing screw (protective earth) connection should not be removed when the equipment is energized.*

Trip outputs switch to select single or triple trip.

6. DESCRIPTION

6.1 Introduction

Worldwide, the energy sector is currently undergoing profound change as a result of high levels of energy demand; more distribution lines and advanced supervision systems are required. Given the need for creating intelligent infrastructure, FANOX has developed the SIA family of products to carry out this function.

The family of SIA relays is designed to protect the secondary transformation and distribution centers of electricity grids. Protection features include protection against instantaneous and inverse time overcurrent (for the phases and the neutral), and it also has external trip support (temperature, pressure, etc.) depending on the characteristics of each model.

The protection functions can be enabled selectively by using both the front panel and the communications links to the SICom program, allowing for precise coordination with another relay.
Additional benefits include that all of the models have been designed to be supplied 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.

6.2 Relay description

The SIA-C relay is a protection relay designed for secondary distribution. One of its main characteristics is the ability to power itself by using the switchgear´s current. Standard 1A or 5 A secondary current transformers are used for this, which allow self-powering with lower levels of current.
The relay powers itself from 0.16xIn with single-phase current, 0.1xIn with 2-phase and 0.075xIn with three-phase current.

The relay is maintenance free when this type of power supply is used. As a result, it is especially useful in any centers where auxiliary power is not available or cannot be guaranteed.

The SIA-C relay is housed in a metal box with galvanic isolation on all its measurement inputs and outputs (except for communications ports and battery power supply, as these are sporadic connections). This fact allows the relay to have the best possible level of electromagnetic compatibility, both in terms of emission and immunity from, radiated and conducted interferences. These levels are the same as those established for primary substations.

The relay has an LCD with two lines and twenty columns and a keypad with six standard buttons to navigate through the menus.

There are also 2 dedicated keys, RESET key and a specific key to execute the CB opening from the front part of the relay.

There are up to (7) seven configurable LEDs indicators and 1 magnetic flag. By default, the LEDs are configured to show:

SIACxxxxxx2xxx and SIACxxxxxx4xxx:

LEDS	
Led 1	CONFIGURABLE
Led 2	CONFIGURABLE
Led 3	CONFIGURABLE
Led 4	CONFIGURABLE
Led 5	CONFIGURABLE
Led 6	CONFIGURABLE
Led 7	CONFIGURABLE

SIACxxxxxx3xxx:

LEDS	
Led 1	CONFIGURABLE
Led 2	CONFIGURABLE
Led 3	CONFIGURABLE
Led 4	CONFIGURABLE
Led 5	NON-CONFIGURABLE
Led 6	NON-CONFIGURABLE
Led 7	NON-CONFIGURABLE

Furthermore, the relay is provided with up to (depending on model):

10 inputs

1 trip output or 3 trip outputs

7 configurable outputs

SIACxxxxxx2xxx: 1 trip output + 4 Outputs + 4 Inputs

SIACxxxxxx2xxx Signaling outputs
Output 1: trip output 1
Output 2
Output 3
Output 4
Output 5

SIACxxxxxx3xxx: 3 trip outputs + 2 Outputs + 4 Inputs

SIACxxxxxx3xxx outputs
Output 1: trip output 1
Output 2: trip output 2
Output 3: trip output 3
Output 4
Output 5

SIACxxxxxx4xxx: 7 Outputs + 10 Inputs

SIACxxxxxx4xxx Signaling outputs
Output 1: trip output 1
Output 2
Output 3
Output 4
Output 5
Output 6
Output 7
Output 8

The relay can save the following information (FIFO- First in First out method), allowing any registered incidents to be analyzed with the corresponding date and time thanks to the internal RTC (Real Time Clock).

- Up to 1024 events
- To facilitate the analysis of events, it is fitted with 20 fault reports (16 events per fault report) and 10 records in COMTRADE format (50 cycles per record). Fault reports start when any of the protection functions picks-up and it finishes when any of the mentioned functions trips.
- Load data profiling (168 records)

The relay is provided with a front communication port (micro-USB). This port allows a PC to be connected, which can be used to monitor the relay using the SICom communications software (supplied by FANOX). Besides, the front port can be used to power the relay by using an USB cable which can be directly connected to the PC.

Remote communication is available depending on model (RS485 rear port - Modbus RTU protocol, (IEC60870-5-103 and DNP3.0 Serial upcoming) and rear ethernet RJ45 port (Modbus TCP protocol).

The protection functions provided, easy-to-use interface, low amount of maintenance and simple integration make the SIA-C a precise and practical solution for protecting both industrial and public electrical grids and transformation and distribution centers. The main features of the relay are listed below, and these features will be explained in the rest of the manual:

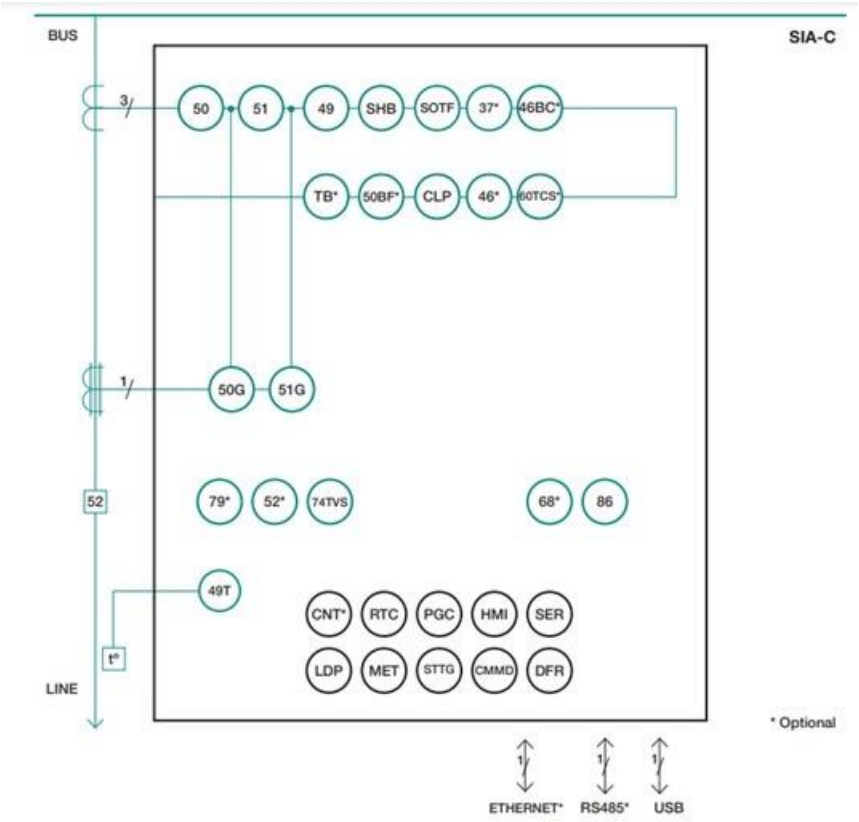
Function	Description	SIA-C
Protection		
50	Instantaneous phase overcurrent	1
50G	Instantaneous measured neutral overcurrent	1
51	Inverse time phase overcurrent	1
51G	Inverse time measured neutral overcurrent	1
SOTF	Switch On to fault	1
49T	External trip	✓ (Through configurable inputs)

SHB	Second harmonic Blocking	1
49	Thermal image	1
CLP	Cold load pickup	1
74TVS	Trip voltage Supervision	1
52	Breaker Wear Monitoring	1
TB	Trip block for switch disconnector	1 (optional)
50_2	Instantaneous phase overcurrent	1 (optional)
50G_2	Instantaneous measured neutral overcurrent	1 (optional)
37	Instantaneous phase undercurrent	1 (optional)
46	Phase balance current protection	1 (optional)
46BC	Broken Conductor	1 (optional)
50BF	Breaker Failure monitoring	1 (optional)
60CTS	CT Supervision	1 (optional)
79	AC Reclosing device	1 (optional)
PGC	Programmable Logic Control	V3
Breaker Wear Monitoring		
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 DFT measurement with ±2% over ±20% over the nominal current and ±4% or ± 5 mA in the rest of the range. In case the current is between 0.002 to 0.0125 times the nominal current the accuracy will be 0.5mA.	✓
Inputs and Outputs		
	External trip input (without power supply)	By means of configurable inputs
	Configurable inputs (without power supply)	Depending on model: 4 Inputs 10 Inputs
	Trip output for STRIKER	1 or 3 depending on model
	Configurable signaling outputs	Depending on model: 2 configurable outputs 4 configurable outputs 7 configurable outputs

Communication and HMI		
	Front port: micro USB (Modbus RTU)	✓
	Rear port: RS485 (Modbus RTU) **IEC60870-5-103 and DNP3 upcoming*	Optional
	Ethernet RJ45 port (Modbus TCP)	Optional
	SICom Program	✓
	HMI: LCD, 20x2 and 6 keys + 1 reset key + 1 key to open the CB + Battery key	✓
	LED Indicators	7
Power supply		
	Self-powering with standard CTs: 0.075xIn three phase/0.1xIn two phase/0.16xIn single phase	✓
	Auxiliary power: 24-230 Vdc / Vac, (50/60 Hz)	✓ (Vdc (±20%) / Vac (±15%))
	Internal commissioning battery	Optional
Monitoring and recording		
	Sequential Events Recording (SER)Events	1024
	Disturbance Fault Recording (DFR)	20 fault reports (16 events each one) 10 records in COMTRADE format (50 cycles per record)
	Load data Profiling (LDP)	168 records
	Commands	✓
	Settings groups	4
	Real-Time Clock (RTC)	✓
	Test menu	✓
	Self-diagnosis	✓

- All the information saved in non-volatile memory to be maintained even when the relay is switched off,

6.3 Functional Diagram



ANSI CODE PROTECTIONS	
50	Instantaneous phase overcurrent
51	Inverse time phase overcurrent
50G	Instantaneous measured neutral overcurrent
51G	Inverse time measured neutral overcurrent
SOTF	Switch on To Fault
SHB	Second Harmonic Blocking
49	Thermal overload
49T	External trip
CLP	Cold Load Pickup
37	Instantaneous phase undercurrent
46	Phase balance current protection
46BC	Broken Conductor Detection
52	Breaker wear monitoring
79	AC Reclosing device
60CTS	Phase CT supervision
74TVS	Trip voltage supervision
50BF	Circuit Breaker Failure
TB	Trip Block
PGC	Programmable logic control

ADDITIONAL FUNCTIONS	
CNT	Counters
RTC	Real Time Clock
PGC	Programmable Logic Control
HMI	Human Machine Interface
SER	Sequential Event Recording
DFR	Disturbance Fault Recording
LDP	Load Data Profiling
MET	Metering
STTG	Settings Groups
CMMD	Commands

6.4 Selection & Ordering codes

SIA-C

Overcurrent & Earth Fault Protection Relay – Dual & Self-powered

1 5										**PHASE CURRENT MEASUREMENT** 1 A 5 A (Only for mechanics digit G and H)
	0									**NEUTRAL CURRENT MEASUREMENT** 1 A or 5 A
		0								**NET FREQUENCY** 50 Hz or 60 Hz (selectable by general settings)
			5 F							**POWER SUPPLY** Self-powered + 24-230 Vac/dc (Dual) Self-powered + 24-230 Vac/dc (Dual) + Commissioning battery
				0 1 2						**ADDITIONAL FUNCTIONS** - + 50-2 + 50G-2 + 37 + 46 + 46BC + 50BF + 60CTS + TB + 79 (Only for “inputs and outputs” digit 2 and 4) + 50-2 + 50G-2 + 37 + 46 + 46BC + 50BF + 60CTS + TB (Only for “inputs and outputs” digit 3)
					0 1 3					**COMMUNICATIONS** 0: USB Port (Modbus RTU) 1: USB Port (Modbus RTU) + Rear Serial Port (Modbus RTU, DNP3.0 or IEC60870-5-103) 3: USB Port (Modbus RTU) + Rear Serial Port (Modbus RTU, DNP3.0 or IEC60870-5-103) + rear Ethernet Port (RJ45) (Modbus TCP) (Only for "inputs and outputs" digit 4)
						2 3 4				**INPUTS AND OUTPUTS** 1 Trip output (Striker) + 4 Outputs + 4 Inputs 3 Trip outputs (Striker) + 2 Outputs + 4 Inputs 1 Trip output (Striker) + 7 Outputs + 10 Inputs
							F G H			**MECHANICS** Withdrawable assembly Non-withdrawable assembly Non-withdrawable front-back welded assembly
								A B C		**LANGUAGE** English, Spanish, and German English, Spanish, and Turkish English, Spanish, and French
									D	**ADAPTATION** 50 + 51 + 50G + 51G + SHB + CLP + 49 + 52 + 74TVS + 49T + PGC + SOTF

NOTE: Not all combinations are possible. Please confirm with Fanox the chosen model.

6.5 Phase CT and neutral CT selection

SIA-C relay requires current transformers with the following specifications:

SIAC/1: CT Burden ≤2.5 VA

SIAC/5: CT Burden ≤2.5 VA

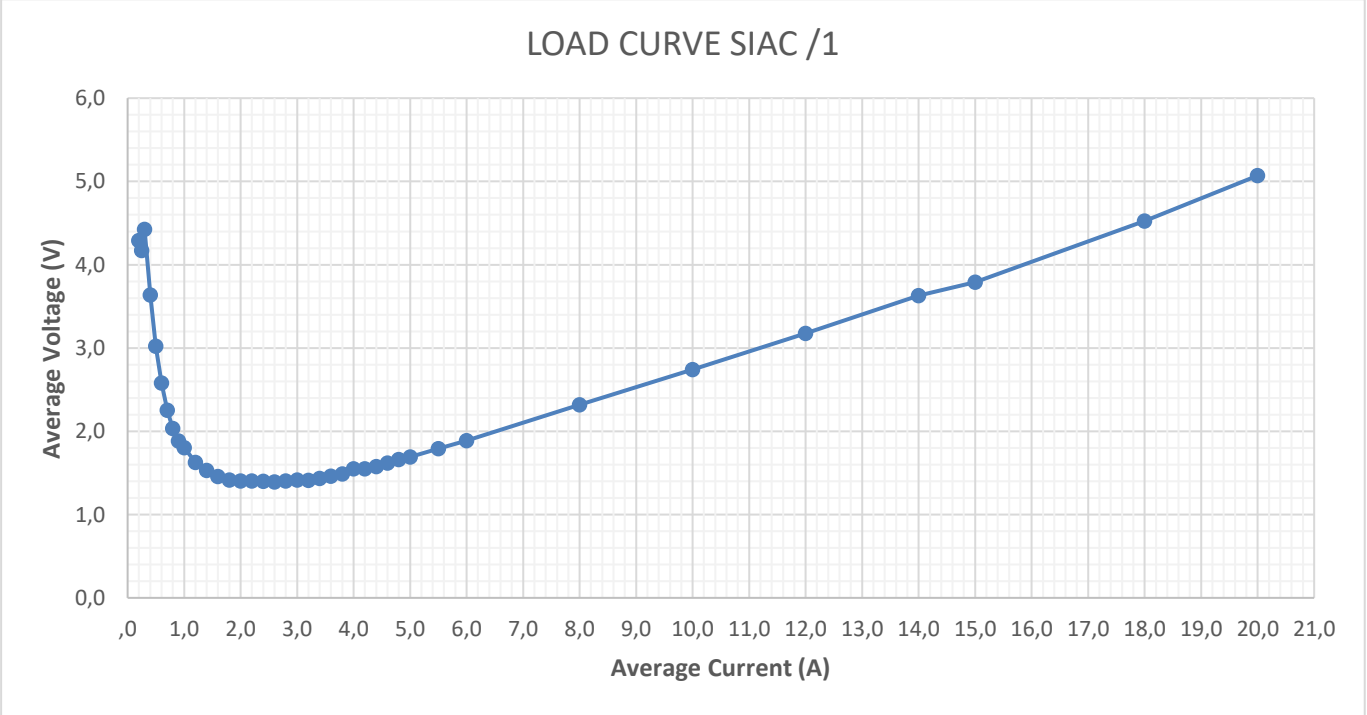
The relay can measure up to 30xIn in the phases and up to 16xIn in the neutral:

Phases measurement: 0.05-30xIn

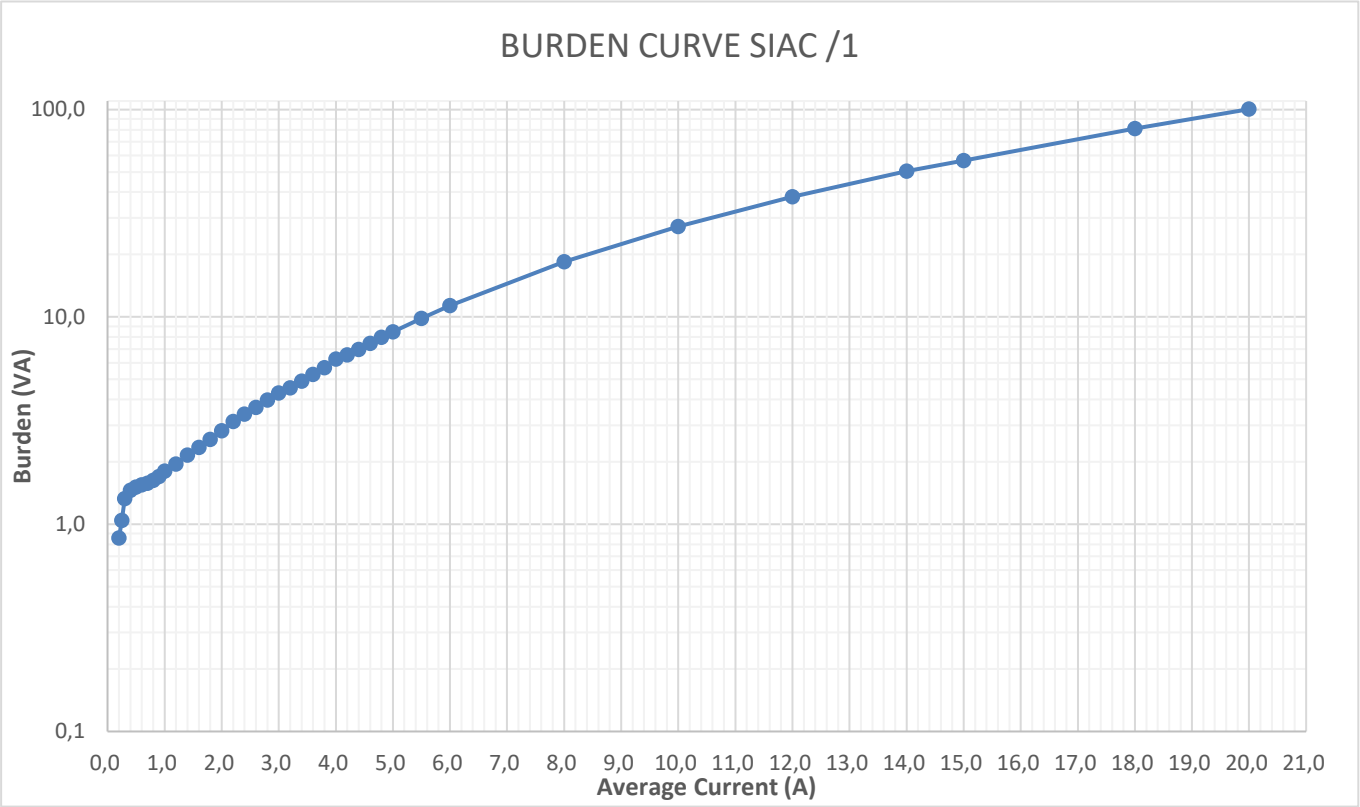
Neutral measurement: 0.002-16xIn

Model	Phase	Neutral	Phase range	Neutral range
SIAC55	CT 5 A	Residual phase connection	0.25-150 A	0.01-80 A
SIAC11	CT 1 A	Residual phase connection	0.05-30 A	0.002-16 A
SIAC51	CT 5 A	CT 1 A	0.25-150 A	0.01-16 A

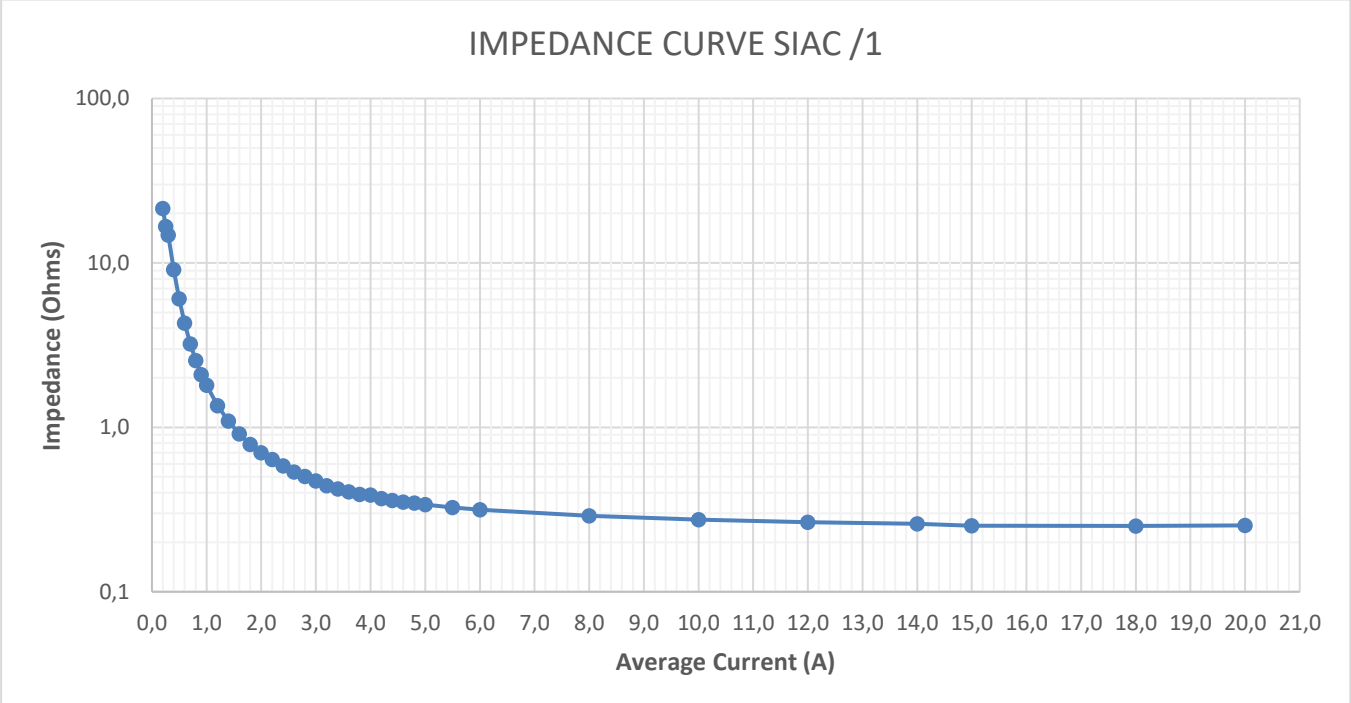
6.5.1 Load curve for SIA-C relay



6.5.2 Burden curve for SIA-C relay



6.5.3 Impedance curve for SIA-C relay



7. GENERAL SETTINGS

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

The settings can be changed either from the HMI or through communications.
Any change of set values will restart all functions, irrespective they are activated or not.

7.1 General

Function	Description	Minimum	Maximum	Step	Unit	Default
	Generals					
	Language	-	-	-	- (1)	ENGLISH
	Settings Group	1	4	1	-	1
	Clearing time	0.000	1.000	0.001	s	0.010
	Minimum Response time	0.000	1.000	0.001	s	0.000
	Phase Reset Time	0.000	60.000	0.001	s	0.100
	Neutral Reset Time	0.000	60.000	0.001	s	0.100
	Identification (2)	-	-	-	-	User Identific.

(1) Different options available depending on model.

(2) Setting not available in HMI.

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

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

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

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

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

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

7.2 Function 74TVS. Trip Voltage Supervision

The relay monitors the trip voltage level in order to verify the relay can provide enough energy to the opening mechanism. In case the voltage level is not sufficient, the relay will show a message “NO TRIP POWER” on the main screen.

This protection function can be set by using one parameter, which must be selected according to the striker used.

Function	Description	Minimum	Maximum	Step	Unit	Default
74TVS	**Trip Voltage Supervision**					
	Trip Voltage Level	12	24	12, 17, 22, 24	Vdc	17

7.3 Measurement

Function	Description	Minimum	Maximum	Step	Unit	Default
	Measurements					
	Frequency	50	60	50/60	Hz	50
	Neutral Nominal Current	1	5	1/5	A	1
	CT Phase Ratio	1.0	3000.0	0.1	-	100.0
	CT Neutral Ratio	0.0 (3)	3000.0	0.1	-	100.0

(3) If neutral Ratio is set to 0, the neutral measurement will be internally calculated by the relay. If any other value is set, the neutral current will be measured through A7-A8 terminals.

7.4 LDP. Load data Profiling

Function	Description	Minimum	Maximum	Step	Unit	Default
LDP	**Load data Profiling**					
	Current Level	0.01	10	0.01	xIn	0.4
	Interval Time	1	60	1	min	1

7.5 Inputs

Function	Description	Minimum	Maximum	Step	Unit	Default
	Inputs					
	Debounce time	2	63	1	ms	20 ms

7.6 USB Communication

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

7.7 Remote Communications

7.7.1 Rear Serial Communication

Function	Description	Minimum	Maximum	Step	Unit	Default
	Rear Serial Communications					
	Baudrate	4800	115200	4800, 9600, 19200, 38400, 57600, 115200	bauds	19200
	Parity	-	-	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
	Protocol	-	-	Modbus RTU, IEC 60870-5-103 or DNP3.0	-	Modbus RTU

MODBUS RTU

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

DNP3.0 SERIAL

Function	Description	Minimum	Maximum	Step	Unit	Default
	DNP3.0 Communications					
	Address	1	247	1	-	4
	Master address	1	247	1	-	1
	Self Address(**)	-	-	No/Yes	-	Yes
	Multi Master(**)	-	-	No/Yes	-	No
	Pre Transmition Delay(**)	0	250	1	ms	5
	ClkSyncEnable(**)	-	-	No/Yes	-	No
	Unsolicited Response Enable(**)	-	-	No/Yes	-	Yes
	Unsolicited Response Retries(**)	0	10	1	-	3

	Unsolicited Response TimeOut(**)	0	60000	1	ms	2000
	SolRes Timeout(**)	0	60000	1	ms	2000
	Select Timeout(**)	1	300	1	s	15

(**) Not available in HMI.

IEC60870-5-103

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

7.7.2 Rear TCP Communications

Function	Description	Minimum	Maximum	Step	Unit	Default
	Rear Serial Communications					
	Protocol	-	-	Modbus TCP, DNP3.0 TCP, IEC-104 or IE61850*	-	Modbus TCP
	IP Address (**)	0.0.0.0	223.255.255.255	-	-	192.168.200.100
	Subnet (**)	0.0.0.0	255.255.255.255	-	-	255.255.255.0
	Gateway (**)	0.0.0.0	223.255.255.255	-	-	192.168.200.1
	DNS-1(**)	0.0.0.0	223.255.255.255	-	-	0.0.0.0
	DNS-2 (**)	0.0.0.0	223.255.255.255	-	-	0.0.0.0
	SNTP (**)	-	-	-	-	0.es.pool.ntp.org

(**) Not available in HMI.

MODBUS TCP

Function	Description	Minimum	Maximum	Step	Unit	Default
	MODBUS TCP					
	Slave address	1	247	1	-	3

Modbus port is 502.

8. PROTECTION AND CONTROL FUNCTIONS

8.1 Function 52. Circuit Breaker monitoring

This function allows the status of the circuit breaker to be monitored and preventive maintenance to be performed, for which the following parameters need to be configured:

Group	Description	Minimum	Maximum	Step	Unit	Default
52	**Circuit breaker monitoring**					
	Maximum number of openings	1	10,000	1	-	10
	Maximum accumulated amperes	1	100,000	1	M(A^2)	1,000
	Closing time	0.02	30.00	0.01	s	0.10
	Maximum repeated openings	1	10,000	1	-	3
	Time of maximum repeated openings	1	300	1	min	9

NOTE: The “Maximum accumulated amperes” adjustment units are M(A^2) (square mega amperes) whilst the “Accumulated amperes counter” units are K(A^2) (square kilo amperes).

It is also necessary to assign the logical inputs 52a and/or 52b to a physical input.

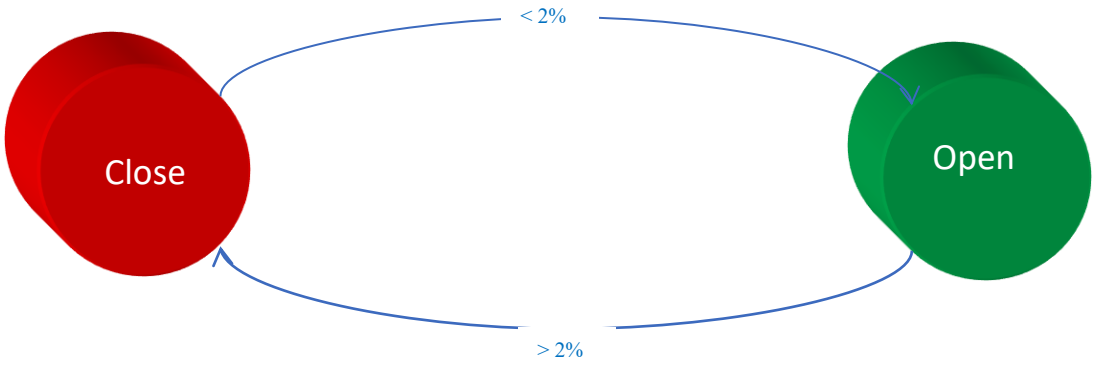
This function provides information about the circuit breaker status and if any maintenance alarm has been activated.

The following statuses are associated with this function:

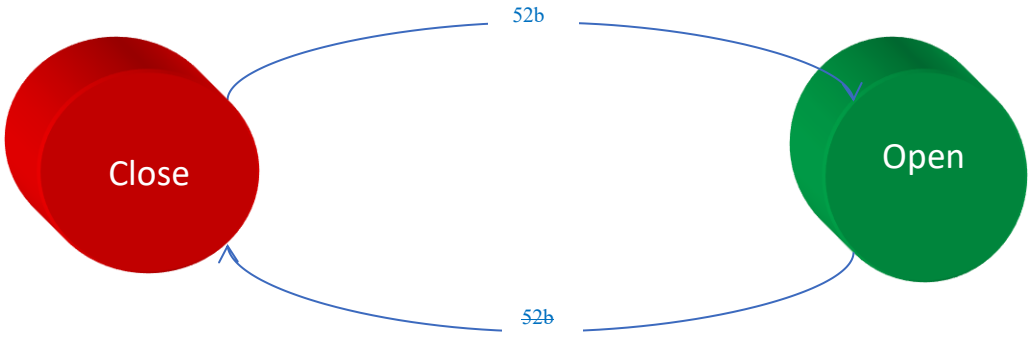
Function	Status	Description
52	Open	
	Closed	
	Error	
	Number of configured openings exceeded	Activated if the counter that measures the number of openings exceeds the “Maximum number of openings” setting
	Number of configured accumulated (I2t) amps exceeded	Activated if the accumulated amps counter exceeds “Maximum accumulated amps” setting
	Repeated Trips	Activated if the number of openings exceeds the setting in “Maximum repeated openings” for the time set in “Time of maximum repeated openings”

The way that the circuit breaker is monitored becomes more or less complex depending on whether it is fitted with no breaker contacts, one breaker contact (52a or 52b) or both (52a and 52b).

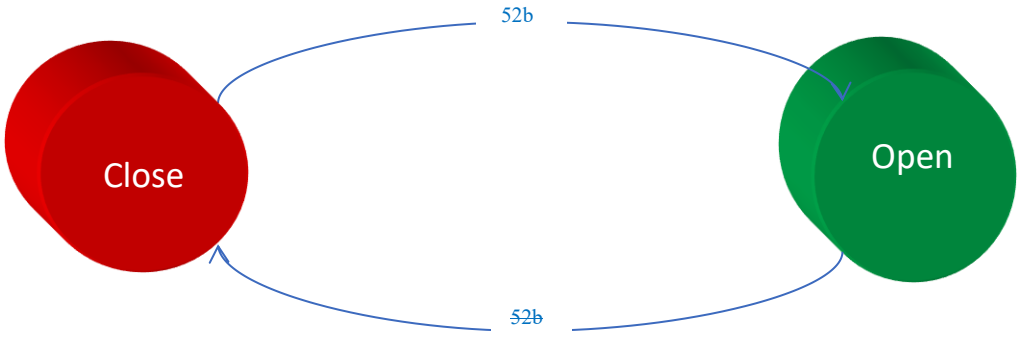
If no breaker contacts are used, the monitoring of the circuit breaker is made through the current measurement. This is, if less than 2% of the rated current is detected it is considered the breaker is open and for higher currents the CB is considered closed:



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” logic signal. The 52b logic signal is calculated internally as the negative of 52a.

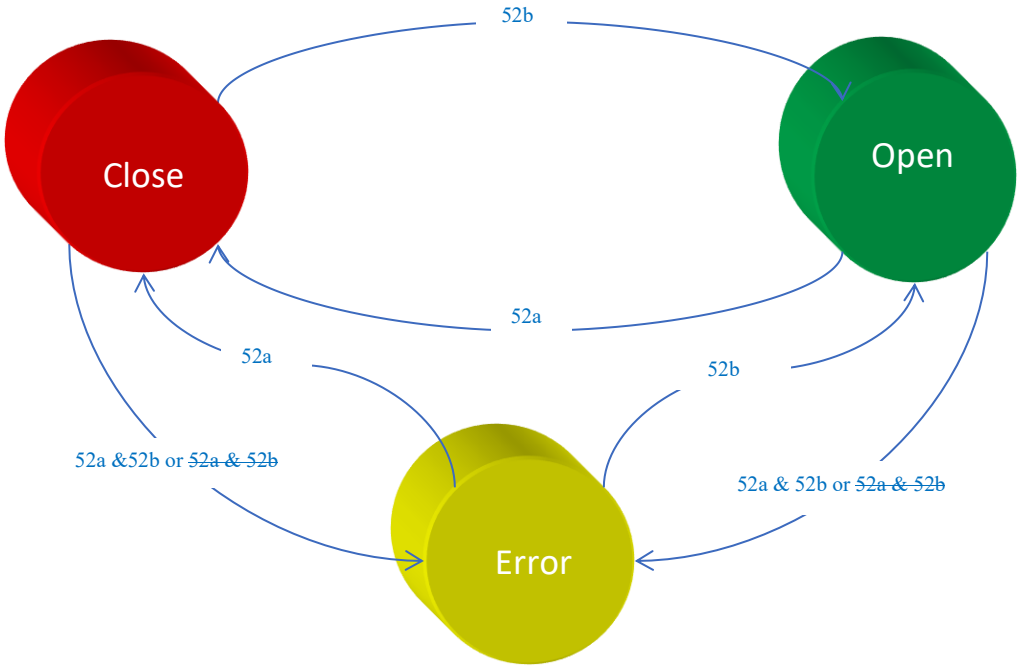


If only the circuit breaker 52b contact is available, it should be wired to the corresponding physical input. This physical input is then assigned to the “52b” logic signal. The 52a logic signal is calculated internally as the negative of 52b.



If both of the 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 logic signals: the circuit breaker 52a contact to the “52a” logic signal, and the circuit breaker 52b contact to the “52b” logic signal. The circuit breakers automaton is considered as having eight statuses: open, closed and error.

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



8.1.1 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 from local or remote communications (ModBus RTU or DNP 3.0).

For the commands to have an effect, they should be assigned to the corresponding outputs. The “Open circuit breaker” and “Close circuit breaker” bits are assigned to their corresponding outputs in the “CONTROL” status group in the status menu.

8.1.2 Counter to register the number of openings

The SIA-C relay is fitted with a counter that registers the number of times the circuit breaker opens.
This counter is associated with the “Maximum number of openings” setting. When the number of openings exceeds this preset value, the “Maximum number of openings” status is activated, and its corresponding event is generated.
This counter reading can be set to any value from within its range from the HMI or by communications.

8.1.3 Accumulated amps counter: I2t

An accumulated amps counter is also fitted. This counter accumulates the amps that are cleared by the circuit breaker by opening.
When the circuit breaker opens, the maximum number of primary amps in any of the phases is detected. This reading is squared and divided by 1000 and then rescaled to KA and accumulated. If the current detected in the opening is less than the rated current, the rated current value is used for the accumulation.
It is used in conjunction with the counter of the number of openings, to measure the circuit breaker aging process.
Since primary amps are being accumulated, it is essential to correctly adjust the phase CT transformation ratio.
The “Maximum accumulated amps” setting is associated with this counter. When the number of accumulated amps exceeds this preset value, the “Maximum accumulated amps” status is activated, and its corresponding event is generated.

The value of this counter can be started at any value within its range from the HMI or from communications, if this protection is fitted on a circuit breaker with a previous service life.

This alarm can be replaced by modifying the Accumulated Amps counter.
The display unit shall be KA² (square kilo amperes).

8.1.4 Maximum openings in a time window

As well as counting the number of times the circuit breaker opens, the SIA-C relay sets up a time window and the maximum number of openings allowed during this time. Both parameters can be adjusted.
When this number is exceeded, the “Repeated Trips” 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.

8.2 Function SOTF. Switch On To Fault

The SIA-C is an electronic device that provides a start-up time (the time from device activation to operational capacity). Ideally, this start-up time should be minimized.

Depending on the specific application, it may be necessary to evaluate the need for a fast-tripping time at device start-up. For instance, if the installation includes short-circuit fuses, extremely fast tripping protection might be unnecessary. In installations with guaranteed auxiliary voltage, the device obtains energy for tripping in a very short time. Additionally, the type of striker being used also impacts energy requirements, as certain strikers require less energy for activation.

The most critical scenario occurs when the device operates in self-powered mode (without auxiliary voltage or battery) under low-current fault conditions.

To minimize tripping time when the relay is in self-powered mode, the **Switch-On-to-Fault (SOTF)** characteristic is applied. This function allows tripping in the shortest possible time when the current, in self-powered mode, exceeds the configured threshold. This minimum time corresponds to the time required for the relay to start up, also referred to as **wake-up time**.

The **Safe Time** parameter indicates the duration for which the function remains active, starting from the moment the relay detects current flow in self-powered mode.

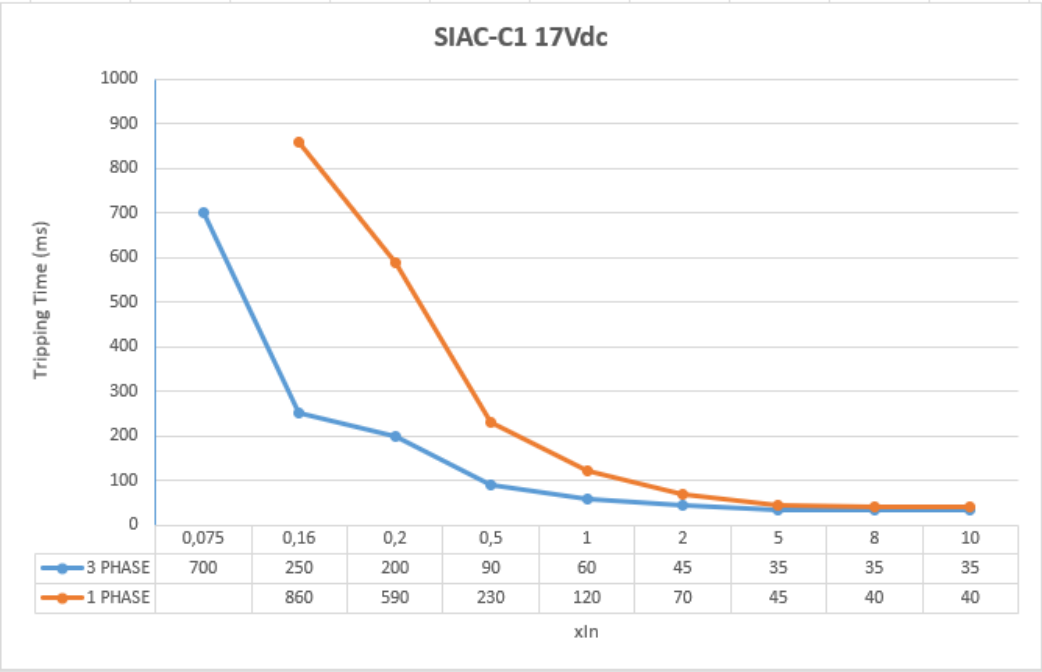
Function	Description	Minimum	Maximum	Step	Unit	Default
SOTF	**Switch on to Fault**					
	Function Enable	-	-	Yes/No	-	No
	Current Tap	0.05	30.00	0.01	xIn	7.00
	Safe Time	0.001	5.000	0.001	s	5.000

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

8.2.1 SOFT CURVES

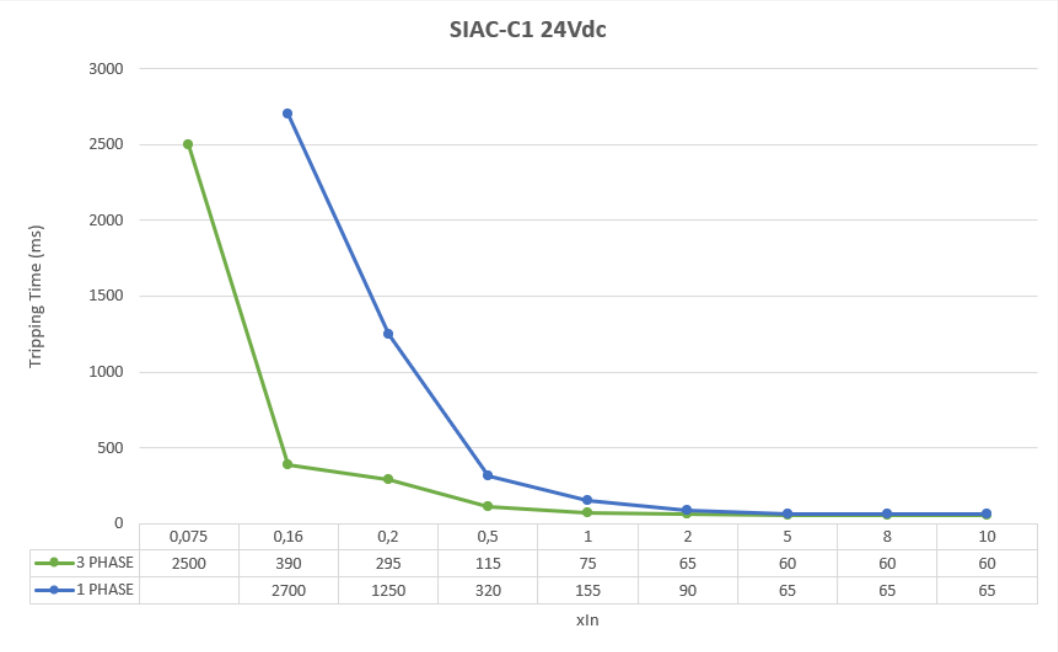
Switch on to fault tripping times are measured without auxiliary nor battery power and mainly depend on the magnitude of current injected. The higher the injected current is the faster the trip time and it is measured in times the rated current.

The trip voltage level, the rated current of the relay and single-phase or three-phase injection also have an influence on the SOTF tripping times.



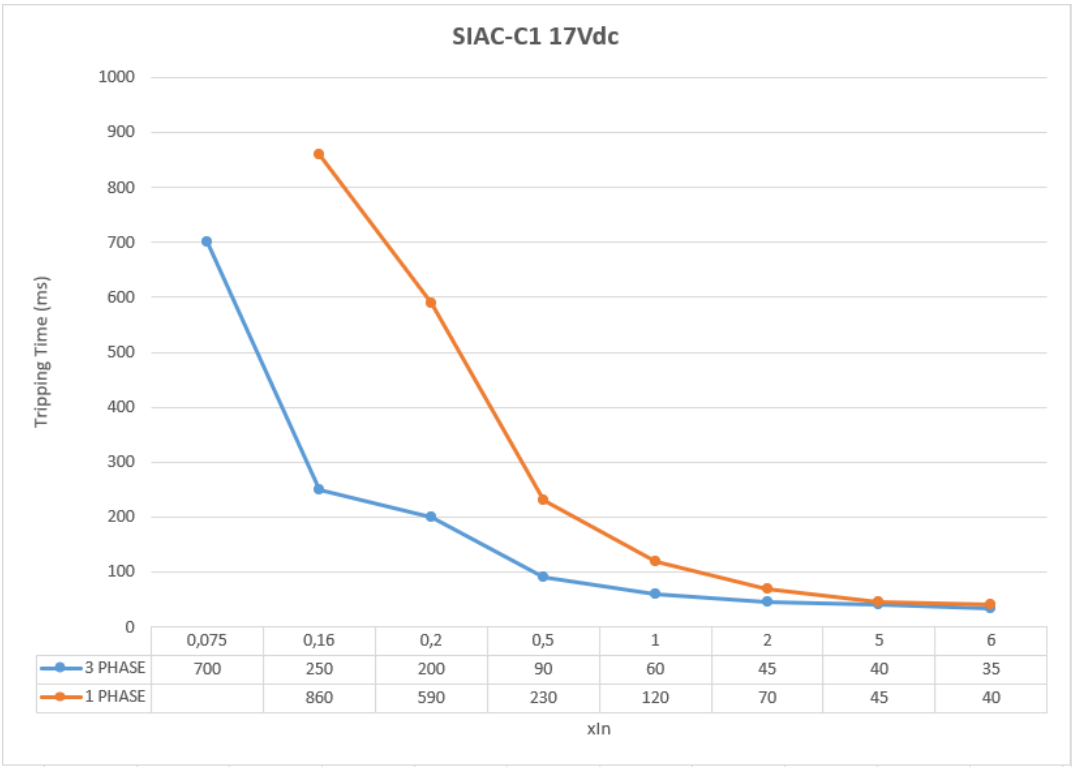
	0,075	0,16	0,2	0,5	1	2	5	8	10
3 PHASE	700	250	200	90	60	45	35	35	35
1 PHASE		860	590	230	120	70	45	40	40

Without auxiliary voltage nor battery. Trip voltage level at 17 VDC. Rated current of the relay 1A.



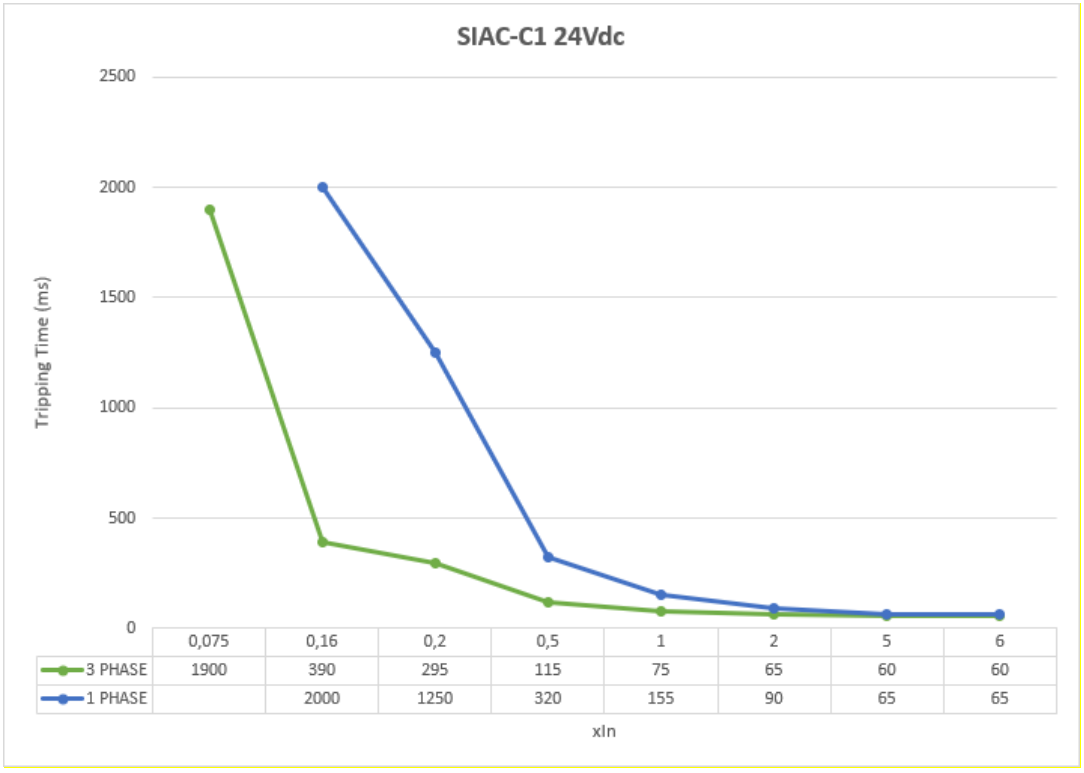
	0,075	0,16	0,2	0,5	1	2	5	8	10
3 PHASE	2500	390	295	115	75	65	60	60	60
1 PHASE		2700	1250	320	155	90	65	65	65

Without auxiliary voltage nor battery. Trip voltage level at 24 VDC. Rated current of the relay 1A.



	0,075	0,16	0,2	0,5	1	2	5	6
3 PHASE	700	250	200	90	60	45	40	35
1 PHASE		860	590	230	120	70	45	40

Without auxiliary voltage nor battery. Trip voltage level at 17 VDC. Rated current of the relay 5A.



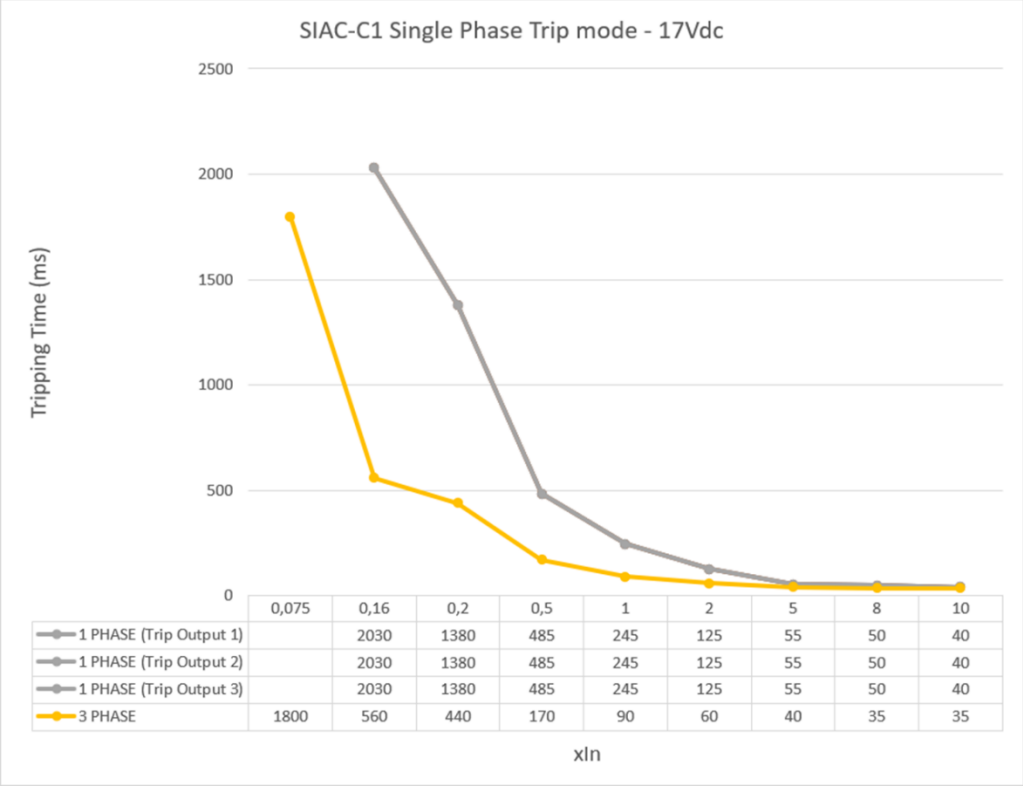
	0,075	0,16	0,2	0,5	1	2	5	6
3 PHASE	1900	390	295	115	75	65	60	60
1 PHASE		2000	1250	320	155	90	65	65

Without auxiliary voltage nor battery. Trip voltage level at 24 VDC. Rated current of the relay 5A.

For model SIACx00xxx**3**xxD, single-phase trip or triple-phase trip is available by means of a switch.

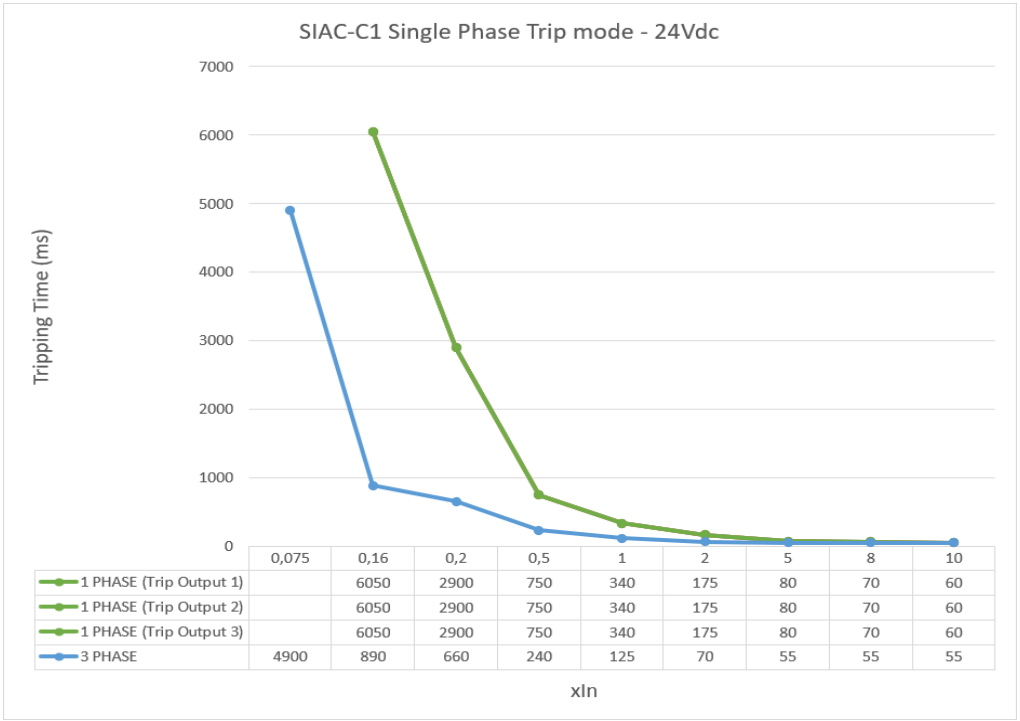
Triple-phase SOTF tripping times are the same as the ones for the models that only have triple-phase tripping. So, for this case, the corresponding graphics would be the ones displayed above.

For single-phase tripping mode, the tripping times are graphically depicted below:



	0,075	0,16	0,2	0,5	1	2	5	8	10
1 PHASE (Trip Output 1)		2030	1380	485	245	125	55	50	40
1 PHASE (Trip Output 2)		2030	1380	485	245	125	55	50	40
1 PHASE (Trip Output 3)		2030	1380	485	245	125	55	50	40
3 PHASE	1800	560	440	170	90	60	40	35	35

Without auxiliary voltage nor battery. Trip voltage level at 17 VDC. Rated current of the relay 1A.



	0,075	0,16	0,2	0,5	1	2	5	8	10
1 PHASE (Trip Output 1)		6050	2900	750	340	175	80	70	60
1 PHASE (Trip Output 2)		6050	2900	750	340	175	80	70	60
1 PHASE (Trip Output 3)		6050	2900	750	340	175	80	70	60
3 PHASE	4900	890	660	240	125	70	55	55	55

Without auxiliary voltage nor battery. Trip voltage level at 24 VDC. Rated current of the relay 1A.

8.3 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	0.02	300.000	0.001	s	15.000
	Cold Load Time	0.02	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.

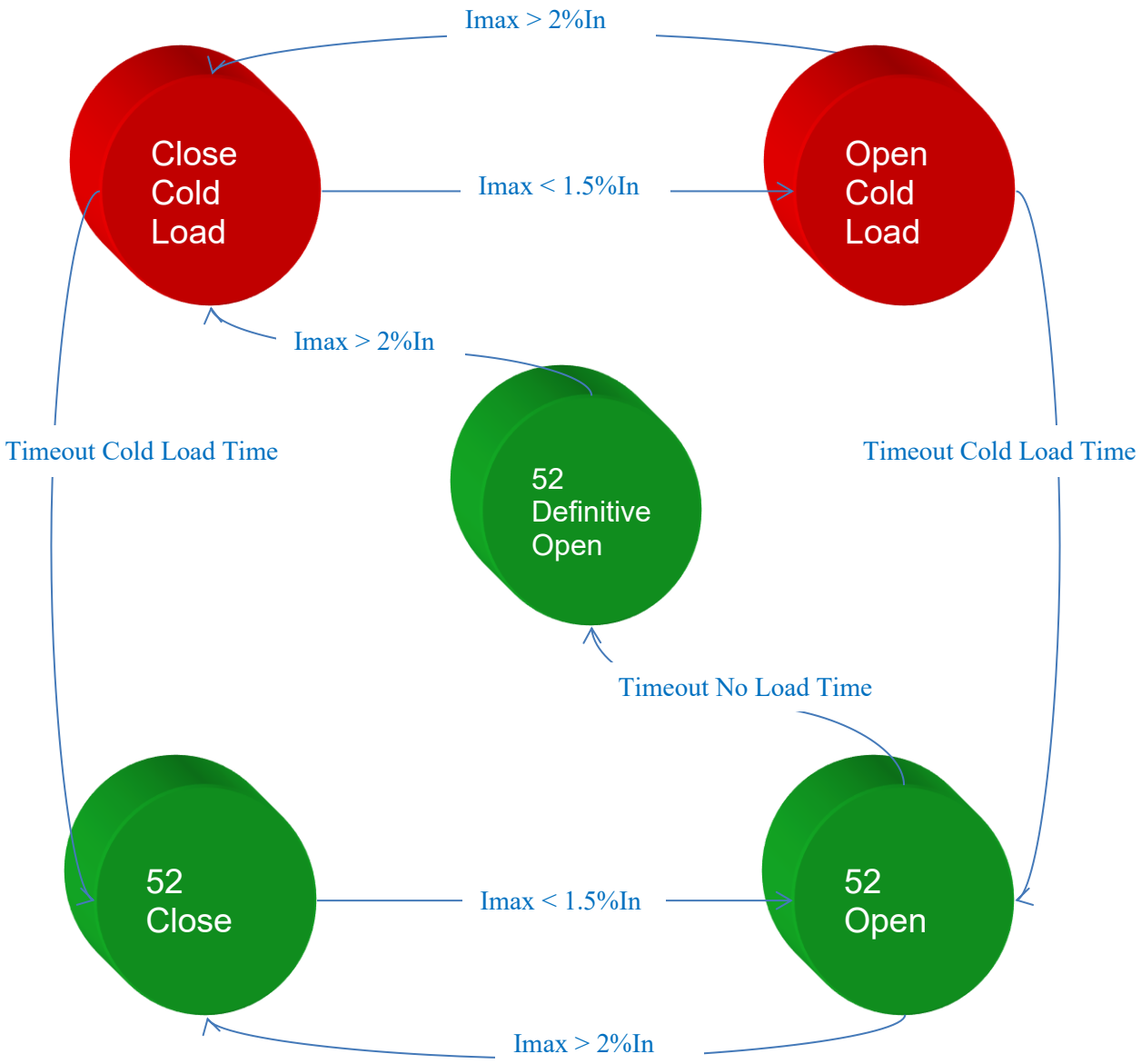
- **Cold Load Time**: If the Cold Load Pickup function is in working conditions (after the circuit has been closed), the new setting group is applied. After being in Close Cold Load or Open Cold Load (the red states of the automaton shown below) for the time defined in this parameter, the relay returns 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 1.5% of the rated current, the line is considered open. When the current is higher than the 2% of the rated current the line is considered closed.

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

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



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

8.4 Function SHB. Second Harmonic Blocking

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.

Group	Description	Minimum	Maximum	Step	Unit	Default
SHB	**Second harmonic blocking**					
	Function Enable	-	-	Yes/No	-	No
	Current tap	5	50	1	%	5
	Reset time	0.000	300.00	0.001	s	0.020
	Block Threshold	0.05	30.00	0.01	xIn	10

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

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

The SHB will only be applied in functions that have this option in the “function enable” setting. When the Function Enable of these protection functions is set to “SHB”, the relay will supervise the second harmonic content in order to trip or block the trip depending on the percentage of second harmonic present in the current signal.

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

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

8.5 Function TB. Trip block protection for the switchgear

This protection function is only available depending on model.
Some transformation centers use a combination of switchgear and fuses for cutting out. As switchgears have a limited opening current, the fuses are responsible for cutting out the circuit for high current short circuits. This prevents the switchgear being 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.

Group	Description	Minimum	Maximum	Step	Unit	Default
TB (*)	**Trip block protection for the switchgear**					
	Function Enable	-	-	Yes/No	-	No
	Current Tap	1.50	30.00	0.01	x In	7.0

(*) Optional depending on model

8.6 Function 50. Instantaneous phase overcurrent

This protection function can be set by using three parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
50_1 50_2(*)	**Instantaneous phase overcurrent**					
	Function Enable	-	-	No/Alarm/Trip/SHB	-	No
	Current Tap	0.05	30.00	0.01	xIn	5.00
	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 the set value in “current tap” parameter for an equal or greater amount of time than this pre-set value, the protection function activates (trips) and does not reset itself until the value of the phase drops below the point of current tap.

When the Function Enable is set to “Alarm/Trip”; the accuracy of the Time Delay is equal to the pre-set time ±30 ms or ±0.5% (whichever is greater). If the Function Enable is set to “SHB”, the accuracy of the Time Delay is equal to the pre-set time ±50 ms or ±0.5% (whichever is greater).

The function activates at 100% of the pre-set input and deactivates at 95%. The reset will be according the “phase reset time” general setting.

8.7 Function 50G. Instantaneous measured neutral overcurrent

This protection function can be set by using three parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
50G_1 50G_2 (*)	**Instantaneous measured neutral overcurrent**					
	Function Enable	-	-	No/Alarm/Trip/SHB	-	No
	Current Tap	0.002	10.00	0.001	xIn	5.00
	Time Delay	0.000	300.000	0.001	s	0.200

(*) Optional depending on model

The Time Delay is completely independent from the operating current that flows through the relay, so if the neutral current exceeds the set value in “current tap” parameter for an equal or greater amount of time than this pre-set value, the protection function activates (trips) and does not reset itself until the value of the neutral current drops below the point of current tap.

When the Function Enable is set to “Alarm/Trip”; the accuracy of the Time Delay is equal to the pre-set time ±30 ms or ±0.5% (whichever is greater). If the Function Enable is set to “SHB”, the accuracy of the Time Delay is equal to the pre-set time ±50 ms or ±0.5% (whichever is greater).

The function activates at 100% of the pre-set input and deactivates at 95%. The reset will be according the “neutral reset time” general setting.

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8.8 Function 50/51. Inverse time phase overcurrent

This protection function can be set by using five parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
50/51	**Inverse time phase overcurrent**					
	Function Enable	-	-	No/Alarm/Trip/SHB	-	No
	Curve type	-	-	(1*)	-	IEC Standard Inverse
	Time Dial (TMS)	0.01	2.00	0.01	-	1.25
	Current Tap	0.05	20.00	0.01	xIn	5.00
	Time Delay	0.000	300.000	0.001	s	0.200

(1*) IEC Inverse, IEC Very inverse, IEC Extremely inverse, IEC Long time inverse, IEC Short Time Inverse, Defined time, IEEE Inverse, IEEE Very inverse, IEEE Extremely inverse, CO_P20, CO_P40, CO8, User Defined Curve 1, Curve 2, Curve 3, Curve 4.

If a curve is selected for the curve setting, the function is activated if the current through any of the phases is higher than the 110% of the tap and the trip time depends on the curve, time dial and current tap settings. When the Function Enable is set to “Alarm/Trip”; the accuracy of the trip time is equal to the theoretical trip time ±30 ms or ±5% (whichever is greater). If the Function Enable is set to “SHB”, the accuracy of the trip time is equal to the theoretical trip time ±50 ms or ±5% (whichever is greater). In this case, the function is activated at 110% of the set tap value, and it deactivates at 100%.

If the option “Defined time” is selected for the curve setting, the unit behaves like an instantaneous overcurrent unit. In this case, the function is activated if the current through any of the phases is higher than the 100% of the tap and 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 pre-set value, the protection function activates (trips) and does not reset itself until the value of the phase drops below the point of current tap. In this case, the function is activated at 100% of the set tap value, and it deactivates at 95%. When the Function Enable is set to “Alarm/Trip”; the accuracy of the Time Delay is equal to the pre-set time ±30 ms or ±0.5% (whichever is greater). If the Function Enable is set to “SHB”, the accuracy of the Time Delay is equal to the pre-set time ±50 ms or ±0.5% (whichever is greater).

The reset will be according the “phase reset time” general setting.

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

If the relation between the fault current and the tap is higher than 30, the relay will consider the corresponding theoretical trip time for this factor equal to 30.

8.9 Function 50/51G. Inverse time measured neutral overcurrent

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

Function	Description	Minimum	Maximum	Step	Unit	Default
50/51G	**Inverse time measured neutral overcurrent**					
	Function Enable	-	-	No/Alarm/Trip/SHB	-	No
	Curve type	-	-	(1*)	-	IEC Standard Inverse
	Time Dial (TMS)	0.01	2.00	0.01	-	1.25
	Current Tap	0.002	10.00	0.001	xIn	5.00
	Time Delay	0.000	300.000	0.001	s	0.200

(1*) IEC Inverse, IEC Very inverse, IEC Extremely inverse, IEC Long time inverse, IEC Short Time Inverse, Defined time, IEEE Inverse, IEEE Very inverse, IEEE Extremely inverse, CO_P20, CO_P40, CO8, User Defined Curve 1, Curve 2, Curve 3, Curve 4.

If a curve is selected for the curve setting, the function is activated if the neutral current (measured or calculated depending on the “Neutral Ratio” setting) is higher than the 110% of the tap and the trip time depends on the curve, time dial and current tap settings. When the Function Enable is set to “Alarm/trip”; the accuracy of the trip time is equal to the theoretical trip time ±30 ms or ±5% (whichever is greater). If the Function Enable is set to “SHB”, the accuracy of the trip time is equal to the theoretical trip time ±50 ms or ±5% (whichever is greater). In this case, the function is activated at 110% of the set tap value, and it deactivates at 100%.

If the option “Definite time” is selected for the curve setting, the unit behaves like an instantaneous overcurrent unit. In this case, the function is activated if the neutral current (measured or calculated depending on the “Neutral Ratio” setting) is higher than the 100% of the tap and the time delay is independent from the operating current flowing through the relay, so if the neutral current exceeds its predetermined value for an equal or greater amount of time than this pre-set value, the protection function activates (trips) and does not reset itself until the value of the neutral current drops below the point of current tap. When the Function Enable is set to “Alarm/Trip”; the accuracy of the Time Delay is equal to the pre-set time ±30 ms or ±0.5% (whichever is greater). If the Function Enable is set to “SHB”, the accuracy of the Time Delay is equal to the pre-set time ±50 ms or ±0.5% (whichever is greater). In this case, the function is activated at 100% of the set tap value, and it deactivates at 95%.

The reset will be according the “neutral reset time” general setting.

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

If the relation between the fault current and the tap is higher than 30, the relay will consider the corresponding theoretical trip time for this factor equal to 30.

8.10 Function 49. Thermal Image Protection

Thermal image is a measure of heating and cooling of an electric machine. Unlike overcurrent protection, it does not start counting the time when it detects a fault, but it is continuously determining the thermal state of the machine that monitors. The trip time depends on the thermal constants adjusted, the current flowing and the prior thermal state of the machine.
The thermal image is calculated based on the following equation:

$$\theta = 100 \times (I/I_t)^2 \times (1 - e^{-t/\zeta}) + \theta'_0 \times e^{-t/\zeta}$$

Where:

I, maximum R.M.S. current of three phases
I_t, adjusted tap current
ζ, thermal constant
θ'_0, initial thermal state

The trip time is given by the equation:

$$t = \zeta \times \ln \times \{[(I/I_t)^2 - (\theta'_0 / 100)] / [(I/I_t)^2 - 1]\}$$

The algorithm uses the maximum of the three phase currents. If the maximum is greater than 15% of the adjusted tap, heating thermal constant is applied. If the maximum is less than 15% of the adjusted tap cooling thermal constant is considered.

The overload function trips when the thermal image reaches the value of 100%. This value is reached in time when the current is equal to the function adjusted in thermal function. If the trip occurs, the function is reset when the thermal image falls below the Trip value of 100% level.

It provides an adjustable level of thermal imaging to generate an alarm.

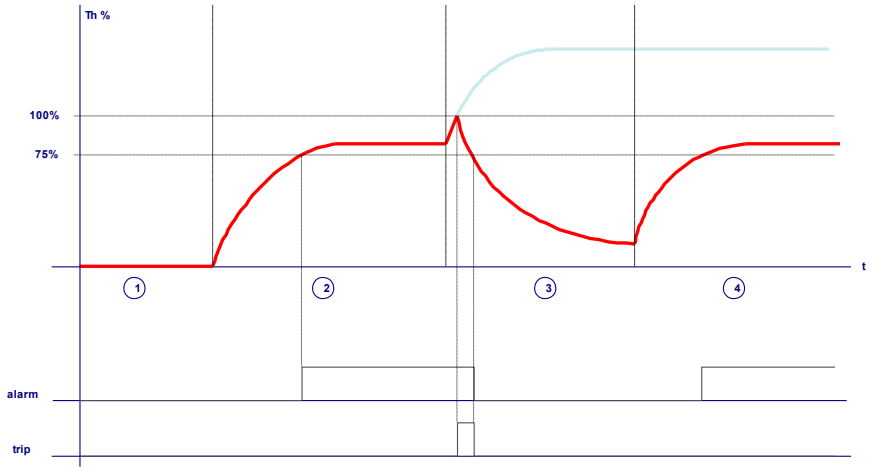
As the current measurement algorithm used is R.M.S., in the thermal model is considered the heat produced by the harmonics.

This protection function is adjusted by setting five different parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
49	**Thermal image protection function**					
	Function Enable	-	-	No/Alarm/Trip	-	No
	Current Tap	0.10	2.40	0.01	x In	1.2
	ζ heating	3	600	1	min	3
	ζ cooling	1	6	1	ζ heating	1
	Alarm	20	99	1	%	80

8.10.1 Thermal image measurement evolution graphic

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



Supposing that thermal image protection has an adjusted tap of 1,1 times the nominal current and an alarm level of 75%:

- Zone 1: The machine is de-energized for a long time. Thermal image is 0%.
- Zone 2: The machine is supplied 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, it is applied 1,2 times the nominal current. Thermal image would evolve so as to get the thermal balance corresponding to 1,2 times the nominal current Th = $(I/It)^2$ = 119%. This would occur if the “Function enable” of the thermal function is disabled. If the Function Enable is permitted, 49 protection function performs when the thermal image reaches the value of 100%. Once tripped, current is cut 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.

The accuracy of the trip time is the theoretical trip time is ±5% of the theoretical time.

Thermal image protection alarm bit is active if the thermal image measurement is over the adjusted alarm level and it is reset when the thermal image value is below the 95% of the set alarm.

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 100%.

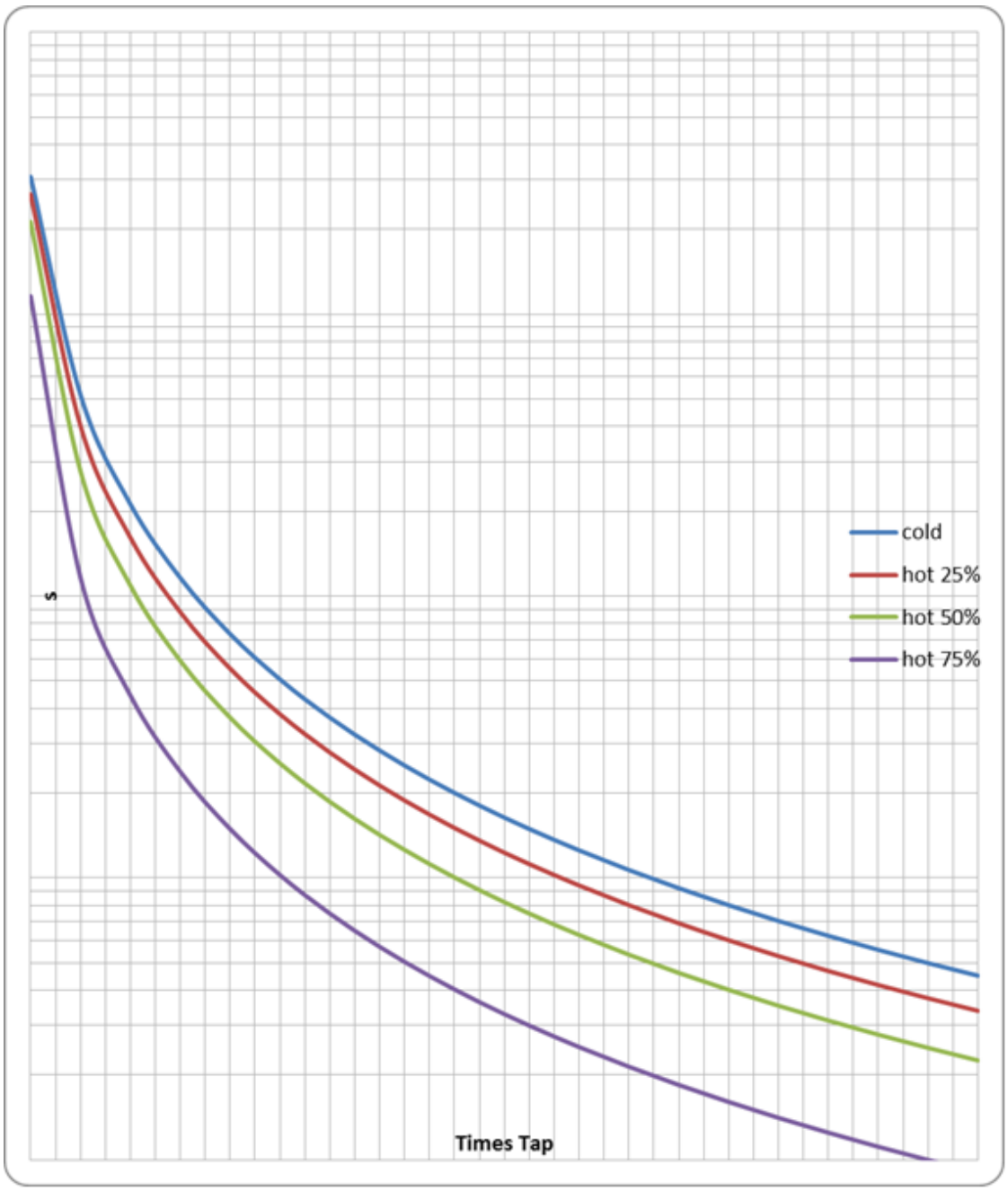
8.10.2 Thermal image with memory

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

8.10.3 Thermal image measurement display. Reset.

Thermal image measurement can be displayed on Measurement menu.

8.10.4 Thermal protection curves



This is the thermal curve for ζ = 3 minutes.

8.11 Function 46. Phase balance current protection

This protection function is based on negative sequence component of the current (I-2) and it can be set by using the following parameters:

Group	Description	Minimum	Maximum	Step	Unit	Default
46 (*)	**Phase balance current protection / Negative sequence inverse time overcurrent**					
	Function Enable	-	-	No/Alarm/Trip/SHB	-	No
	Curve Type	-	-	(1*)	-	IEC Standard Inverse
	Time Dial (TMS)	0.01	2.00	0.01	-	1.25
	Current Tap	0.05	20.00	0.01	x In	1.00
	Time Delay	0.000	300.000	0.01	s	0.200

(*) Optional depending on model

(1*) IEC Inverse, IEC Very inverse, IEC Extremely inverse, IEC Long time inverse, IEC Short Time Inverse, Defined time, IEEE Inverse, IEEE Very inverse, IEEE Extremely inverse, CO_P20, CO_P40, CO8, User Defined Curve 1, Curve 2, Curve 3, Curve 4.

If a curve is selected for the curve setting, the function is activated if the negative sequence component of the current is higher than the 110% of the tap and the trip time depends on the curve, time dial and current tap settings. When the Function Enable is set to “Alarm/Trip”; the accuracy of the trip time is equal to the theoretical trip time ±30 ms or ±5% (whichever is greater). If the Function Enable is set to “SHB”, the accuracy of the trip time is equal to the theoretical trip time ±50 ms or ±5% (whichever is greater). In this case, the function is activated at 110% of the set tap value, and it deactivates at 100%.

If the option “Defined time” is selected for the curve setting, the unit behaves like an instantaneous negative sequence overcurrent unit. In this case, the function is activated if the negative sequence component of the current is higher than the 100% of the tap and the time delay is independent from the negative sequence current flowing through the relay, so if the negative sequence current exceeds its predetermined value for an equal or greater amount of time than this pre-set value, the protection function activates (trips) and does not reset itself until the value of the phase drops below the point of current tap. When the Function Enable is set to “Alarm/Trip”; the accuracy of the Time Delay is equal to the pre-set time ±30 ms or ±0.5% (whichever is greater).

If the Function Enable is set to “SHB”, the accuracy of the Time Delay is equal to the pre-set time ±50 ms or ±0.5% (whichever is greater). In this case, the function is activated at 100% of the set tap value, and it deactivates at 95%.

The reset will be according the “phase reset time” general setting.

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

8.12 Function 46BC. Broken Conductor Detection

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

Function	Description	Minimum	Maximum	Step	Unit	Default
46BC (*)	**Broken Conductor Detection**					
	Function Enable	-	-	No/Alarm/Trip	-	No
	Current tap	15	100	1	%	50
	Time Delay	0.030	300.000	0.001	s	50.000

(*) Optional depending on model

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

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

The function activates at 100% of the pre-set input and deactivates at 95%. The reset will be according the “phase reset time” general setting.

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

For the function to activate the relay must measure at least 0.05xIn of I1 during 40ms.

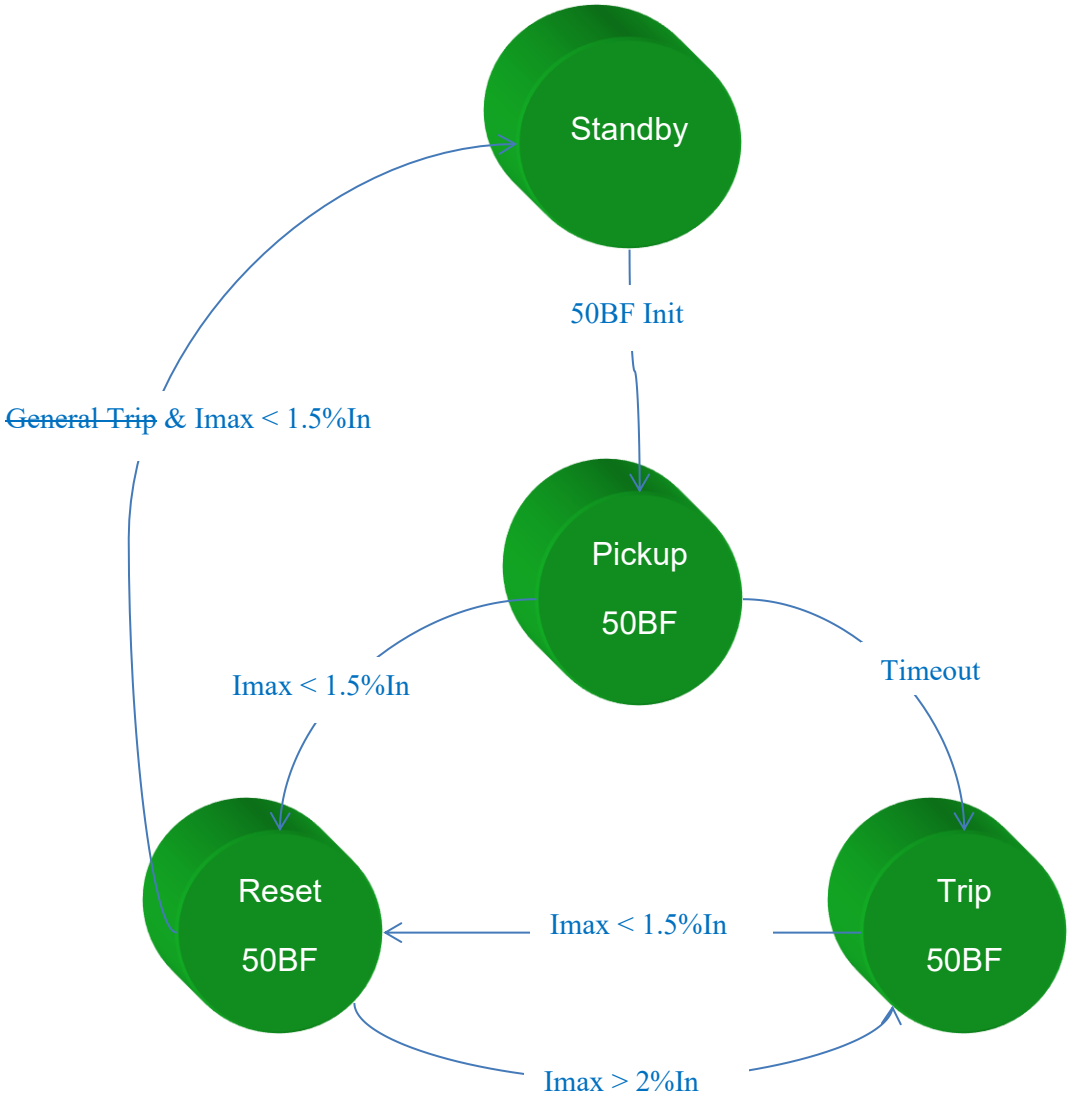
8.13 Function 50BF. Breaker Failure monitoring

This protection function is only available depending on model and the settings are as follows:

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

(*) Optional depending on model

The following automaton describes the open fault function:



The start of 50BF function is associated to the general trip. Once the trip happens, the time is counted. If, following the adjusted open fault time, the switch is not detected to have open, the function indicates an alarm. The function is reset when the circuit breaker is detected open.

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 1.5% of the rated current, the circuit breaker is considered to be open.

8.14 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	0.05	30.00	0.01	xIn	1.00
	Time delay	0.06	300.000	0.001	s	0.200
	Dead Tap	0.00	1.00	0.01	xIn	0.50

(*) Optional depending on model

The Time Delay is completely independent from the operating current that flows through the relay, so if the phase current is below the set value in “current tap” parameter for an equal or greater amount of time than this pre-set value, the protection function activates (trips) and does not reset itself until the value of the neutral current drops below the point of current tap.

However, the start of the function is limited by the “Dead tap” setting:

The setting “Dead Tap” 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 “dead tap” setting, the function will not trip although this current is lower than the tap.

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

The reset will be according the “phase reset time” general setting.

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

8.15 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	0.02	300.000	0.001	s	2.000

(*) Optional depending on model

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

If a current lower than 1.5% 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 1.5% 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.

8.16 Function 79. AC Reclosing Device

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

The reclose can be disabled if it is not required, by setting the **Function Enable** parameter to NO.

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, there is a signal with a logic condition that can be assigned to the start condition of the recloses (logic signal - **79N# Start**). Then, the rest of the cycles are always done sequentially, that is, once the first reclose cycle is done, the reclose condition must be achieved again for the second cycle to 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, gives 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**					
	Function Enable	-	-	No/Yes	-	No
	Hold Enable	-	-	No/Yes/No time	-	No
	Reclose Number	1	5	1	-	1
	Reclose 1 time	0.002	300.000	0.001	s	0.200
	Reclose 2 time	0.002	300.000	0.001	s	0.500
	Reclose 3 time	0.002	300.000	0.001	s	1.000
	Reclose 4 time	0.002	300.000	0.001	s	2.000
	Reclose 5 time	0.002	300.000	0.001	s	5.000
	Hold time	0.002	300.000	0.001	s	1.000
	Reset Time	0.002	300.000	0.001	s	1.000
	Safe time	0.002	300.000	0.001	s	1.000

(*) 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 Close Time” bit.

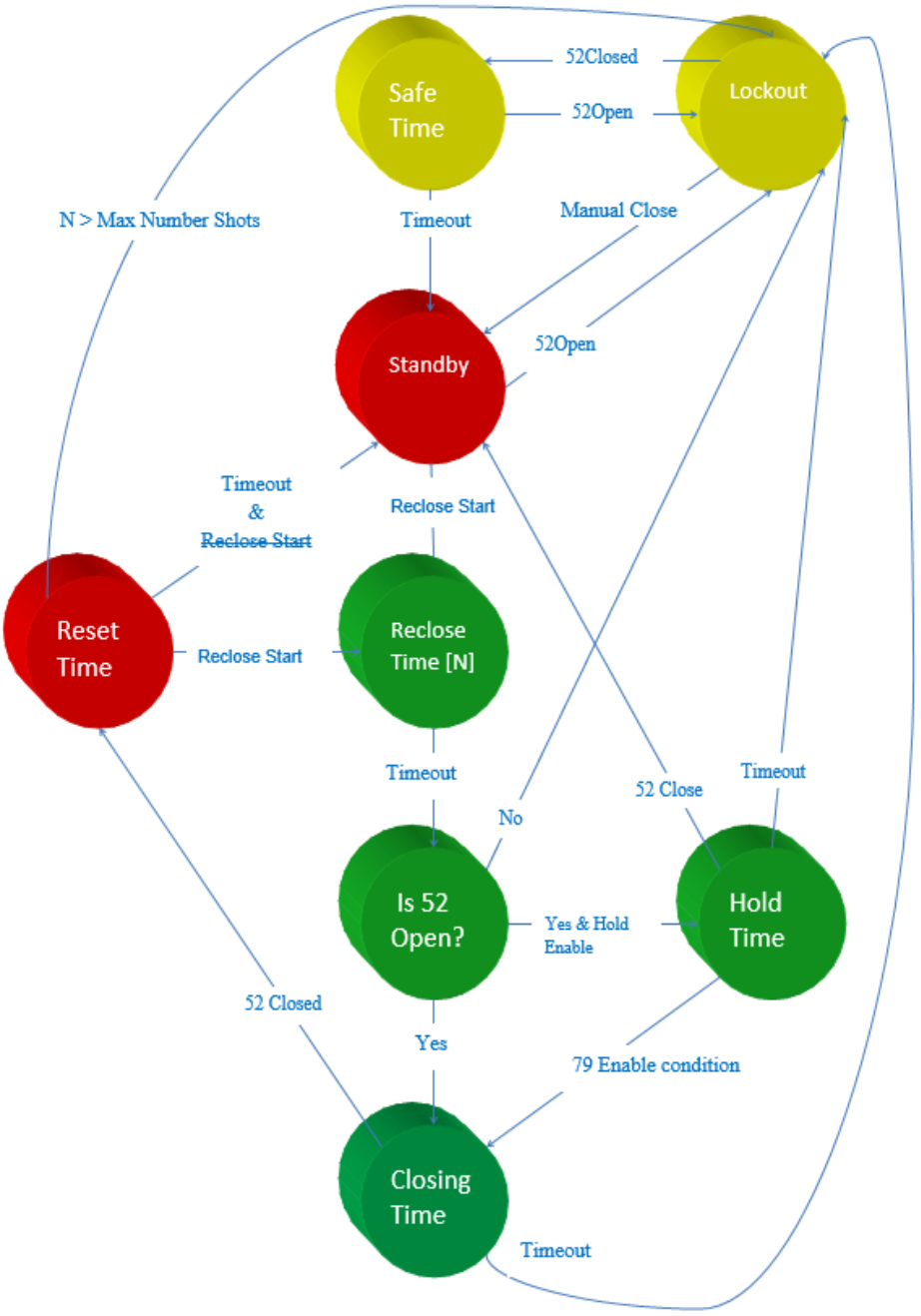
It must be possible to block the recloser, especially if maintenance tasks are carried out on the substation.

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

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

This function states can be associated to an alarm, logic alarm and outputs by means of 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.

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

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

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

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

- ✓ Circuit breaker closing (from manual or remote control): it switches to Standby.

✓ Unexpected condition from a reclose cycle: it switches to Safe time.

There is a logical signal “79 Start” in the configurable logic. Default configuration is as follow:

Reclose Condition	Default Configuration
79 Start	General Trip

8.17 Function 49T. External trip

The relay has up to 10 configurable inputs and any of them can be configured as external trip input. This input is normally connected to a bimetallic contact fitted to the power transformer. This serves as a backup to the overcurrent functions.

Auxiliary supply is not required. It allows the connection of a bimetallic free potential contact. When this contact closes, it activates the input.

This input is especially protected against magnetic noise.

The external trip is available from the minimum required current to power the relay (0.075xIn in 3-phase/0.16xIn in single phase).

8.18 IEC60255-151 Curves

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

- Inverse Curve
- Very Inverse Curve
- Extremely Inverse Curve
- Long time inverse
- Short time inverse

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

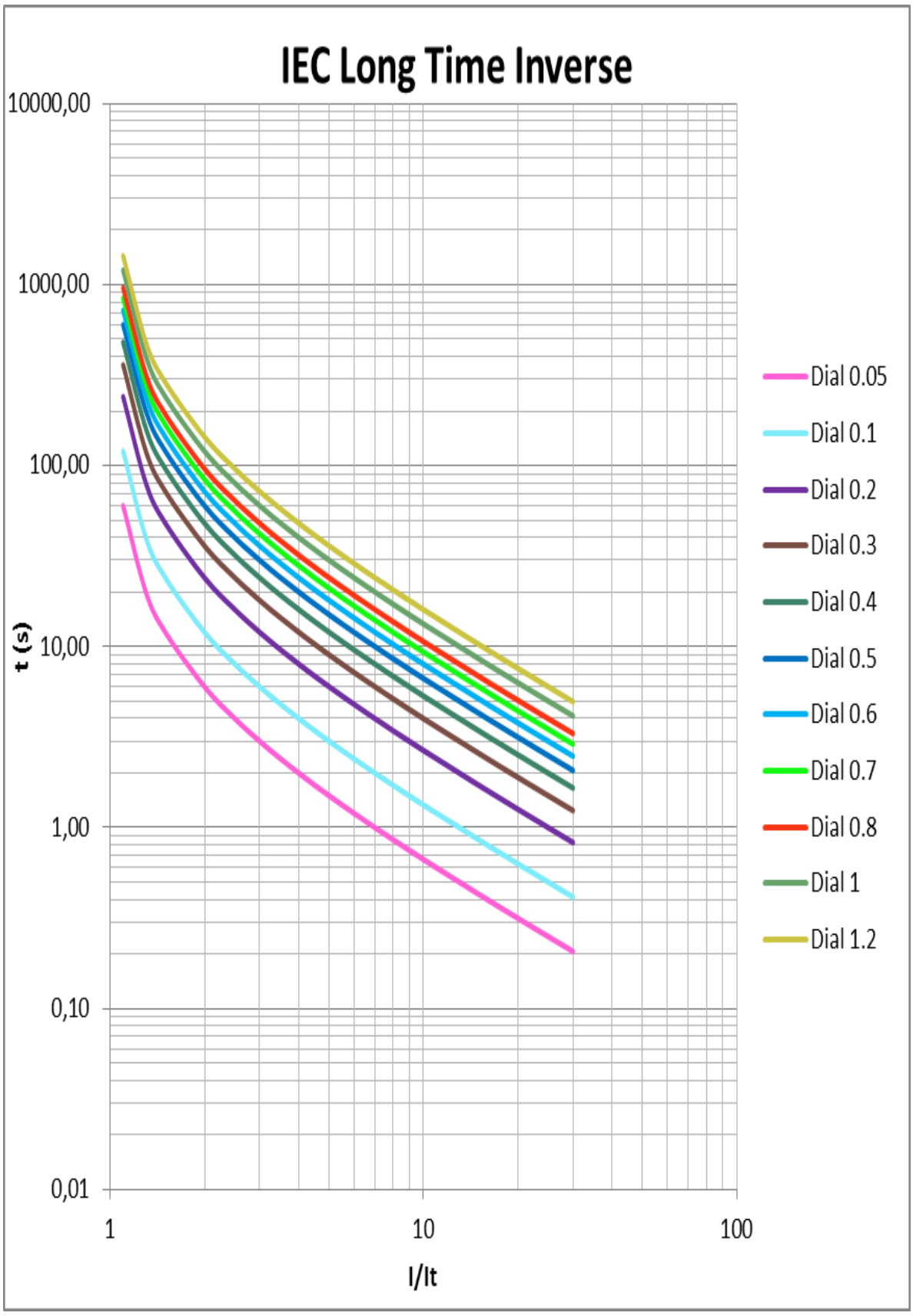
$$t = \frac{A \times D}{V^P - Q} + B \times D + K$$

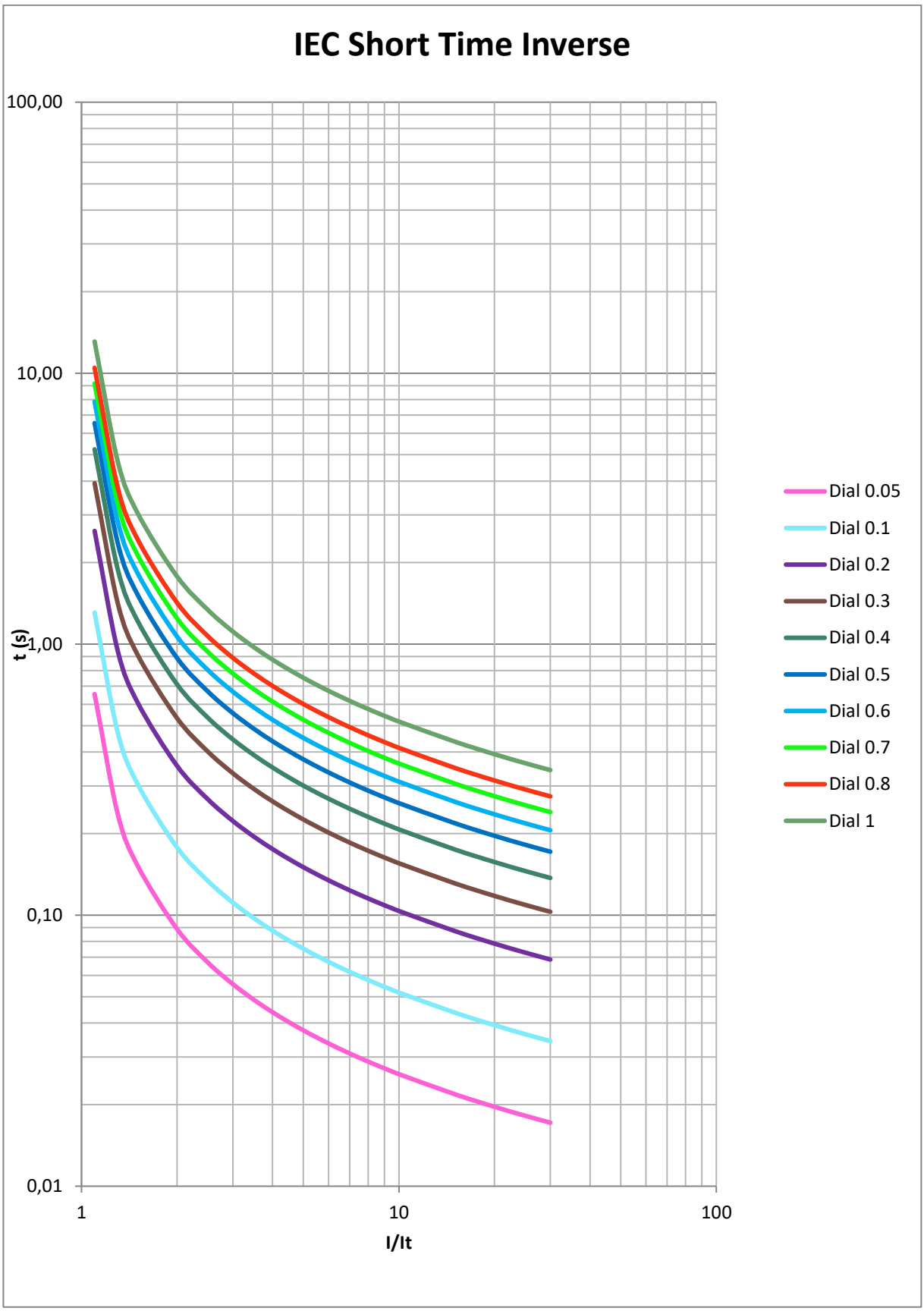
$$V = \frac{I}{I_{adjusted}}$$

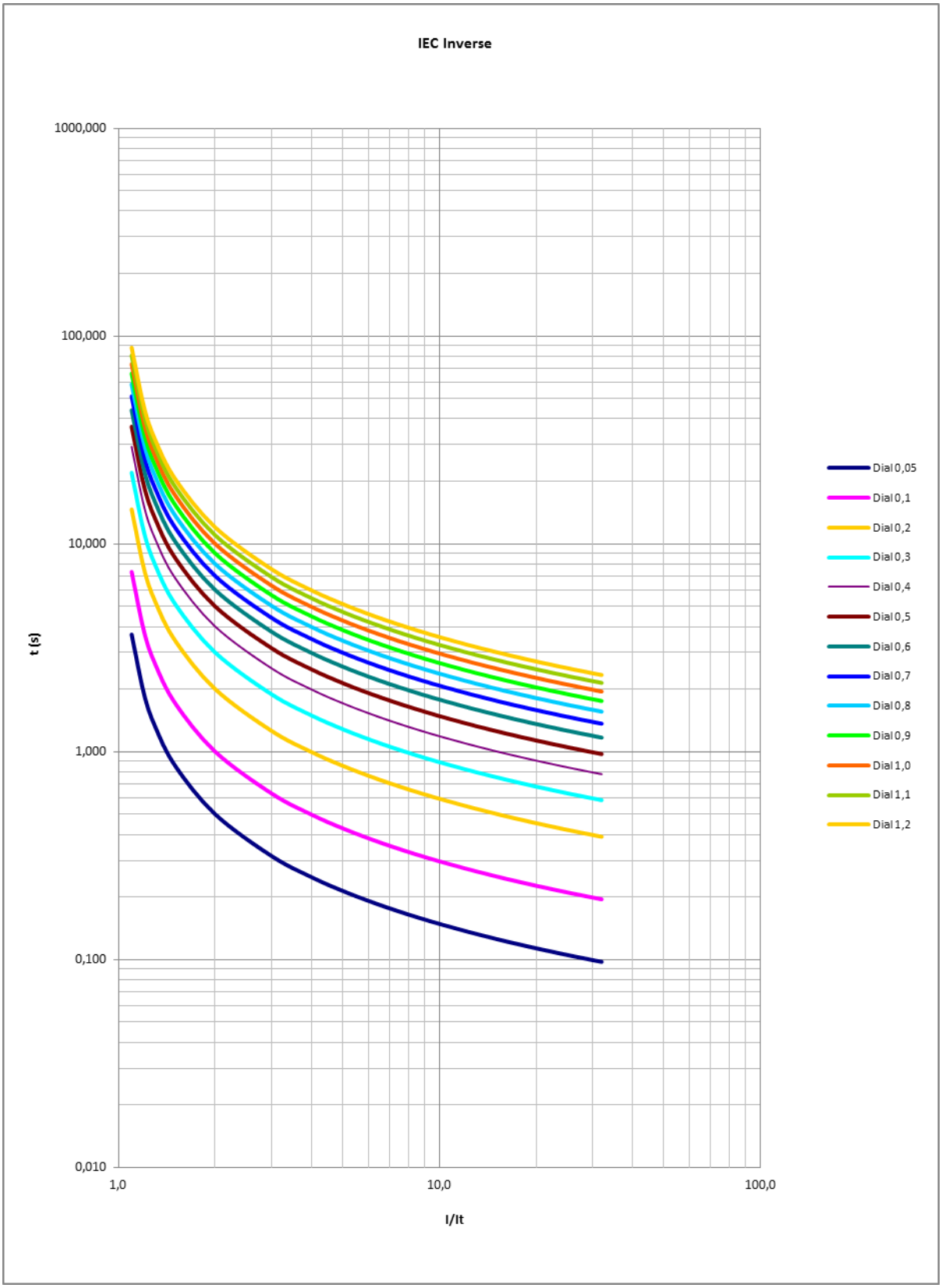
“V” must be 30 (maximum). If this relation is higher than 30, the relay will consider the corresponding theoretical trip time for this factor equal to 30.

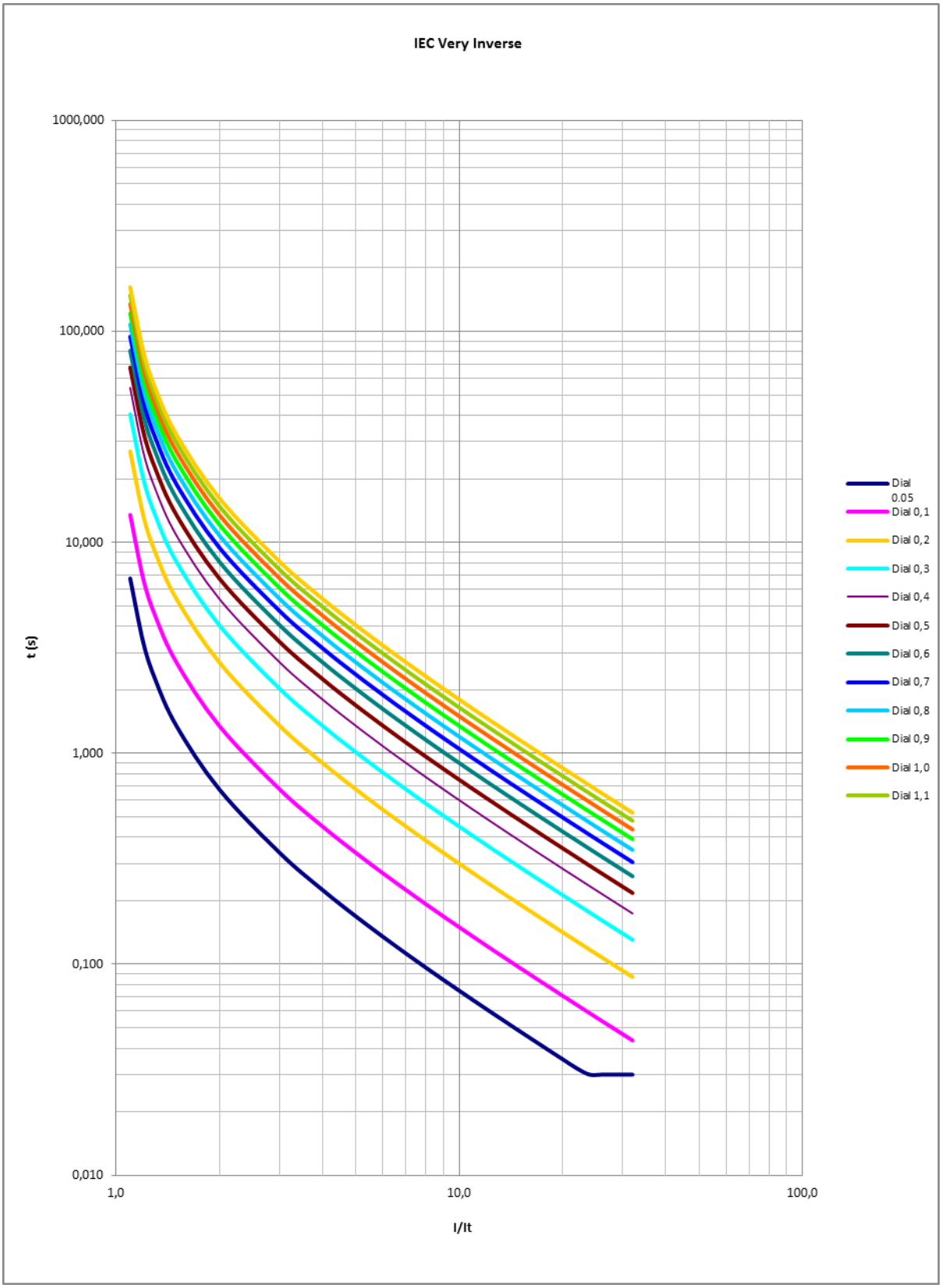
Parameters	A	P	Q	B	K
Long Time Inverse	120	1	1	0	0
Short Time Inverse	0.05	0.04	1	0	0
Ext. Inverse	80	2	1	0	0
Very Inverse	13,5	1	1	0	0
Inverse	0.14	0.02	1	0	0

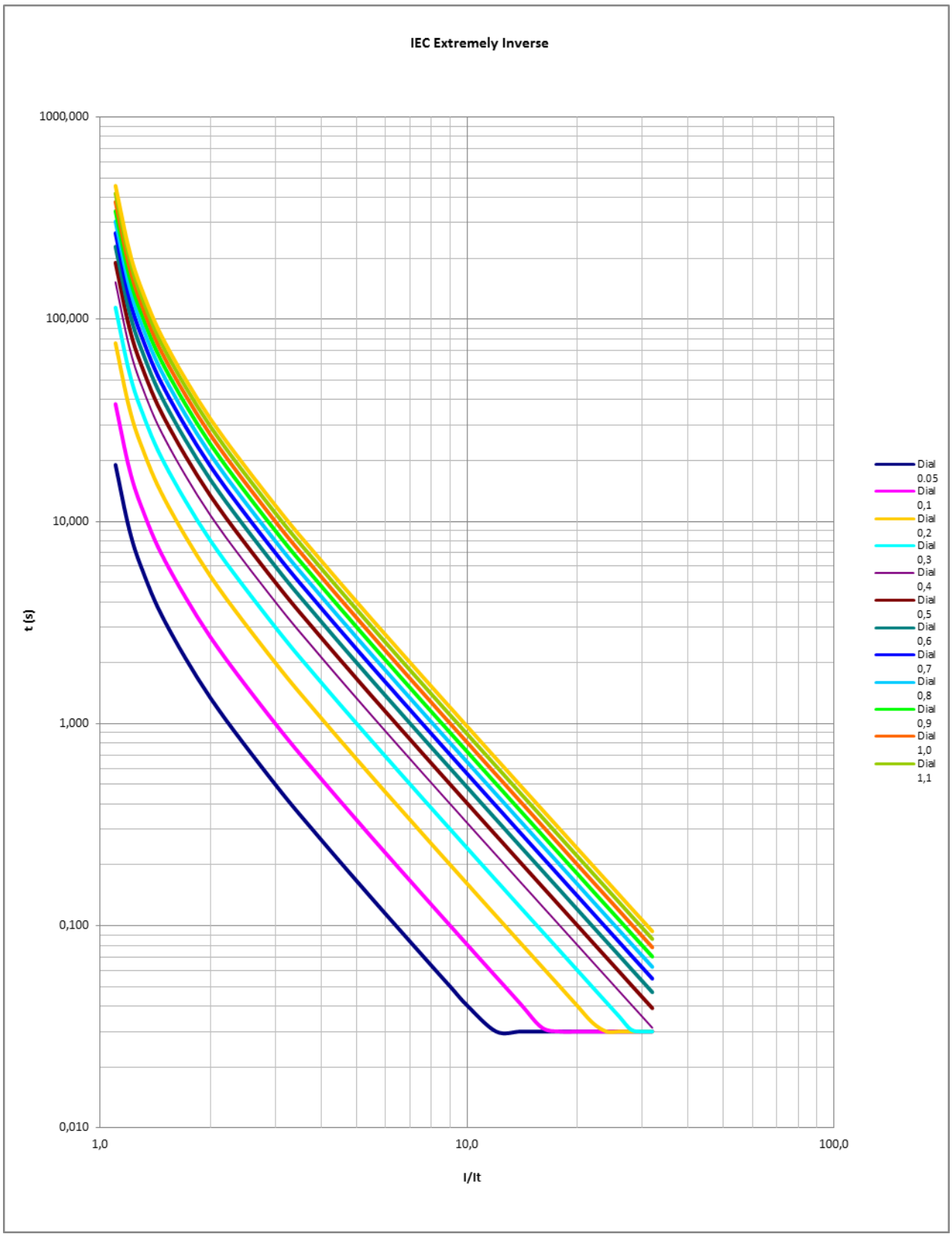
The curve can mode from its axis using the D time selection device, which the user can adjust. $I_{adjusted}$ is the initial operating current, set by the user.


IEC 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
Dial 1.2


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


IEC 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 0,3
Dial 0,4
Dial 0,5
Dial 0,6
Dial 0,7
Dial 0,8
Dial 0,9
Dial 1,0
Dial 1,1
Dial 1,2


IEC 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 0,3
Dial 0,4
Dial 0,5
Dial 0,6
Dial 0,7
Dial 0,8
Dial 0,9
Dial 1,0
Dial 1,1


IEC 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 0,3
Dial 0,4
Dial 0,5
Dial 0,6
Dial 0,7
Dial 0,8
Dial 0,9
Dial 1,0
Dial 1,1

8.19 IEEE Curves

The IEEE curves follow the following mathematical equation:

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

Where:

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

"V" must be 30 (maximum). If this relation is higher than 30, the relay will consider the corresponding theoretical trip time for this factor equal to 30.

And we have the following curves:

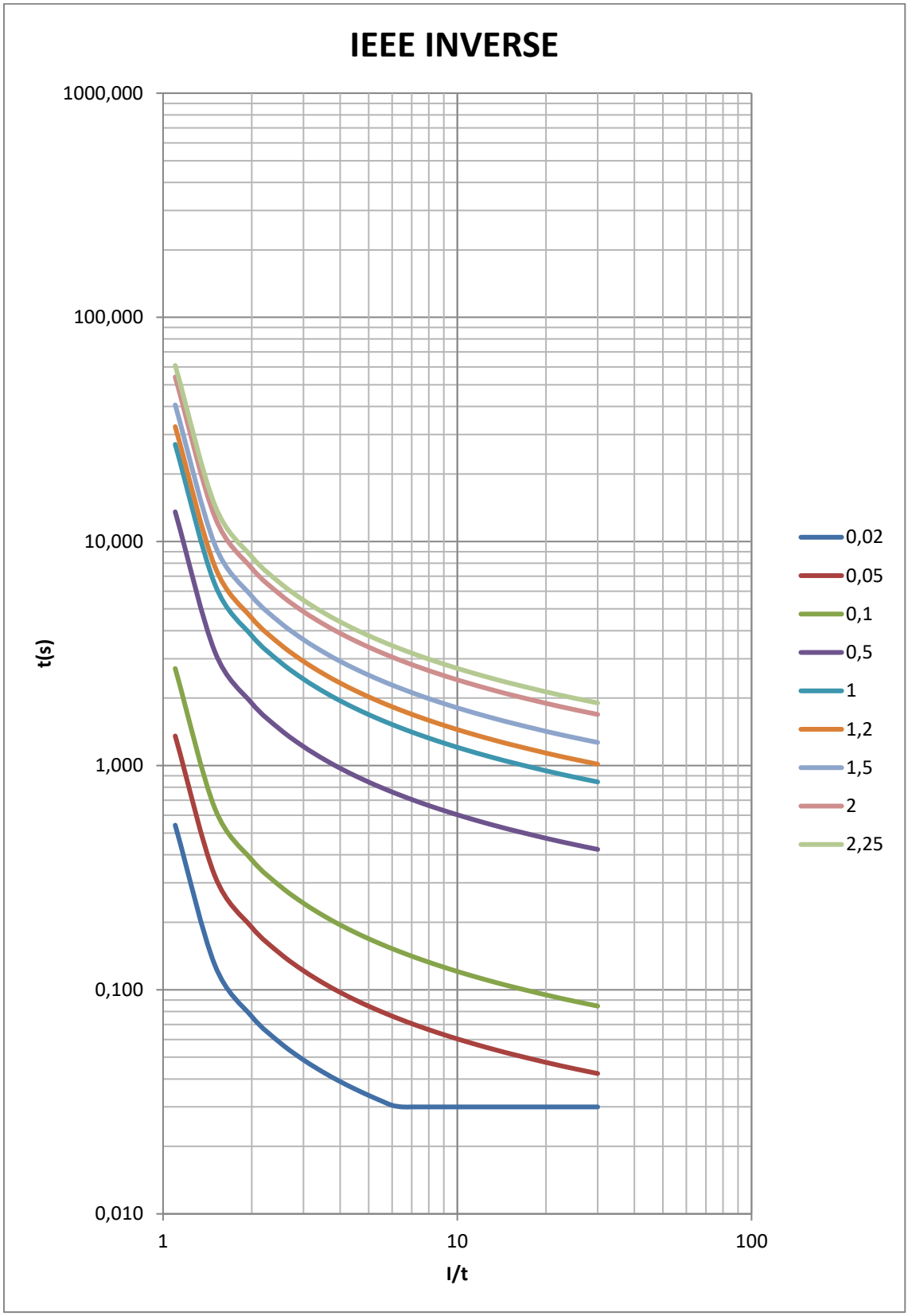
- Inverse Curve
- Very Inverse Curve
- Extremely Inverse Curve

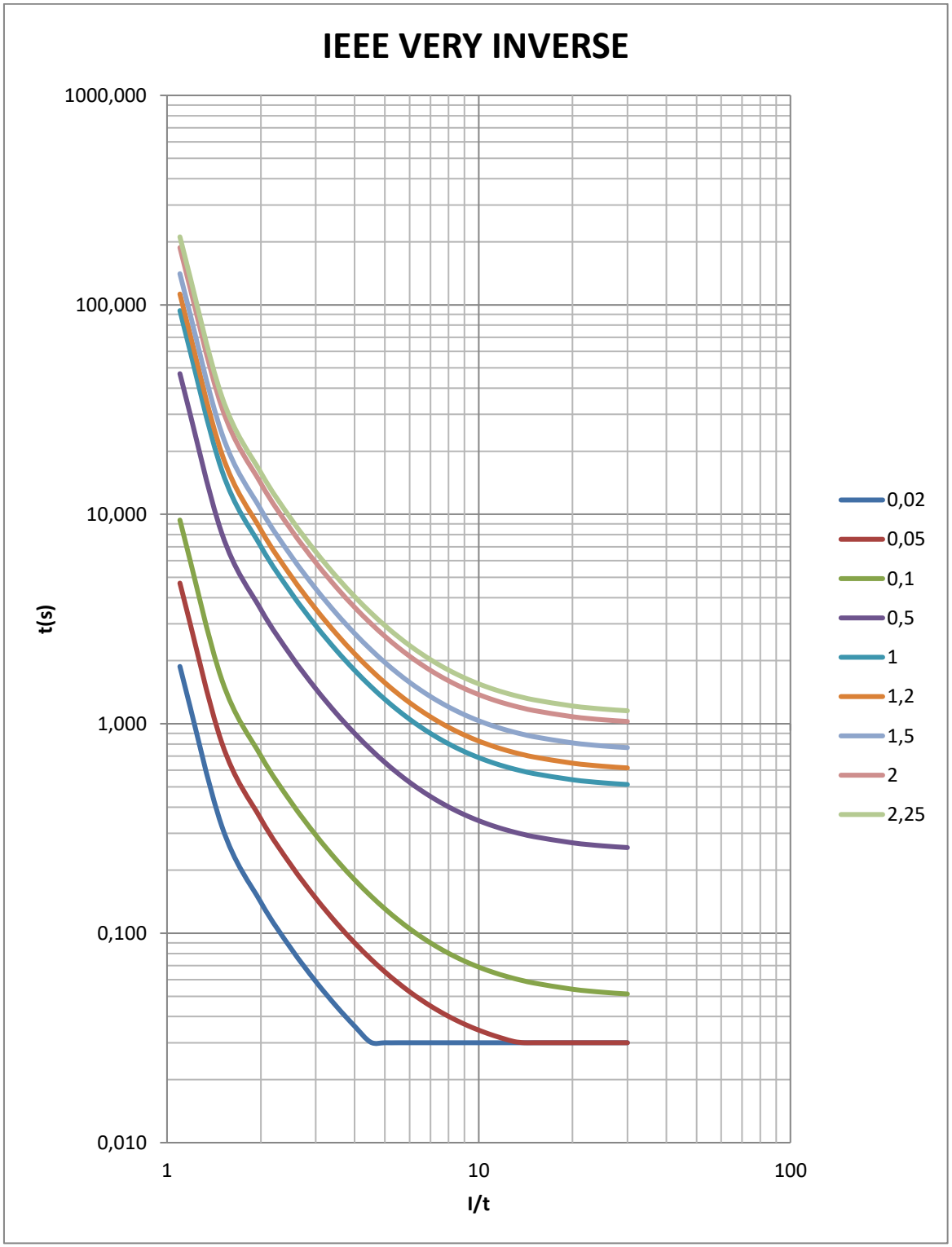
Which relate to the parameters figuring in the following Setting group:

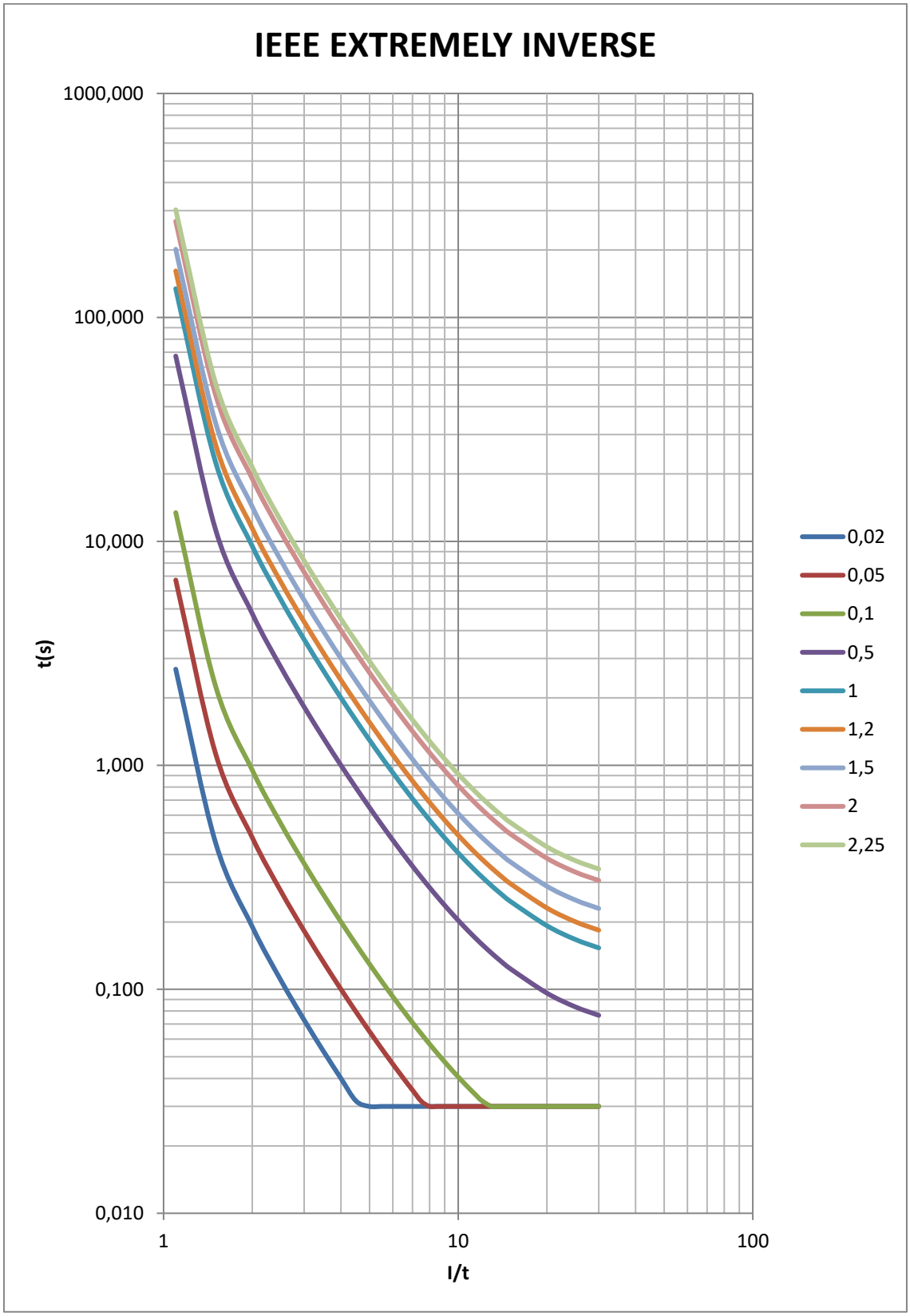
Parameters	A	P	B
Ext. Inverse	28,2	2	0,1217
Very Inverse	19,61	2	0,491
Inverse	0,0515	0,02	0,114

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

Iadjusted is the initial operating current, set by the user.


IEEE INVERSE
1000,000
100,000
10,000
1,000
0,100
0,010
t(s)
1
10
100
I/t
0,02
0,05
0,1
0,5
1
1,2
1,5
2
2,25


IEEE VERY INVERSE
1000,000
100,000
10,000
1,000
0,100
0,010
t(s)
1
10
100
I/t
0,02
0,05
0,1
0,5
1
1,2
1,5
2
2,25


IEEE EXTREMELY INVERSE
1000,000
100,000
10,000
1,000
0,100
0,010
t(s)
1
10
100
I/t
0,02
0,05
0,1
0,5
1
1,2
1,5
2
2,25

8.20 CO Curves

The CO curves follow the following mathematical equation:

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

Where:

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

"V" must be 30 (maximum). If this relation is higher than 30, the relay will consider the corresponding theoretical trip time for this factor equal to 30.

And we have the following curves:

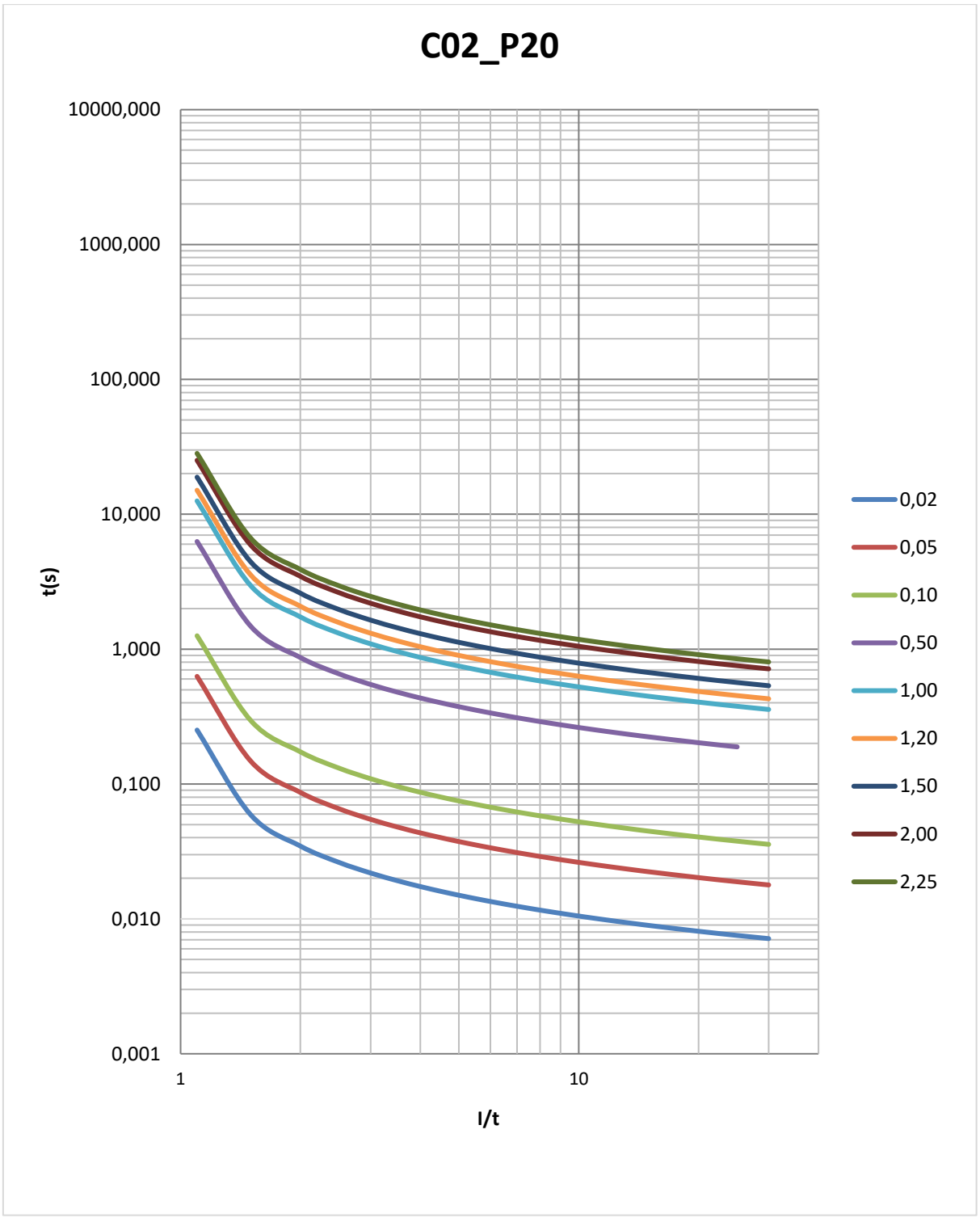
- CO_P20: US Short Time Inverse Curve
- CO_P40: US Short Time Inverse Curve
- CO8: US Time Inverse Curve

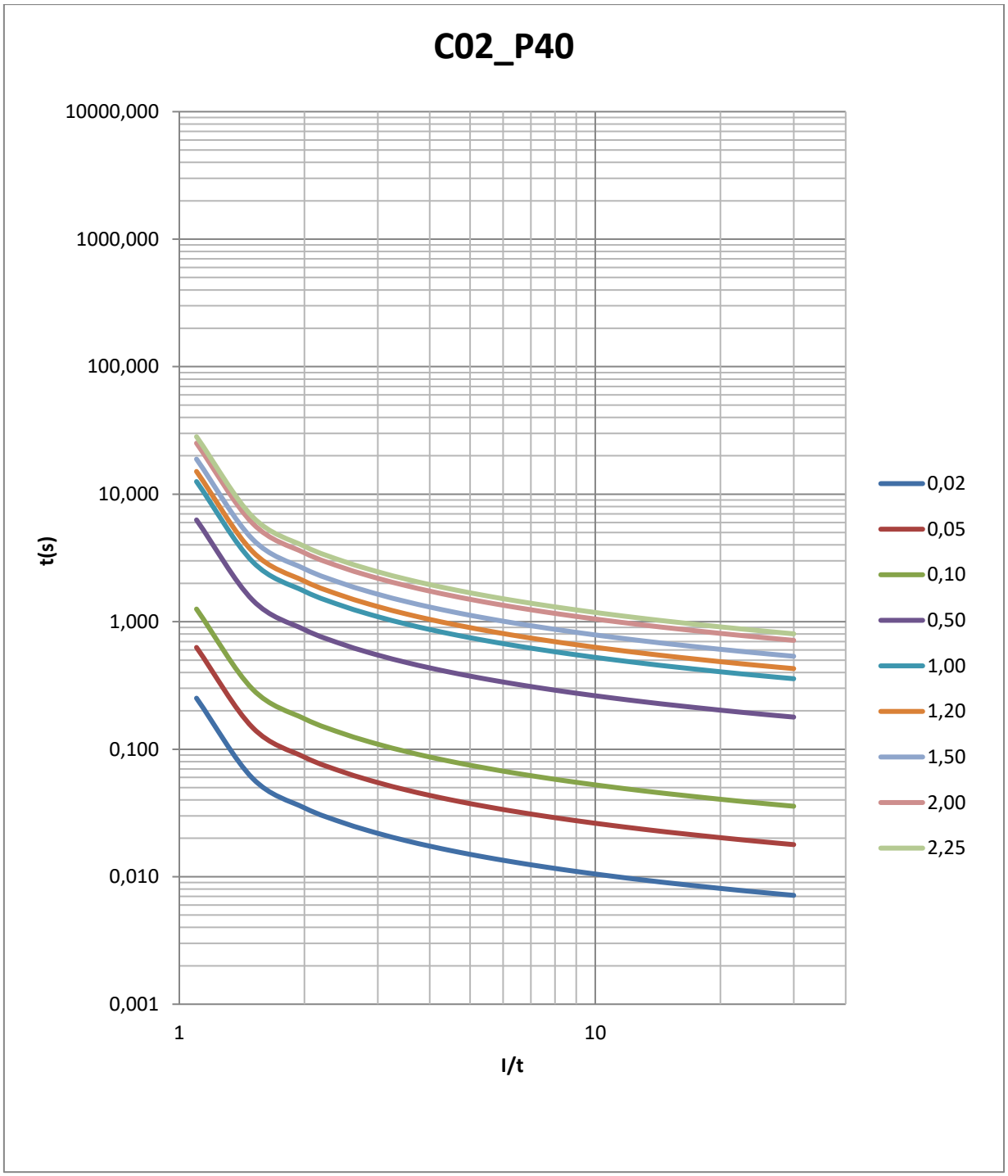
Which relate to the parameters figuring in the following Setting group:

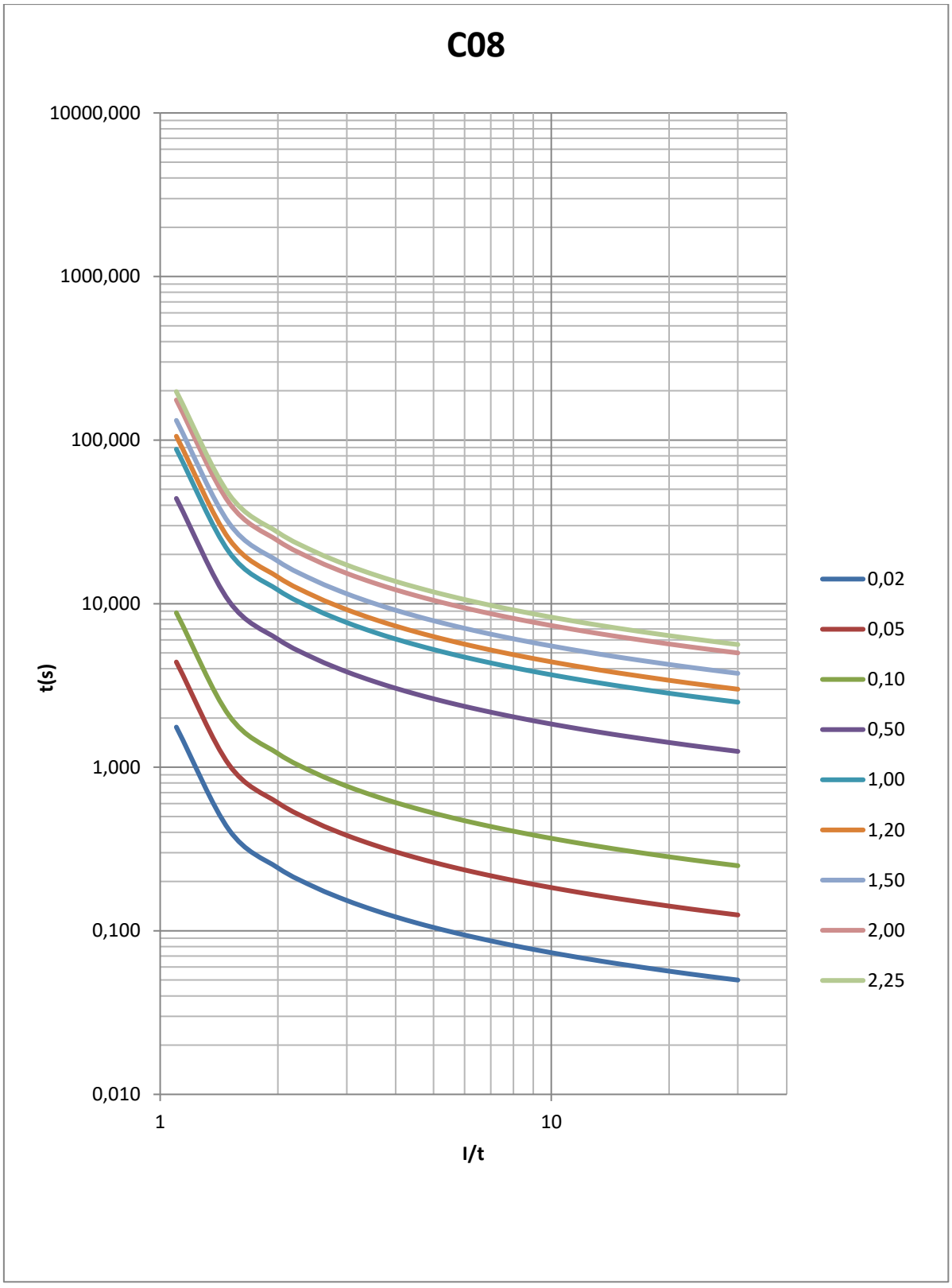
Parameters	A	P	B
CO_P20	0.02394	0.02	0.01694
CO_P40	0.16758	0.02	0.11858
CO8	5.95	2	0.18

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

Iadjusted is the initial operating current, set by the user.


C02_P20
10000,000
1000,000
100,000
10,000
1,000
0,100
0,010
0,001
t(s)
1
10
I/t
0,02
0,05
0,10
0,50
1,00
1,20
1,50
2,00
2,25


C02_P40
10000,000
1000,000
100,000
10,000
1,000
0,100
0,010
0,001
t(s)
1
10
I/t
0,02
0,05
0,10
0,50
1,00
1,20
1,50
2,00
2,25

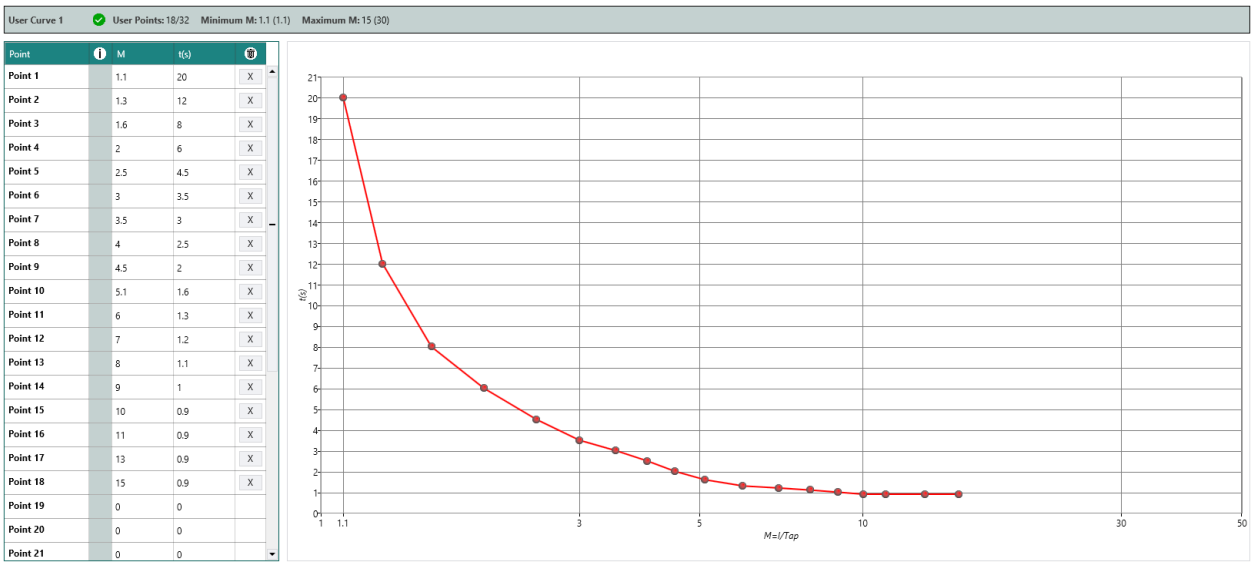

C08
10000,000
1000,000
100,000
10,000
1,000
0,100
0,010
t(s)
1
10
I/t
0,02
0,05
0,10
0,50
1,00
1,20
1,50
2,00
2,25

8.21 User Defined Curves

User defined curves allow customization of the relay's time-current response. Instead of using standard inverse curves (like IEC or IEEE types), the user can define up to four custom curves, each consisting of up to 32 points.

The points are established by two parameters:

- $M = \frac{I}{Tap}$, the ratio of measured current to the tap setting.
- t(s): Operating time (in seconds).



To ensure proper operation of user defined curves, it is essential to set the Time Dial Setting (TMS) to 1.

8.22 Application examples

In Fanox relays, the taps (protection thresholds) from which the protection functions will start to protect are adjusted in times the nominal current of the installed current transformers. (parameter that will be called “In” in the following examples). So,

If 3 phase 100/1 current transformers are used and the function ANSI 50 should start to protect from 700 amperes to trip after 200 milliseconds, the settings will be:

CT Phase Ratio: 100 (ratio 100/1)

ANSI 50 current tap: 7 (7xIn=7x100=700 A)

Time Delay: 0.2 s

Working principle: If the relay detects a current equal or higher than 700 A, the function will be activated. If the fault persists for the set time (in this case 200 milliseconds) the relay will trip. The accuracy of the time will be +/-30 ms o +/-0.5%, greater of both, so the admissible range for the trip time will be: [170-230 ms].

If 3 phase 75/1 current transformers are used and the función ANSI 51 should be set to 100 amperes with a IEC very Inverse curve and a time multiplier setting of 0.5, the settings will be:

CT Phase Ratio: 75 (ratio 75/1)

ANSI 51 current tap: 1.33 (1.33xIn=1.33x75=100 A)

Curve: IEC Very Inverse

TMS: 0.5

Working principle: If the relay detects a current equal or higher than the 110 A (this function is activated from the 110% of the tap) the function will be picked-up. If the mentioned fault current is maintained for the theoretical trip time that is calculated depending on the fault current, curve and TMS, the relay will trip.

For a fault of 200 Amperes, the theoretical time will be 6.75 seconds:

Tap	Current Fault	Current fault/Tap	TMS		Theoretical Time
100	200	2	0,5		6,750

To calculate the admissible trip time range, different considerations should be considered:

1) The admissible accuracy for the current measurement (out of +/-20% the nominal current) is +/-4% so the admissible measurement range is [192-208 A]

The theoretical trip time for the mentioned measurement range will be:

Theoretical time for 192 A= 7.337 seconds

Tap	Current Fault	Current fault/Tap	TMS		Theoretical Time
100	192	1,92	0,5		7,337

Theoretical time for 208 A=6.250 seconds

Tap	Current Fault	Current fault/Tap	TMS		Theoretical Time
100	208	2,08	0,5		6,250

2) The accuracy of the trip time is +/-30 ms o +/-5%, greater of both.

So, -5% will be applied to the minimum of the calculated theoretical trip time (6.25 seconds) and +5% will be applied to the maximum of the calculated theoretical trip time (7.337 seconds), resulting in the following admissible range for the trip time: **[5.93-7.70 seconds]**

It is important to know that if both overcurrent protection functions (50 and 50/51), phase or neutral, are enabled, instantaneous 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, instantaneous overcurrent function will always work. This is a way to ensure that at high fault currents the trip will be very fast to avoid any damage on the elements the relay is protecting.

It is shown some examples 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=100 A

50 function settings

- Tap: 11xI_n=1100 A
- Operating time: 0.05 s

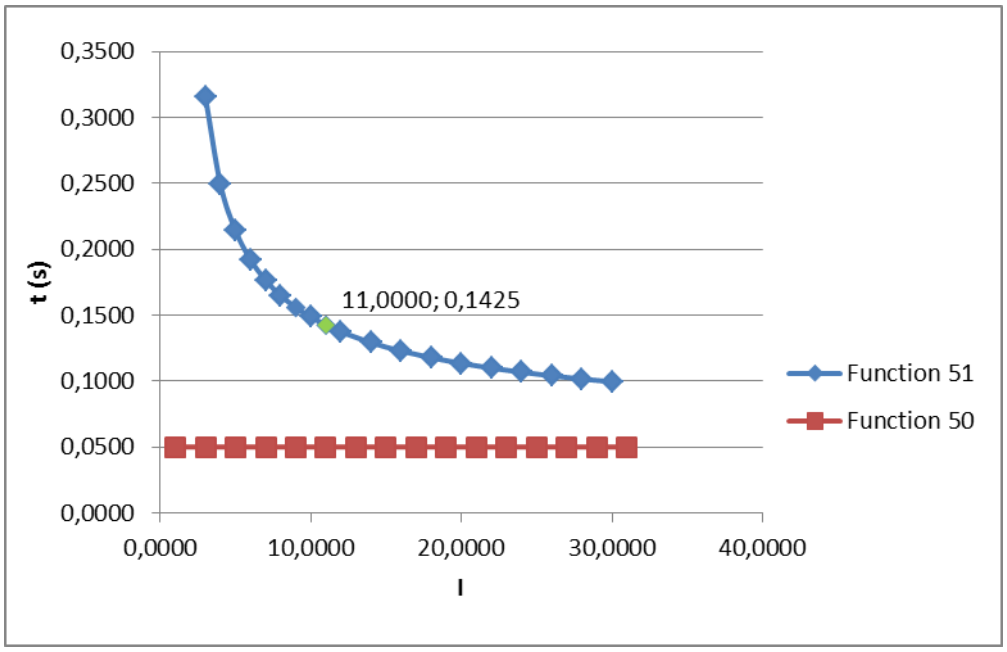


Figure 1. 50 and 50/51 IEC Inverse

If overcurrent fault is 11xI_n=1100 Ap, 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, instantaneous overcurrent (ANSI 50) function will work.

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

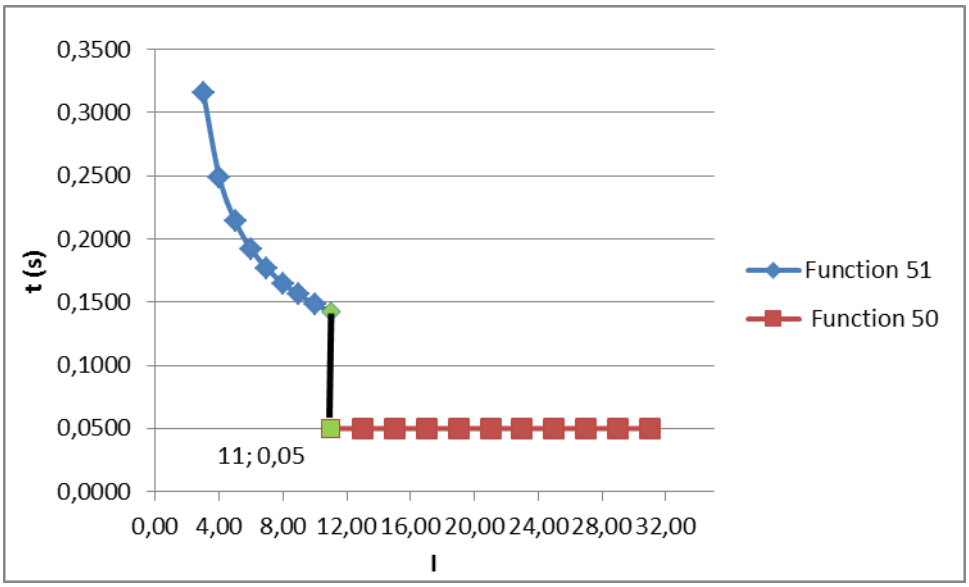


Figure 2. Relay tripping curve

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=500 A

50 function settings

- Tap: 14xI_n=7000 A
- Operating time: 0.1 s

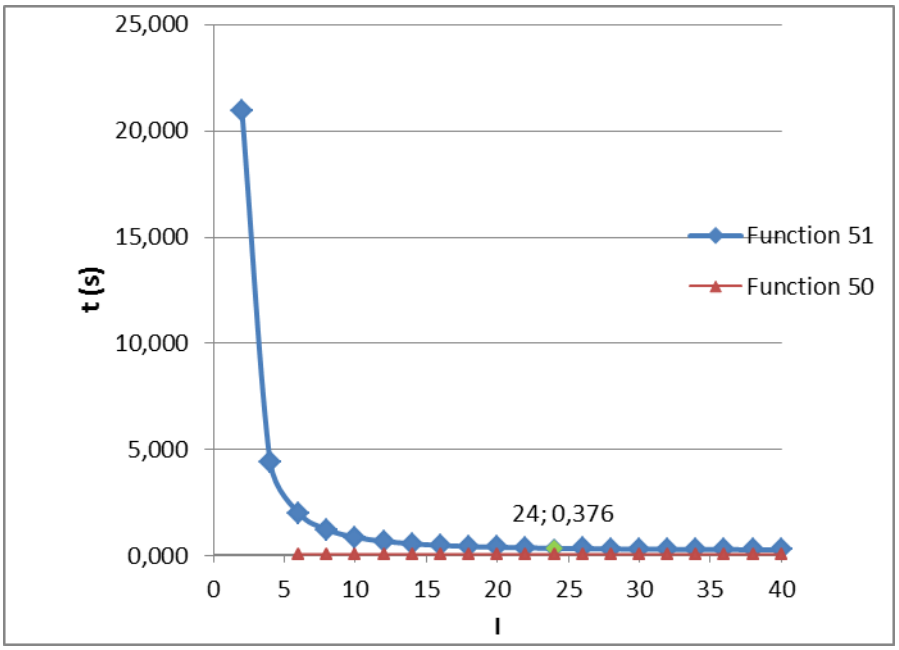


Figure 3. 50 and 50/51 IEEE Extremely Inverse

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 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:

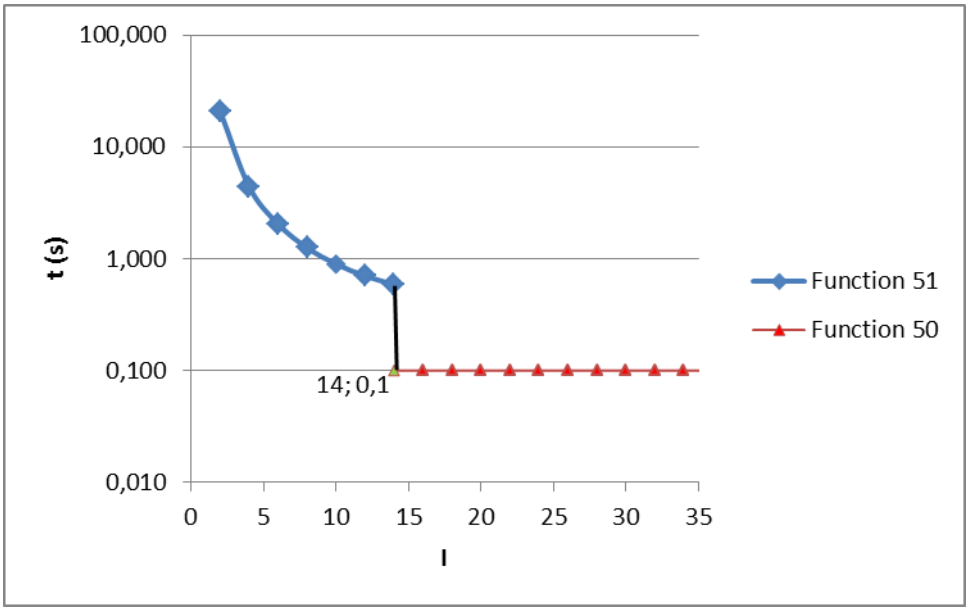


Figure 4. Relay tripping curve

APPLICATION EXAMPLE 3:

In this example it is explained what occurs when it is selected in curve type parameter “DEFINITE TIME”. In this case, 50/51 function works as 50 function.

Starting from the following information

Line details:

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

50/51 function settings

- Curve type: Definite time
- Tap 1xIn=100 A
- Operating time: 5 s

50 function settings

- Tap: 15xIn=1500 A
- Operating time: 1 s

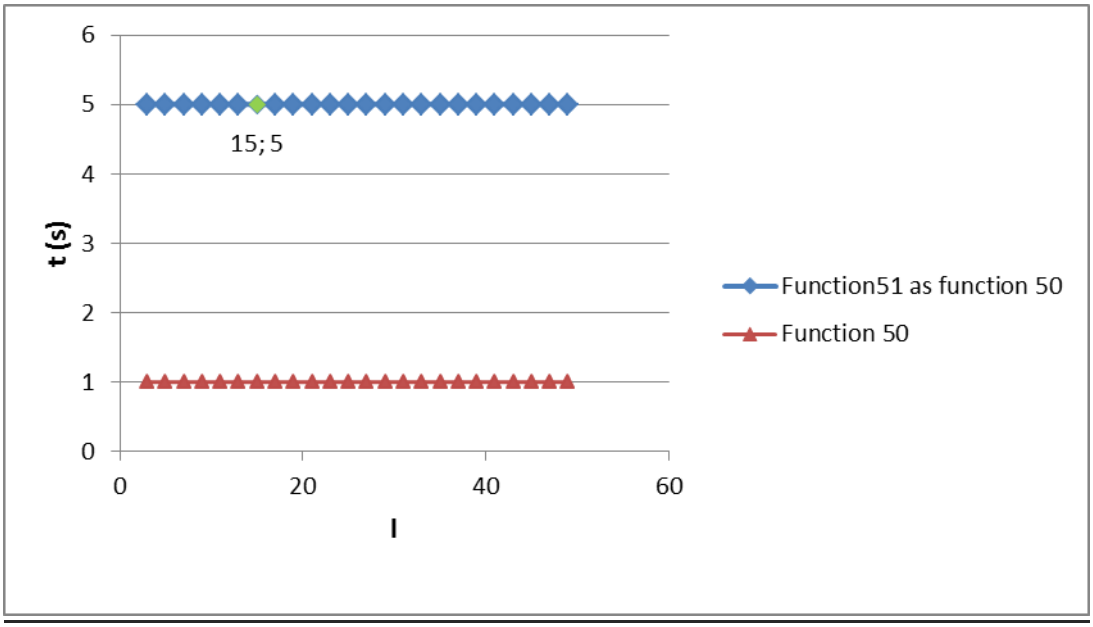


Figure 5. Function 50/51 (as 50) and function 50.

If overcurrent fault is $15xI_n$=1500 Ap, Definite time curve defines a tripping value of 5 s (Figure 5) for 50/51 function. It is considered that this time is too high, so when current fault reaches $15xI_n$, instantaneous overcurrent function will work (function 50).

The figure below (Figure 6), shows the tripping curve of the relay:

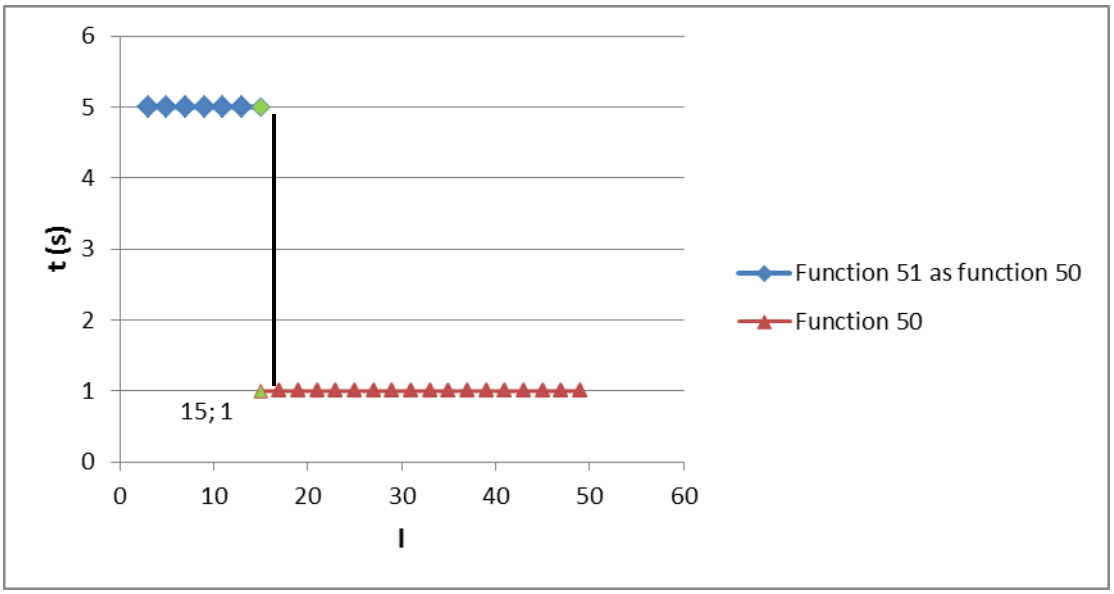


Figure 6. Relay tripping curve

9. SETTINGS GROUPS

There are (4) four configurable setting groups in general settings. The active setting group can be modified in two ways:

- The user can configure the default active setting group in general settings. (Setting group 1, Setting group 2, Setting group 3, Setting group 4). No PGC input is used.
- By means of two PGC inputs (Settings G1 and Settings G2), the active setting group can be changed depending on the active PGC input.

00	Active setting group will be the one configured in general settings.
01	Setting group 1 active (PGC Settings Group 1 active)
10	Setting group 2 active (PGC Settings Group 2 active)
11	Setting group 3 active (PGC Settings Group 2 and PGC Settings Group 2 active)

NOTE: Setting group 4 can only be activated and configured on general settings.

In the zero position the active setting group will be the one configured in general settings. The PGC inputs prevail over the setting group configured in general settings.

10. MONITORING AND CONTROL

10.1. Measurements

Three-phase currents (I-A, I-B and I-C), neutral current (I-N (measured) and 3I-0 (internally calculated)), sequence currents (I-1 and I-2)*, second harmonic of each phase (IA-2H, IB-2H and IC-2H), maximum current (Imax) and thermal image (TI), trip voltage level (1 measurement or 3 measurements depending on model)* are given as fundamental values (DFT).

)* indicates the measurement is available depending on model).

Sampling, of 16 samples/cycle, is performed

The accuracy of the phases and neutral measurements:

±2% in a band of ± 20% the nominal current and ±4% or ± 5 mA in the rest of the band.
In case the current is between 0.002 to 0.0125 times the nominal current the accuracy will be 0.5mA.

Phase measurement: 0.02 to 30 times the nominal current.

Neutral measurement: 0.002 to 16 times the nominal current.

In the case of the second harmonics currents the relay shows the measurements in amperes (although the function is set in percentage). In this case, it is necessary to have a minimum of 80 milliamps of the fundamental current.

10.2. Load data profiling

SIA-C relay provides the demand of current with the following characteristics:

- Number of records: 168
- 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: Ones 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.

This function records values that exceed the LDP current level setting during the selected interval.

10.3. Counters

The following counters are provided:

1 Number of openings of the circuit breaker
2 Accumulated amperes (I2t) during the openings of the circuit breaker

10.4. States and Events

The state is given by real-time information generated by the relay. Some states have an event associated with them, which is a register of a change made to the state. There are states that have an activation event associated with them, and other states have two associated events: activation and deactivation. These events are registered in a circular memory (buffer) with a capacity for up to 1024 events. The memory timestamp is accurate to 1 millisecond.
The events will be registered in non-volatile FRAM memory, and the events are conserved even if the relay is not powered. The relay keeps and processes the correct date and time, even without electrical power while the internal commissioning battery works (the lifetime of this battery is 20 years).
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.: 51_1.4 = 51 START UP
Event State	ON(Activated) /OFF(Deactivated): an event is generated for activations and deactivations
Associated Measurement	Depending on the event
Date	Day/Month/Year Hour:Minutes:Seconds:Milliseconds

The following list shows all the states of the relay and their associated events:

Register description	State	Event Description	Event State	Associated Measurement
GENERAL				
Disturbance Fault Recording				
DFR	New DFR	New DFR	Activation/Deactivation	-
	Reports erased	Reports erased	Activation/Deactivation	-
General states				
	Trip	Trip	Activation/Deactivation	Maximum phase current.
	External trip	External trip	Activation/Deactivation	-
	Trip block	Trip block	Activation/Deactivation	Maximum Current
	Local	Local	Activation/Deactivation	-
	Settings change	Settings change	Activation/Deactivation	-
	Conf. Changed	Conf. Changed	Activation/Deactivation	-
	Events Erased	Events Erased	Activation/Deactivation	-
	SinglePhaseTrip(*)	SinglePhaseTrip	Activation/Deactivation	-
	Settings Group 1	Settings Group 1	Activation/Deactivation	-
	Settings Group 2	Settings Group 2	Activation/Deactivation	-
	Settings Group 3	Settings Group 3	Activation/Deactivation	-
	Settings Group 4	Settings Group 4	Activation/Deactivation	-
	TCP Conf. Changed	TCP Conf. Changed	Activation/Deactivation	-
	S.Conf.changed	S. Conf. changed	Activation/Deactivation	-
	Phase A Pickup	Phase A Pickup	Activation/Deactivation	Phase A Current (A)
	Phase B Pickup	Phase B Pickup	Activation/Deactivation	Phase B Current (A)
	Phase C Pickup	Phase C Pickup	Activation/Deactivation	Phase C Current (A)
	Pickup	Pickup	Activation/Deactivation	Maximum Current
	Ground pickup	Ground pickup	Activation/Deactivation	Neutral Current (A)
	Phase A Trip	Phase A Trip	Activation/Deactivation	Phase A Current (A)
	Phase B Trip	Phase B Trip	Activation/Deactivation	Phase B Current (A)
	Phase C Trip	Phase C Trip	Activation/Deactivation	Phase C Current (A)
	Ground trip	Ground trip	Activation/Deactivation	Neutral Current (A)
	Phase Trip	Phase Trip	Activation/Deactivation	Maximum Current

Self Diagnostic				
	Ready	Ready	Activation/Deactivation	-
	TCP Conf. Error	TCP Conf. Error	Activation/Deactivation	-
	Serial Conf. Error	Serial Conf. Error	Activation/Deactivation	-
	Measure error	Measure error	Activation/Deactivation	-
	Error NVM	Error NVM	Activation/Deactivation	-
	By Default	By Default	Activation/Deactivation	-
	Error Curves	Error Curves	Activation/Deactivation	-
	Error SFLASH	Error SFLASH	Activation/Deactivation	-
	Aux. Power	Aux. Power	Activation/Deactivation	-
	Self-Power	Self-Power	Activation/Deactivation	Maximum current
	USB Power	USB Power	Activation/Deactivation	-
	Battery Power	Battery Power	Activation/Deactivation	-
	Enable LEDS	Enable LEDS	Activation/Deactivation	-
	Enable OUTP234(*)	Enable OUTP234	Activation/Deactivation	-
	Enable OUTP4(*)	Enable OUTP4	Activation/Deactivation	-
	Enable OUTP5	Enable OUTP5	Activation/Deactivation	-
	Enable LCD	Enable LCD	Activation/Deactivation	-
	Enable RS485(*)	Enable RS485	Activation/Deactivation	-
	Enable OUTP678(*)	Enable OUTP678	Activation/Deactivation	-
Date				
	Need Sync.	Need Sync.	Activation/Deactivation	-
	Set date/time	Set date/time	Activation/Deactivation	-
Measurement				
	50 Hz	50Hz	Activation/Deactivation	-
LDP				
	Reports Erased	Reports Erased	Activation/Deactivation	-
Inputs (Models SIACx00xxx2xxD, SIACx00xxx3xxD)				
	Input 1	Input 1	Activation/Deactivation	-
	Input 2	Input 2	Activation/Deactivation	-
	Input 3	Input 3	Activation/Deactivation	-

	Input 4	Input 4	Activation/Deactivation	-
Inputs (Model SIACx00xxx4xxD)				
	Input 1	Input 1	Activation/Deactivation	-
	Input 2	Input 2	Activation/Deactivation	-
	Input 3	Input 3	Activation/Deactivation	-
	Input 4	Input 4	Activation/Deactivation	-
	Input 5	Input 5	Activation/Deactivation	-
	Input 6	Input 6	Activation/Deactivation	-
	Input 7	Input 7	Activation/Deactivation	-
	Input 8	Input 8	Activation/Deactivation	-
	Input 9	Input 9	Activation/Deactivation	-
	Input 10	Input 10	Activation/Deactivation	-
Outputs (Model SIACx00xxx2xxD)				
	Trip Output 1	Trip 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	-
Outputs (Model SIACx00xxx3xxD)				
	Trip Output 1	Trip Output 1	Activation/Deactivation	-
	Trip Output 2	Trip Output 2	Activation/Deactivation	-
	Trip Output 3	Trip Output 3	Activation/Deactivation	-
	Output 4	Output 4	Activation/Deactivation	-
	Output 5	Output 5	Activation/Deactivation	-
Outputs (Model SIACx00xxx4xxD)				
	Trip Output 1	Trip Output 1	Activation/Deactivation	-
	Output 2	Output 2	Activation/Deactivation	-
	Output 3	Output 3	Activation/Deactivation	-
	Output 4	Output 4	Activation/Deactivation	-
	Output 5	Output 5	Activation/Deactivation	-

	Output 6	Output 6	Activation/Deactivation	-
	Output 7	Output 7	Activation/Deactivation	-
	Output 8	Output 8	Activation/Deactivation	-
PGC				
	Reset TI	Reset TI	Activation/Deactivation	-
	External Trip	External Trip	Activation/Deactivation	-
	Settings Group 1	Settings Group 1	Activation/Deactivation	-
	Settings Group 2	Settings Group 2	Activation/Deactivation	-
	O/C Block	O/C Block	Activation/Deactivation	-
	E/F Block	E/F Block	Activation/Deactivation	-
	Logic Signal 1	Logic Signal 1	Activation/Deactivation	-
	Logic Signal 2	Logic Signal 2	Activation/Deactivation	-
	Logic Signal 3(*)	Logic Signal 3	Activation/Deactivation	-
	52a(*)	52a	Activation/Deactivation	-
	52b(*)	52b	Activation/Deactivation	-
	52b-A(*)	52b-A	Activation/Deactivation	-
	52b-B(*)	52b-B	Activation/Deactivation	-
	52b-C(*)	52b-C	Activation/Deactivation	-
	79 Start(*)	79 Start	Activation/Deactivation	-
	79 Enable(*)	79 Enable	Activation/Deactivation	-
	Hot Line Tag(*)	Hot Line Tag	Activation/Deactivation	-
Leds				
	LED 1	LED 1	Activation/Deactivation	-
	LED 2	LED 2	Activation/Deactivation	-
	LED 3	LED 3	Activation/Deactivation	-
	LED 4	LED 4	Activation/Deactivation	-
	LED 5	LED 5	Activation/Deactivation	-
	LED 6	LED 6	Activation/Deactivation	-
	LED 7	LED 7	Activation/Deactivation	-
	Bistable	Bistable	Activation/Deactivation	-

COMMUNICATION				
HMI				
	Access Denied	Access Denied	Activation/Deactivation	-
	Invalid Authn.	Invalid Authn.	Activation/Deactivation	-
	Reset Key	Reset Key	Activation/Deactivation	-
	Identification	Identification	Activation/Deactivation	-
	HMI Activity	-	Activation/Deactivation	-
	Open Breaker	Open Breaker	Activation/Deactivation	-
	Close Breaker	Close Breaker	Activation/Deactivation	-
	79 Block	79 Block	Activation/Deactivation	-
	79 Unblock	79 Unblock	Activation/Deactivation	-
	Local Control	Local Control	Activation/Deactivation	-
	Remote Control	Remote Control	Activation/Deactivation	-
	Reset	Reset	Activation/Deactivation	-
	Reset thermal image	Reset thermal image	Activation/Deactivation	-
USB COM				
	Access Denied	Access Denied	Activation/Deactivation	-
	Invalid Authn.	Invalid Authn.	Activation/Deactivation	-
	Set Counter	Set Counter	Activation/Deactivation	-
	Identification	Identification	Activation/Deactivation	-
	Local COM.	Local COM.	Activation/Deactivation	-
	Open Breaker	Open Breaker	Activation/Deactivation	-
	Close Breaker	Close Breaker	Activation/Deactivation	-
	79 Block	79 Block	Activation/Deactivation	-
	79 Unblock	79 Unblock	Activation/Deactivation	-
	Local Control	Local Control	Activation/Deactivation	-
	Remote Control	Remote Control	Activation/Deactivation	-
	Reset	Reset	Activation/Deactivation	-
	Reset thermal image	Reset thermal image	Activation/Deactivation	-

Modbus RTU (*)				
	Access Denied	Access Denied	Activation/Deactivation	-
	Invalid Authn.	Invalid Authn.	Activation/Deactivation	-
	Set Counter	Set Counter	Activation/Deactivation	-
	Remote COM.	Remote COM.	Activation/Deactivation	-
	Open Breaker	Open Breaker	Activation/Deactivation	-
	Close Breaker	Close Breaker	Activation/Deactivation	-
	79 Block	79 Block	Activation/Deactivation	-
	79 Unblock	79 Unblock	Activation/Deactivation	-
	Reset	Reset	Activation/Deactivation	-
	Reset thermal image	Reset thermal image	Activation/Deactivation	-
Rear TCP (*)				
	No Profile	No Profile	Activation/Deactivation	-
	Config. Error	Config. Error	Activation/Deactivation	-
	Alive	Alive	Activation/Deactivation	-
Modbus TCP (*)				
	Access Denied	Access Denied	Activation/Deactivation	-
	Invalid Authn.	Invalid Authn.	Activation/Deactivation	-
	Set Counter	Set Counter	Activation/Deactivation	-
	Remote COM.	Remote COM.	Activation/Deactivation	-
	Open Breaker	Open Breaker	Activation/Deactivation	-
	Close Breaker	Close Breaker	Activation/Deactivation	-
	79 Block	79 Block	Activation/Deactivation	-
	79 Unblock	79 Unblock	Activation/Deactivation	-
	Reset	Reset	Activation/Deactivation	-
	Reset thermal image	Reset thermal image	Activation/Deactivation	-

WEB (*)				
	Access Denied	Access Denied	Activation/Deactivation	-
	Invalid Authn.	Invalid Authn.	Activation/Deactivation	-
	Set Counter	Set Counter	Activation/Deactivation	-
	Remote COM.	Remote COM.	Activation/Deactivation	-
	Open Breaker	Open Breaker	Activation/Deactivation	-
	Close Breaker	Close Breaker	Activation/Deactivation	-
	79 Block	79 Block	Activation/Deactivation	-
	79 Unblock	79 Unblock	Activation/Deactivation	-
	Reset	Reset	Activation/Deactivation	-
	Reset thermal image	Reset thermal image	Activation/Deactivation	-
IEC-103 (*)				
	Remote COM.	Remote COM.	Activation/Deactivation	-
	Open Breaker	Open Breaker	Activation/Deactivation	-
	Close Breaker	Close Breaker	Activation/Deactivation	-
	79 Block	79 Block	Activation/Deactivation	-
	79 Unblock	79 Unblock	Activation/Deactivation	-
	Reset	Reset	Activation/Deactivation	-
	Reset thermal image	Reset thermal image	Activation/Deactivation	-
DNP3 (*)				
	Remote COM.	Remote COM.	Activation/Deactivation	-
	Open Breaker	Open Breaker	Activation/Deactivation	-
	Close Breaker	Close Breaker	Activation/Deactivation	-
	79 Block	79 Block	Activation/Deactivation	-
	79 Unblock	79 Unblock	Activation/Deactivation	-
	Reset	Reset	Activation/Deactivation	-
	Reset thermal image	Reset thermal image	Activation/Deactivation	-

PROTECTION AND CONTROL				
74TVS (Models SIACx00xxx2xxD, SIACx00xxx4xxD)				
	No Trip Power	No Trip Power	Activation/Deactivation	Trip voltage
74TVS (Model SIACx00xxx3xxD)				
	No Trip Power	No Trip Power	Activation/Deactivation	Trip voltage
	No Trip Power A	No Trip Power A	Activation/Deactivation	Trip voltage A
	No Trip Power B	No Trip Power B	Activation/Deactivation	Trip voltage B
	No Trip Power C	No Trip Power C	Activation/Deactivation	Trip voltage C
Circuit Breaker Monitoring (Models SIACx00xxx2xxD, SIACx00xxx4xxD)				
52	52 Error	52 Error	Activation/Deactivation	-
	Open Num. Alarm	Open Num. Alarm	Activation/Deactivation	Maximum current
	I2t Alarm	I2t Alarm	Activation/Deactivation	-
	Open/Time Alarm	Open/Time Alarm	Activation/Deactivation	Maximum current
	52 Open	52 Open	Activation/Deactivation	Maximum current
	52 Close	52 Close	Activation/Deactivation	Maximum current
Circuit Breaker Monitoring (Model SIACx00xxx3xxD)				
52	52A Error	52A Error	Activation/Deactivation	-
	52Aopen	52Aopen	Activation/Deactivation	Maximum current
	52Aclosed	52Aclosed	Activation/Deactivation	Maximum current
	52AopeningAlarm	52AopeningAlarm	Activation/Deactivation	Maximum current
	52AI2tAlarm	52AI2tAlarm	Activation/Deactivation	Maximum current
	52AopeningTalarm	52AopeningTalarm	Activation/Deactivation	-
	52B Error	52B Error	Activation/Deactivation	-
	52Bopen	52Bopen	Activation/Deactivation	Maximum current
	52Bclosed	52Bclosed	Activation/Deactivation	Maximum current
	52BopeningAlarm	52BopeningAlarm	Activation/Deactivation	Maximum current
	52BI2tAlarm	52BI2tAlarm	Activation/Deactivation	Maximum current
	52BopeningTalarm	52BopeningTalarm	Activation/Deactivation	-
	52C Error	52C Error	Activation/Deactivation	-
	52Copen	52Copen	Activation/Deactivation	Maximum current
	52Cclosed	52Cclosed	Activation/Deactivation	Maximum current

	52CopeningAlarm	52CopeningAlarm	Activation/Deactivation	Maximum current
	52CI2tAlarm	52CI2tAlarm	Activation/Deactivation	Maximum current
	52CopeningTalarm	52CopeningTalarm	Activation/Deactivation	-
	52 Open	52 Open	Activation/Deactivation	Maximum current
	52 Close	52 Close	Activation/Deactivation	Maximum current
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	-
Switch On To Fault				
SOTF	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
	Phase Trip	Phase Trip	Activation/Deactivation	Maximum current
Cold Load Pickup				
CLP	CLP Disable	CLP Disable	Activation/Deactivation	-
	52 Close	52 Close	Activation/Deactivation	-
	52 Open	52 Open	Activation/Deactivation	-
	52 Def. Open	52 Def. Open	Activation/Deactivation	-
	Close CLP	Close CLP	Activation/Deactivation	-
	Open CLP	Open CLP	Activation/Deactivation	-
	CLP	CLP	Activation/Deactivation	-

Trip Block for Switch Disconector				
TB	Phase A Block	Phase A Block	Activation/Deactivation	Phase A current
	Phase B Block	Phase B Block	Activation/Deactivation	Phase B current
	Phase C Block	Phase C Block	Activation/Deactivation	Phase C current
	Phase Block	Phase Block	Activation/Deactivation	Maximum current
Definite time phase overcurrent				
50_1 **50_2 (*)**	Phase A pick-up	Phase A pick-up	Activation/Deactivation	Phase A current
	Phase B pick-up	Phase B pick-up	Activation/Deactivation	Phase B current
	Phase C pick-up	Phase C pick-up	Activation/Deactivation	Phase C current
	Phase Pick-up	Phase Pick-up	Activation/Deactivation	Maximum current
	Phase A Trip	Phase A Trip	Activation/Deactivation	Phase A current
	Phase B Trip	Phase B Trip	Activation/Deactivation	Phase B current
	Phase C Trip	Phase C Trip	Activation/Deactivation	Phase C current
	Phase Trip	Phase Trip	Activation/Deactivation	Maximum current
Definite time neutral overcurrent				
50G_1 **50G_2 (*)**	Ground Pick-up	Ground Pick-up	Activation/Deactivation	Neutral current
	Ground Trip	Ground Trip	Activation/Deactivation	Neutral current
Inverse time phase overcurrent				
50/51	Phase A pick-up	Phase A pick-up	Activation/Deactivation	Phase A current
	Phase B pick-up	Phase B pick-up	Activation/Deactivation	Phase B current
	Phase C pick-up	Phase C pick-up	Activation/Deactivation	Phase C current
	Phase Pick-up	Phase Pick-up	Activation/Deactivation	Maximum current
	Phase A Trip	Phase A Trip	Activation/Deactivation	Phase A current
	Phase B Trip	Phase B Trip	Activation/Deactivation	Phase B current
	Phase C Trip	Phase C Trip	Activation/Deactivation	Phase C current
	Phase Trip	Phase Trip	Activation/Deactivation	Maximum current
Inverse time neutral overcurrent				
50/51G	Ground Pick-up	Ground Pick-up	Activation/Deactivation	Neutral current
	Ground Trip	Ground Trip	Activation/Deactivation	Neutral current

Thermal Image				
49	Alarm	Alarm	Activation/Deactivation	Thermal Image
	Trip	Trip	Activation/Deactivation	Thermal image
Phase Balance Current (*)				
46	Pick-up	Pick-up	Activation/Deactivation	Negative sequence current
	Trip	Trip	Activation/Deactivation	Negative sequence current
Broken Conductor Detection (*)				
46BC	Pick-up	Pick-up	Activation/Deactivation	I2/I1
	Trip	Trip	Activation/Deactivation	I2/I1
Breaker Failure Supervision (*)				
50BF	Pick-up	Pick-up	Activation/Deactivation	Maximum current
	Trip	Trip	Activation/Deactivation	Maximum current
Instantaneous Phase Undercurrent (*)				
37	Phase A pick-up	Phase A pick-up	Activation/Deactivation	Phase A current
	Phase B pick-up	Phase B pick-up	Activation/Deactivation	Phase B current
	Phase C pick-up	Phase C pick-up	Activation/Deactivation	Phase C current
	Phase Pick-up	Phase Pick-up	Activation/Deactivation	Maximum current
	Phase A Trip	Phase A Trip	Activation/Deactivation	Phase A current
	Phase B Trip	Phase B Trip	Activation/Deactivation	Phase B current
	Phase C Trip	Phase C Trip	Activation/Deactivation	Phase C current
	Phase Trip	Phase Trip	Activation/Deactivation	Maximum current
Phase CT Supervision (*)				
60CTS	Pick-up	Pick-up	Activation/Deactivation	Maximum current
	Alarm	Alarm	Activation/Deactivation	Maximum current

AC Reclosing Device (*)				
79	79 Standby	79 Standby	Activation/Deactivation	-
	79 Reclose Time	79 Reclose Time	Activation/Deactivation	-
	79 Is 52 Open?	79 Is 52 Open?	Activation/Deactivation	-
	79 Hold Time	79 Hold Time	Activation/Deactivation	-
	79 Close Time	79 Close Time	Activation/Deactivation	-
	79 Reset Time	79 Reset Time	Activation/Deactivation	-
	79 Lockout	79 Lockout	Activation/Deactivation	-
	79 Safe Time	79 Safe Time	Activation/Deactivation	-
	79 Manual Open	79 Manual Open	Activation/Deactivation	-
	79 Enabled	79 Enabled	Activation/Deactivation	-

(*) Optional depending on model

A brief description of the general states is given below:

- **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.
- **Measure error**: The self-diagnosis algorithms have detected a problem in the measurement block.
- **Ready**: No errors
- **Setting change**: Activated when the settings are changed.
- **Date-time set**: Activated when the date-time is synchronized.
- **Local communication**: this is the sum of the “HMI activity” and “Local communication” bits from the “Local communication” state group
- **By Default**: the relay is set to default settings and does not execute the trip.

10.5. Disturbance Fault Recording

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, up to 20 fault reports with 16 events in each. 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 pressing “◄” from the standby menu. The next information can be checked:

- Date-time at which the fault started.
- List of all events that occurred in the relay during the fault (trip reason, fault currents, outputs, etc.)

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 last 10 fault reports in COMTRADE format – cyclic recording by FIFO method (with 50 cycles per record – resolution 16 samples/cycle). The first three of these cycles correspond to pre-fault.

The DFR starts when a function pickup happens and the DFR will take place when the trip is finished or when the record is full.

The COMTRADE file is downloaded by communications through the front or rear port using the Modbus protocol. The SICom communications program allows the user to download and save the reports in COMTRADE format (IEEE C37.111-1991).

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 analize 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-faultcycles and analog/digital channels.

The format of a COMTRADE header file can be shown below:

The following additional information is included in the COMTRADE header file (*.hdr): date-time, number, relay identification and a list of all the events that occurred in the relay while COMTRADE file was being generated. Shown below is the format of a COMTRADE header file, generated by the SICom program:

********** .HDR COMTRADE **********

Cycles pre-fault = 3
Total cycles = 50
Analog channels = 4
Digital channels = 32
COMTRADE = 33
Date/Time = 10/23/2018 - 15:47:02.584

The following information is included in each COMTRADE file:

Number	Analog channels
1	Phase A current
2	Phase B current
3	Phase C current
4	Neutral current

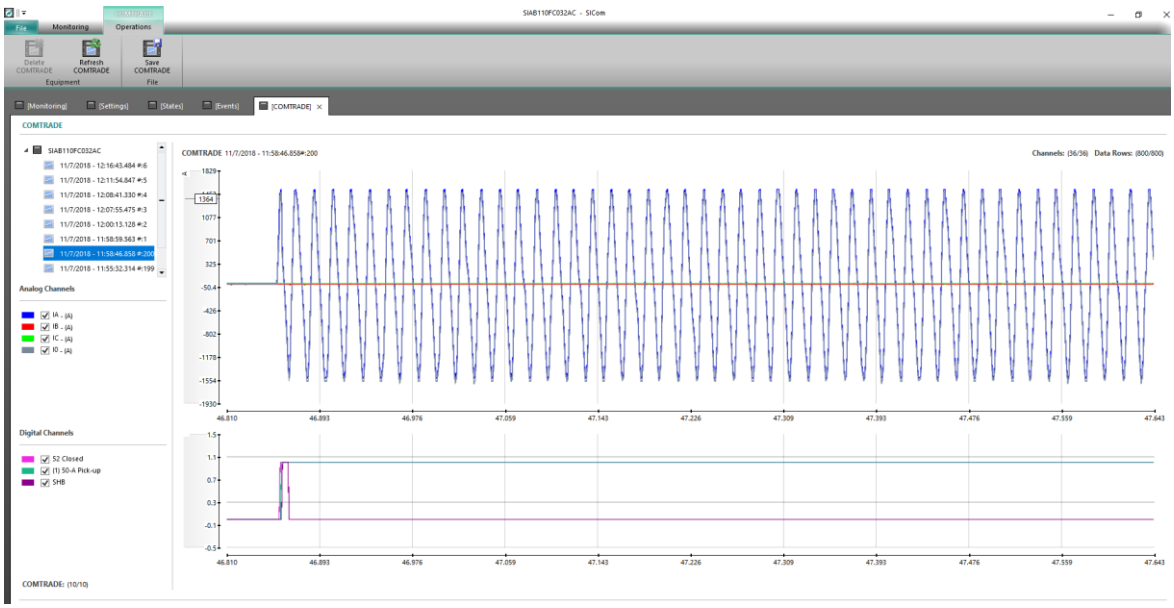
This current is already in primary amps.

As well as the analogue magnitudes, the relay saves 32 digital records, with the same precision as 16 cycle samples. These 32 bits are as follows:

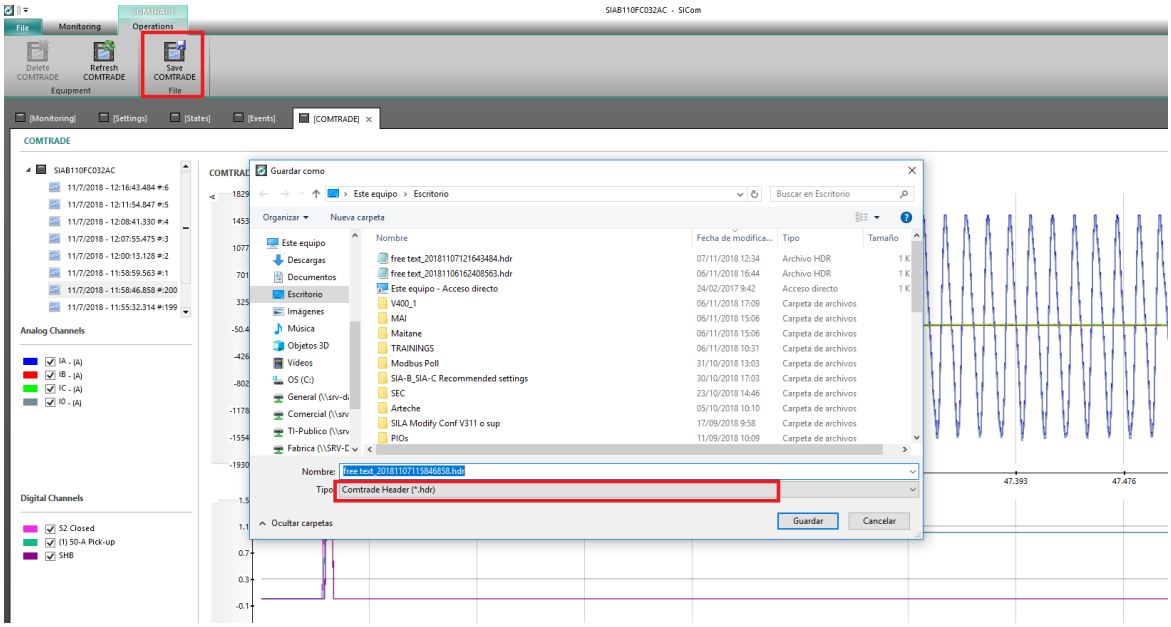
No.	Digital channels
1	SOTF Phase Trip
2	50_1 Phase Trip
3	50G_1 Ground Trip
4	50_2 Phase Trip
5	50G_2 Ground Trip
6	51 Phase Trip
7	51G Ground Trip
8	37 Trip
9	49 Trip
10	46 Trip
11	46BC Trip
12	External Trip
13	General Trip
14	52 Close
15	50_1 Phase Pick-up
16	50_2 Phase Pick-up

No.	Digital channels
17	50G_1 Ground Pick-up
18	50G_2 Ground Pick-up
19	51 Phase Pick-up
20	51G Ground Pick-up
21	37 Pick-up
22	46 Pick-up
23	46BC Pick-up
24	General Phase A Pick-up
25	General Phase B Pick-up
26	General Phase C Pick-up
27	No Trip Power
28	SHB
29	Trip Block Phase Block
30	Output 1
31	Output 2
32	Output 3

It is possible to visualize the COMTRADE file using SICom software:



Using SICom software, it is possible to save the COMTRADE file.



10.6. Self-diagnosis

Diagnostic algorithms are run on device switched on and continuously during operation of the relay. These diagnostics guarantee the correct working of the device, as a preventive process.

The following general considerations apply:

- Communications between different CPUs are confirmed with corresponding integrity checks. Continuing anomalies will lead to the restarting of the device.
- Data constituting settings are confirmed with corresponding checks. Furthermore, all tables of settings are stored in two copies. The relay can work with a corrupted table, but not if both tables are corrupted.
- A Watchdog mechanism exists, both between and within the different main CPUs. Loss of activity in any CPU will lead to the restarting of the device, which will be logged as an event.

The state flag bits associated with this process are as follows:

Ready	It is active when the firmware version doesn't match the hardware model.
Measurement Error	It is active when there is a defect in the hardware.
Error NVM	It is active when there is a problem with the communication between the main CPU and the communication CPU.
Test Menu	It is active when the user enters in the Test Menu.
Curves Error	It is active when there is corrupted data on the settings page of the memory. It is performed on initialization and on each change.
SFLASH Error	It is active when there is corrupted data on the configuration page of the memory. It is performed on initialization and on each change.
Auxiliary power	It is active when the relay is powered by auxiliary power.
Self Power	It is active when the relay is self- powered.
USB Power	It is active when the relay is powered by USB.
Battery Power	It is active when the relay is powered by its internal battery.

There is also a bit on this menu that is active when a factory restoration is applied and generates an event registered on the SER.

By Default	Default settings or configuration are applied.

Diagnostic algorithms are run while the relay is being started up and continuously when the relay is operating. This diagnostic is a preventative process to guarantee that the relay is in good operational condition.

As general considerations:

- Communications between different CPUs are confirmed by the corresponding integrity checking. If continuous anomalies are detected, the relay will be reset.
- Data related to set values are confirmed by the corresponding checking. Likewise, all setting, setting groups are doubled, and the relay has the capability for working with a damaged Setting group, but not with two damaged Setting groups.
- There is a Watchdog device both between and in main CPUs. If any CPU goes out of operation the relay will be reset, and this condition will be identified as an event.

No Trip Power message indicates the relay has not enough energy to trip. This situation is not permanent, and it is solved once the relay achieves the necessary energy to trip thanks to enough time has passed, more current is injected or other auxiliary supply is used.

The other errors are related to the communication of the 2 microprocessors that are included in the relay.

Measurement error event always is generated when the BATTERY key is pressed because when this key is pressed only one of the microprocessors is operative.

If this problem occurs with a model without commissioning battery and appears on the standby screen, the relay should be replaced, and it will be necessary to contact Fanox.

On the other hand, “By Default” means that the relay is operating under factory settings, being all protection functions disabled.

If any of the above cases is detected by the relay, the relay is not ready, and the trip is blocked until the situation is solved.

10.7. Date and Time by Real Time Clock (RTC)

The protection devices require a clock, enabling them to have a date and time stamped for events and registers. This clock is maintained while the internal commissioning battery works (the lifetime of this battery is 20 years).

This clock can be synchronized by any of the two following procedures:

- From the HMI. In this case the date and time can be entered via the keyboard. The relay will store the new event indicating that it has been synchronized.
- Protocol. The behavior is identical to the HMI. The relay will synchronize the date and time, and a new synchronization event is carried out.

10.8. Programmable Logic Control

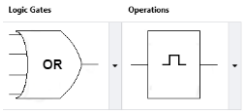
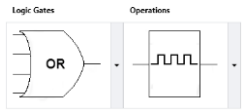
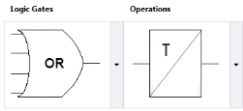
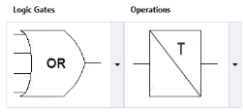
SIA-C relay is provided with up to 7 configurable LEDs. Besides, up to 7 configurable outputs are included.

Logical signals are internal binary states result of the Programmable Logic Control. The logical signal has a specific and defined meaning to be used by the rest functions of the Device.

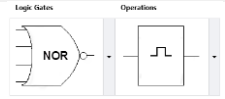
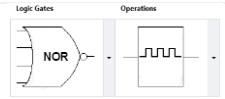
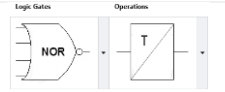
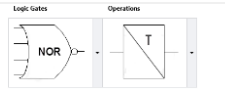
Logical states	Description
Reset TI	Conditions to reset the thermal image
External Trip	49T External Trip
Settings Group 1	Activation Settings group 1
Settings Group 2	Activation Settings group 2
Block 50/51	Function 50 and 51P trip block
Block 50/51/N/G	Function 50N/G and 50/51N/G trip block
Logic Signal 1	Free PGC
Logic Signal 2	Free PGC
Logic Signal 3	Free PGC
52a	Contact 52a of the circuit breaker
52b	Contact 52b of the circuit breaker
79 Start	Start for the recloser function
79 Enable	Condition for the hold enable in recloser function
Hot Line Tag	Conditions to activate the Hot Line Tag. When it is activated, the function 79 is blocked and reclosing is not permitted.

The outputs and LEDs are the result of PROGRAMMABLE LOGIC CONTROL which can be configured from HMI or from SICom software.

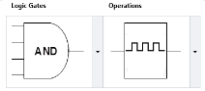
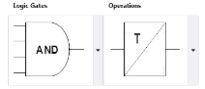
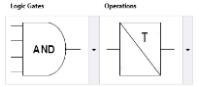
For each output and LED, there is a LOGICAL GATE. It can perform a logical operation up to 4 binary states to obtain other binary results. The PGC the LOGICAL GATES that are supported by SIA-C are:

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)
	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

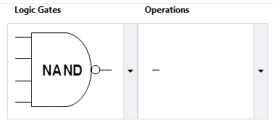
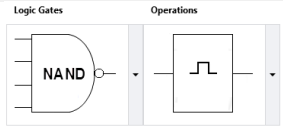
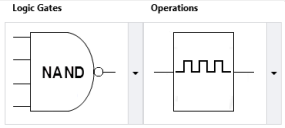
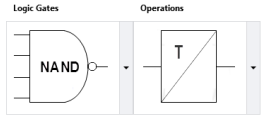
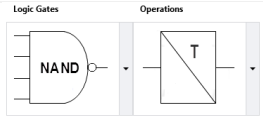
Note: Pulse duration is adjustable between 1 – 1000000 ms (step 1 ms)

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)
	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

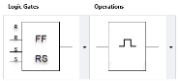
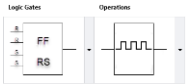
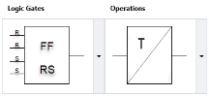
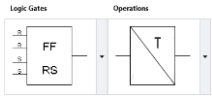
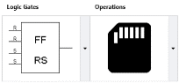
Note: Pulse duration is adjustable between 1 – 1000000 ms (step 1 ms)

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)
	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

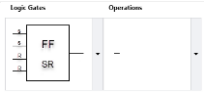
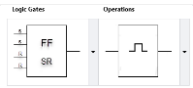
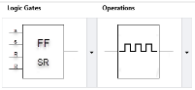
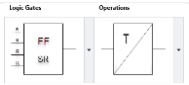
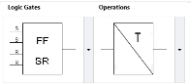
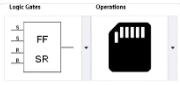
Note: Pulse duration is adjustable between 1 – 1000000 ms (step 1 ms)

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)
	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

Note: Pulse duration is adjustable between 1 – 1000000 ms (step 1 ms)

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)
	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
	NON VOLATIL	Time up: The location in the non-volatile memory where it is saved (adjustable **from 1 to 32, each location must be used only once**)	RSFF 		-

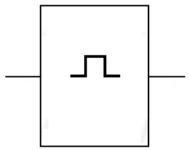
Note: Pulse duration is adjustable between 1 – 1000000 ms (step 1 ms)

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)
	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
	NON VOLATIL	Time up: The location in the non-volatile memory where it is saved (adjustable **from 1 to 32, each location must be used only once)**	SRFF 		-

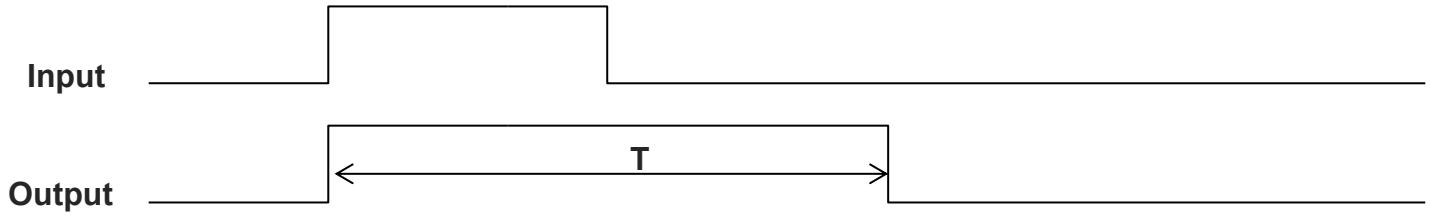
Note: Pulse duration is adjustable between 1 – 1000000 ms (step 1 ms)

10.8.1. Logical gate selection guide

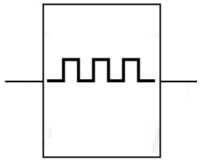
1 PULSE



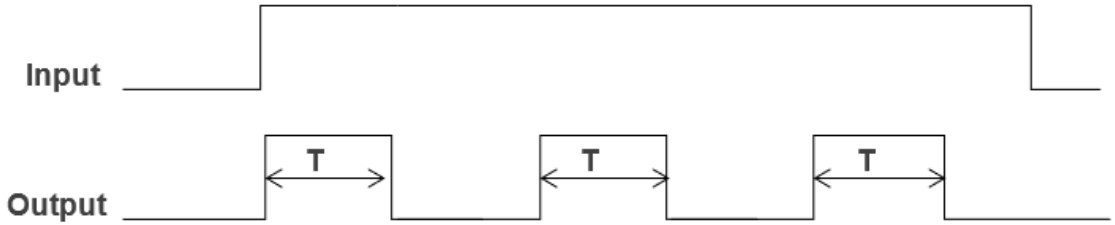
The configured signal will make a pulse of the adjusted time in “pulse duration” parameter once the input signal is activated.



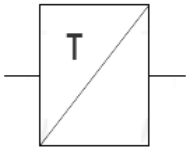
PULSES (Same time on and time off)



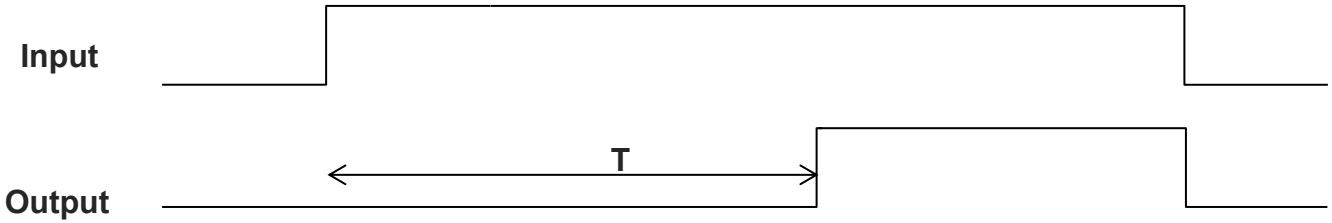
The configured signal will make pulses of the adjusted time in “pulse duration” parameter while the input signal is activated.



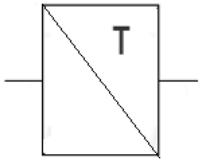
TIMER UP



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

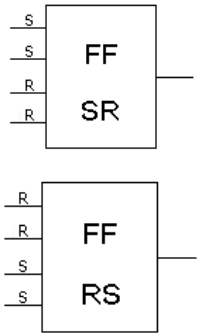


TIMER DOWN

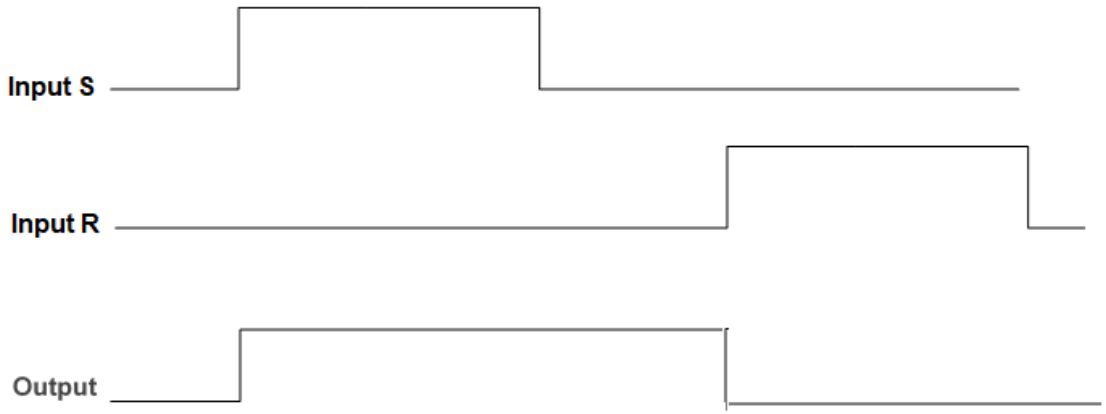


Once the configured signal is activated, it waits the adjusted time in “pulse duration” parameter to deactivate itself.

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.



Function 86 (latch condition) can be implemented through signaling outputs configuration. It is necessary to configure one of the signaling outputs as trip output and after this configuration if RSFF or SRFF is chosen the latch of this output is permitted. **In case the relay is pure self-powered** (without auxiliary voltage), the relay is switched off after the trip, so the LATCH options are only applicable if the logic is saved in the non-volatile memory.

By default, the logic configuration is:

	OUTPUT	*LOGICAL GATE*	BINARY STATES
LOGIC	Reset TI	*OR4*	• HMI Reset TI • USB COM Reset TI • Modbus RTU Reset TI
	External Trip	*Not configured*	----
	Settings Group 1	*Not configured*	----
	Settings Group 2	*Not configured*	----
	Block 50/51	*Not configured*	----
	Block 50/51/N/G	*Not configured*	----
	Logic Signal 1	*Not configured*	----
	Logic Signal 2	*Not configured*	----
	Logic Signal 3	*Not configured*	----
	52a	*Not configured*	----
	52b	*Not configured*	----
	79 Start	*OR4*	• General Trip
	79 Enable	*Not configured*	----
	Hot Line Tag	*Not configured*	----

10.8.2. Digital Inputs

The SIA-C is provided with 4 or 10 digital inputs (depending on model) that can be configured by the user from the HMI or by using the SICom program.

Model	Configurable Inputs
SIACxxxxxx2xxx and SIACxxxxxx3xxx	4 configurable inputs
SIACxxxxxx4xxx	10 configurable inputs

The current to activate the inputs is the same as to self-power the relay.

Activated by short circuiting the terminals (without auxiliary voltage).

10.8.3. Digital Outputs

Additionally to the trip output(s), the SIA-C relay is provided with up to 7 configurable outputs that can be set by the user. The outputs can be configured from the HMI or through the SICom software.

Model	Configurable outputs
SIACxxxxxx2xxx	4 configurable outputs
SIACxxxxxx3xxx	2 configurable outputs
SIACxxxxxx4xxx	7 configurable outputs

Trip outputs are partially configurable, this is, Operation and Pulse Duration parameters can't be configured, they are set by default to a pulse of 50ms. Criteria, States and Logic Gate can be modified by Sicom software, as modification is not available from the HMI.

By default, the configuration is as follows:

- Trip Output 1: it is activated if there is a general trip or an open breaker command is done.
- Output 2/Trip Output 2(*): it is activated if there is a general trip or an open breaker command is done.
- Output 3/Trip Output 3(*): it is activated if there is a general trip or an open breaker command is done.
- Output 4: it is activated if the 79 closing time starts or a close breaker command is done.
- Output 5: it is activated if the relay is not ready.

(*) Depending on the model it can be a binary output or a trip output.

SIACxxxxxx2xxx: 1 trip output + 4 Outputs + 4 Inputs

	OUTPUT	*LOGICAL GATE*	BINARY STATES
PHYSICAL OUTPUTS	Trip Output 1	*OR4_PULSES*	• General Trip • HMI Open Breaker • USB COM Open Breaker • Modbus RTU Open Breaker
	Output 2	*OR4_PULSES*	• General Trip • HMI Open Breaker • USB COM Open Breaker • Modbus RTU Open Breaker
	Output 3	*OR4_PULSES*	• General Trip • HMI Open Breaker • USB COM Open Breaker • Modbus RTU Open Breaker
	Output 4	*OR4_PULSES*	• 79 Close Time • HMI Close Breaker • USB COM Close Breaker • Modbus RTU Close Breaker
	Output 5	*NOR4*	• Self Diagnostic Ready

SIACxxxxxx3xxx: 3 trip outputs + 2 Outputs + 4 Inputs

	OUTPUT	*LOGICAL GATE*	BINARY STATES
PHYSICAL OUTPUTS	Trip Output 1	*OR4_PULSES*	• General Trip • HMI Open Breaker • USB COM Open Breaker • Modbus RTU Open Breaker
	Trip Output 2	*OR4_PULSES*	• General Trip • HMI Open Breaker • USB COM Open Breaker • Modbus RTU Open Breaker
	Trip Output 3	*OR4_PULSES*	• General Trip • HMI Open Breaker • USB COM Open Breaker • Modbus RTU Open Breaker
	Output 4	*OR4_PULSES*	• 79 Close Time • HMI Close Breaker • USB COM Close Breaker • Modbus RTU Close Breaker
	Output 5	*NOR4*	• Self Diagnostic Ready

SIACxxxxxx4xxx: 7 Outputs + 10 Inputs

	OUTPUT	*LOGICAL GATE*	BINARY STATES
PHYSICAL OUTPUTS	Trip Output 1	*OR4_PULSES*	• General Trip • HMI Open Breaker • USB COM Open Breaker • Modbus RTU Open Breaker
	Output 2	*OR4_PULSES*	• General Trip • HMI Open Breaker • USB COM Open Breaker • Modbus RTU Open Breaker
	Output 3	*OR4_PULSES*	• General Trip • HMI Open Breaker • USB COM Open Breaker • Modbus RTU Open Breaker
	Output 4	*OR4_PULSES*	• 79 Close Time • HMI Close Breaker • USB COM Close Breaker • Modbus RTU Close Breaker
	Output 5	*NOR4*	• Self Diagnostic Ready
	Output 6	*Not configured*	
	Output 7	*Not configured*	
	Output 8	*Not configured*	

Checking the configuration of the outputs can be done either through Sicom software or through the HMI.

To get the activation of the outputs, the sum of the current in all the phases must be at least:

- Trip Outputs: minimum self-powering level.
- Outputs 2, 3 and 4: Sum of the phases 360 mA
- Output 5: Sum of the phases 520mA
- Rest of the outputs: Auxiliary supply or USB

10.8.4. Leds

The device is equipped with 7 LEDs. Depending on the model, LEDs from 5 to 7 are configurable (SIACxxxxxx2xxx and SIACxxxxxx4xxx) or not (SIACxxxxxx3xxx).

By default, the configuration is:

	OUTPUT	*LOGICAL GATE*	BINARY STATES
LEDS	LED 1	*Not configured*	• ----
	LED 2	*Not configured*	• ----
	LED 3	*Not configured*	• ----
	LED 4	*Not configured*	• ----
	LED 5 (*)	*OR4*	• Self Diagnostic Ready
	LED 6 (*)	*SRFF*	• Set: General Trip • Reset: HMI Reset Key
	LED 7 (*)	*OR4*	• General Pickup

(*) Not configurable in model SIACxxxxxx3xxx (3 trip outputs).

The current to activate the LEDs is the same as to self-power the relay.

10.9. Commands

By HMI or by communications, depending on model is possible to:

- Open Breaker
- Close Breaker
- Block 79
- Unblock 79
- Local control
- Remote control
- Reset
- Reset Thermal Image

When Open Breaker command is performed, the trip output is activated (originating the corresponding event) and the message “trip general” will be displayed on main screen.

10.10. Test Menu

The SIA-C relay has a test menu that can be used to check the operation of the signaling components and the outputs. It is important to point out that the operation of the outputs does not work if the test is performed with the commissioning battery.

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.

✋**NOTE**: When performing the test menu, the protection will not be available, and it will be possible to open the circuit breaker. Only authorized personnel can do this job.
To obtain more detailed information, the method for navigating the menus is explained graphically in the keypad and display section.

10.11. Power supply

The SIA-C relay is designed to be self-powered using the cell current. Besides, depending on mode, it is possible to select, apart from self-powering, an auxiliary supply (24-230 Vdc/Vac (Dual).

It can also be supplied through a USB cable which goes directly to the PC. The USB is plugged into the front communications port. Using USB cable for power supply does not inhibit the USB communications port, as it can be used simultaneously.

10.11.1. Self-Powering

The SIA-C powers itself from the operating current through standard current transformers that are connected to the line. Self-powering is achieved with very low levels of current: a minimum of 0.075xIn three phase current or 0.16xIn one phase.
The relay is maintenance free when this type of power supply is used, as it does not require auxiliary power components (batteries). As a result, it is especially useful in any centers where auxiliary power is not available or cannot be guaranteed, and the facilities require protection with low levels of current.

There is a self-power transformer per phase (3 self-power transformers), separating current circuits completely.

10.11.2. 24-230 Vac, 50/60 Hz auxiliary power

The 24-230 Vac (±15%) auxiliary powers are taken from the transformation center secondary voltage. If this option is required, this needs to be selected in the list of models.
It is normal for transformation substations to have auxiliary voltage. This voltage is not guaranteed because a short-circuit may cause this auxiliary voltage loss. However, the complete auxiliary voltage loss is produced in primary faults between phases, which are very unlikely and generate a lot of current. In other words, for faults with low contribution of current, AC auxiliary voltage keeps its level and supplies the relay and for faults with auxiliary voltage sag and high contribution of current, the self-powering characteristic keeps the relay operative. The continuous operation of SIA-C is guaranteed with the levels of self-powering (0.075xIn three phase current or 0.16xIn one phase) and the auxiliary power supply 24-230Vac.

10.11.3. 24-220 Vdc auxiliary power supply

The 24-220 Vdc (±20%) auxiliary power is taken from the transformation center RTU power supply. Therefore, the relay can be powered all the time, allowing it to be continually monitored (status, measurements of transformation center current, events…). The relay is totally operational at this power and if a fault occurs, the trip time matches the time setting. In a situation where the center is deenergized, if this is energized and a fault induced with the instantaneous function set at 20 ms, the trip time will be 20 ms.

10.11.4. Supply through the front USB port

A USB cable connected directly to the PC can be used to power the relay up. The USB cable is plugged into the front communications port. Using USB cable for power supply does not inhibit the USB communications port, as it can be used simultaneously.

A power bank can be also connected to the front port to switch the relay on.

It is useful for cases like commissioning operations, discharges and repairs to the transformation center, as these are situations when there is no auxiliary voltage or current in the line and they normally cause more events, grounding, forgotten tools, bad terminations, etc.
The possibility of using this power supply together with the possibility of activating the trip contact from the test menu allows the trip circuit to be tested before the transformation center is powered up.

10.11.5. Commissioning battery

A specific key is available in the front part of the relay.

Pressing this key, it is possible to switch the relay on and navigate through the different menus. Thanks to this option, the user can check all the information recorded during the fault. This is, checking the events and the fault reports is possible, and this action allows the user to know all the information regarding the fault situation.

The working of the relay is independent from the internal battery. This battery is just an accessory that allows the user to set the relay and to analyze the information recorded in fault reports and events menus, but it does not take part on the main working of the relay.

Once you press the Battery key, the relay is switched on for 15 seconds if no key is pressed.
If the relay is powered with other types of supply, pressing the battery key has not any effect in the relay.

If the relay is switched on by pressing battery key and then other power supply is connected to the relay, the relay considers automatically the new power supply.

When this key is pressed an event called “battery” and an event of Measure Error is generated. This last event is originated because, once this key is pressed, only one microprocessor is activated and there is no communication between the microprocessors.

The internal battery model is LS14500 from SAFT and its lifetime is 20 years.

It is not possible to use rechargeable batteries or other types of battery.

If there is any issue with this type of supply, as the lifetime is 20 years, it is probable other investigations will be carried out, so in this case, please, contact Fanox.

Although the end user shall not access the battery or replace it, in the following section, the procedure is explained.

The internal battery model is LS14500 from SAFT and its lifetime is 20 years.

It is not possible to use rechargeable batteries or other types of battery.

If there is any issue with this type of supply, as the lifetime is 20 years, it is probable other investigations will be carried out, so in this case, please, contact Fanox.

Although the end user will not need to access the battery or replace it, in the following section, the procedure is explained.

How to change the internal battery

1. Disconnect the relay. Switch the power supply off to avoid any dangerous situation.
2. Unscrew the 4 screws on the front of the relay to extract it from the RMU.
3. Access to the side of the relay.

4. Unscrew the 2 screws to remove the cover from the battery compartment.

5. Remove the battery and replace it respecting polarity (+ facing up):

Battery characteristics:

- AA 3.6V lithium battery
- Model LS14500 from SAFT
- Do not use rechargeable batteries or other types of battery

6. Put on the battery cover and tighten the 2 screws.

7. Put the relay into the RMU again and tighten the 4 screws on the front to fix the relay.

CAUTION – Risk of fire if battery is replaced with incorrect type or polarity. Dispose of used batteries according to instructions.

HAZARD OF EXPLOSION

- Do not recharge the battery.
- Do not short circuit the battery.
- Do not crush the battery.
- Do not disassemble the battery.
- Do not heat the battery above 100ºC (212ºF)
- Do not throw the battery into fire or water.

Failure to follow these instructions can result in death, serious injury, or relay damage.

10.12. Opening mechanism: STRIKER

Polarized: The trip is associated to a striker. The type of trip is a polarized trip, this is, the trip is associated to a striker. There are a lot of models of strikers in the market, with different trip energies, being for example 50 mJ (0.05W·s) and operation voltage of 6V, or 135 mJ (0.1W·s) and operation voltage of 24V.

The opening mechanism is activated by means of a striker. The activation of the trip generates a pulse train.

The **Trip Voltage Level** setting allows adjusting the trip voltage level required by the selected striker. The default value is 17 Vdc, although there are several options:

- 12 Vdc
- 17 Vdc
- 22 Vdc
- 24 Vdc

The relay will allow the trip when it gets the selected trip voltage, so if a lower level that the required by the striker is adjusted, it may result on tripping without enough energy and not activating the striker.

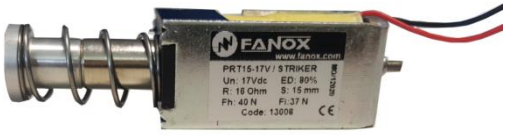
On the other hand, if a higher level that the required by the striker is selected, the activation of the striker is guaranteed, however, the fault trip time during start-up may be increased. Fanox encourages selecting the correct value of this critical setting and offers its expertise at any doubt.

The activation of the SIA-C trip output means that a capacitor has discharged on the output terminals. This discharge of energy is enough to activate a striker that mechanically acts on a mechanism to open the current circuit. The striker is connected directly to the SIA-C output, which supplies enough power to activate it (24 Vdc – 135mJ).

The striker is a bistable device with simple action. The striker shaft is moved by a spring. The striker is activated by a polarized low-power electrical signal, supplied by the relay if a fault occurs. Resetting the shaft to its position is done manually. Resetting the striker has to be done in such a way as to guarantee that the opening mechanism is closed. This is normally done manually.

As an example, the characteristics of the striker on the above image are next:

- Travel: 8mm
- Strength of the spring:
    - Start of travel: .....37 N
    - End of travel: .....18 N
- Response time: .....4 ms
- Level of protection: IP-40



Nominal voltage (Un)	17 Vdc
Travel	15 mm
Magnetic Retention Force (Frm)	72 N
Initial Force (Fi)	37 N
Final Force (Fh)	17 N
Useful magnetic Force	35 N
Isolation class	Y
Cycles at Un (ED)	80%
Resistance at 20ºC	16 Ohm
Protection class	IP00

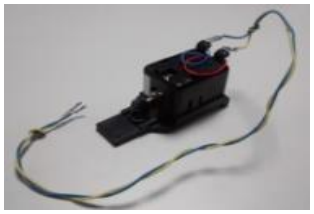
The Fanox SIA-C relay is able to trip different strikers existing in the market. Below some examples are listed:

LUCY ELECTRIC

SEL

SIEMENS

SCHNEIDER ELECTRIC (MITOP)



Due to the existing variety in the market, it is important to check the voltage and the necessary energy for its activation.

If you have any doubt, please contact with Fanox.

11. TECHNICAL SPECIFICATIONS AND STANDARDS

11.1. Technical Specifications

Function 50-1 **Function 50-2 (*)**	Function Enable: No/Alarm/Trip/SHB
	Current Tap: 0.05 to 30.00 xIn (step 0.01 xIn)
	Time Delay: 0.000 to 300.000 s (step 0.001 s)
	Activation level: 100%
	Deactivation level: 95%
	Temporized deactivation (phase reset time setting)
	Timing accuracy: Without SHB permitted: ± 30 ms or ± 0.5% (greater of both). With SHB permitted: ± 50 ms or ± 0.5% (greater of both).
Function 50G-1 **Function 50G-2 (*)**	Function Enable: No/Alarm/Trip/SHB
	Current Tap: 0.002 to 10.00 xIn (step 0.01 xIn)
	Time Delay: 0.000 to 300.000 s (step 0.001 s)
	Activation level: 100%
	Deactivation level: 95%
	Temporized deactivation (neutral reset time setting)
	Timing accuracy: Without SHB permitted: ± 30 ms or ± 0.5% (greater of both). With SHB permitted: ± 50 ms or ± 0.5% (greater of both).
Function 51	Function Enable: No/Alarm/Trip/SHB
	Curve Type: IEC 60255-151, IEEE and CO curves. IEC (Definite time, standard inverse, very inverse, extremely inverse, long time inverse, short time inverse) and IEEE (Moderately inverse, very inverse, extremely inverse) and CO (CO_P20, CO_P40, CO8). User defined curves (curve 1, curve 2, curve 3, curve 4) Time Delay: 0.000 to 300.000 s (step 0.001 s)
	Time Dial (TMS): 0.01 to 2 (step 0.01)
	Current Tap: 0.05 to 20.00 xIn (step 0.01 xIn)
	Curve, current activation level: 110%
	Curve, current deactivation level: 100%
	Defined time, current activation level: 100%
	Defined time, current deactivation level: 95%
	Temporized deactivation (phase reset time setting)
	Timing accuracy for IEC, IEEE and CO curve selection: Without SHB permitted: ± 30 ms or ± 5% (greater of both). With SHB permitted: ± 50 ms or ± 5% (greater of both). Timing accuracy for defined time selection: Without SHB permitted: ± 30 ms or ± 0.5% (greater of both). With SHB permitted: ± 50 ms or ± 0.5% (greater of both).
Function 51G	Function Enable: No/Alarm/Trip/SHB
	Curve Type: IEC 60255-151, IEEE and CO curves. IEC (Definite time, standard inverse, very inverse, extremely inverse, long time inverse, short time inverse) and IEEE (Moderately inverse, very inverse, extremely inverse) and CO (CO_P20, CO_P40, CO8). User defined curves (curve 1, curve 2, curve 3, curve 4) Time Delay: 0.000 to 300.000 s (step 0.001 s)
	Time Dial (TMS): 0.01 to 2 (step 0.01)
	Current Tap: 0.002 to 10.00 xIn (step 0.01 xIn)
	Curve, current activation level: 110%
	Curve, current deactivation level: 100%

	Defined time, current activation level: 100%
	Defined time, current deactivation level: 95%
	Temporized deactivation (neutral reset time setting)
	Timing accuracy for IEC, IEEE and CO curve selection: Without SHB permitted: ± 30 ms or ± 5% (greater of both). With SHB permitted: ± 50 ms or ± 5% (greater of both). Timing accuracy for defined time selection: Without SHB permitted: ± 30 ms or ± 0.5% (greater of both). With SHB permitted: ± 50 ms or ± 0.5% (greater of both).
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: 0.05 to 30.00 xIn (step 0.01 xIn)
	Activation level: 100%
	Deactivation level: 95%
	Temporized deactivation
Function SOTF	Function Enable: No/Yes
	Current Tap: 0.05 to 30.00 xIn (step 0.01 xIn)
	Safe time: 0.001 to 5.000 (step 0.001 s)
	Activation level: 100%
	Deactivation level: 95%
Function 49T	External trip by means of configurable inputs. Activated by short circuiting the terminals (without auxiliary voltage)
Function 49	Function enable: No/Yes
	Current tap: 0.10 to 2.40 In (step 0.01xIn)
	ζ heating: 3 to 600 min (step 1 min)
	ζ cooling: 1 to 6 x ζ 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 CLP	Function Enable: No/Yes
	Settings groups: 1 to 4 (step 1)
	No load Time: 0.020 to 300.000 s (step 0.001 s)
	Cold load Time: 0.020 to 300.000 s (step 0.001 s)
	Open breaker activation 6% In and reset threshold: 8% In
Function 52	Maximum number of openings: 1 to 10.000 (step 1)
	Maximum accumulated amperes: 0 to 100.000 (M(A²)) (step 1)
	Opening time: 0.001 to 5.000 s (step 0.001 s)
	Closing time: 0.001 to 5.000 s (step 0.001 s)
	Excessive repeated openings: 1 to 10.000 (step 1)
	Repetitive openings/Time: 1 to 300 min (step 1 min)
	Open breaker activation and reset threshold: 6% In
Function 79 (*)	Function Enable: No/Yes
	Hold Enable: No/Yes/No Time
	Number of recloses: 1 to 5 (step 1)
	Reclose time 1, 2, 3, 4, 5: 0.002 to 300.000 s (step 0.001 s)
	Hold time: 0.002 to 300.000 s (step 0.001 s)
	Reset time: 0.002 to 300.000 s (step 0.001 s)
	Safe time: 0.002 to 300.000 s (step 0.001 s)
	Locking possibilities: inputs, commands.
	Function Enable: No/Yes

Function TB (*)	Tap: 1.50 to 30.00 xIn (step 0.01 xIn)
Function 46 (*)	Function Enable: No/Alarm/Trip/SHB
	Curve Type: IEC 60255-151, IEEE and CO curves. IEC (Definite time, standard inverse, very inverse, extremely inverse, long time inverse, short time inverse), IEEE (Moderately inverse, very inverse, extremely inverse) and CO (CO_P20, CO_P40, CO8). User defined curves (curve 1, curve 2, curve 3, curve 4) Time Delay: 0.000 to 300.000 s (step 0.001 s)
	Time Dial (TMS): 0.01 to 2 (step 0.01)
	Current Tap: 0.05 to 20.00 xIn (step 0.01 xIn)
	Curve, current activation level: 110%
	Curve, current deactivation level: 100%
	Defined time, current activation level: 100%
	Defined time, current deactivation level: 95%
	Temporized deactivation (phase reset time setting)
	Timing accuracy for IEC, IEEE and CO curve selection: Without SHB permitted: ± 30 ms or ± 5% (greater of both). With SHB permitted: ± 50 ms or ± 5% (greater of both). Timing accuracy for defined time selection: Without SHB permitted: ± 30 ms or ± 0.5% (greater of both). With SHB permitted: ± 50 ms or ± 0.5% (greater of both).
Function 46BC (*)	Function enable: No/Yes
	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%
	Temporized deactivation (phase reset time setting)
Function 37 (*)	Function Enable: No/Alarm/Trip
	Current tap: 0.05 to 30.00 xIn (step 0.01 xIn)
	Minimum Level: 0.00 to 1.00 xIn (step 0.01 xIn)
	Time delay: 0.060 to 300.000 s (step 0.001 s)
	Activation level: 100%
	Deactivation level: 105%
	Temporized deactivation
	Timing accuracy: ±30 ms or ±0.5% (greater of both)
Function 60CTS (*)	Function enable: No/Yes
	Time delay: 0.020 to 300.000 s (step 0.001 s)
	Open breaker activation 6% and reset threshold.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: 6% In
Function 74TVS	Trip Voltage level: 12, 17. 22 or 24 Vdc
Programmable logic control (PGC)	OR4, OR4_LATCH, OR4_PULSES, OR4_TIMERUP, OR4_PULSE, NOR4, NOR4_TIMERUP, NOR4_PULSE, NOR4_PULSES, AND4, AND4_PULSES, AND4_TIMERUP, AND4_PULSE, AND4_LATCH, NAND4, NAND4_TIMERUP, NAND4_PULSE
Settings tables	4 settings groups
	Selectable by input or general setting.
SER	1024 events
	16 samples/cycle

Disturbance fault recording (DFR)	4 analog channels and 32 digital channels
	20 fault reports, 16 events in each. 10 disturbance records in COMTRADE format (50 cycles each).
	COMTRADE IEEE C37.111-1991
Load Data Profiling (LDP)	Demand of current with the following characteristics: - Number of records: 168 - Recording mode circular - Sampling rate (interval): configurable through communications (1-60 min)
Trip output	24 Vdc; 135 mJ (activation of the striker or low-powered coil) Depending on the model, a single-phase trip or single/triple-phase trip is available by means of a switch.
Outputs (*)	Up to 7 configurable outputs: Up to 3 NO-NC outputs Up to 4 NO outputs 250 Vac – 5 A 30 Vdc – 5 A
Inputs (*)	Up to 10 configurable inputs: they are activated by short-circuiting the terminals without external supply. Any of them can be configured for the external trip.
Current measurements	Fundamental values (DFT)
	Sampling: 16 samples/cycle
	±2% in a band of ± 20% the nominal current and ±4% or ± 5 mA in the rest of the band. In case the current is between 0.002 to 0.0125 times the nominal current the accuracy will be 0.5mA.
	Phase measurement range: 0.02 to 30 times the nominal current Neutral measurement range: 0.002 to 16 times the nominal current
Communications	Local port (micro USB): Modbus RTU
	RS485 rear port: Modbus RTU (*)
	RS485 rear port: Modbus RTU, IEC60870-5-103 or DNP3.0 Serial (**)
	Ethernet (RJ45): Modbus TCP (*)
Self-powering from current	Three-phase self-powering level: 0.075xIn CT /1→> 75 mA CT/5→I > 375 mA
Power supply (*)	24-230 Vac/Vdc (Vdc (±20%) / Vac (±15%))
Battery Supply	Commissioning internal battery
Transformers	Power supply and measurement with standard CTs /1 or CTs /5
Energizing Quantities	Burden of current inputs: ≤2.5 VA (for 1 A and 5 A) Burden of power supply unit VDC: Max. 5 W VAC: Max. 10 VAs
Environmental conditions	Operating temperature: -40 to 70ºC
	Storage temperature: -40 to 80ºC
	Relative humidity: 95%
Mechanical characteristics	Metallic box
	Panel mounted
	Non-withdrawable models: Vertical model:177 x 155 x 171.22 (mm) Withdrawable model: 177 x 155 x 185.17 (mm)
	Weight: 3.5 kg
	IP-54 panel mounted (mechanics G and H) IP-40 panel mounted (mechanics F)

(*) Optional depending on the model

11.2. Standards

TEST	TEST STANDARD	LEVEL
1. DIELECTRIC TESTS		
1.1. Impulse voltage	IEC60255-27 Clause 10.6.4.2	5 kV 1 kV
1.2. Dielectric voltage	IEC60255-27 Clause 10.6.4.3	2 kV 0,5 kV
1.3. Insulation resistance	IEC60255-27 Clause 10.6.4.4	500 VDC
2. ELECTROMAGNETIC COMPATIBILITY (EMC) tests		
2.1. EMISSION		
2.1.1. Radiated emission	IEC 60255-26 CISPR11 CISPR22 table 1 table 6 table 7	class A class A
2.1.2. Conducted emission	IEC 60255-26 CISPR22 table 2 table 2/4	class A
2.2. IMMUNITY		
2.2.1. Slow damped oscillatory wave (1 MHz)	IEC 60255-26 (IEC 61000-4-18) Clause 7.2.6	2,5 kV CM 1,0 kV DM 1 kV CM 0 kV DM
2.2.2. Electrostatic discharges	IEC 60255-26 (IEC 61000-4-2) Clause 7.2.3	6 kV cont. 8 kV air
2.2.3. Radiated radio frequency magnetic field	IEC 60255-26 (IEC 61000-4-3) Clause 7.2.4	80 - 1000 MHz 10 V/m 1,4 – 2,7 GHz 10 V/m 80, 160, 380, 450, 900, 1850, 2150 MHz 10 V/m
2.2.4. Fast transient/burst	IEC 60255-26 (IEC 61000-4-4) Clause 7.2.5	☒ Zone A 4 kV CM 2 kV CM ☐ Zone B 2 kV CM 1 kV CM
2.2.5. Surge	IEC 60255-26 (IEC 61000-4-5) Clause 7.2.7	☒ Zone A to 4 kV LE to 2 kV LL ☐ Zone B to 2 kV LE to 1 kV LL
2.2.6. Conducted disturbance induced by RF fields	IEC 60255-26 (IEC 61000-4-6) Clause 7.2.8	0,15 - 80 MHz 10 V 27, 68 MHz 10 V

2.2.7. Power frequency voltage (50 Hz)	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 (50 Hz)	IEC 60255-26 (IEC 61000-4-8) Clause 7.2.10	30 A/m cont. 300 A/m 1-3 s
2.2.9. D.C. Voltage dips	IEC 60255-26 (IEC 61000-4-29) Clause 7.2.11	100%; 10-1000 ms 60%; 200 ms 30%; 500 ms
2.2.10. A.C. voltage dips	IEC 60255-26 (IEC 61000-4-11) Clause 7.2.11	100%; 0,5 – 25 c. 60%; 10/12 c. 30%; 25/30 c.
2.2.11. D.C. voltage interruptions	IEC 60255-26 (IEC 61000-4-29) Clause 7.2.11	100%; 5s
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% Ut_dc 100/120 Hz
2.2.14. D.C gradual shut-down/start-up	IEC 60255-26 Clause 7.2.13	Shut-down ramp 60 s 5 min off Start-up ramp 60 s
2.2.15. Damped oscillatory magnetic field (100 kHz and 1 MHz)	IEC 61000-4-10	☒ Zone A 100 A/m (peak) ☐ Zone B 30 A/m (peak)
2.2.16. Pulse magnetic field	IEC 61000-4-9	1000 A/m
3. MECHANICAL ENVIRONMENTAL CONDITIONS		
3.1. Vibration response	IEC 60255-1 (IEC 60255-21-1) Clause 6.13.1	class 1
3.2. Vibration endurance	IEC 60255-1 (IEC 60255-21-1) Clause 6.13.1	class 1
3.3. Shock response	IEC 60255-1 (IEC 60255-21-2) Clause 6.13.2	class 1
3.4. Shock withstand	IEC 60255-1 (IEC 60255-21-2) Clause 6.13.2	class 1
3.5. Bump	IEC 60255-1 (IEC 60255-21-2) Clause 6.13.2	class 1
3.6. Seismic (single axis sweep)	IEC 60255-1 (IEC 60255-21-3) Clause 6.13.3	class 1
4. CLIMATIC ENVAIRONMENTAL CONDITIONS		
4.1. Dry heat operational	IEC 60255-1 (IEC 60068-2-2, test Bd) Clause 6.12.3.1	+70°C; 72h

4.2. Cold operational	IEC 60255-1 (IEC 60068-2-1, test Ad) Clause 6.12.3.2	-40°C; 72h
4.3. Dry heat storage	IEC 60255-1 (IEC 60068-2-2, test Bb) Clause 6.12.3.3	+80°C; 72h
4.4. Cold storage	IEC 60255-1 (IEC 60068-2-1, test Ab) Clause 6.12.3.4	-40°C; 72h
4.5. 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
4.6. Damp heat, steady state	IEC 60255-1 (IEC 60068-2-78, test Cab) Clause 6.12.3.6	+40°C; 93% 10 days
4.7. 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

11.3. Thermal resistance

- 4xIn continuously.
- 30 x In for 10 seconds.
- 100 x In for 1second.

12. COMMUNICATION AND HMI

12.1. Front Communication: USB

One communication port is installed on the front of the relay. The connector that is used is a micro USB. The protocol that is used is Modbus RTU (19200 -8bit – no parity – 1 stop bit). The protocol map and documentation that are used are attached in an appendix to this manual.
To write commands it is necessary to set up a communication session (identification command) which it will be closed after a period of time without communication. To set up a communication session it will be necessary a password. To write commands the password will be adjusSetting group.

To be able to use the local communication, it is necessary to put the relay in local mode. For this purpose, execute the command “local control”. By default, the relay is in local mode.

12.2. Rear communication

To be able to use the rear communication, it is necessary to put the relay in remote mode. For this purpose, execute the command “remote control”.

Rear Serial Port (RS485) for Modbus RTU, IEC60870-5-103 or DNP3.0 serial

There is one RS485 port for Modbus RTU protocol (Upcoming: IEC60870-5-103 or DNP3.0 serial protocols). The RS485 port output has two terminals (+,-), located on the rear of the relay.

This port can be used to continuously monitor the relay from a remote PC or SCADA system. Up to 32 relays can be connected to one bus: each device with a different Modbus address. The relay Modbus address can be configured using the SICom software.

To minimize communication errors as a result of noise, the use of a stranded and shielded cable is recommended for the physical connection. All of the + terminals on one side, and all of the - terminals on the other must be connected together in order to make the connection.

Resisters 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 minimum required current to achieve remote communication: 480mA as the sum of the phases or 390mA on one phase.

With one Rear Ethernet Port (RJ45) port for Modbus TCP/IP

In this case there is one RJ45 port for Modbus TCP/IP protocol.

Auxiliary power is needed to activate the RJ45 port.

12.3. LED indicators

The SIA-C front panel is provided with 7 configurable LED pilot that by default show:

LEDS	DEFAULT CONFIGURATION
Led 1	Not configured
Led 2	Not configured
Led 3	Not configured
Led 4	Not configured
Led 5	Ready
Led 6	Trip
Led 7	Pickup

Some situations can occur that involve the activation of different LEDs, this is, there can be more than one led activated at the same moment. It is possible to verify the correct running of the LEDs via test menu.

12.4. LCD and keypad

The front of the SIA-C 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, state and events. All the information is organized 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 keyboard is provided with 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, leds and outputs are reset (if they are activated and the reason of their activation is clear) and the key can also be used to delete all of the events from the "Events" menu and fault reports, from "Faults" menu.

Minimum required current to have backlight LCD, the sum of the current in all the phases should be at least 470 mA. If only one phase is used, 470 mA should be injected.

12.5. SICom Communications program

The SICom program works with the Windows®, Windows 7, Windows 8, Windows 10 and Windows 11 operative systems.
The following operations can be carried out using the SICom program:

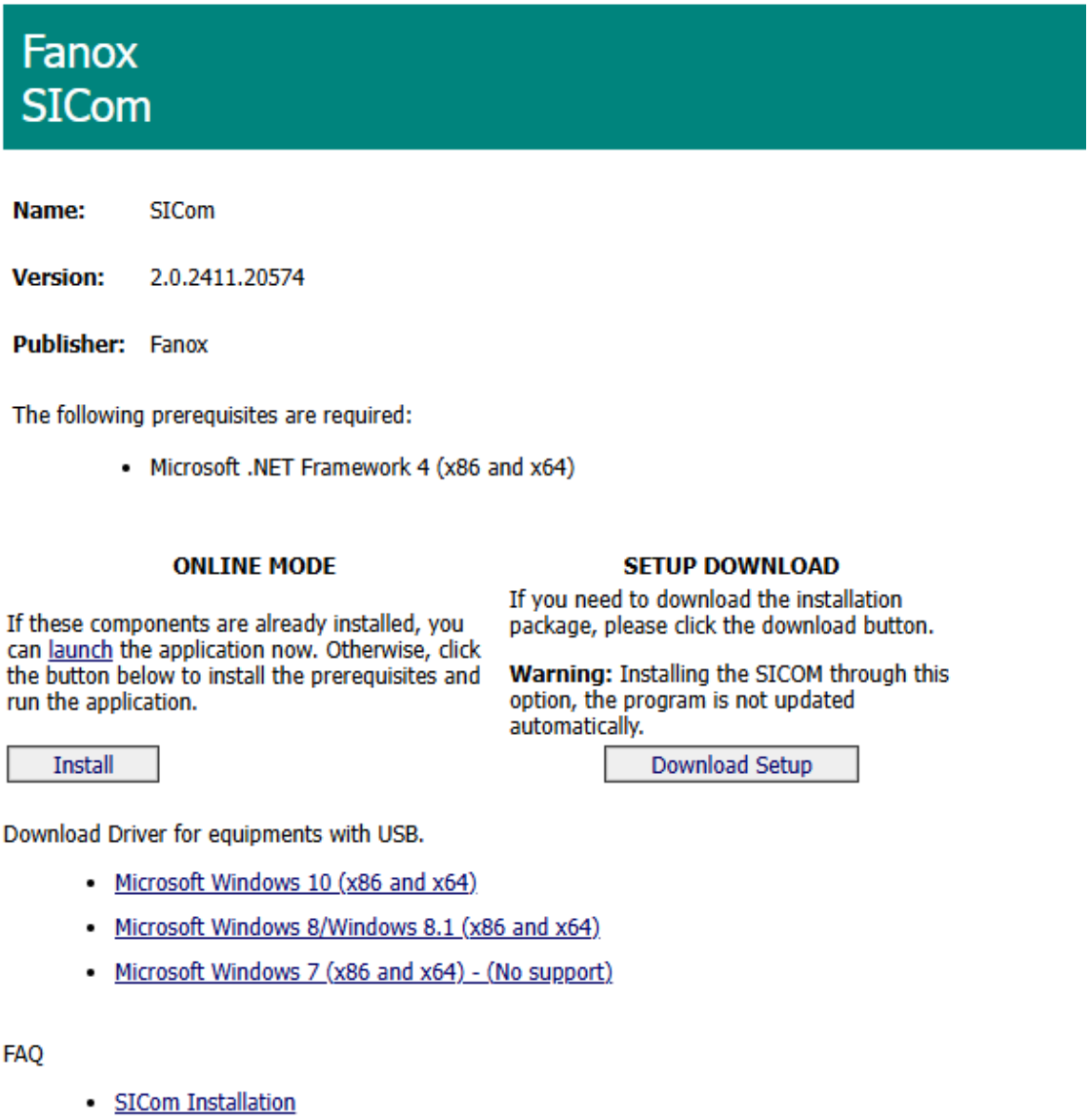
- Status reading
- Measurement reading
- Reading and changing settings
- Reading and changing configuration
- Reading and deleting events
- Reading and deleting DFR (fault reports and COMTRADE files)
- Changing the user passwords
- Loading settings files
- Loading configuration files
- Date-time synchronization
- Checking the versions of the relay
- Configuring the communication parameters.
- Configuring and checking load data profiling

12.5.1. 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.

12.6. Users management

The relay enables the creation of local user accounts to give the authorized individual different permissions.

Every user account can be assigned different roles, and the user roles can be changed as needed.

ROLES:

Roles

SIAC100F134GAD
- Role 0
- Role 1
- Role 2
- Role 3
- Role 4
- Role 5

Role	Modify Settings	Execute Commands	Modify Configurations	Manage Security
Role 0	☐	☐	☐	☐
Role 1	☐	☑	☐	☐
Role 2	☑	☐	☑	☐
Role 3	☑	☑	☑	☐
Role 4	☑	☑	☑	☑
Role 5	☑	☑	☑	☑

USERS:

Users

SIAC100F134GAD
- General
- HMI

User	Active	Custom Name	Password	Role
General				
User 1	☑	Viewer	Fanox/0000	Role 0
User 2	☑	Operator	Fanox/1111	Role 1
User 3	☑	Engineer	Fanox/2222	Role 2
User 4	☑	Installer	Fanox/3333	Role 3
User 5	☑	Admin	Fanox/4444	Role 4
User 6	☑	SAdmin	Fanox/5555	Role 5
User 7	☐			Role 0
User 8	☐			Role 0
User 9	☐			Role 0
User 10	☐			Role 0
HMI				
User 1	☑	Viewer	0000	Role 0
User 2	☑	Operator	1111	Role 1
User 3	☑	Engineer	2222	Role 2
User 4	☑	Installer	3333	Role 3
User 5	☑	Admin	4444	Role 4
User 6	☑	SAdmin	5555	Role 5
User 7	☐			Role 0
User 8	☐			Role 0
User 9	☐			Role 0
User 10	☐			Role 0

There are up to 10 configurable users where it is possible to associate the corresponding password and the applicable role.

The password can be customized by following the next specifications:

Minimum number of characters: 8

Maximum number of characters: 10

Use a lower case

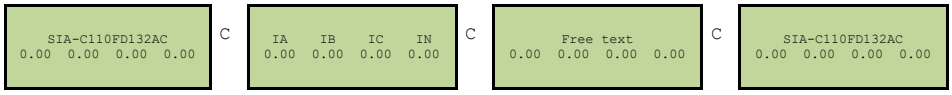
Use an upper case

Use a special character

12.7. MENUS

12.7.1. 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, settings, and events. 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).

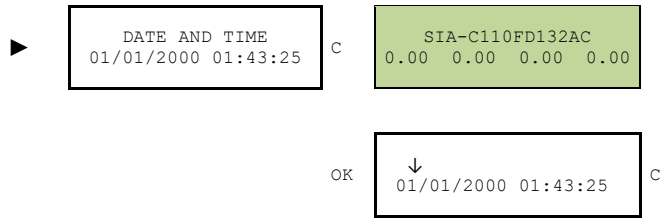
- NO TRIP POWER
- MEASUREMENT ERROR
- EVENTS ERROR
- EEPROM ERROR
- DATE & TIME ERROR

12.7.2. 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 and 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.
The navigation through the menus is described as graphically as possible below.

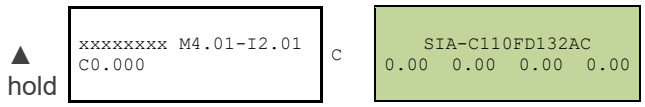
12.7.3. Date-time menu

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.



12.7.4. Versions and serial number

The relay versions menu can be accessed from the standby mode screen by pressing the key "▲". This displays the software versions of the relay processors. Press the "C" key to return to the standby mode screen.

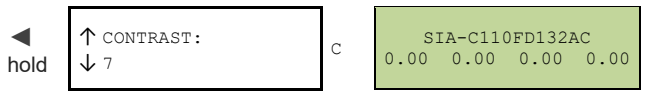


12.7.5. Contrast

The contrast menu can be accessed from the standby mode screen by holding the "◄" key.

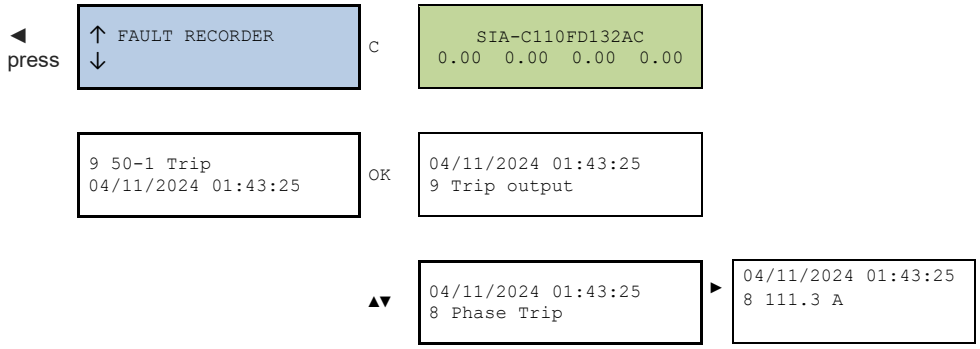
Contrast level can be changed using the "▲" and "▼" keys.

Press the "C" key to return to the standby mode screen.



12.7.6. Fault report

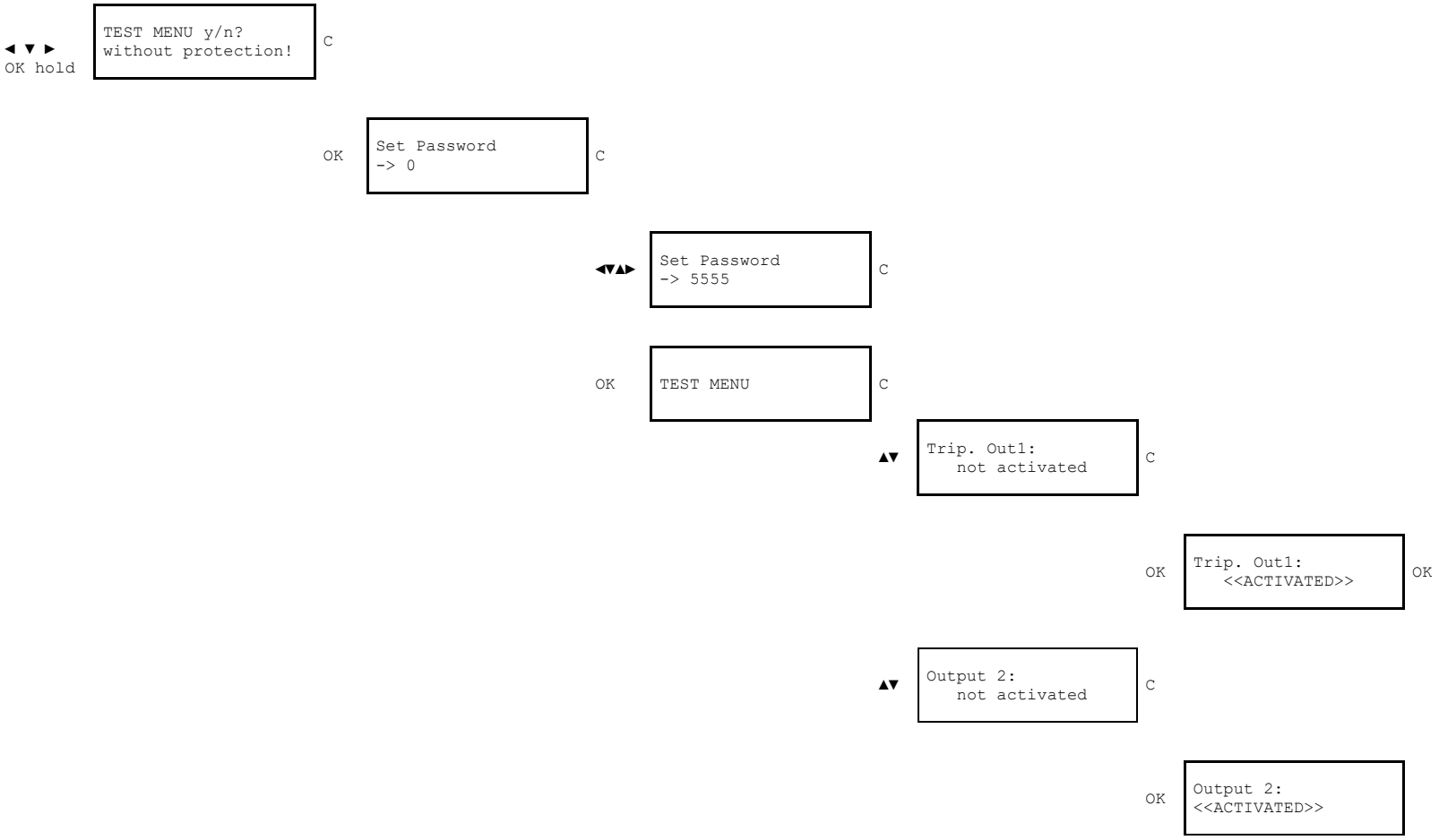
From the standby mode screen, press the "◄" key to access the fault report. Use the "▲" and "▼" keys to find the fault report and pressing "OK" the data of this fault report can be read.

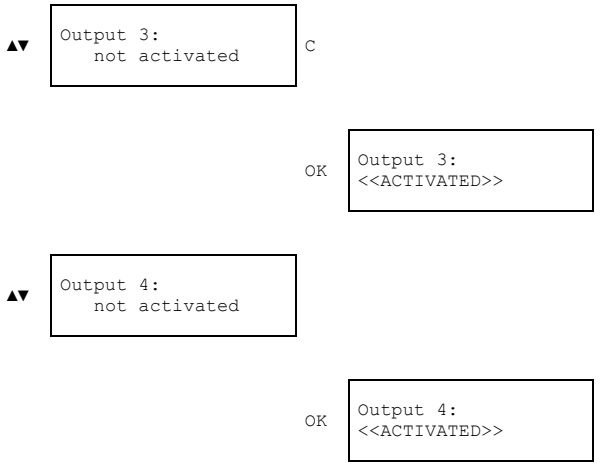


The name of the fault reports indicates the function that has tripped and originated the fault report.

12.7.7. Test Menu

The “Test menu” is accessed from the standby screen by sequentially pressing the “◄”, “▼” and “►” keys, and then holding down the “OK” key. From here, press “OK” to access the components that can be tested.



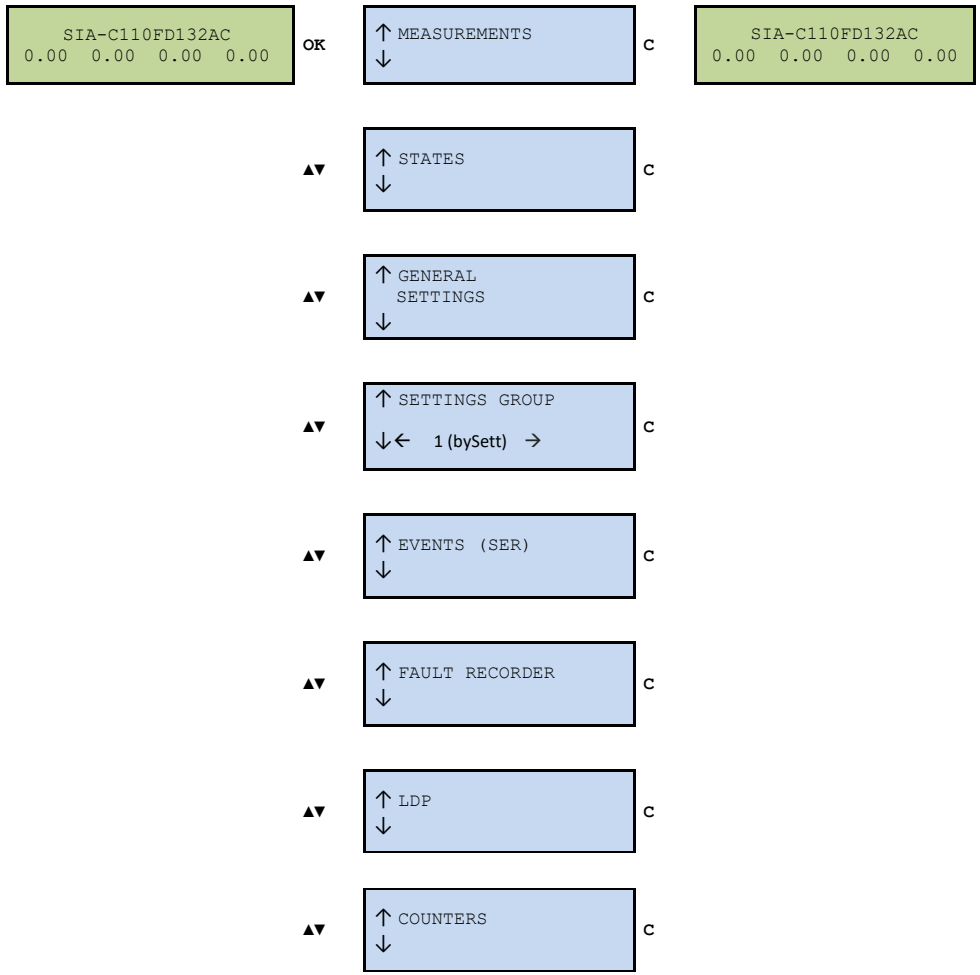


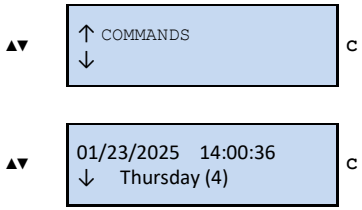
The number of outputs depend on the model

12.7.8. Functions Menu

The SIA-C relay menu is split up into 8 main parts:

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

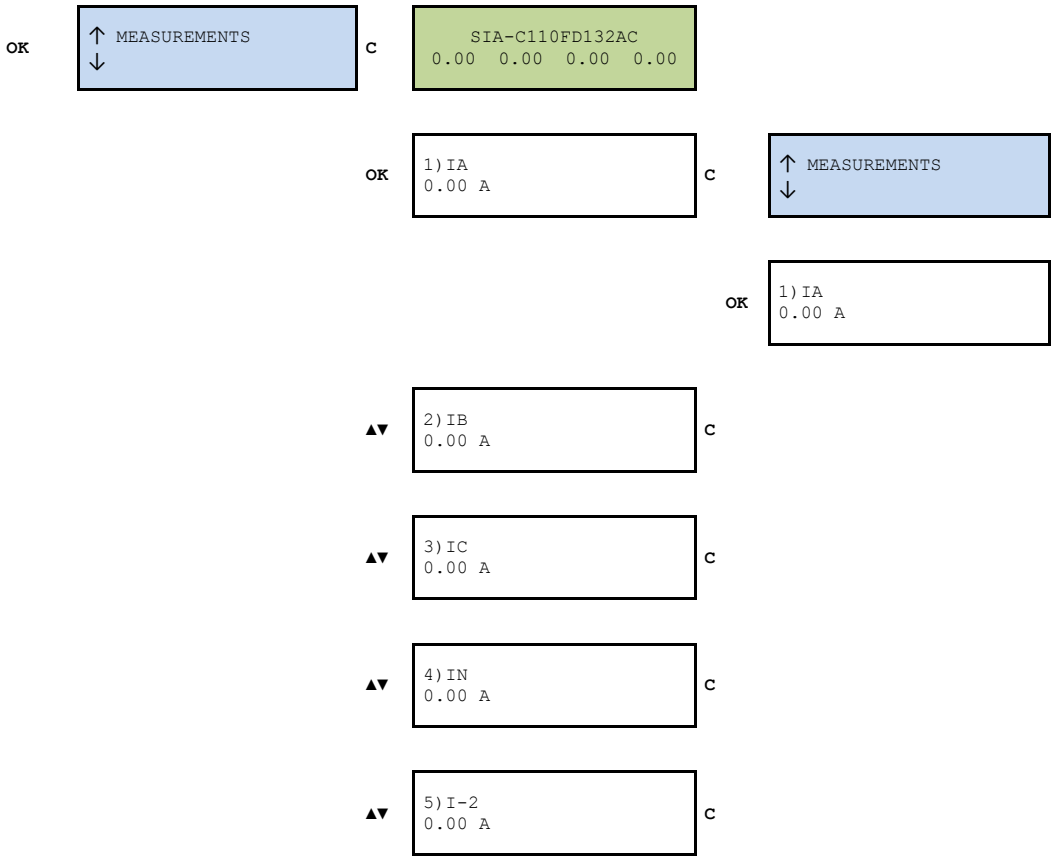

SIA-C110FD132AC
0.00 0.00 0.00 0.00
OK
↑ MEASUREMENTS
↓
C
SIA-C110FD132AC
0.00 0.00 0.00 0.00
▲▼
↑ STATES
↓
C
▲▼
↑ GENERAL
SETTINGS
↓
C
▲▼
↑ SETTINGS GROUP
↓← 1 (bySett) →
C
▲▼
↑ EVENTS (SER)
↓
C
▲▼
↑ FAULT RECORDER
↓
C
▲▼
↑ LDP
↓
C
▲▼
↑ COUNTERS
↓
C

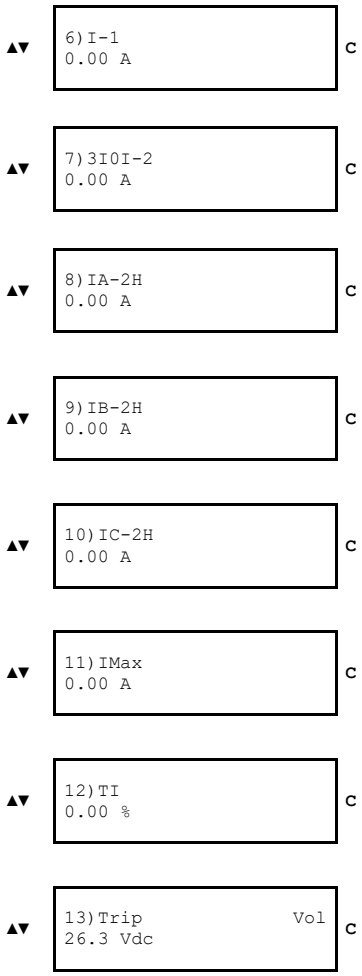


Press the “**OK**” key to access the second level from the main screen. Use the ▲ and ▼ keys to move from one menu section to another in the second level. Use the “**C**” key to return to a higher level.

12.7.9. Measurements 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 “MEASUREMENTS” screen and press “OK”. Use the “▲” and “▼” keys to position the cursor over the measurement and to see its value.




▲▼
6)I-1
0.00 A
C
▲▼
7)3I0I-2
0.00 A
C
▲▼
8)IA-2H
0.00 A
C
▲▼
9)IB-2H
0.00 A
C
▲▼
10)IC-2H
0.00 A
C
▲▼
11)IMax
0.00 A
C
▲▼
12)TI
0.00 %
C
▲▼
13)Trip Vol
26.3 Vdc
C

12.7.10. States 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 “STATES” screen and press “OK”. Use the “▲” and “▼” keys to position the cursor over the measurement and to see its value.

12.7.11. 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 “GENERAL SETTINGS” or “SETTINGS GROUP” screens and press “OK”. This takes you to the setting 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.

The value of the “CT Phase ratio” and “CT Neutral ratio” general settings is the result given by dividing the number of turns on the primary winding by the number on the secondary winding. For example: With TI 100/1, the setting would be 100.

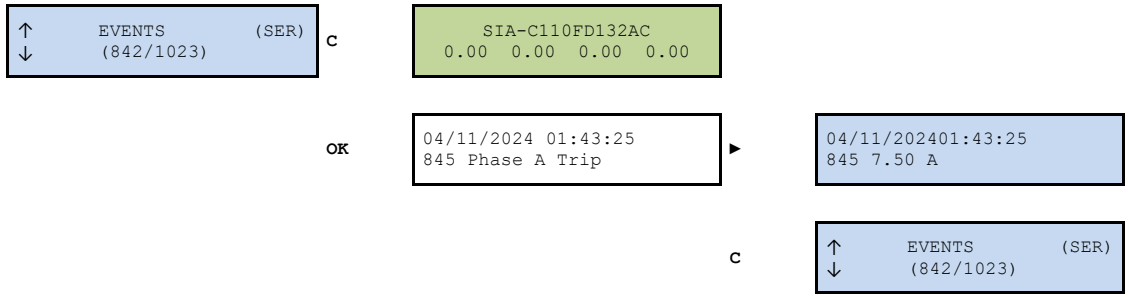
It is necessary to enter a password to change a setting for the first time. The settings can be changed after entering the password, until returning either manually or automatically to the standby mode screen. The system returns automatically to the standby mode screen if no key is pressed for five minutes.
The factory setting password for the relay is 5555. This password can be changed using the SICom program.

The keys ▲, ▼, ◄ and ► are used to enter the password. The keys ▲ and ▼ are used to introduce a value or a character, and the ◄ and ► ones are used to move from one character to another. If it is necessary to change one of the password characters or numbers due to an error, press “**C**” to delete it. Press “**OK**” to validate the password.

The method for navigating through the settings menu and the sequence to follow to change a setting are shown graphically below:

12.7.12. Events 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 “EVENTS” screen and the number of events in the buffer will be displayed. Press “OK” and use the “▲” and “▼” keys to position the cursor over the events.



12.7.13. Fault reports

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 “FAULT RECORDER” screen. Press “OK” and use the “▲” and “▼” keys to position the cursor over the Fault Report. It is also possible to access fault Report menu pressing “◄” key from standby screen.

To delete the fault reports, position the cursor over the fault report menu and press and hold the “RESET” key, until password is requested. Introduce the password and press OK until there is a massage informing “fault reports erased

12.7.14. Load Data Profiling (LDP)

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 “LDP” screen. Press “OK” and use the “▲” and “▼” keys to position the cursor over the records.

12.7.15. Counters menu

The first line of menus can be accessed from the standby mode screen by pressing the “OK” key. Use the “▲” and “▼” keys to move the cursor through the different screens until it is positioned over the “COUNTERS” screen. Press “OK” and use the “▲” and “▼” keys to view the different possible commands. Press the “OK” key to perform a command and press the “OK” key again to confirm the command.

12.7.16. Commands Menu

The first line of menus can be accessed from the standby mode screen by pressing the “OK” key. Use the “▲” and “▼” keys to move the cursor through the different screens until it is positioned over the “COMMANDS” screen. Press “OK” and use the “▲” and “▼” keys to view the different possible commands. Press the “OK” key to perform a command and press the “OK” key again to confirm the command.

12.7.17. Date and time

The first line of menus can be accessed from the standby mode screen by pressing the “OK” key. Use the “▲” and “▼” keys to move the cursor through the different screens until it is positioned over the “Date and time” screen. Press “OK” and use the ▲, ▼, ◄ and ► keys to change the date and time. Press OK key to confirm the change and C key to go back to the previous menu.

”.”

13. COMMISSIONING

13.1. Checklist for Commissioning

The commissioning sheets that are needed to register the commissioning process and the specific settings for each installed piece of relay are found in the Appendix.

13.2. Electrostatic discharge

Before handling any of the relay electronic components, make sure that you have read the section of the user manual related to electrostatic discharges.

13.3. Visual Inspection

Make sure that the cabling has been installed as per the external connection diagrams.

13.4. Earthing

It is very important for the relay to be earthed correctly. To check this, make sure that the relay earth connection, located on the reverse side of the relay, is correctly connected to the facility local earth connection.

13.5. Current transformers

The high voltage that is generated in the secondary circuits of current transformers can cause death and could damage the facility. Therefore, the secondary circuits of current transformers should never be opened.

13.6. Auxiliary power

There is the possibility of auxiliary supply in SIA-C relay, this must be specified on the order reference. The amount of auxiliary power required for the SIA-C relay should be checked: 230 Vac 50/60 Hz, 110 Vac 50/60Hz or 24 Vdc.

13.7. Front communications port

To perform this test, connect a PC with the SICom software program to the SIA-C relay, and check that there are no communication errors. It is important to check communications port (COM) which is assigned to USB.

13.8. Commissioning

It is recommended that the following safety measures are taken before starting up the facility for the first time, or after a trip event:

- FANOX recommends the use of the KITCOM accessory with a battery in the front port. This additional energy source allows the relay to be monitored and the trip to function without the need for self-power in any breakdown situation.
- Once all of the connections have been made, we recommend a check to make sure that they are correct, safe and well attached.
- The “complete test” menu procedure should be applied. ✋ **NOTE! See 10.10.**
- It is important to check that the measurements are correct once the facility has been powered up.

Maintenance: FANOX recommends a minimum of one facility inspection per year, to at least go through the test menu and check the values of the measurements.

NOTES:

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