SIA F

Overcurrent & Earth Fault Protection Relay

USER´S MANUAL

1. RECEPTION, HANDLING & INSTALLATION

1.1. 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 equipment 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.

1.2. Reception of relays

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

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

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

1.3. Handling electronic equipment

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

Just by moving, a person can build up an electrostatic potential of several thousand volts. Discharging this energy into electronic components can cause serious damage to electronic circuits. 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 equipment is well protected by the metal housing, which should not be removed as the equipment 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 equipment 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.

1.4. Installation, commissioning and service

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

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

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

It is necessary to connect the equipment 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 equipment 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 equipment must be used within the stipulated electrical and environmental limits.

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

1.5. Storage

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

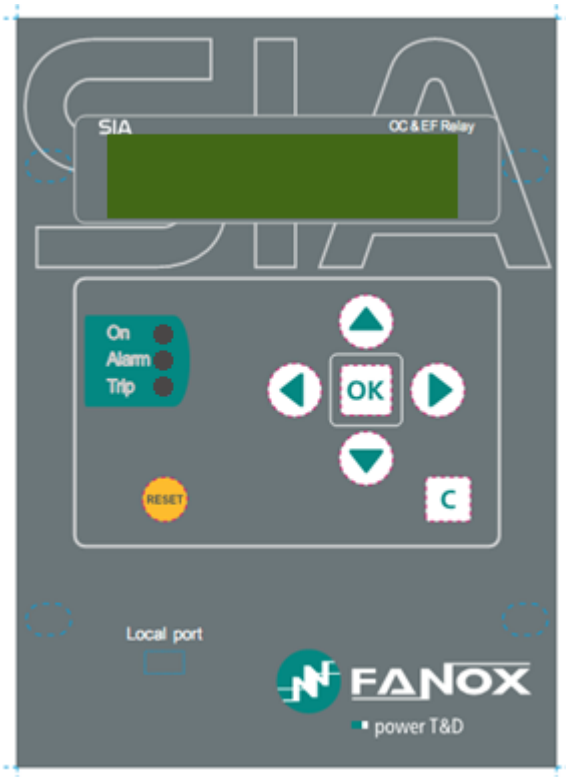
1.6. Recycling

Before recycling the equipment, 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…

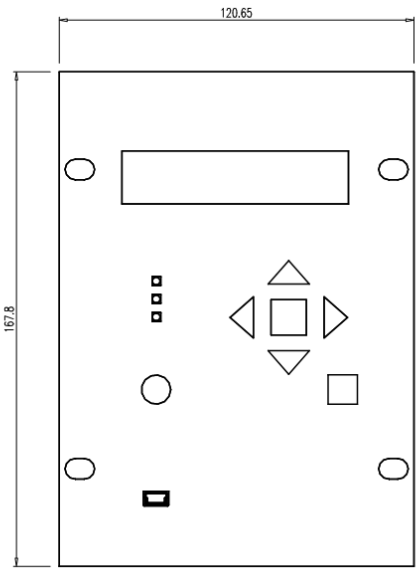
2. DIMENSIONS AND CONNECTION DIAGRAMS

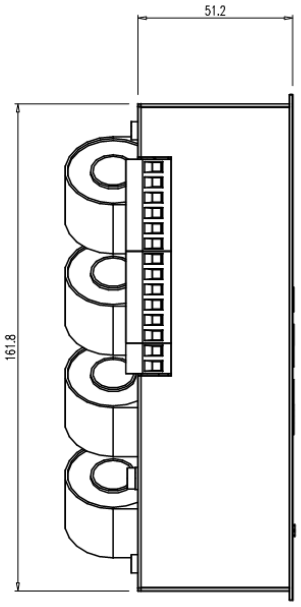
2.1. Frontal view

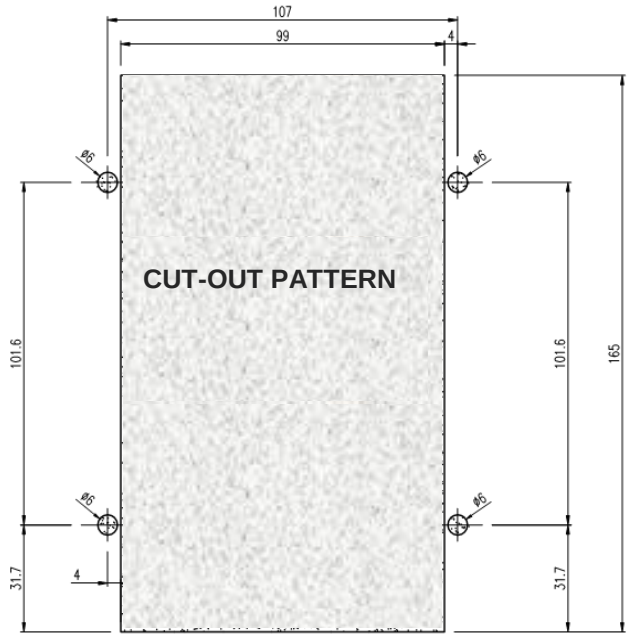


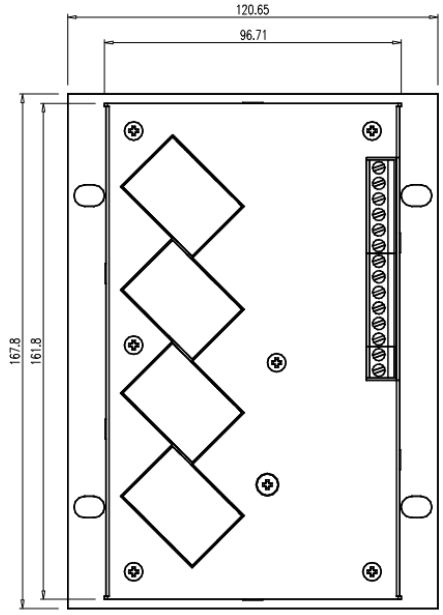
2.2. Case dimensions

The dimensions are in mm.



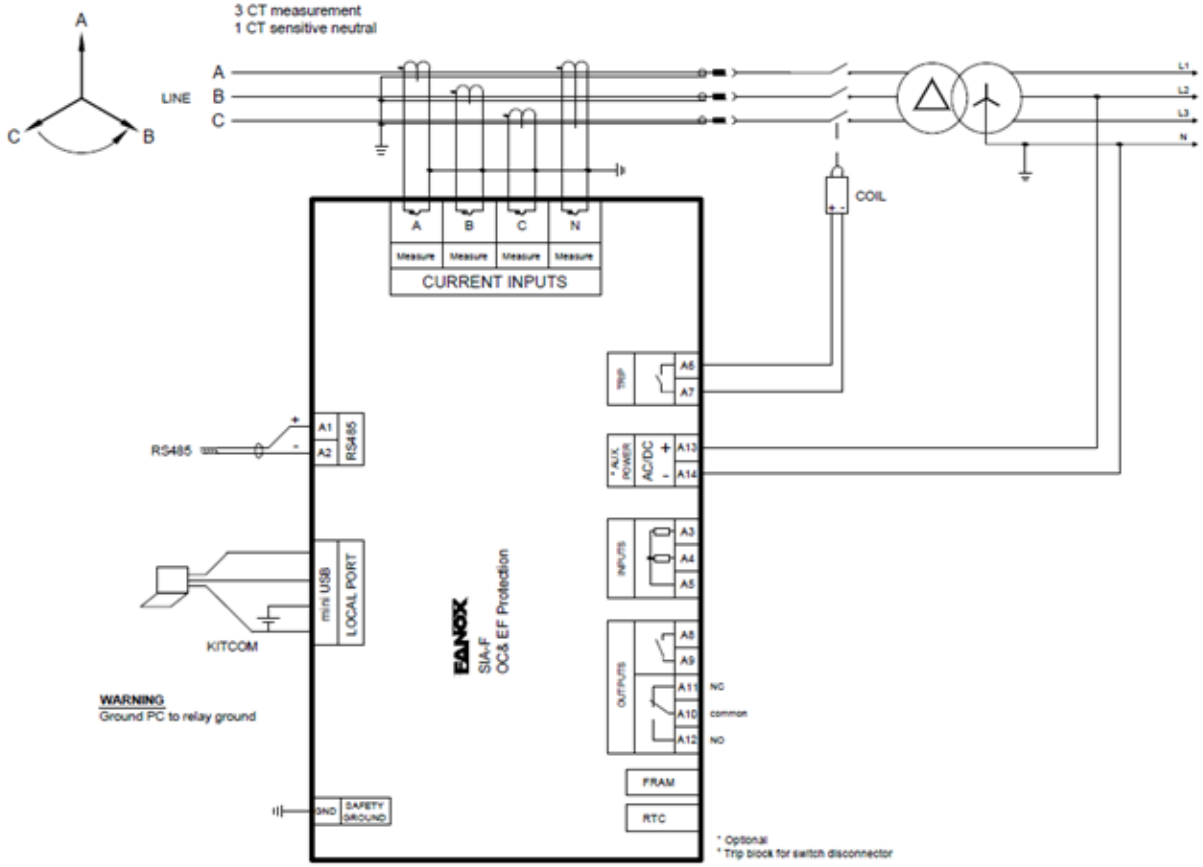






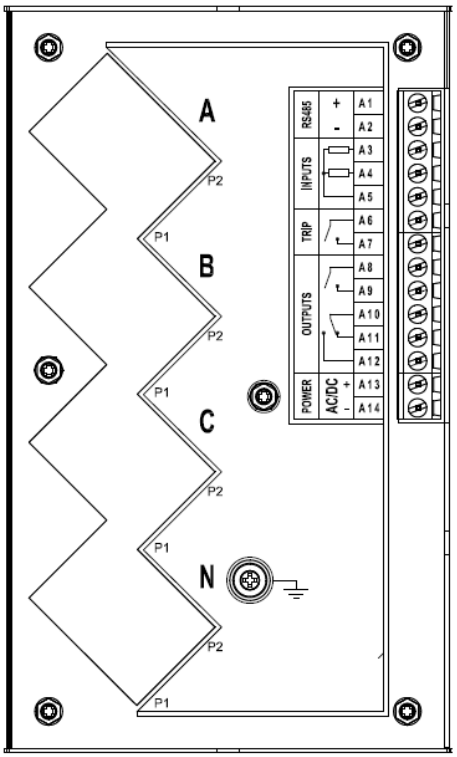
2.3. Connection diagram

3 Phase CT and neutral CT Connection



2.4. Terminals

A1	+	**RS 485**
A2	-	
A3	Input-1	**INPUTS**
A4	Input-2	
A5	Common inputs	
A6-A7	Trip output	**TRIP**
A8-A9	Output 2	**OUTPUTS**
A10	Common output 3	
A11	NC-3	
A12	NO-3	
A13	+	**U aux**
A14	-	



3. DESCRIPTION

3.1. Introduction

Worldwide, the energy sector is currently undergoing a 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 other equipment.

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 centres, as well as allowing it to operate properly under adverse conditions.

3.2. Equipment description

The SIA-F equipment is a protection relay designed for secondary distribution.

It is supplied with 110-230 Vac / 90-300 Vdc auxiliary voltage. It is possible to choose 24-48 Vdc auxiliary for each model. As for the rest of the SIA family, it can be supplied through its front communications port via an external battery, using the KITCOM adapter or connecting to PC directly using a USB cable. This facilitates the start-up of the centers and the management of events. The operation is guaranteed when the SIA-F equipment is supplied from USB.

As well as the functions to protect against instantaneous phase and neutral overcurrents and phase and neutral inverse time overcurrents, it is possible to choose thermal image, circuit braking monitoring and circuit breaker opening fault unit for each model. It is also equipped with a trip blocking to protect the switchgear in centers that combine switchgear and fuses.

Depending on model it is included a breaker management block, which monitors the switch condition, the number of breaks and the accumulated amps. It generates an indication if these are excessive, it determines whether or not an Opening fault has occurred and allows the breaker close and open commands from the HMI and via the communications port (either locally or remotely).

The SIA-F equipment has two inputs and two outputs that can be configured by the user (programmable logic) apart from trip output and 3 leds.

In order to facilitate the analysis of events, it is fitted with 4 fault reports (24 events per fault report). Fault report´s start can be configured by the user. Each register includes the events that have occurred during the incident.

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

The equipment has a LCD with two lines and twenty columns and a membrane keyboard with six buttons. These allow the display of the equipment state, the current measurements in the primary and the events or incidents associated with the equipment, and adjustments to be made to the protection criteria. These events are saved in a non-volatile memory to conserve them in case of power failures.

There are three LED indicators on the front of the SIA-F equipment. These indicate if the equipment is On (LED ON), if an alarm has happened (LED ALARM) or if a trip has happened (LED TRIP). The equipment has storage for up to 200 events, allowing any recorded incidents to be analyzed. All SIA-F models are equipped with a real-time clock (RTC).

Current measurements are performed using RMS values, with 2% accuracy in a band of ± 20% when compared with rated current and 4% in the rest of the range. Standard 5 A and 1 A current transformers (CTs) are used.

The equipment has two communication ports: a front port (USB) and a rear port (RS485). The front port allows a PC to be connected, which can be used to monitor the equipment using the SICom communications program (supplied by FANOX). Front port can be used to power the equipment by using a USB cable which can be directly connected with PC. The rear port RS485 allows the equipment to be integrated as part of a system (SCADA). The ModBus RTU protocol is used in both ports. Setting-up a session allows four levels of access to be set up with passwords that can be configured by the user.

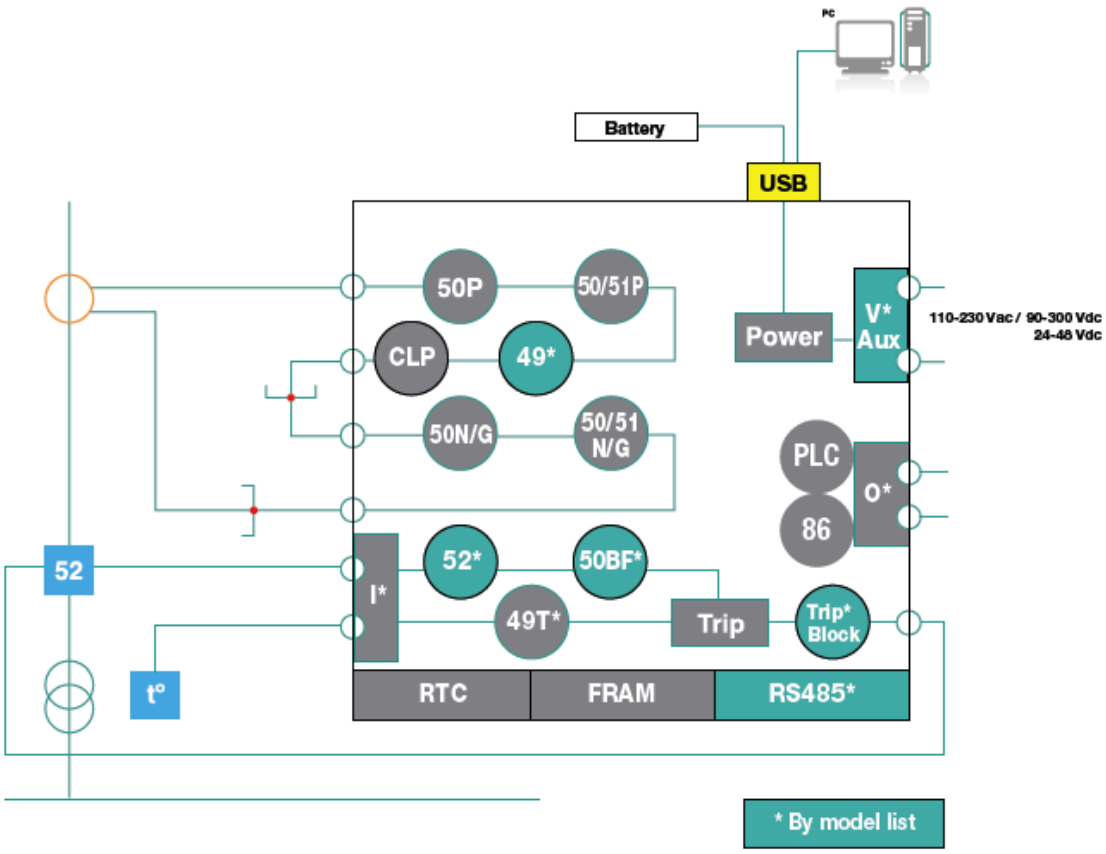
The protective functions provided, easy-to-use interface, low amount of maintenance and simple integration make the SIA-F a precise and practical solution for protecting both industrial and public electrical grids and transformation and distribution centers. The protection offered by the SIA-F against earth faults is sensitive enough to be used in electric systems where the earth fault current is low. It can be set to 0.1 times the rated neutral current and, depending on the model, the rated neutral current can go as low as 0.1 A. The main features of the equipment are listed below, and these features will be explained in the rest of the manual:

Function	Description	SIA-F
Protection		
50P	Phase instantaneous overcurrent protection function	1
50N/G	Neutral instantaneous overcurrent protection function	1
50/51P	Phase inverse time overcurrent protection function	1
50/51N/G	Neutral inverse time overcurrent protection function	1
CLP	Cold load pickup	1
Fuse + Switchgear	Trip blocking to protect the switchgear	1 (optional)
49	Thermal image	1 (optional)

52	Circuit breaker monitoring	1 (optional)
50BF	Circuit breaker opening fault	1 (optional)
86	Trip Output Lockout using the PLC.	✓
PLC	Programmable Logic Control	V2
Measurements		
	Phase and neutral RMS measurement with 2% accuracy on a band of ±20% over the nominal current and 4% over the rest of the range.	IA, IB, IC, IN, Imax and TI
Inputs and Outputs		
	Configurable Inputs	2 (Optional)
	Configurable (PLC) outputs	2 (Optional)
	Trip output (configurable)	1 Potential free
Communication and HMI		
	Front port: USB (ModBus, RTU 19200)	✓
	Rear port: RS485 (ModBus, RTU 19200)	✓(Optional)
	SICom Program	✓
	HMI: LCD, 20x2 and 6 keys + 1 reset button	✓
	LED Indicators	3
Power supply		
	Auxiliary voltage 110-230 Vac / 90-300 Vdc	Optional
	Auxiliary voltage: 24-48 Vdc	Optional
	USB supply	✓
	KITCOM adaptor	✓

Monitoring and recording		
	Events saved in the non-volatile FRAM* memory	200
	Fault reports	4
	Counters	Optional
	Commands	Optional
	Real-Time Clock (RTC)	✓
	Test menu	✓
	Self-diagnosis	✓

3.3. Functional Diagram



3.4. Model List

TYPE	PHASE MEASUREMENT	NEUTRAL MEASUREMENT	NET FREQUENCY	POWER SUPPLY	ADDITIONAL FUNCTIONS	COMMUNICATIONS	INPUTS - OUTPUTS	MECHANICS	LANGUAGE	ADAPTATION	
SIAF											50P+50/51P+50N/G+50/51N/G+86+PLC+Cold Load Pickup
	1 5										1 A 5 A
		1 5 B									1 A 5 A 0,2 A
			0								Defined by General Setting
				A B							24-48 Vdc 90-300 Vdc / 110-230 Vac
					0 1 B C						- +52+50BF+49 + Trip Block for switch disconnector + Trip Block for switch disconnector +52+ 50BF +49
						0 1					USB frontal + rear RS485
							0 1				3 led's + trip output + 2 input + 2 outputs (configurable)
								0			-
									A B C D		English, Spanish and German English, Spanish and Turkish English , Spanish and French English , Spanish and Russian
										A	-

3.5. Phase CT and neutral CT selection

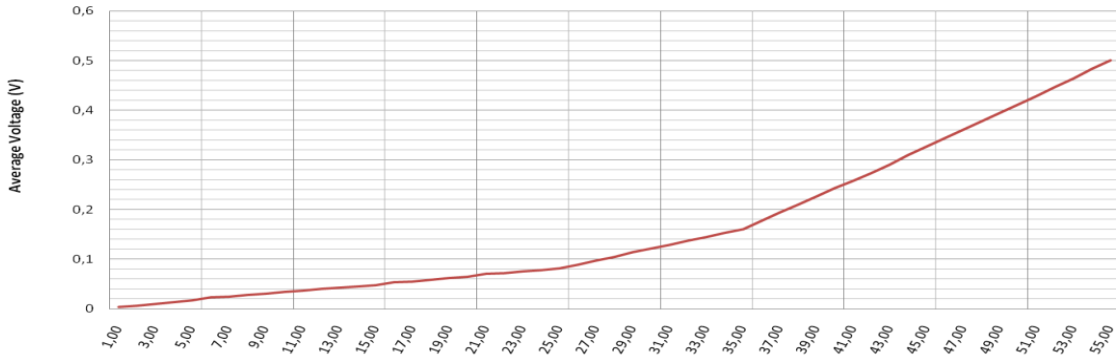
The following table shows a summary of phase and neutral CT combinations:

Model	Phase	Neutral	se range	utral range
SIAF55	CT 5 A	Residual phase connection	.50 A	-150 A
SIAF11	CT 1 A	Residual phase connection	0 A	-30 A
SIAF51	CT 5 A	CT 1 A	.50 A	-30 A
SIAF1B	CT 1 A	CT 0,2 A	0 A	2-6 A
SIAF5B	CT 5 A	CT 0,2 A	.50	2-6 A

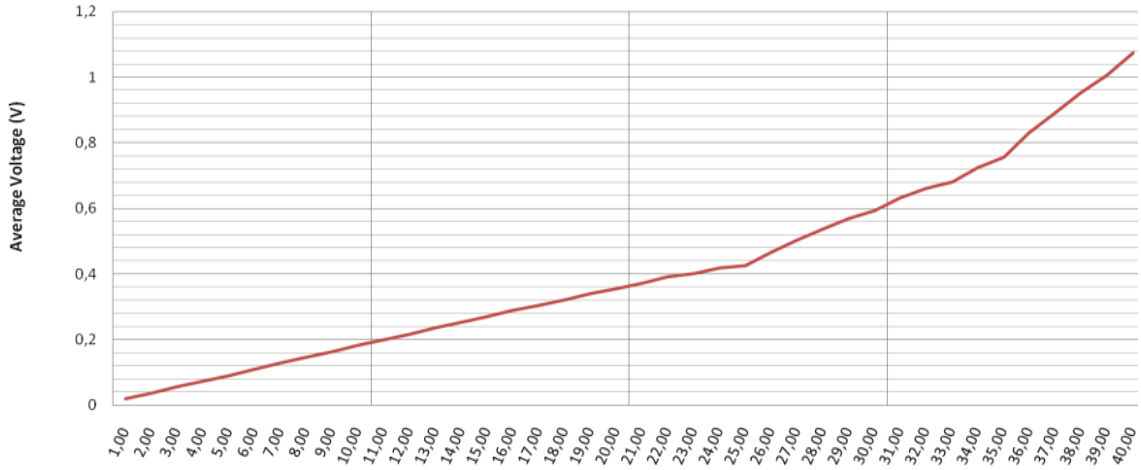
In order to assure a correct running of the relay, it is necessary to use the proper current transformer. Therefore, the load of measurement circuits of the relay and the load of connection cables between CT's and relay must be taken into account.

PRECISION	BURDEN	RELAYS
5P10	0,5 VA	SIA-F/1
5P20	0,5 VA	SIA-F/1
5P30	0,5 VA	SIA-F/1
5P10	1 VA	SIA-F/5
5P20	1 VA	SIA-F/5
5P30	1 VA	SIA-F/5

3.5.1. Load curve for relay SIA-F/1



3.5.2. Load curve of relay SIA-F/5



4. PROTECTION FUNCTIONS

4.1. 50P Function. Phase instantaneous phase overcurrent

This protection function can be set by using three parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
50P	**Phase instantaneous overcurrent**					
	Permission	-	-	Yes/No	-	No
	Tap	0,10	30,00	0,01	I nominal	5,00
	Operating time	0,02	300,00	0,01	s	0,2

The operating time is independent from the operating current flowing through the equipment, 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.

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

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

4.2. 50/51P Function. Phase inverse time overcurrent

This protection function can be set by using five parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
50/51P	**Phase inverse time overcurrent**					
	Permission	-	-	Yes/No	-	No
	Curve	-	-	(1*)	-	Extremely Inverse
	Dial	0,02	1,25	0,01	-	1,25
	Tap	0,10	7,00	0,01	Inominal	1,00
	Operating time	0,02	300,00	0,01	s	0,2

(1*) Inverse, Very inverse, Extremely inverse, Defined time

If the option "Defined time" is selected for the curve setting, the unit behaves like an instantaneous overcurrent unit. In this case, the unit operating time is set by the parameter "Operating time".

If a curve (inverse, very inverse or extremely inverse) is selected for the curve setting, the operating time depends on the curve, dial and tap settings.

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

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

The reset is instantaneous in both cases.

The activation time is accurate to ±5% or ±30ms, whichever is greater, of the theoretical activation time.

The curves used are IEC 60255-151, which are described in the "Curves" section.

4.3. 50N/G Function. Neutral instantaneous overcurrent

This protection function can be set by using three parameters:

Function	Description	Minimum	Maximum	Step	Unit	Default
50N/G	**Neutral instantaneous overcurrent**					
	Permission	-	-	Yes/No	-	No
	Tap	0,10	30,00	0,01	I nominal	1,00
	Operating time	0,02	300,00	0,01	s	0,2

The operating time is completely independent from the operating current that flows through the equipment, 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 phase drops below the point of current pick-up.

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

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

4.4. 50/51N/G Function. Neutral inverse time overcurrent

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

Function	Description	Minimum	Maximum	Step	Unit	Default
50/51N/G	**Neutral inverse time overcurrent**					
	Permission	-	-	Yes/No	-	No
	Curve	-	-	(1*)	-	Extremely Inverse
	Dial	0,02	1,25	0,01	-	1,25
	Tap	0,10	7,00	0,01	Inominal	0,50
	Operating time	0,02	300,00	0,01	s	0,2

(1*) Inverse, Very inverse, Extremely inverse, Defined time

If the option "Defined time" is selected for the curve setting, the unit behaves like an instantaneous overcurrent unit. In this case, the unit operating time is adjusted by using the parameter "Operating time".

If a curve (inverse, very inverse or extremely inverse) is selected for the curve setting, the operating time depends on the curve, dial and tap settings.

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

If the unit operates with a curve, the function is activated at 110% of the set tap value, and it deactivates at 100%. The reset is instantaneous in both cases.

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

The curves used are IEC 60255-151, which are described in the "Curves" section.

4.5. Cold Load Pickup

This unit is used to prevent undesired operations of the overcurrent functions in the cases where when the line is reenergized; all the loads enter at the same time.

The settings of this function are as follows:

Function	Description	Minimum	Maximum	Step	Unit	Default
CLP	**Cold Load Pickup**					
	Permission	-	-	Yes/No	-	No
	Setting group	1	3	1	-	3
	No Load time	0.02	300.00	0.01	s	15
	Cold Load Time	0.02	300.00	0.01	s	15

The two time 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**: After the circuit has been closed, during this time the new setting group is applied. After this time, the relay returns to the adjusted setting group.

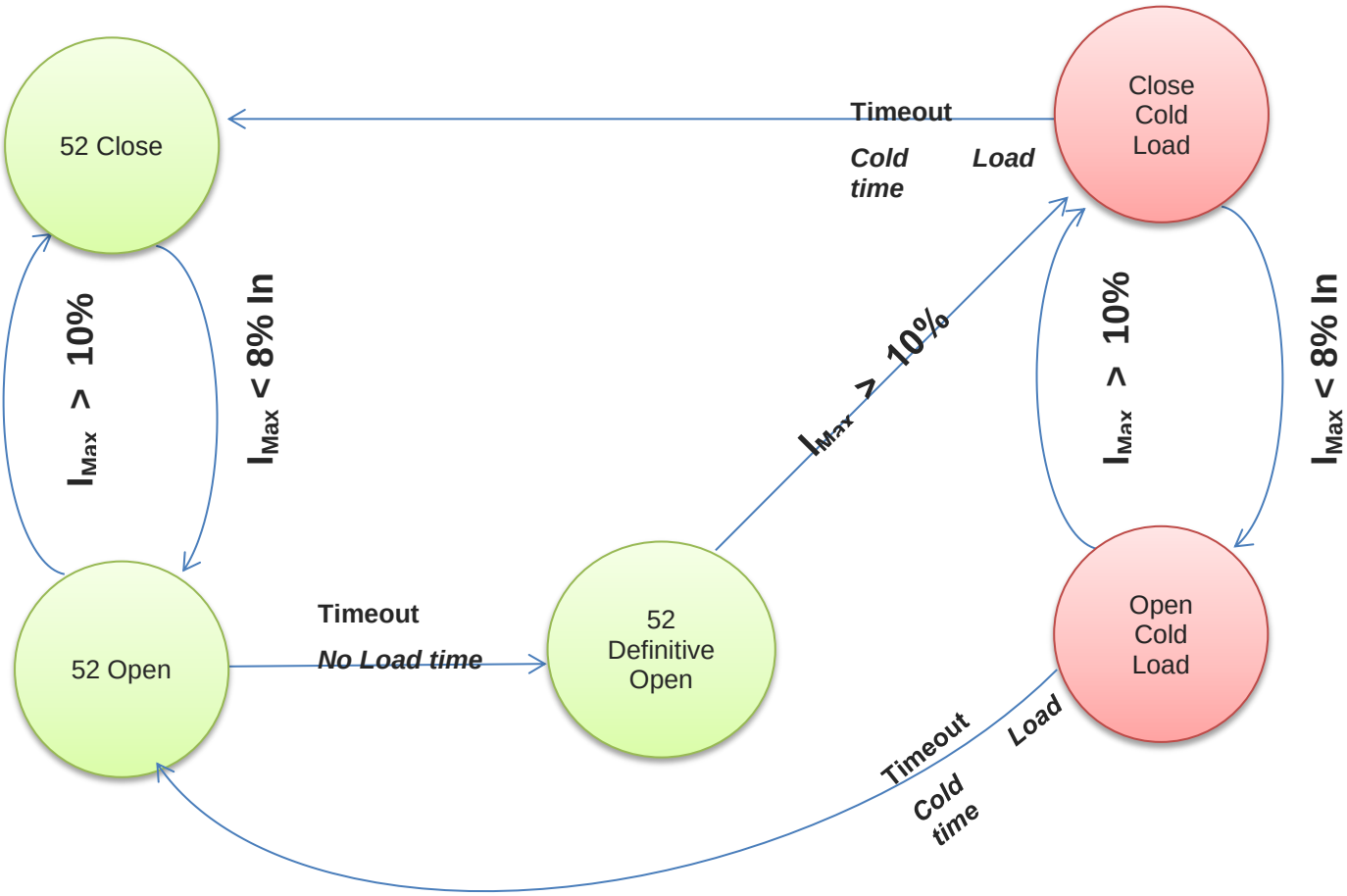
The function operates according to the following automaton. The automaton consists of five states, in three of those states the relay works with normal setting group (the table adjusted in general settings), and in the other two, with the new settings group.

The relay uses the current level to determine the circuit breaker state (open or closed). If the current is less than 10% of the rated level, it is understood that the line is open, with an extremely low usage level (operating at night, or on weekends). In one case or the other Cold Load is in working condition.

The relay usually operates with the settings in their active table. 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 regardless of the circuit breaker situation, this is, without taking into account whether the circuit breaker is maintained closed or is open.

When the setting group changed occurs, not all the protection functions change, only 50P, 50/51P, 50N/G and 50/51N/G functions are modified to new settings.



4.6. Trip block protection for the switchgear

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

Group	Description	Minimum	Maximum	Step	Unit	Default
	Trip block protection for the switchgear					
	Blocking	-	-	Yes/No	-	Yes
	Blocking limit	1,50	20,00	0,01	I nominal	7,00

4.7. 52 Function. Circuit breaker monitoring

This function allows the state 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**					
	Excessive number of openings	1	10000	1	-	10
	Maximum accumulated amps	1	100000	1	M(A^2)	1000
	Opening time	0,02	300,00	0,01	s	0,10
	Closing time	0,02	300,00	0,01	s	0,10
	Excessive repeated openings	1	10000	1	-	3
	Time of excessive repeated openings	1,00	300,00	0,01	min	9,00

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 state and if any maintenance alarm has been activated.

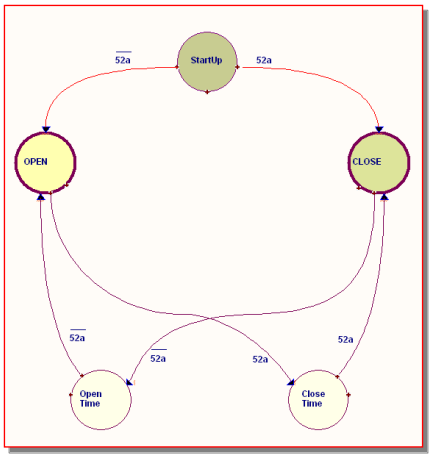
The following states are associated with this function:

Function	State	Description
52	Start	Energized/De-energized These are the different states of the circuit breaker automatic control
	Error	
	Open	
	Opening time	
	Opening fault	
	Closed	
	Closing time	
	Closing fault	
	No. of configured openings exceeded	Activated if the meter that measures the number of openings exceeds the "Excessive number of openings" setting
	No. of configured accumulated (I2t) amps exceeded	Activated if the accumulated amps meter exceeds "Maximum accumulated amps" setting
	Repeated Trips	Activated if the number of openings exceeds the setting in "Excessive repeated openings" for the time set in "Time of excessive repeated openings"
	52a	-
	52b	-

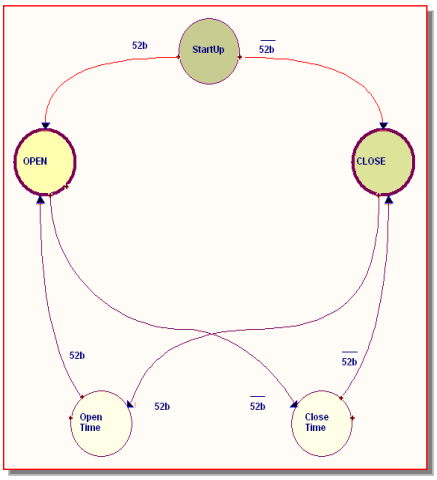
The circuit breaker performance is shown in the following finite state machine:

The way that the circuit breaker is monitored becomes more or less complex depending on whether it is fitted with one breaker contact (52a or 52b) or both (52a and 52b).

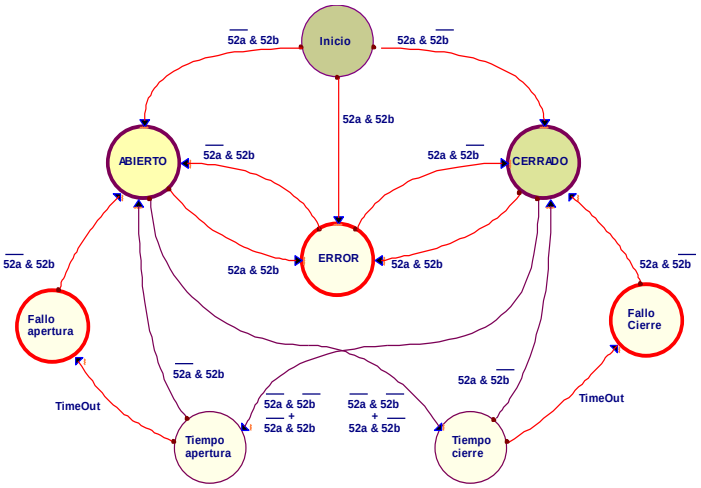
If only the circuit breaker 52a contact is available, it should be wired to the corresponding physical input. This physical input is then assigned to the "52a Input" logical input. The 52b logical input is calculated internally as the negative of 52a. The circuit breaker automaton is considered as having four states: start, open, closed and error.



If only the circuit breaker 52b contact is available, it should be wired to the corresponding physical input. This physical input is then assigned to the "52b Input" logical input. The 52a logical input is calculated internally as the negative of 52b. The circuit breaker automaton is considered as having four states: start, open, closed and error.



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 logical inputs: the circuit breaker 52a contact to the "52a Input" logical input, and the circuit breaker 52b contact to the "52b Input" logical input. The circuit breaker automaton is considered as having eight states: start, open, closed, error, opening time, opening fault, closing time and closing fault.



4.7.1. Circuit breaker opening and closing commands

The circuit breaker opening and closing commands are implemented. These commands can be executed from the HMI command menu or through communications.

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" state group in the state menu.

4.7.2. Counter to register the number of openings

The SIA-F equipment is fitted with a counter that registers the number of times the circuit breaker opens.

This meter is associated with the "Maximum number of openings" setting. When the number of openings exceeds this pre-set value, the "Excessive number of openings" state is activated and its corresponding event is generated.

This counter reading can be set to any value within its range from the HMI or by communications.

4.7.3. 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 metering 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 pre-set value, the "Excessive accumulated amps" state 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.

4.7.4. Excessive openings per time

As well as counting the number of times the circuit breaker opens, the SIA-F equipment 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" state is activated and its corresponding event is generated.

4.8. 49 Function. Thermal Image Protection

Thermal image is a measure of heating and cooling of an electric machine. Unlike overcurrent protection, do not start counting the time when it detects a fault, but 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 accuracy of the tripping time is ±5% or ± 2 s (the greatest of both values) the theoretical time.

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 taken into account.

The overload function trips when the thermal image reaches the value of 100%. This value is reached in time when the current flowing is equal to the function adjusted in thermal function.

It provides an adjustable level of thermal imaging to generate an alarm. If the trip occurs, the function of overload is reset when the thermal image falls below the set alarm level.

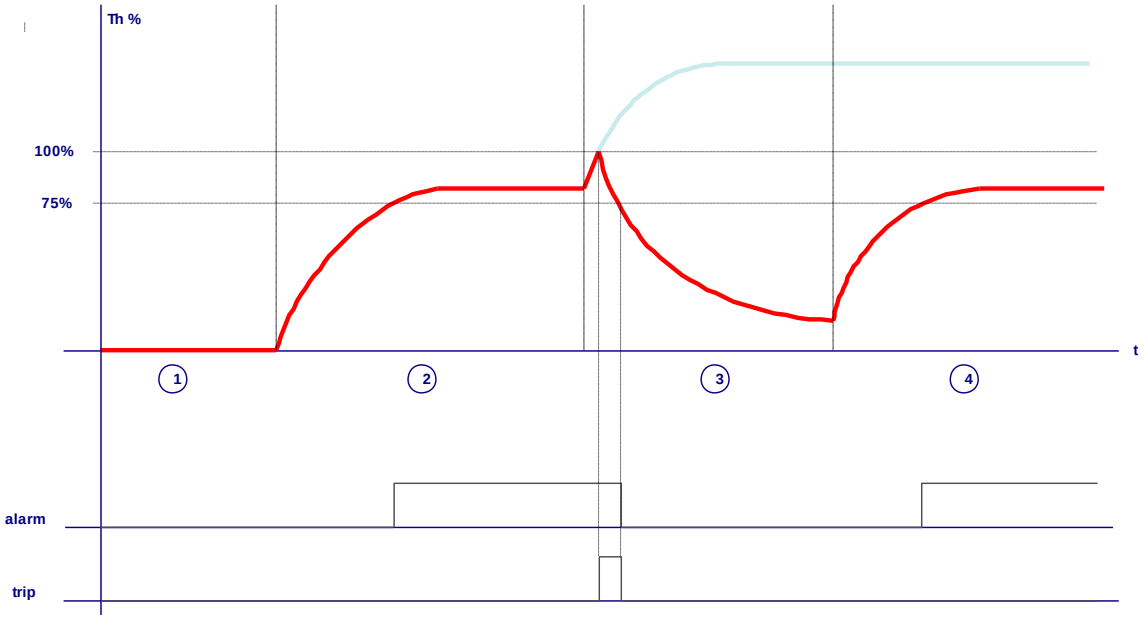
As the current measurement algorithm used is R.M.S., in the thermal model is taken into account the heat produced by the harmonics.

This protection function is adjusted by setting five different parameters:

Function	Description	Minimum	Maximum	Pitch	Unit	Default
49	**Thermal image protection function**					
	Permission	-	-	Yes/No	-	No
	Tap	0,10	2,40	0,01	I nom	1,2
	ζ heating	3	600	1	min	3
	ζ cooling	1	6	1	ζ heating	1
	Alarm	20	99	1	%	80

4.8.1. Thermal image measurement evolution graphic

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



We suppose that thermal image protection has and 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: We supply the machine with the nominal current. Thermal image evolutions so as to get the value of the thermal balance corresponding to one time the nominal current Th = $(I/It)^2$ = 82%. The time that it takes in getting the thermal balance depends on the adjusted heating constant.
- Zone 3: Once reached the thermal image corresponding to the application of one time the nominal current, we apply 1.2 times the nominal current. 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 we had the permission of the thermal function disabled. If the permission is disabled, 49 protection function performs when the thermal image reaches the value of 100%. Once tripped, current 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.

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

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

4.8.2. Thermal image with memory

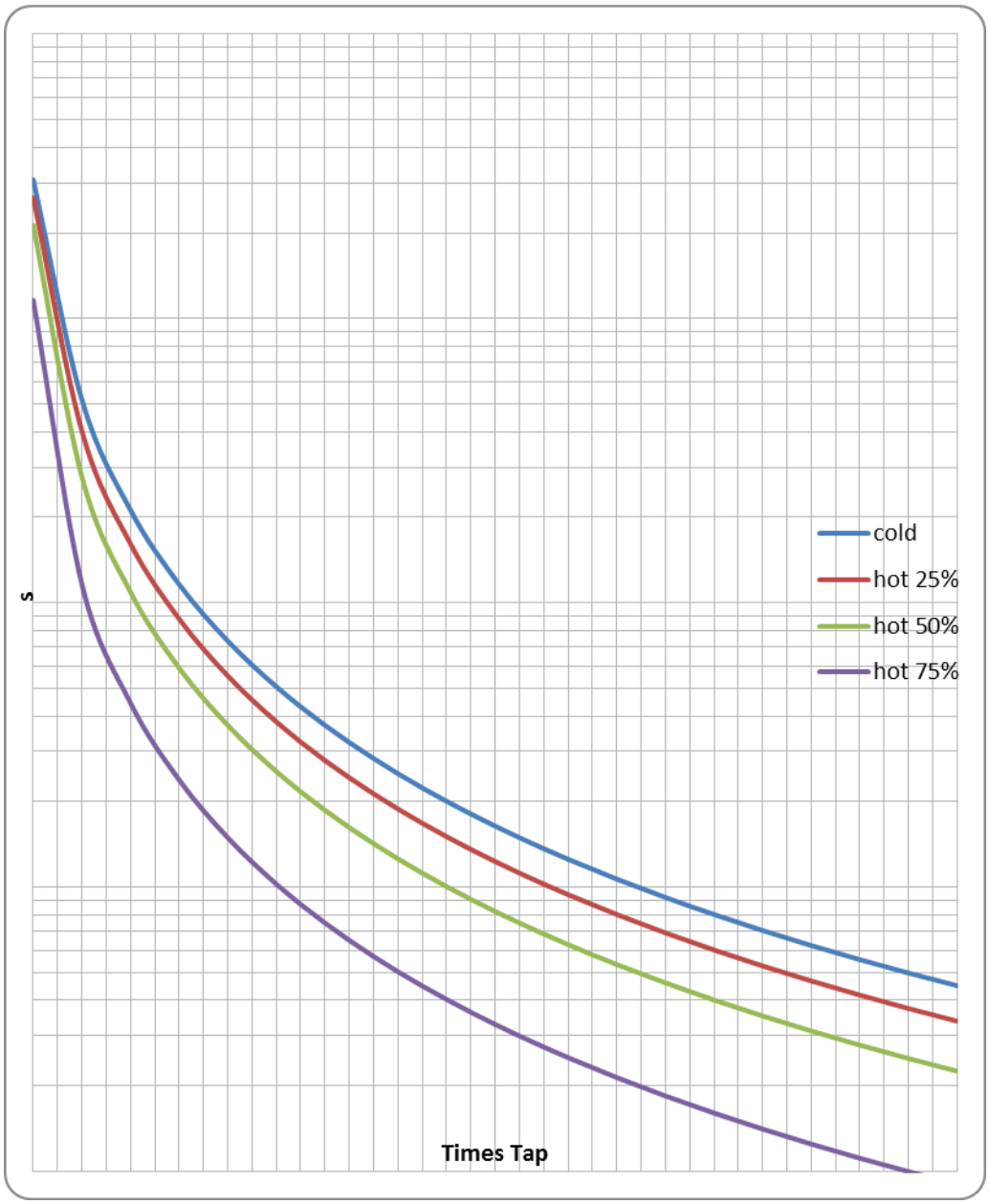
Thermal image is stored in non-volatile RAM memory periodically every second. By this way, though the relay loses the power supply, it will keep the thermal state of the machine.

4.8.3. Thermal image measurement display. Reset.

Thermal image measurement can be displayed on Measurement menu and Counters menu.

Display is possible in Measurement menu. Display and thermal image value reset is possible in Counters menu.

4.8.4. Thermal protection curves



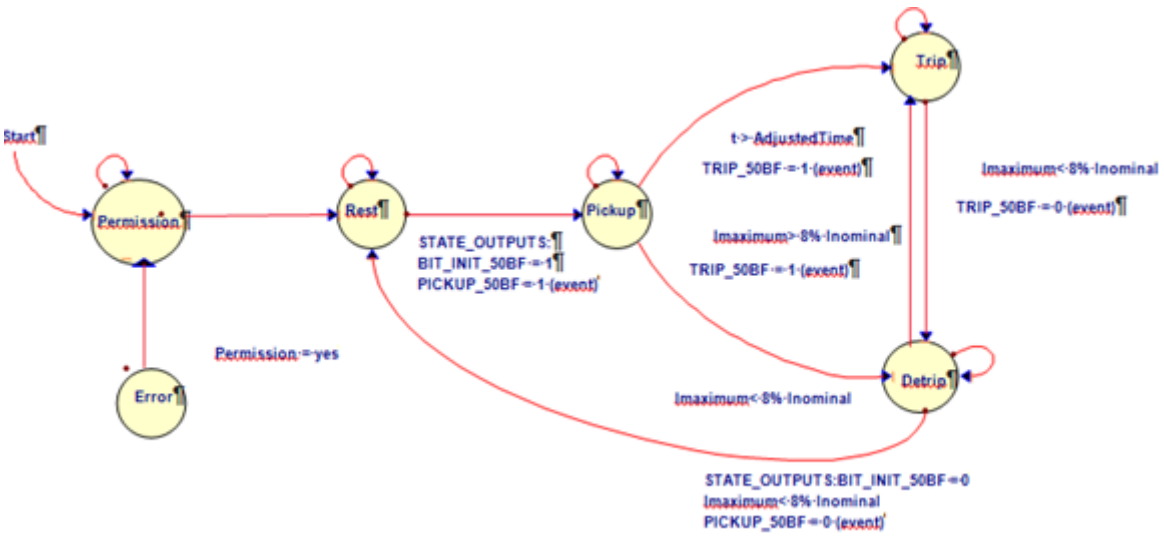
This is the thermal curve for ζ = 3 minutes.

4.9. 50BF Function. Circuit Breaker opening fault

The settings of this function are as follows:

Function	Description	Minimum	Maximum	Pitch	Unit	Default
50BF	**Circuit breaker opening fault**					
	Permission	-	-	Yes/No	-	No
	Opening fault time	0,02	1,00	0,001	s	0,2

The following automaton describes the open fault function:



When the “50BF Init” state is activated, a switch is made to the "50BF init” and time is counted. If, following the adjusted open fault time, the switch is not detected to have open, the function trips. The function is reset when the circuit breaker is detected to have opened, and the “50BF Init” state has been reset.

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 8% of the rated current, the circuit breaker is considered to be open.

The “50BF Start” state is an adjustable logic output. The default configuration is shown below:

- Opening fault input activation (50BF init)
- Circuit breaker opening from an HMI/local modbus
- Circuit breaker opening from a remote modbus
- General trip

4.10. General Settings

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

Function	Description	Minimum	Maximum	Pitch	Unit	Default
	General settings					
	Equipment identifier (1*)	-	-	-	-	"free text"
	Frequency	-	-	*60/50*	*Hz*	*50*
	Serial Number	-	-	-	-	*0*
	Language	-	-	-	-	English
	Settings active group (2*)	1	3	1	-	1
	Transformation ratio of the phase CTs	1.0	2000.0	0.1	-	100
	Transformation ratio of the neutral CTs	1.0	2000.0	0.1	-	100
	Local communication address	1	247	1	-	1
	Password	-	-	-	-	****
	Remote communication address	1	247	1	-	2
	Remote communication baudrate	4800	38400	-	bps	19600

(1*) "EQUIPMENT IDENTIFIER" setting is adjustable by communications and through HMI.

(2*) "SETTINGS ACTIVE GROUP" setting can be changed also through inputs.

NOTE: When the frequency is changed it is necessary to reinitialize the relay twice to ensure that the setting is loaded correctly.

4.11. Setting Group

There are three group settings tables and one general table. The settings table which is active at a specific moment can be modified in two ways:

- Changing the active Table settings. In the general group there is a setting which establishes which table is active.
- By means of two inputs. To this end four possibilities are defined.

Input-2	Input-1	Setting group
0	**0**	This situation is governed by the active table settings.
0	**1**	Table 1
1	**0**	Table 2
1	**1**	Table 3

If none of the inputs is activated (the zero position) the active item is defined by the active table settings defined in the general group. Regarding other options, regardless of that established by the settings, the inputs prevail over the settings.

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

If both inputs are activated item is defined by table 3.

4.12. Protection Settings

The SIA-F's settings are listed below with their description, maximums, minimums, units and the values for the factory settings.

Group	Description	Minimum	Maximum	Step	Unit	Default
50P	**Phases instantaneous overcurrent**					
	Permission	-	-	Yes/No	-	No
	Tap	0,10	30,00	0,01	Inominal	5,00
	Operating time	0,02	300,00	0,01	s	0,2
50/51P	**Phase inverse time overcurrent**					
	Permission	-	-	Yes/No	-	No
	Curve	-	-	(1*)	-	Extremely inverse
	Dial	0,02	1,25	0,01	-	1,25
	Tap	0,10	7,00	0,01	I nominal	1,00
	Operating time	0,02	300,00	0,01	s	0,2
50N/G	**Neutral instantaneous overcurrent**					
	Permission	-	-	Yes/No	-	No
	Tap	0,10	30,00	0,01	I nominal	1,00
	Operating time	0,02	300,00	0,01	s	0,2
50/51N/G	**Neutral inverse time overcurrent**					
	Permission	-	-	Yes/No	-	No
	Curve	-	-	(1*)	-	Extremely inverse
	Dial	0,02	1,25	0,01	-	1,25
	Tap	0,10	7,00	0,01	I nominal	0,50
	Operating time	0,02	300,00	0,01	s	0,2
CLP	**Cold Load Pickup**					
	Permission	-	-	Yes/No	-	No
	Setting group	1	3	1	-	3
	No Load time	0.02	300.00	0.01	s	15
	Cold Load Time	0.02	300.00	0.01	s	15

Group	Description	Minimum	Maximum	Step	Unit	Default
	Trip block protection for the switchgear					
	Blocking	-	-	Yes/No	-	Yes
	Blocking limit	1,50	20,00	0,01	I nominal	7,00
52	**Circuit breaker monitoring**					
	Excessive number of openings	1	10000	1	-	10
	Maximum accumulated amps	1	100000	1	$M(A^2)$	1000
	Opening time	0,02	300,00	0,01	s	0,10
	Closing time	0,02	300,00	0,01	s	0,10
	Excessive repeated openings	1	10000	1	-	3
	Time of excessive repeated openings	1,00	300,00	0,01	min	9,00
49	**Thermal Image**					
	Permission	-	-	Yes/No	-	No
	Tap	0,10	2,40	0,01	I nom	1,2
	ζ heating	3	600	1	min	3
	ζ cooling	1	6	1	ζ heating	1
	Alarm	20	99	1	%	80
50BF	**Circuit breaker opening fault**					
	Permission	-	-	Yes/No	-	No
	Opening fault time	0,02	1,00	0,01	s	0,2

Protection settings can be changed by HMI and by communication.

Every settings change implies the initialization of the functions; even the functions are not activated.

4.13. IEC 60255-151 Curves

The SIA-F relay complies with the curves shown in standard IEC 60255-151 Curves:

- Inverse Curve
- Very Inverse Curve
- Extremely Inverse Curve

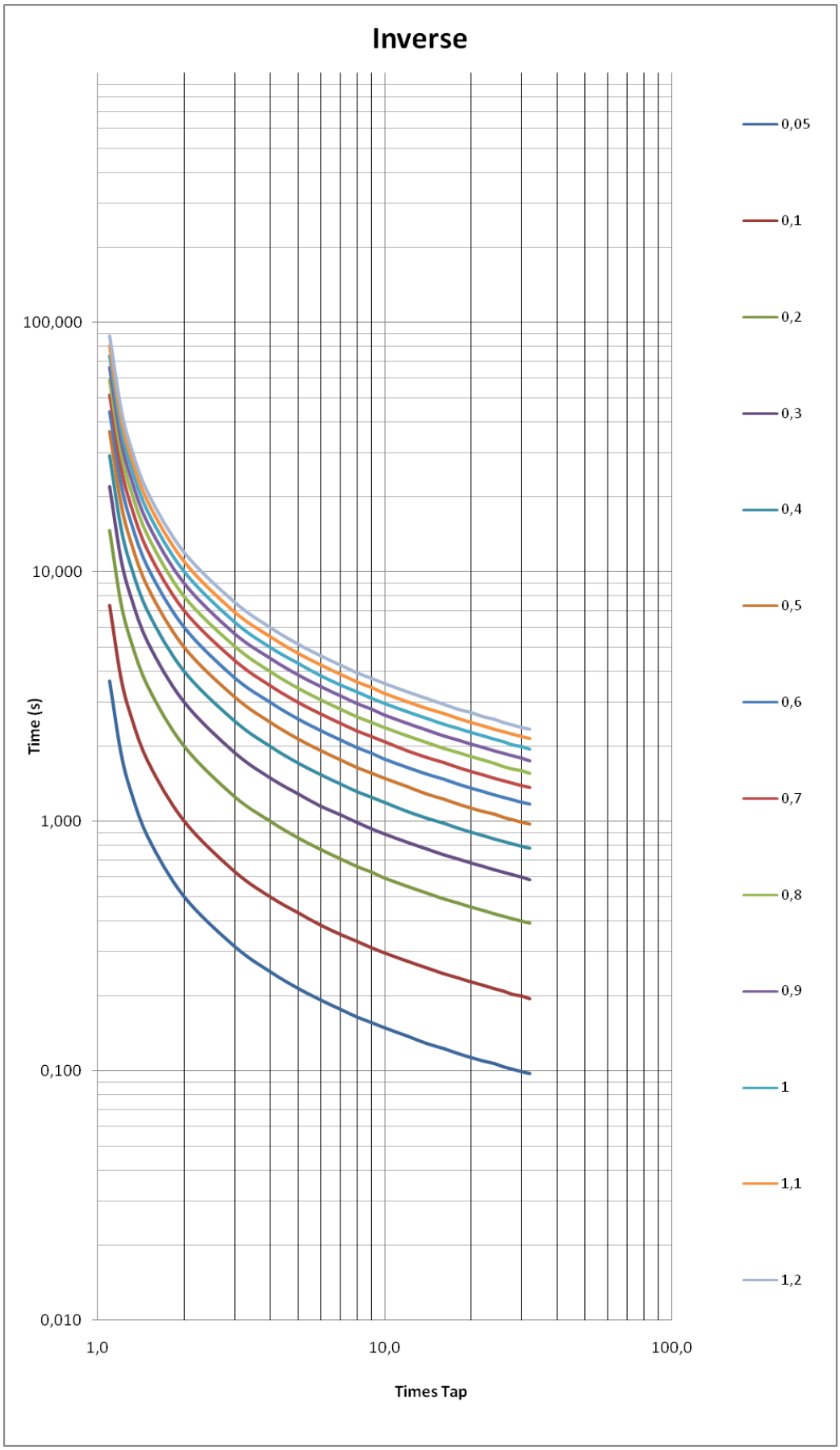
There is a general mathematical equation that defines the time in seconds as a function of the current:

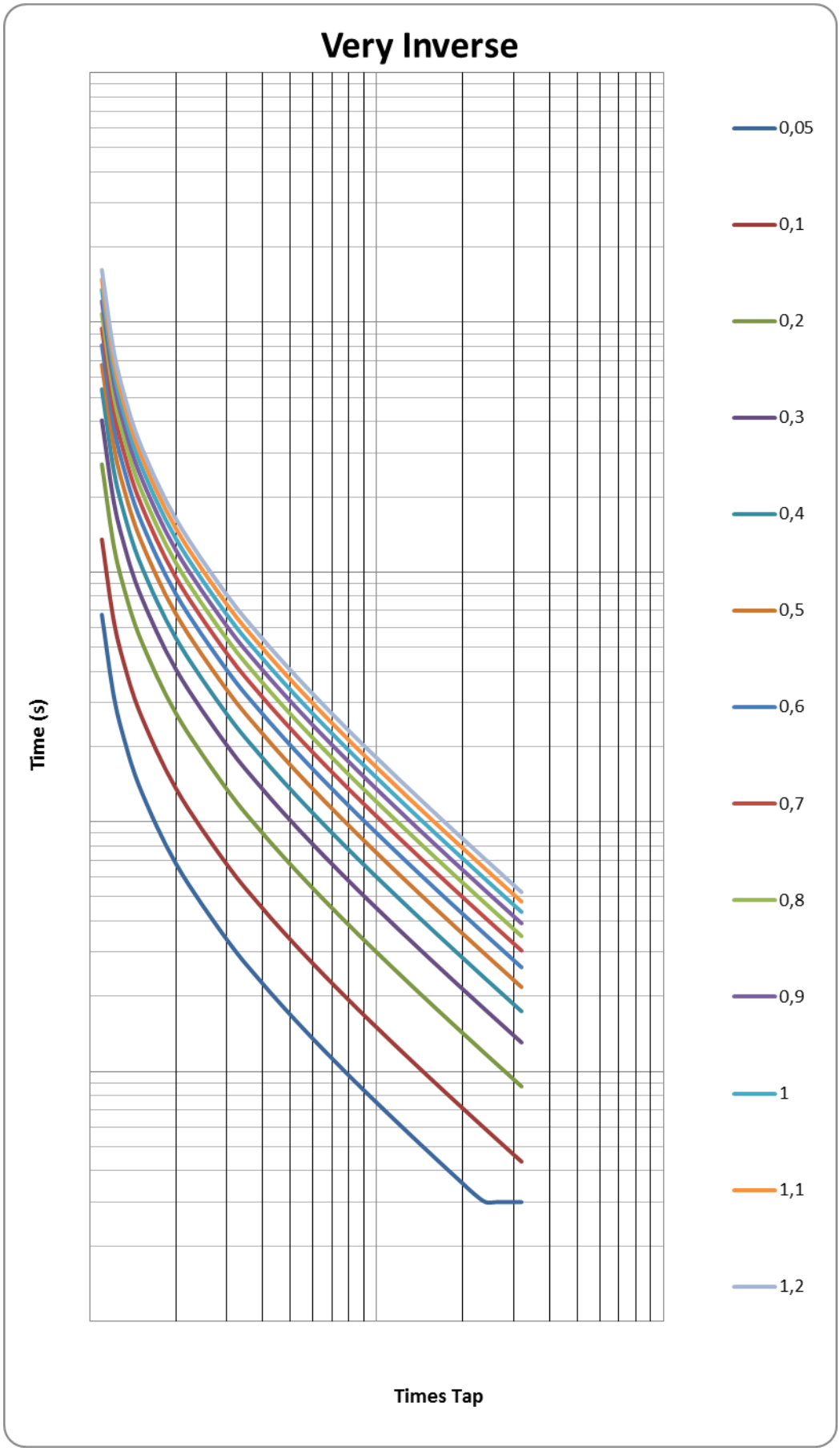
$$t = \frac{A \times D}{V^P - Q} + B \times D + K \qquad V = \frac{I}{I_{adjusted}}$$

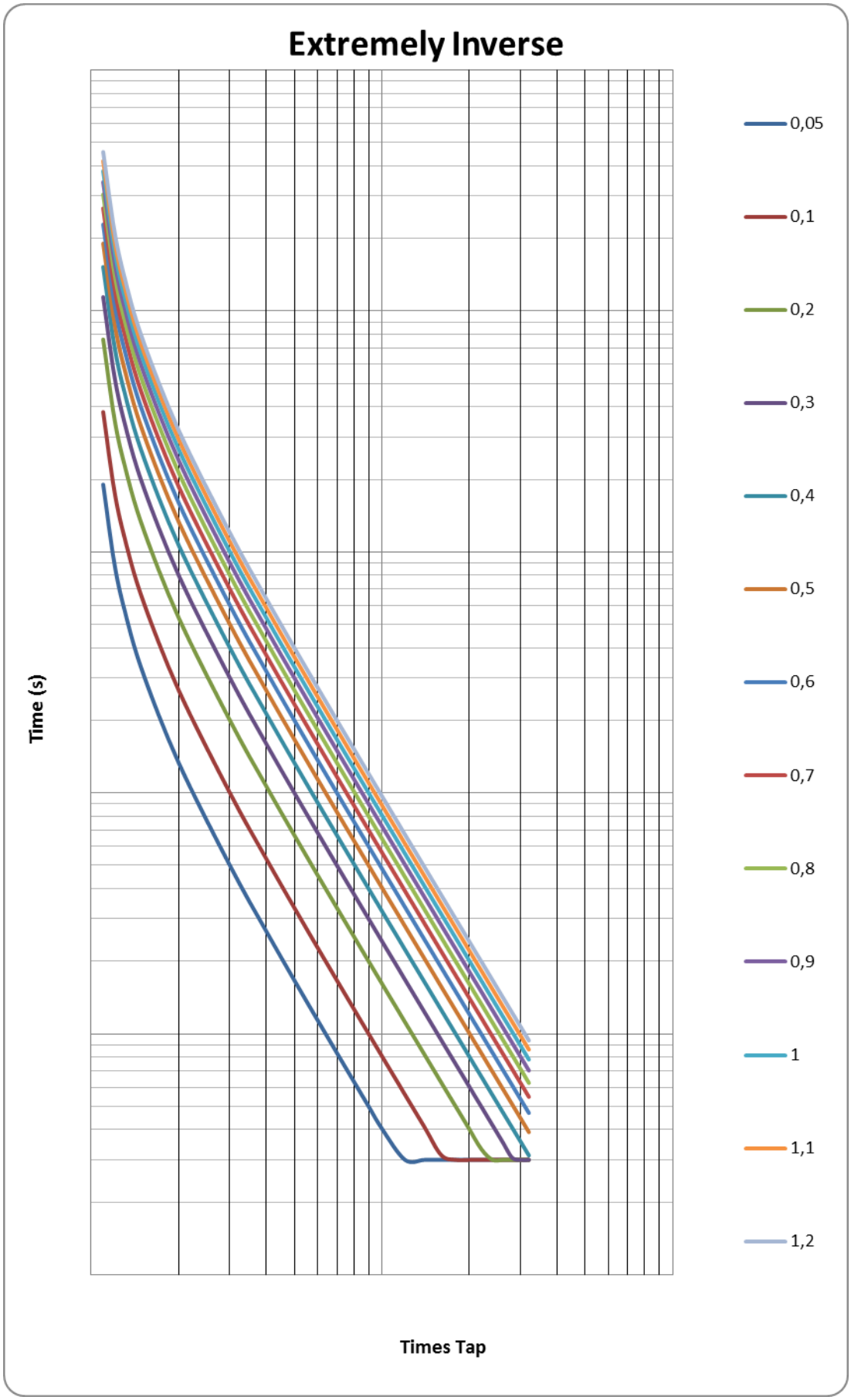
Parameters	A	P	Q	B	K
Ext. Inverse	80	2	1	0	0
Very Inverse	13,5	1	1	0	0
Inverse	0,14	0,02	1	0	0

The curve can be displaced on the axis using the time dial, **D**, which can be adjusted by the user.
V is Times Tap

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


Inverse
100,000
10,000
1,000
0,100
0,010
Time (s)
1,0
10,0
100,0
Times Tap
0,05
0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
1
1,1
1,2


Very Inverse
Time (s)
Times Tap
0,05
0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
1
1,1
1,2


Extremely Inverse
Time (s)
Times Tap
0,05
0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
1
1,1
1,2

4.14. Application examples

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

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

50 function settings

- Tap: 11xI_n
- Operating time: 0.05 s

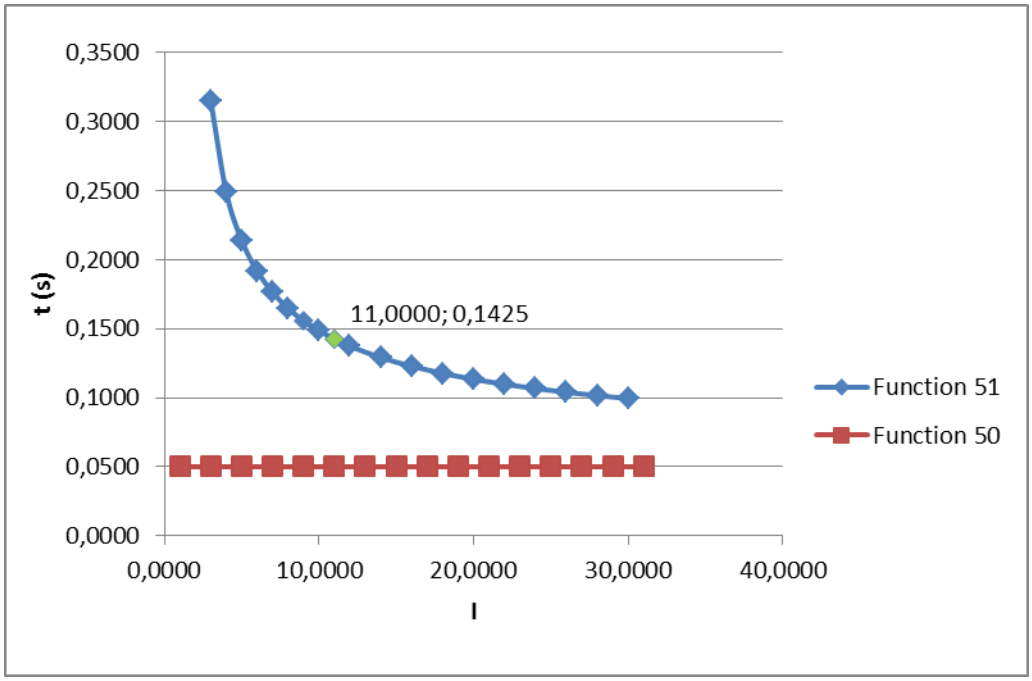


Figure 1. 50 y 50/51 IEC Inverse

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 $11xI_n$, definite time overcurrent function will be work.

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

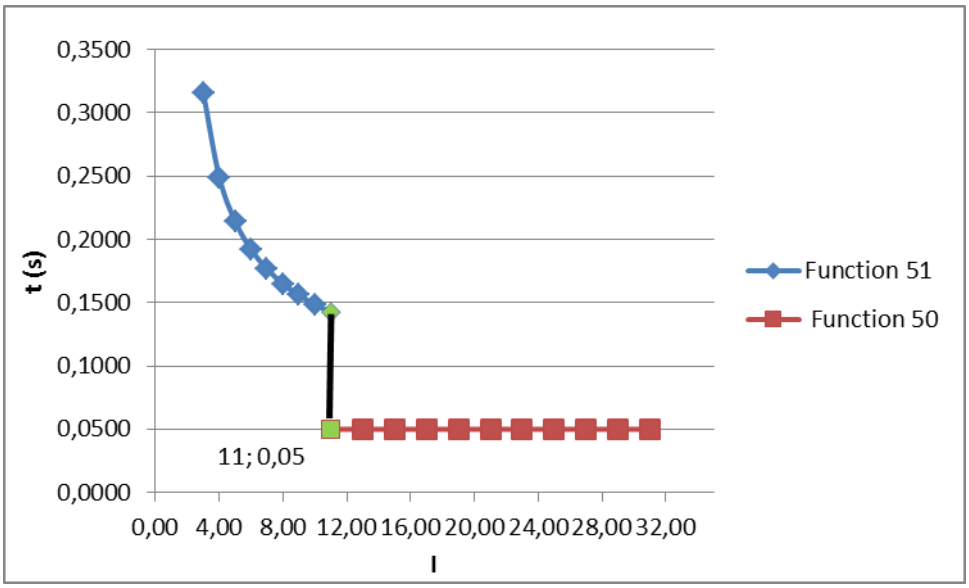


Figure 2. Relay tripping curve

APPLICATION EXAMPLE 2

Starting from the following information:

***Line details**:*

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

50/51 function settings

- Curve type: ANSI Extremely Inverse
- Dial: 2.20
- Tap: $1xI_n$

50 function settings

- Tap: $14xI_n$
- Operating time: 0.1 s

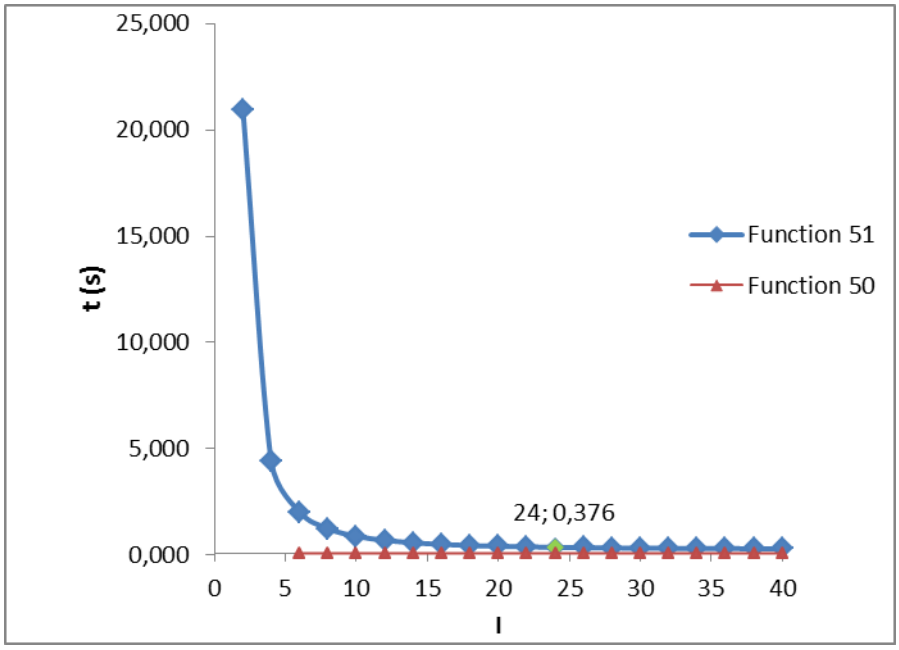


Figure 3. 50 y 50/51 ANSI Extremely Inverse

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

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

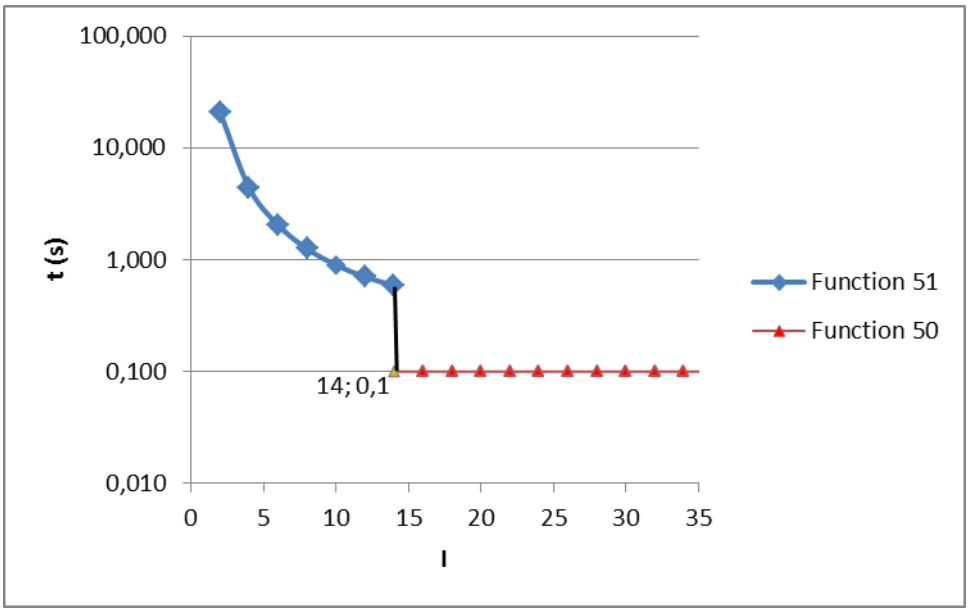


Figure 4. Relay tripping curve

APPLICATION EXAMPLE 3

In this example it is explained what occurs when it is selected in curve type parameter “DEFINITE TIME”. In this case, 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
- Operating time: 5 s

50 function settings

- Tap: 15xIn
- Operating time: 1 s

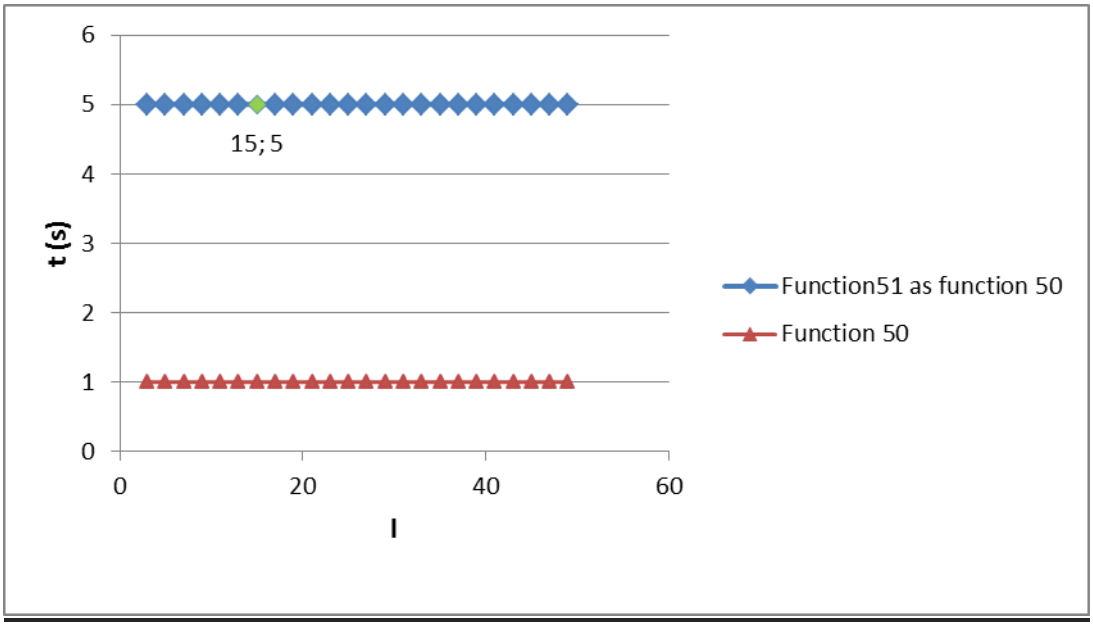


Figure 5. Function 50/51 (as 50) and function 50.

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 $15xI_n$, definite time overcurrent function will be work function 50).
The figure below (Figure 6), shows the tripping curve of the relay:

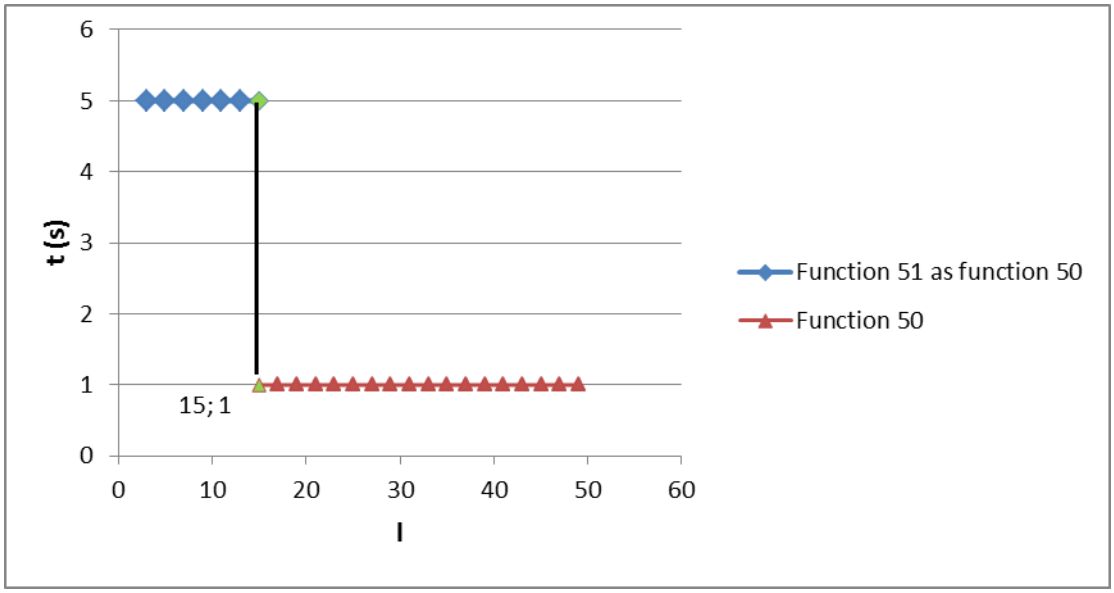


Figure 6. Relay tripping curve

5. MONITORING AND CONTROL

5.1. Measurements

Measurements of the thermal image, three-phase currents, neutral current and maximum current are given in RMS. A sampling, of 16 samples/cycle, is performed.

The accuracy of the measurement is ±2% over a band of ±20% of rated current and ±4% over the rest of the measurement range.

Below are the phase and neutral measurement ranges of the SIAF models. There values are understood as secondary current:

Model	Phase range	Neutral range	Phase rated current	Neutral rated current
SIAF5*	1-150 A	*	5 A	*
SIAF1*	0,2-30 A	*	1 A	*
SIAF*5	*	1-150 A	*	5 A
SIAF*1	*	0,2-30 A	*	1 A
SIAF*B	*	0,04-6 A	*	0,2 A

- Frequency — 50 Hz or 60 Hz rated. ± 3 Hz
- Thermal resistance — Twice the continuous rated current

5.2. Counters

The SIA-F stores in non-volatile FRAM memory:

- Breaker opening number
- Accumulated amperes during the breaker opening

5.3. States and Events

The state is given by real-time information generated by the equipment. Some states have an event associate with them, which is a register of a change made to the state.

Group	Status
50P	**Definite time phase overcurrent**
	50P_1 Phase A pickup
	50P_1 Phase B pickup
	50P_1 Phase C pickup
	50P_1 Pickup
	50P_1 Phase A trip
	50P_1 Phase B trip
	50P_1 Phase C trip
	50P_1 Trip
50/51P	**Inverse-time phase overcurrent**
	50/51P Phase A pickup
	50/51P Phase B pickup
	50/51P Phase C pickup
	50/51P Pickup
	50/51P Phase A trip
	50/51P Phase B trip
	50/51P Phase C trip
	50/51P Trip
50N/G	**Definite-time neutral overcurrent**
	50N/G Pickup
	50N/G Trip
50/51N/G	**Inverse-time neutral overcurrent**
	50/51N/G Pickup
	50/51N/G Trip
CLP	**Cold Load pickup**
	CLP disable
	52 Closed

	52 Open
	52 Definitive open
	Close Cold Load
	Open Cold load
	Cold Load Pickup
INPUTS (*)	**Inputs**
	Input 1
	Input 2
OUTPUTS (*)	**Outputs**
	Led ON
	Led Alarm
	Led Trip
	Trip Output
	Output 2
	Output 3
	52a
	52b
	External trip
	50BF Init
	Fault Init
	50P Block
	50N/G Block
	Reset
	Settings Group 1
	Settings Group 2
49 (*)	**Thermal Image**
	49 Alarm
	49 Trip
50BF (*)	**Breaker Failure**
	50BF Pickup
	50BF Trip

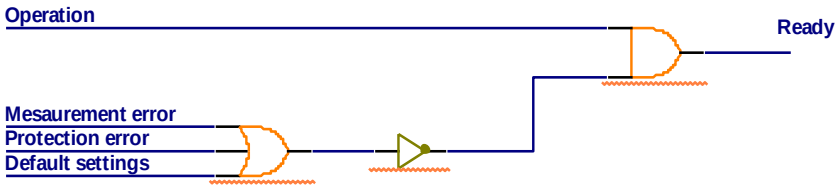
52 (*)	**Circuit Breaker Monitoring**
	52 Start
	52 Error
	52 Open
	52 Opening time
	52 Opening Error
	52 Close
	52 Closing Time
	52 Closing error
	Openings number alarm
	Alarm I2t
	Openings/time
	Contact 52a
	Contact 52b
GENERALS	**General states**
	General trip
	External Trip
	50Hz
	Trip Block Enable
	Measure error
	Ready
	Settings changed
	Data/time synchronozation
	Local Activity
	Factory settings
	Eeprom Error
	Eeprom change
	Events error
REMOTE (*)	**Remote**
	Remote COM.
	Open breaker

	Close breaker
	Reset TI
LOCAL	**Modbus local**
	Local COM.
	HMI Activity
	Open breaker
	Close breaker
	Reset TI

(*)Optional depending on model

A brief description of the general statuses is given below:

- **Trip:** The equipment has tripped. This bit is the or of all the trips, of any functions, plus the external trip input. Should it be required that a function does not generate a trip, this must be prohibited individually. In the case of the external trip input, it is sufficient to not set it.
- **External trip**: A trip has occurred because of external trip input activation
- **Measurement error:** The self-diagnosis algorithms have detected a problem in the measurement block.
- **Protection error:** The self-diagnosis algorithms have detected a problem in the protection block.
- The **Ready bit** agglutinates correct relay operation and has the following logic:



This bit is normally assigned to a contact with an NC contact.

- **Setting change:** This activates when the settings are changed.
- **Date-time setting:** This activates when the date-time are synchronized.
- **Factory settings**: the equipment is set to default settings and does not execute the trip.
- **Eeprom Error:** The self-diagnosis algorithms have detected a problem in the eeprom memory, which contains the settings.
- **Eeprom change:** this activates when the settings or configuration are changed. The settings change which this indication includes are differentiated from the configuration change, which are also stored in said memory.
- **Events error:** The self-diagnosis algorithms have detected a corrupt event in the circular buffer. This bit is reset by deleting the events (from the HMI or by using communications).
- **HMI Activity:** this condition is active if any key has been pressed in the last 15 minutes. Pressing a key implies that the relay is in local.
- **Local communication:** this state is activated when communication through USB port is detected.

Some states have an event associate with them, which is a register of a change made to the state. There are states that have an activation event associated with them, and other states have two associated events: activation and reset. These events are registered in a circular memory (buffer) with a capacity for up to 200 events. The memory timestamp is accurate to 1 millisecond.

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 equipment. To delete the events using the HMI, you have to go to the events menu and press and hold the "RESET" key until the number of events reads 1, and this event is registered as "Events deleted". To delete the events using communications, use the corresponding "delete events" command.

There are states that have an activation event associated with them, and other states have two associated events: activation and reset. These events are registered in a circular memory (buffer) with a capacity for up to 200 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 equipment is not powered. If the Real Time Clock is used, the relay keeps and processes the correct date and time, even without electrical power, for up to 72 hours.

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 equipment. To delete the events using the HMI, you have to go to the events menu and press and hold the "RESET" key until the number of events reads 1, and this event is registered as "Events deleted". To delete the events using communications, use the corresponding "delete events" command. To delete the events it is necessary to enter a password.

Events have the following structure:

Identify	Unique event identifier: e.g.: 51_1.4 = 51P START
Value	ON(Activated) /OFF(Deactivated): an event is generated for activations and deactivations
Year	
Month	
Day	
Time	
Minutes	
Seconds	
Milliseconds	

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

Register description	Bit number	Event number	Status	Event	Cause	Associated measurement
General states						
	bit-00	01	Trip	Trip	Activation/Deactivation	Maximum phase current, from trip activation until deactivation
	bit-01	02	External trip	External trip	Activation/Deactivation	-
	bit-03	07	50 Hz	50 Hz	Activation/Deactivation	-
	bit-04	08	Trip block enable	Trip block enable	Activation/Deactivation	-
	bit-05	16	Measure error	Measure error	Activation/Deactivation	-
	bit-06	17	Ready	Ready	Activation/Deactivation	-
	bit-07	19	Settings changed	Settings changed	Activation/Deactivation	-
	bit-08	21	Set data/time	Set data/time	Activation	-
	bit-09	-	Local communication	-	-	-
	bit-10	23	Factory settings	Factory settings	Activation/Deactivation	-
	bit-11	24	EEPROM error	EEPROM error	Activation/Deactivation	-
	bit-12	28	EEPROM changed	EEPROM changed	Activation/Deactivation	-
	bit-13	32	Events error	Events error	Activation/Deactivation	-
	-	-	-	Fault report	Activation/Deactivation	
	-	-	-	Fault reports erased	Activation	
	-	-	-	Events deleted	Activation	
Local communication						
	bit-00	-	Local communication	-	-	-
	bit-01	-	HMI activity	-	-	-
	bit-17	02	Open breaker	Open breaker	Activation/Deactivation	-
	bit-18	03	Closed breaker	Closed breaker	Activation/Deactivation	-
	bit-23	08	Reset thermal image	Reset thermal image	Activation/Deactivation	-

Register description	Bit number	Event number	Status	Event	Cause	Associated measurement
Inverse time phase overcurrent						
50/51P	bit-00	01	50/51P Phase A pick-up	50/51P Phase A pick-up	Activation/Deactivation	Phase A current
	bit-01	02	50/51P Phase B pick-up	50/51P Phase B pick-up	Activation/Deactivation	Phase B current
	bit-02	03	50/51P Phase C pick-up	50/51P Phase C pick-up	Activation/Deactivation	Phase C current
	bit-03	04	50/51P Pick-up	50/51P Pick-up	Activation/Deactivation	-
	bit-08	05	50/51P A Trip	50/51P A Trip	Activation/Deactivation	Phase A current
	bit-09	06	50/51P B Trip	50/51P B Trip	Activation/Deactivation	Phase B current
	bit-10	07	50/51P C Trip	50/51P C Trip	Activation/Deactivation	Phase C current
	bit-11	08	50/51P Trip	50/51P Trip	Activation/Deactivation	-
Definite time phase overcurrent						
50P	bit-00	01	50P Phase A pick-up	50P Phase A pick-up	Activation/Deactivation	Phase A current
	bit-01	02	50P Phase B pick-up	50P Phase B pick-up	Activation/Deactivation	Phase B current
	bit-02	03	50P Phase C pick-up	50P Phase C pick-up	Activation/Deactivation	Phase C current
	bit-03	04	50P Pick-up	50P Pick-up	Activation/Deactivation	-
	bit-08	05	50P A Trip	50P A Trip	Activation/Deactivation	Phase A current
	bit-09	06	50P B Trip	50P B Trip	Activation/Deactivation	Phase B current
	bit-10	07	50P C Trip	50P C Trip	Activation/Deactivation	Phase C current
	bit-11	08	50P Trip	50P Trip	Activation/Deactivation	-
Inverse time neutral overcurrent						
50/51N/G	bit-04	01	50/51N/G Pick-up	50/51N/G Pick-up	Activation/Deactivation	Neutral current
	bit-12	02	50/51N/G Trip	50/51N/G Trip	Activation/Deactivation	Neutral current
Definite time neutral overcurrent						
50N/G	bit-04	01	50N/G Pick-up	50N/G Pick-up	Activation/Deactivation	Neutral current
	bit-12	02	50N/G Trip	50N/G Trip	Activation/Deactivation	Neutral current

Register description	Bit number	Event number	Status	Event	Cause	Associated measurement
Cold Load Pickup						
CLP	-	-	CLP Disable	-	-	-
	-	-	52 Closed	-	-	-
	-	-	52 Open	-	-	-
	-	-	52 Definitive open	-	-	-
	-	-	Close Cold Load	-	-	-
	-	-	Open Cold load	-	-	-
	bit-	02	Cold Load Pickup	Cold Load Pickup	Activation/Deactivation	-
Inputs						
	bit-00	17	Input 1	Input 1	Activation/Deactivation	-
	bit-01	18	Input 2	Input 2	Activation/Deactivation	-

Register description	Bit number	Event number	Status	Event	Cause	Associated measurement
Outputs						
	bit-00	-	LED On	-	-	-
	bit-01	-	LED Alarm	-	-	-
	bit-02	-	LED Trip	-	-	-
	bit-03	01	Trip Output	Trip Output	Activation/Deactivation	-
	bit-04	02	Output 2	Output 2	Activation/Deactivation	-
	bit-05	03	Output 3	Output 3	Activation/Deactivation	-
	bit-06	18	52a	52a	Activation/Deactivation	-
	bit-07	19	52b	52b	Activation/Deactivation	-
	bit-08	22	External trip	External trip	Activation/Deactivation	-
	bit-09	07	50BF start	50BF start	Activation/Deactivation	-
	bit-10	08	Fault start	Fault start	Activation/Deactivation	-
	bit-11	20	50P block	50P block	Activation/Deactivation	-
	bit-12	21	50N/G block	50N/G block	Activation/Deactivation	-
	bit-13	23	Reset	Reset	Activation/Deactivation	
	bit-14	24	Active group 1	Active group 1	Activation/Deactivation	
	bit-15	25	Active group 2	Active group 2	Activation/Deactivation	
Trip block protection for the switchgear						
	bit-00	01	Phase A block	Phase A block	Activation/Deactivation	Phase A current
	bit-01	02	Phase B block	Phase B block	Activation/Deactivation	Phase B current
	bit-02	03	Phase C block	Phase C block	Activation/Deactivation	Phase C current
	bit-03	04	Phase block	Phase block	Activation/Deactivation	-

Register description	Bit number	Event number	Status	Event	Cause	Associated measurement
Thermal image						
49	bit-04	01	49 Alarm	49 Alarm	Activation/Deactivation	Thermal image value
	bit-12	02	49 Trip	49 Trip	Activation/Deactivation	Thermal image value
Breaker failure						
50BF	bit-00	01	50BF Pick-up	50BF Pick-up	Activation/Deactivation	-
	bit-01	02	50BF Trip	50BF Trip	Activation/Deactivation	-
Circuit breaker monitoring						
52	bit-00	01	52 Start	52 Start	Activation/Deactivation	-
	bit-01	02	52 Error	52 Error	Activation/Deactivation	-
	bit-02	03	52 Open	52 Open	Activation/Deactivation	-
	bit-03	04	52 Opening time	52 Opening time	Activation	-
	bit-04	05	52 Opening error	52 Opening error	Activation/Deactivation	-
	bit-05	06	52 Closed	52 Closed	Activation/Deactivation	-
	bit-06	07	52 Closing time	52 Closing time	Activation	-
	bit-07	08	52 Closing error	52 Closing error	Activation/Deactivation	-
	bit-08	09	Excessive number of openings	Excessive number of openings	Activation/Deactivation	-
	bit-09	10	Excessive accumulated amperes	Excessive accumulated amperes	Activation/Deactivation	-
	bit-10	11	Excessive openings per time	Excessive openings per time	Activation/Deactivation	
	bit-11	12	Contact 52a	Contact 52a	Activation/Deactivation	-
	bit-12	13	Contact 52b	Contact 52b	Activation/Deactivation	-
Remote communication						
	Bit-00	-	Remote communication	-	-	-
	bit-17	02	Open breaker	Open breaker	Open breaker	-
	bit-18	03	Close breaker	Close breaker	Close breaker	-
	bit-23	08	Reset thermal image	Reset thermal image	Reset thermal image	-

5.4. Fault Reports

A fault report is a record of specific events in the period of time when a fault occurs. Event recording can be filled with general events, which provide no information of a fault (settings change, local pulsing, etc.) whereby it could be filled with general information, losing any fault information. Therefore, having a specific events record for the fault period is of significant help to resolve an incident.

This record has a 4 fault capacity, and each fault can store 24 events. At any moment, the information of the twenty most recent fault reports is available. Each new fault report generated is stored on the oldest, is lost, therefore, the information of this one. The fault report is time limited by means of a fault start and a fault end, and these must be clearly established.

The fault report´s start is configurable. When all start-ups disappear it is understood that the fault has disappeared.

The four fault reports are registered in non-volatile FRAM memory. 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 REPORTS” screen. The next information can be checked:

- Date-time at which the fault started.
- List of all events occurred in the equipment during the fault.

To delete the fault reports buffer, position the cursor over the fault report menu and press and hold the "RESET" key, until there is no fault reports. There will be an event "Fault reports erased".

5.5. 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 has a capacitor that allows operation while maintaining the date and time even without power, up to 72 hours (It is understood that the capacitor was previously loaded).

If an event queue occurs, and if synchronized with a date-time previous to the last stored event, the relay will not rearrange the queue but will store the new events immediately after the stored events.

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.

5.6. Digital Inputs

The SIA-F has two digital inputs that can be configured by the user.

The configuration of the inputs is described in point *5.7 Programmable Logic Control & Digital Outputs.*

5.7. Programmable Logic Control & Digital Outputs

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

Physical inputs are the real inputs of the device. SIA-F device has two physical inputs (Input 1 and Input 2). These inputs are translated to two internal binary states which later, can be assigned to logical signal to get a specific operation.

Physical outputs are the real outputs of the Device. SIA-F has a trip output and other two digital outputs (*Output 2 and Output 3).* SIA-F device has 3 LEDS (*ON, Alarm and Trip*), which receive the same treatment as the physical outputs, some working on output relays and others working on led diodes.

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.

LEDs	LED On
	LED Alarm
	LED Trip
PHYSICAL OUTPUTS	Trip Output
	Output 2
	Output 3
LOGICAL SIGNALS	52a contact logical signal
	52b contact logical signal
	External Trip logical signal
	50BF start logical signal
	Fault start logical signal
	50P block logical signal
	50G block logical signal
	Reset logical signal
	Active group 1 logical signal
	Active group 2 logical signal

All the outputs (Leds, physical outputs and logical signals) are the result of a PROGRAMMABLE LOGIC CONTROL which can be configured from HMI or from SICom software.

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

In V2 of the PLC the LOGICAL GATES that are supported by SIAF are:

LOGICAL GATE	HMI SYMBOL
OR4	+
NOR4	τ
OR4_LACTH	Ю
NOR4_LACTH	Φ
OR4_PULSES	⌠
AND4	&
NAND4	§
AND4_PULSES	$

By default, outputs configuration is:

	OUTPUT	*LOGICAL GATE*	BINARY STATES
LEDs	LED On	*OR4_PULSES*	• Ready
	LED Alarm	*NOR4*	• Ready
	LED Trip	*OR4_LACTH*	• General trip
PHYSICAL OUTPUTS	Trip output	*OR4*	• Local opening • General trip
	Output 2	*OR4*	• Local closing
	Output 3	*No configured*	
LOGICAL SIGNALS	52a contact logical signal	*No configured*	
	52b contact logical signal	*OR4*	• Input-2
	External Trip logical signal	*OR4*	• Input-1
	50BF start logical signal	*OR4*	• Local opening • Remote opening • General trip
	Fault start logical signal	*OR4_LACTH*	• General trip
	50P block logical signal	*Not configured*	
	50G block logical signal	*Not configured*	
	Reset logical signal	*Not configured*	
	Active group 1 logical signal	*Not configured*	
	Active group 2 logical signal	*Not configured*	

We are going to use configuration by default as an example:

OUTPUT	LOGICAL GATE	BINARY STATES	DESCRIPTIONS
LED On	*OR4_PULSES*	• Ready	Led On blinks when internal signal “READY” of general state of the device is activated, this indicates that the device is working correctly without any failures.
LED Alarm	*NOR4*	• Ready	Led alarm will activate when internal signal “READY” of general state of the device is deactivated, this indicates some failure has occurred.
LED Trip	*OR4_LACTH*	• General Trip	Led trip will activate when internal signal “GENERAL TRIP” of general state of the device is activated, this indicates that some protection function has tripped. This led will continue activated until the reset of the leds is made.
Trip output	*OR4*	• Local opening • General trip	Trip output will activate when there is a general trip or when 52 opening command is carried out, from local communications or from HMI.
Output 2	*OR4*	• Local closing	Output 2 will be activated when 52 closing command is carried out from local communications or from HMI.
52b logical signal	*OR4*	• Input-2	When physical input 2 is activated, 52a logical output will be activated, and it will used to determine the breaker state.
External trip logical signal	*OR4*	• Input-1	When physical input 1 is activated external trip logical output will be activated, and it will be used to generate a general trip by general protection function.
Start 50BF logical signal	*OR4*	• Local opening • Remote opening • General trip	When a general trip has occurred or when 52a opening command is carried out from local communications start 50BF logical output will be activated and it will be used to initiate the detection of breaker failure by 50BF function.
Fault Start logical signal	*OR4_LACTH*	• General trip	When general trip is activated, fault start logical output will be activated and it will generate a new fault register.

5.8. 86 Function. Trip Output Lockout

When the TRIP OUTPUT is configured like OR4_LACTH the programmable logic allows this output to block.

5.9. Self-diagnosis

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

As general considerations, we should point the following:

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

The following state bits are associated with this process:

Measurement error	Problem in the measurement block
Protection error	Problem in the protection block
Eeprom error	Problem in the eeprom memory, some group is corrupt
Events error	Error in the register of events

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

5.10. Commands

By HMI o by communications is possible to (depending on model):

- Open Breaker
- Close Breaker
- Reset Thermal Image

5.11. Test Menu

The SIA-F equipment has a test menu that can be used to check the operation of the signalling components (LED indicators) and the outputs. It is important to point out that the operation of the outputs is not guaranteed if the test is performed with the battery.

The following table shows the components that can be tested, along with their state depending on whether they are activated or deactivated:

LED ON	Deactivated	On LED off
	Activated	On LED green blinking
LED ALARM	Deactivated	Alarm LED off
	Activated	Alarm LED red fixed
LED TRIP	Deactivated	Trip LED off
	Activated	Trip LED red fixed
Trip Output	Deactivated	Trip Output deactivated
	Activated	Trip Output activated
Output 2	Deactivated	Output 2 deactivated
	Activated	Output 2 activated
Output 3	Deactivated	Output 3 deactivated
	Activated	Output 3 activated

The following key sequence is used to gain access to the test menu: from the main menu, press the keys “◄”, “▼”, and “►” in sequence and then press and hold the "OK" key until the "Test menu" appears on the display. 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.

To obtain more detailed information, the method for navigating the menus is explained graphically in the keypad and display section.

5.12. Power supply

The SIA-F equipment is designed to be supplied from an auxiliary voltage of 110-230 Vac / 90-300 Vdc or 24-48 Vdc (can be selected for each model).

It can also be supplied from a USB cable which is connected through the serial port and goes directly till PC permitting the power supply and the communication simultaneously or from a KITCOM adaptor which 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 normally cause more events, ground connections, forgotten tools, poor terminations, etc.

6. TECHNICAL SPECIFICATIONS AND STANDARDS

6.1. Technical Specifications

Function 50P	Permission: yes/no
	Operating range: 0.10 to 30 x In (step 0.01)
	Operating time: 0.02 to 300 s (step 0.01s)
	Activation level 100%
	Deactivation level 95%
	Instantaneous deactivation
	Timing accuracy: ±30 ms or ±0,5% (whichever is greater)
Function 50N/G	Permission: yes/no
	Operating range: 0.10 to 30 x In (step 0.01)
	Operating time: 0.02 to 300 s (step 0.01s)
	Activation level 100%
	Deactivation level 95%
	Instantaneous deactivation
	Timing accuracy: ±30 ms or ±0,5% (whichever is greater)
Function 50/51P	Permission: yes/no
	Operating range: 0.10 to 7 x In (step 0.01)
	Curves: IEC 60255-151
	Operating time: inverse curve, very inverse curve, extremely inverse curve. Defined time: 0.02 to 300 s (step 0.01 s)
	Dial: 0.02 to 1.25 (step 0.01)
	Curve, activation level 110%
	Curve, deactivation level 100%
	Defined time, activation level 100%
	Defined time, deactivation level 95%
	Instantaneous deactivation
	Timing accuracy: 5% or 30 ms (whichever is greater)
Function 50/51N/G	Permission: yes/no
	Operating range: 0.10 to 7 x In (step 0.01)
	Curves: IEC 60255-151

	Operating time: inverse curve, very inverse curve, extremely inverse curve. Defined time: 0.02 to 300 s (step 0.01 s)
	Dial: 0.02 to 1.25 (step 0.01)
	Curve, activation level 110%
	Curve, deactivation level 100%
	Defined time, activation level 100%
	Defined time, deactivation level 95%
	Instantaneous deactivation
	Timing accuracy: 5% or 30 ms (whichever is greater)
CLP	Permission: yes/no
	Setting table: 1 to 3 (step 1)
	No load time:0.02 to 300 s (step 0.02 s)
	Cold load time: 0.02 to 300 s (step 0.01 s)
Trip block protection for the switchgear	Blocking: Yes/no
	Blocking limit: 1.5 to 20 x In (step 0.01)
Circuit breaker monitoring	Circuit Breaker state: start, open, closed, error, opening time, opening error, closing time, closing error
	Input 52a and/or input 52b
	Opening and closing command
	Alarm, maximum number of openings: 1 a 10000
	Alarm, accumulated amps: 0 a 100000 M(A^2)
	Excessive repeated openings: 1 a 10000
	Time of excessive repeated openings: 1 a 300 min
Function 50BF	Function permission : yes/no
	Opening failure time: 0.02 to 1.00 s (step 0.01 s)
	Open breaker activation threshold: 8% In
	Open breaker reset threshold: 10% In
	Function start: Device trip, opening failure input activation, breaker opening command activation
Function 49	Function permission : yes/no
	Tap: 0.10 a 2.40 Inominal (step 0.01)
	ζ heating: 3 a 600 minutes (step 1 min)

	ζ cooling: 1 a 6 x ζ heating (step 1)
	Alarm level: 20 a 99% (step 1 %)
	Trip level: 100%
	Trip reset: 95% of alarm level
	Timing accuracy:± 5% or± 2 s (whichever is greater)
Programmable logic control (PLC)	OR4, OR4_LATCH, OR4_PULSES, NOR4, NOR4_LATCH, AND4, AND4_PULSES, NAND4
Function 86	Allows to latch (lock out) the contact trip due to programmable logic (PLC).
2 configurable inputs	The same voltage as auxiliary power supply
Frequency	50/60Hz
Current measure	True RMS
	Sampling: 16 samples/cycle
	Accuracy of ±2% in a band of 20% over the rated current and ±4% for the rest of measurement range
Fault reports	4 fault reports with 24 events each
Communications	USB port: Modbus RTU
	RS485 port: Modbus RTU (Optional)
Auxiliary power supply	110-230 Vac / 90-300 Vdc ±20%
	24-48 Vdc ±20%
Battery supply	With KITCOM adapter to USB
Environment	Operating temperature: -10 to 70ºC
	Storage temperature: -20 to 80 ºC
	Humidity: 95%
Transformers	3 or 4 CT /5, /1 or /0.2
Mechanical features	Metallic box
	Panel Mounting
	1/4 Rack – 4 U
	IP-54 on panel

6.2. Standards

1. EMC requirements		
- Emission		
1.1. Radiated emission	IEC 60255-26 EN 55022 EN 55011	Radiated emission limit for Class A (group 1 for EN 55011) on Enclosure port. Frequency range 30MHz - 230MHz (Quasi Peak 40dBµV/m). Frequency range 230MHz - 1000MHz (Quasi Peak 47dBµV/m)
1.2. Conducted emission	IEC 60255-26 EN 55022 EN 55011	Conducted emission limit for Class A (group 1 for EN 55011) on Auxiliary power supply port. Frequency range 0.15MHz – 0.5MHz (Quasi Peak 79µV, Avg 66µV). Frequency range 0.5MHz – 30MHz (Quasi Peak 73µV, Avg 60µV)
- Immunity		
1.3. 1MHz damped oscillatory waves	IEC 60255-26 IEC 61000-4-18	Class 3, Repetition frequency 400Hz, Duration of each application 3s. Common mode for all terminals ±2.5kV. Differential mode for all terminals excepts Communication port ±1kV
1.4. Electrostatic discharge	IEC 60255-26 IEC 61000-4-2	Level 4, Contact discharge ±8kV. Air discharge ±15kV
1.5. Radiated radiofrequency electromagnetic fields	IEC 60255-26 IEC 61000-4-3	Level 3, Test field strenght 10V/m, Frequency 80MHZ - 1000MHz and 1400MHz - 2000MHz, AM Modulation 80% for 1KHz carrier sinusoidal signal
1.6. Electrical fast transients	IEC 60255-26 IEC 61000-4-4	Level 4, Power supply to Earth terminals ±4kV, Signal and control terminals ±2kV. Repetition frequency 5KHz, Burst duration 75s.
1.7. Surge	IEC 60255-26 IEC 61000-4-5	Level 4, Line to earth for all terminals ±4kV. Line to Line for all terminals excepts Communication port ±2kV
1.8. Conducted disturbance induced by radio frequency fields	IEC 60255-26 IEC 61000-4-6	Level 3, Applied voltage 10V, Frequency 0.15MHz - 80 MHz, AM Modulation 80% for 1KHz carrier sinusoidal signal, Dwell time 1s., Test duration >10s.
1.9. Voltage dips, short interruptions and voltage variations	IEC 60255-26 IEC 61000-4-11 IEC 61000-4-29	DC Voltage Dips: 40%, 130ms and 70%, 100ms, 3 times every 10s. DC Voltage Interruption: 100ms, 3 times every 10s.
1.10. Ripple on DC input power port	IEC 60255-26 IEC 61000-4-17	Level 4, Ripple 15%, 50Hz and 100Hz
1.11. Power frequency magnetic field	IEC 60255-26 IEC 61000-4-8	Level 5, Continuous field strenght 100 A/m. Short field strenght for a duration of 3s. 1000 A/m. Frequency 50Hz.
1.12. 100KHz damped oscillatory waves	IEC 61000-4-18	Class 3, Repetition frequency 40Hz, Duration of each application 3s. Common mode: ±2.5kV. Differential mode: ±1kV

1.13. Pulse magnetic fields	IEC 61000-4-9	Field strenght 1000 A/m, Cadence between pulses 40s.
1.14. Damped oscillatory magnetic fields	IEC 61000-4-10	Level 5, Field strenght 100 A/m, Frequency 100KHz and 1MHz, Repetition frequency 40 trans./s at 100KHz, 400 trans/s at 1MHz, Duration of each application 3s.
1.15. Ring wave immunity test	IEC 61000-4-12	Level 4, Line to earth for all terminals ±4kV. Line to Line for all terminals excepts Communication port ±2kV
2. Product safety requirements (including thermal short time rating)		
2.1. Impulse voltage	IEC 60255-27 IEC 60255-5	Each group to earth and with rest of the groups in short-circuit ±5kV. Differential mode for each one of the groups ±1kV
2.2. AC or DC dielectric voltage	IEC 60255-27 IEC 60255-5	Each group to earth and with rest of the groups in short-circuit 2kVac, 50Hz, 1 minute
2.3. Insulation resistance	IEC 60255-27 IEC 60255-5	500V applied between each group to earth and with rest of the groups in short-circuit
2.4. Protective bonding resistance	IEC 60255-27	Test current 2xIn, Test voltage 12Vac during 60s. Resistance shall be less than 0.1 ohm
3. Burden		
3.1. AC burden for CT	IEC 60255-1	Declared on manual
3.2. AC burden for VT		
3.3. AC, DC burden for power supply		
3.4. AC, DC burden for binary inputs		
4. Contact performance		
	IEC 60255-27	
5. Communication requirements		
	ModBus RTU IEC 61850 IEC 60870-5-103 IEC 60870-5-104 DNP 3.0	
6. Climatic environmental requirements	**IEC 60255-27**	
6.1. Cold	IEC 60068-2-1	Cold Operation Ab, -25ºC, 72h Cold transport & Storage Ad, -40ºC, 72h
6.2 Dry heat	IEC 60068-2-2	Dry Heat Operation Bb, +70ºC, 72h Dry Heat transport & Storage Bd, +85ºC, 72h

6.3 Change of temperature	IEC 60068-2-14	Change of Temperature Nb, Upper temp +70ºC, Lower temp -25ºC, 5 cycles, Exposure time 3h, Transfer time 2 min.
6.4 Damp heat	IEC 60068-2-30	Damp Heat Cyclic Db, Upper temp +40ºC, Humidity 93%, 2 cycles. Relay energized
	IEC 60068-2-78	Damp Heat Steady State Test Cab, Upper temp +40ºC, Humidity 85%, 2 days. Relay not energized
7. Mechanical requirements	**IEC 60255-27**	
7.1. Vibration	IEC 60255-21-1 IEC 60068-2-6	Vibration response, Class 1, 10Hz to 59Hz, 0,035mm and 59Hz to 150Hz, 0.5g_n Vibration endurance, Class 1, 10Hz to 150Hz, 1g_n
7.2. Shock	IEC 60255-21-2 IEC 60068-21-2	Shock Response, Class 1, 5g_n, Shock Withstands, Class 1, 15g_n
7.3. Bump	IEC 60255-21-2 IEC 60068-21-2	Bump, Class 1, 10g_n
7.4. Seismic	IEC 60255-21-3 IEC 60068-21-3	Single Axis Sine Sweep, Class 1, X Axis: 1 to 9Hz, 3.5mm and 9 to 35Hz, 1g_n; Y Axis: 1 to 9Hz, 1.5mm and 9 to 35Hz, 0.5g_n
8. Electrical environmental requirements		
8.1. CT Input continuous overload	IEC 60255-27	3xIn without damage for continuous operation
8.2. CT Input short time overload	IEC 60255-27	70xIn without damage for 1s short time overloading
8.3. VT Input continuous overload	IEC 60255-27	Declared on manual, without damage for continuous operation
8.4. VT Input short time overload	IEC 60255-27	Declared on manual, without damage for 10s short time overloading
9. Enclosure protection		
	IEC 60255-27 IEC 60529	IP-54

6.3. Output relays

Outputs relays				
Voltage		48Vdc	110Vdc	230Vac
Rated current	Resistive load	1A	0,3A	8A
	cosϕ=0.4 L/R=7ms	600mA	80mA	6A
Max. switching power	Resistive load	2000VA, 150W		
	cosϕ=0.4 L/R=7ms	1250VA, 90W		
Max. switching voltage	400Vac, 200Vdc			
Rated load	Resistive load	8A at 250Vac, 5A at 30Vdc		
	cosϕ=0.4 L/R=7ms	5A at 250Vac, 3A at 30Vdc		
Operating time		15ms max.		
Release time		5ms max.		

7. COMMUNICATION AND HMI

7.1. Front Communication: USB

One communications port is installed on the front of the equipment. The connector that is used is a mini 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.

The USB cable allows the power supply and the communication simultaneously.

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

For writing 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. For writing commands the password will be adjustable.

Slave address is fixed and equal to 1

7.2. Rear Communication: RS485

An option exists to fit the SIA-F with a rear communications port RS485, to communicate with SCADA or RTU system.

The RS485 port output has two terminals -, +), located on the rear of the equipment. The protocol that is used is ModBus RTU (8bit – no parity – 1 stop bit).

The protocol map and documentation that are used are attached in *8.ModBus RTU protocol*.

This port can be used to continuously monitor the equipment from a remote PC or SCADA system. Up to 32 pieces of equipment can be connected to one bus; each piece with a different ModBus address. The equipment ModBus address and baudrate can be configured using the communications or from HMI.

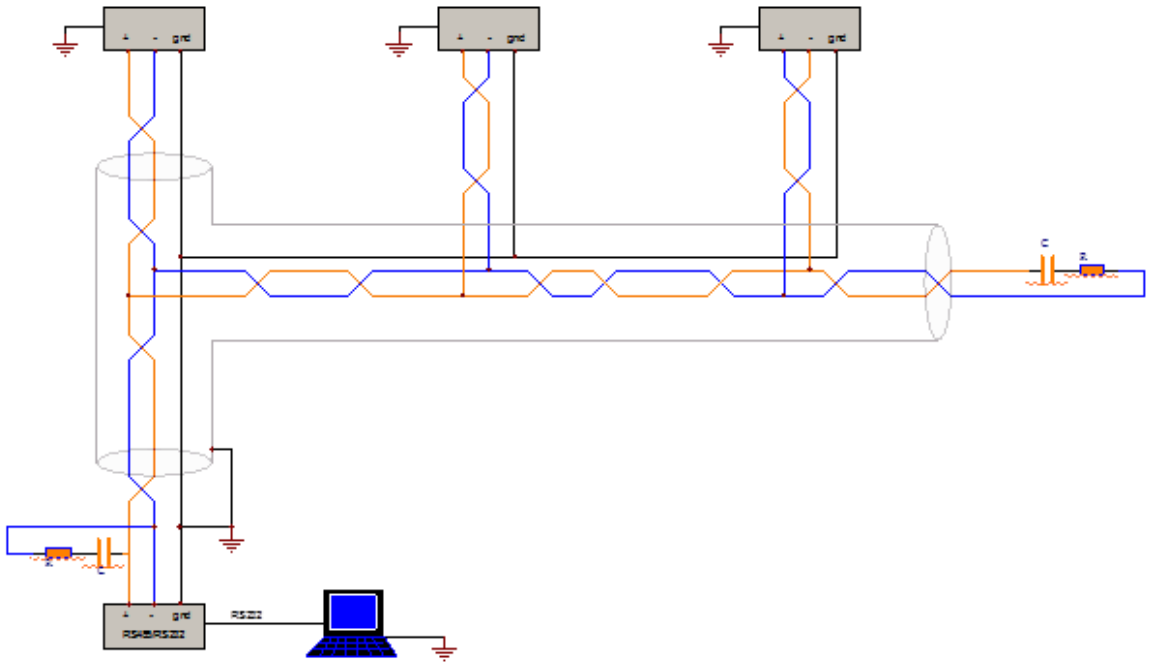
For writing commands it is necessary to open a communication session (identification command) which it will be closed after a period of time without communication. To open a communication session it will be necessary a password

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

If a 2 strand cable is used for communication, the GND terminals must be connected to the shielding. The shielding must be connected to the GND at only one point to avoid circular currents.

Resistors should be used at each end if very long cables are used. The best solution for avoiding reflection is to install resistors at both ends of the cable. The ohm value of these resistors must be equal to the cable impedance value. Fiber optics can be used in very aggressive environments, and they are connected by using the corresponding converters.

Connection diagram of an RS485 bus:



7.3. LED Indicators

The SIA-F front panel has three configurable LED pilot lights. The configuration by default is as follows:

Led ON	It is activated (Green led blinking), if the equipment is switch on
Led Alarm	It is activated (red led fixed) if an alarm occurs
Led Trip	It is activated (red led fixed) if a trip occurs. This led will continue activated until the reset of the leds is made.

Few situations can occur that involve the activation of different LEDs, this is, it 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.

7.4. LCD and keypad

The front of the SIA-F 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 of this information is arranged in a system of menus.

A keypad is fitted to the relay front panel, which can be used to access the information shown on the LCD screen and to navigate through the menu system.

This membrane keyboard has 6 keys that can be used to navigate through the different menus and to change the setting parameters. The ▲ ▼ and ◄ ► keys can be used to navigate through the different menus, the different options in each menu and the different values for the settings parameters.

The "**OK**" key is used to access the menus and the different options, as well as to approve changes to values. The "**C**" key is used to delete and to go back through the menu levels.

As well as the 6 keys, there is also a "**Reset**" key. When "**Reset**" is pressed, the alarm led and the trip led return to their initial position. The "**Reset**" key can also be used to delete all of the events in the "Events" menu.

7.5. SICom Communications program

The SICom program, which works with the Windows® 2000/XP and Windows 7 operating system is provided, and can be used to gain access to all of the equipment information, to modify the settings and to save events using a graphic user interface.

The following operations can be carried out using the SICom program:

- State reading
- Measurement reading
- Reading and changing settings
- Reading and deleting events
- Changing the user passwords
- Loading settings files
- Date-time synchronization
- Checking the versions of the equipment
- Configuring the Modbus address
- Reading and changing counters
- Processes for opening and closing the circuit breaker
- Configuration of the inputs
- Configuration of the outputs
- Configuration of the causes that start a Fault Report

7.6. Setting-up the session: Password

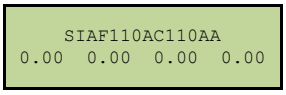
Users must identify themselves with a password in order to execute commands and to change the equipment settings or configuration using the HMI. By default this password is 5555

If after changing the password (it can be changed using HMI or by communications), the new code is forgotten, please contact with Fanox to indicate the procedure to solve this problem.

7.7. MENUS

7.7.1. Standby mode screen

The standby mode screen displays the equipment model. The first line of menus can be accessed by pressing "OK": measurements, state, adjustments and events. If the HMI is left in any position, it returns automatically to its standby mode screen after five minutes if no key is pressed.



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

- PROTECTION ERROR
- MEASUREMENT ERROR
- EEPROM ERROR
- EVENTS ERROR

7.7.2. 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.

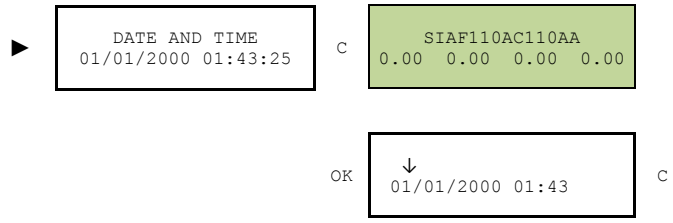
The keys ◄ and ► are used to navigate from one item to another within a parameter. The keys ▲ and ▼ are used to increase or decrease the value. If an invalid value is entered during the process, the "**C**" key can be used to delete it.

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

7.7.3. 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 equipment 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.

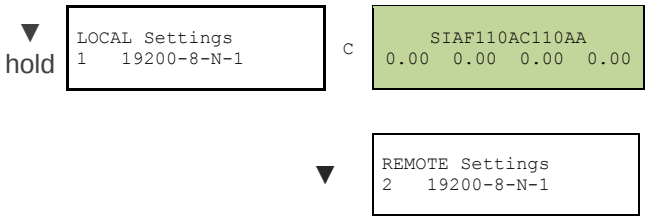


7.7.4. Versions

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

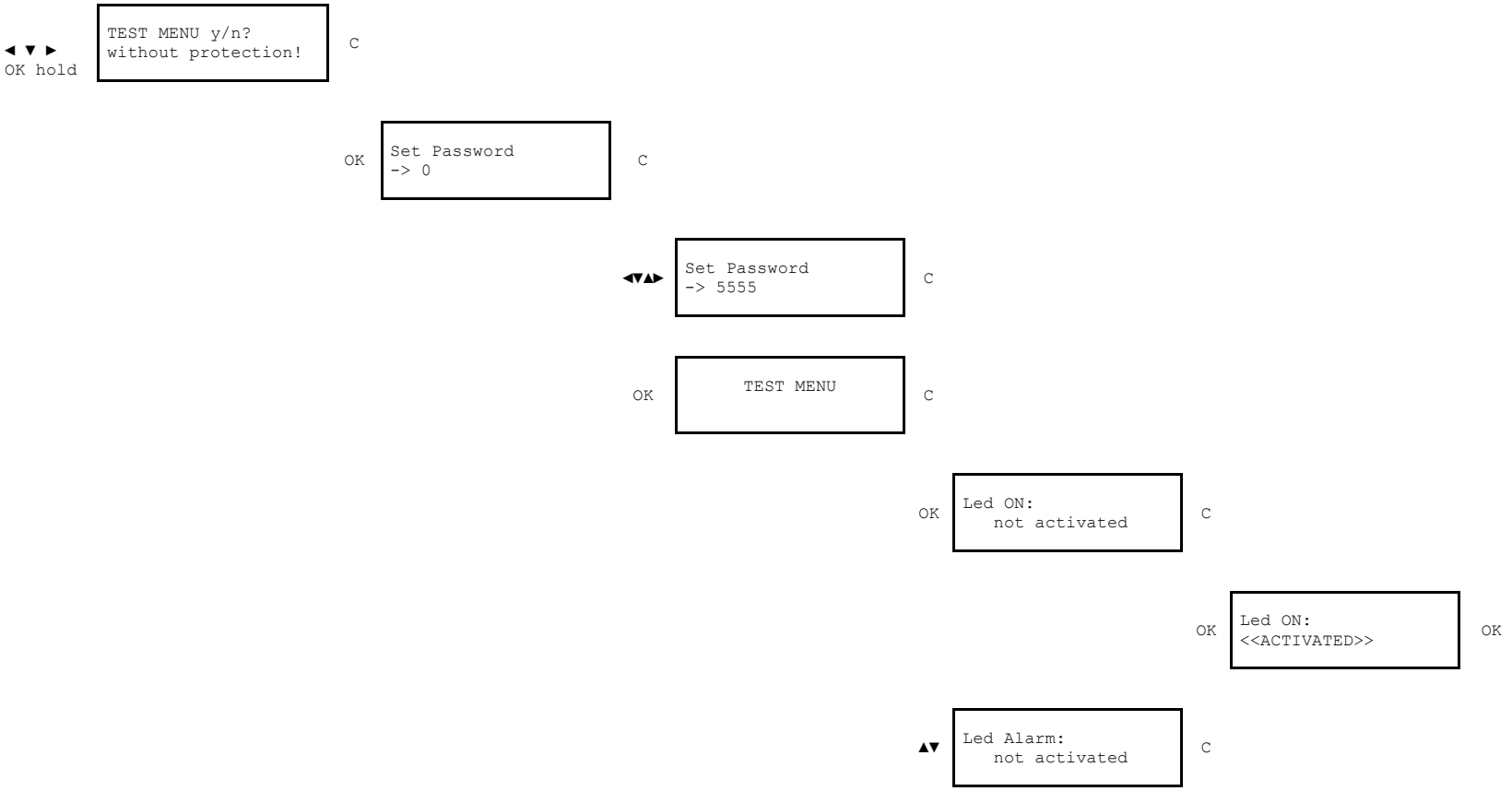
7.7.5. Communication parameters

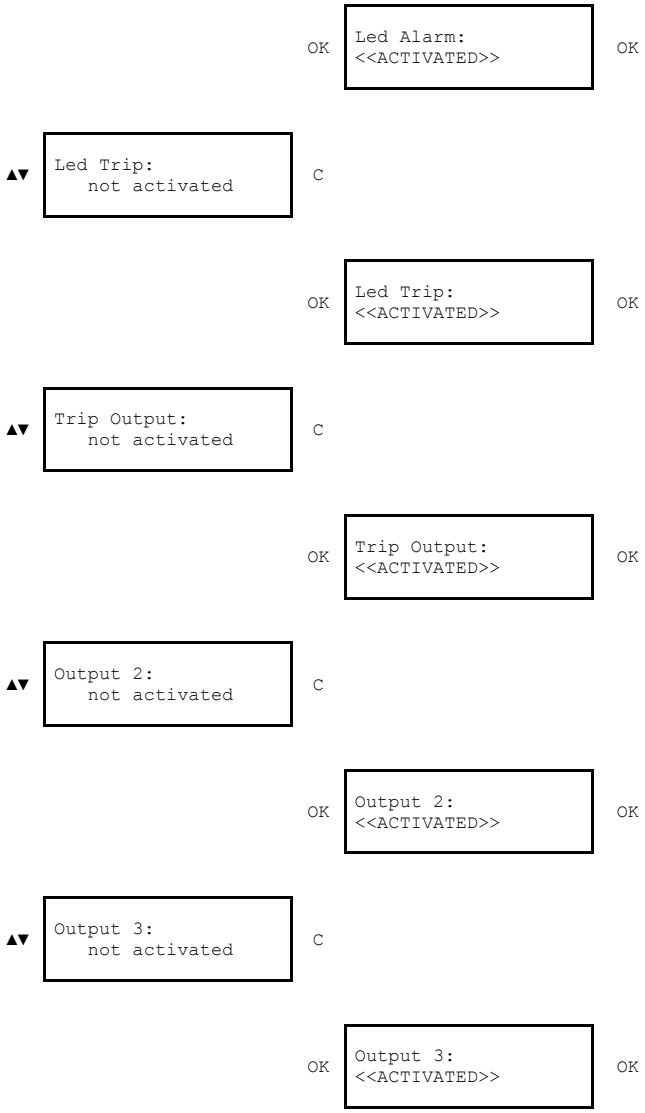
The communications parameters can be viewed holding down the "▼" key from the standby mode screen.



7.7.6. Test Menu

The “Test menu” is accessed from the standby mode 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.

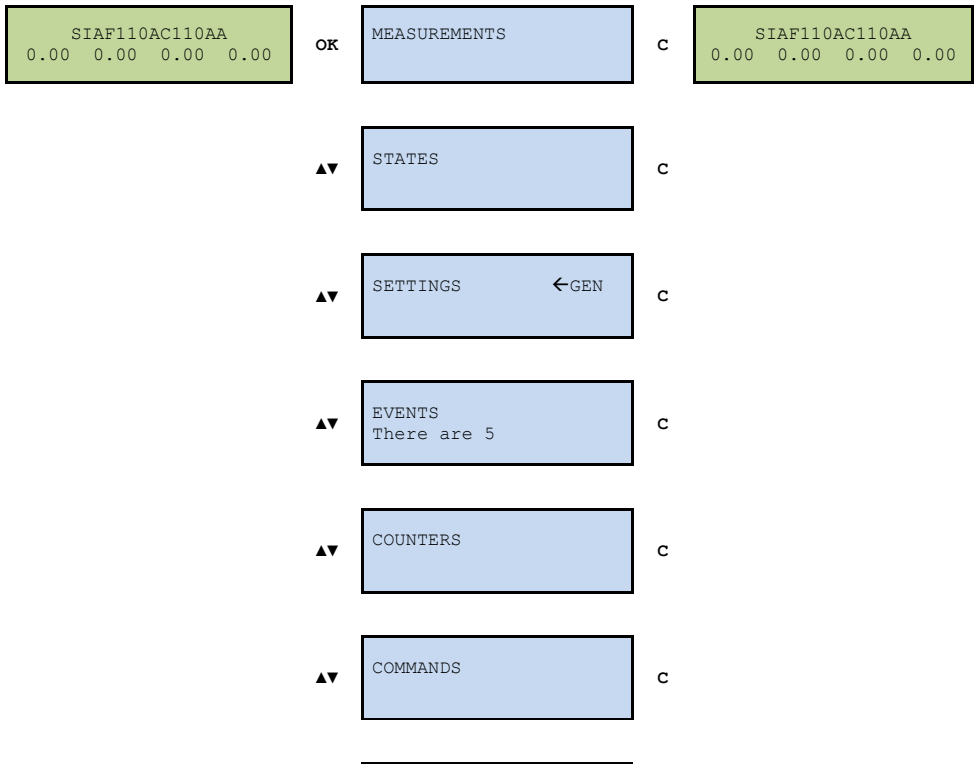



OK
Led Alarm:
<<ACTIVATED>>
OK
▲▼
Led Trip:
not activated
C
OK
Led Trip:
<<ACTIVATED>>
OK
▲▼
Trip Output:
not activated
C
OK
Trip Output:
<<ACTIVATED>>
OK
▲▼
Output 2:
not activated
C
OK
Output 2:
<<ACTIVATED>>
OK
▲▼
Output 3:
not activated
C
OK
Output 3:
<<ACTIVATED>>
OK

7.7.7. Functions Menu

The SIA-F relay menu is split up into 6 main parts:

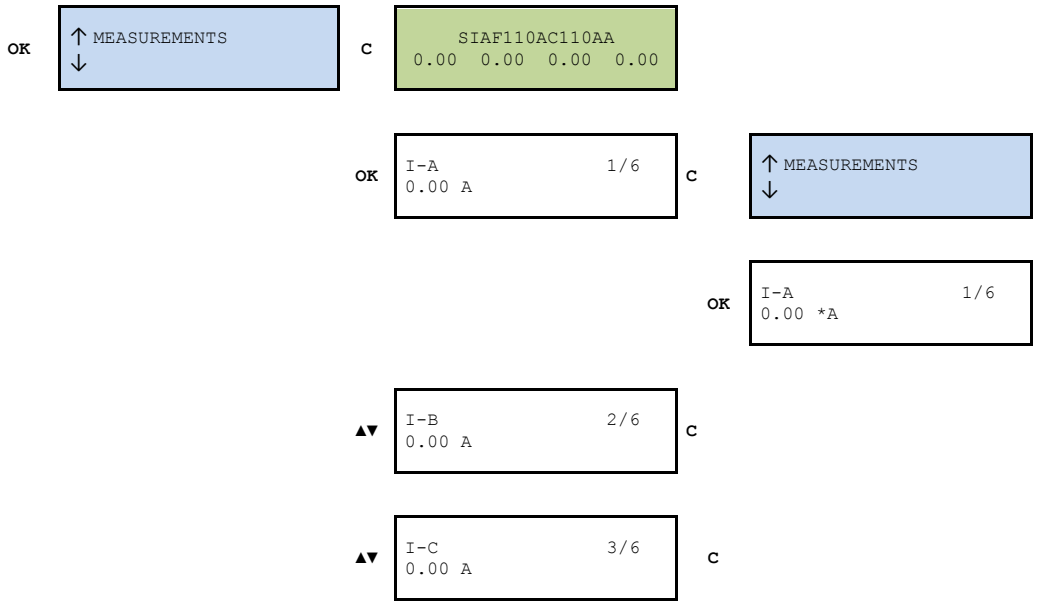
- Measurements.
- State.
- Settings.
- Events.
- Counters
- Commands
- Fault Report

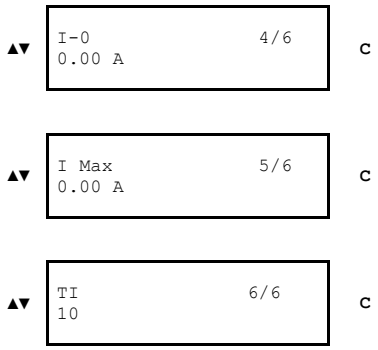


Press the "**OK**" key to access the second level from the main screen. Use the ▲ and ▼ keys to move from one menu section to another in the second level. Use the "**C**" key to return to a higher level.

7.7.8. 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.

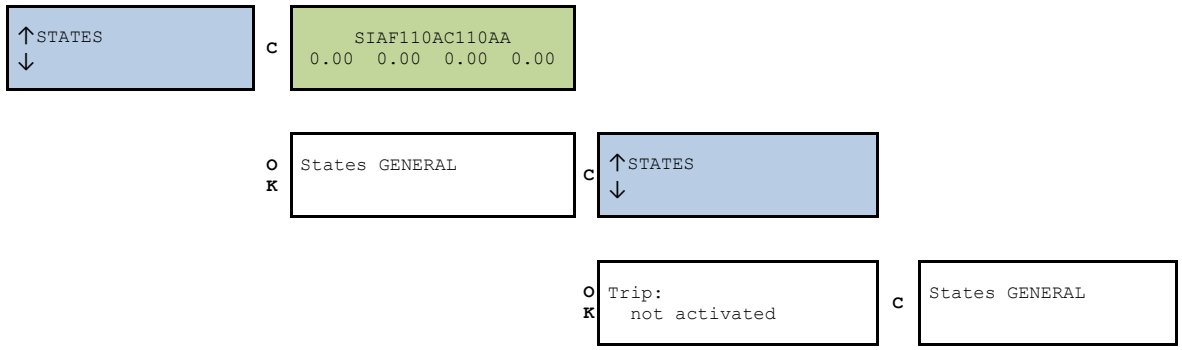


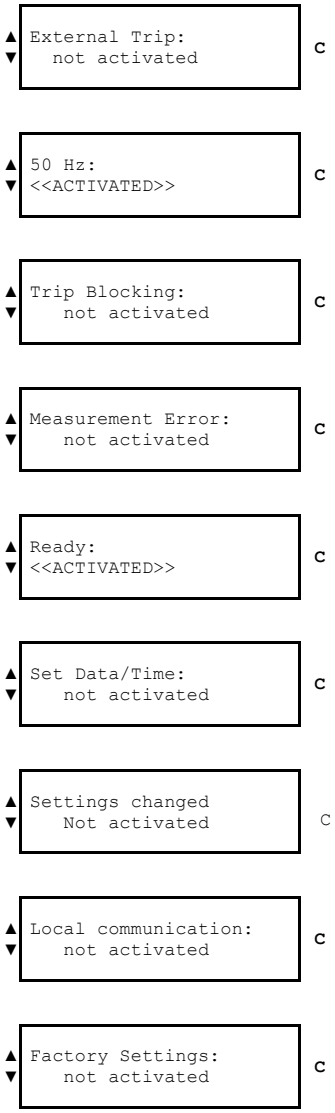


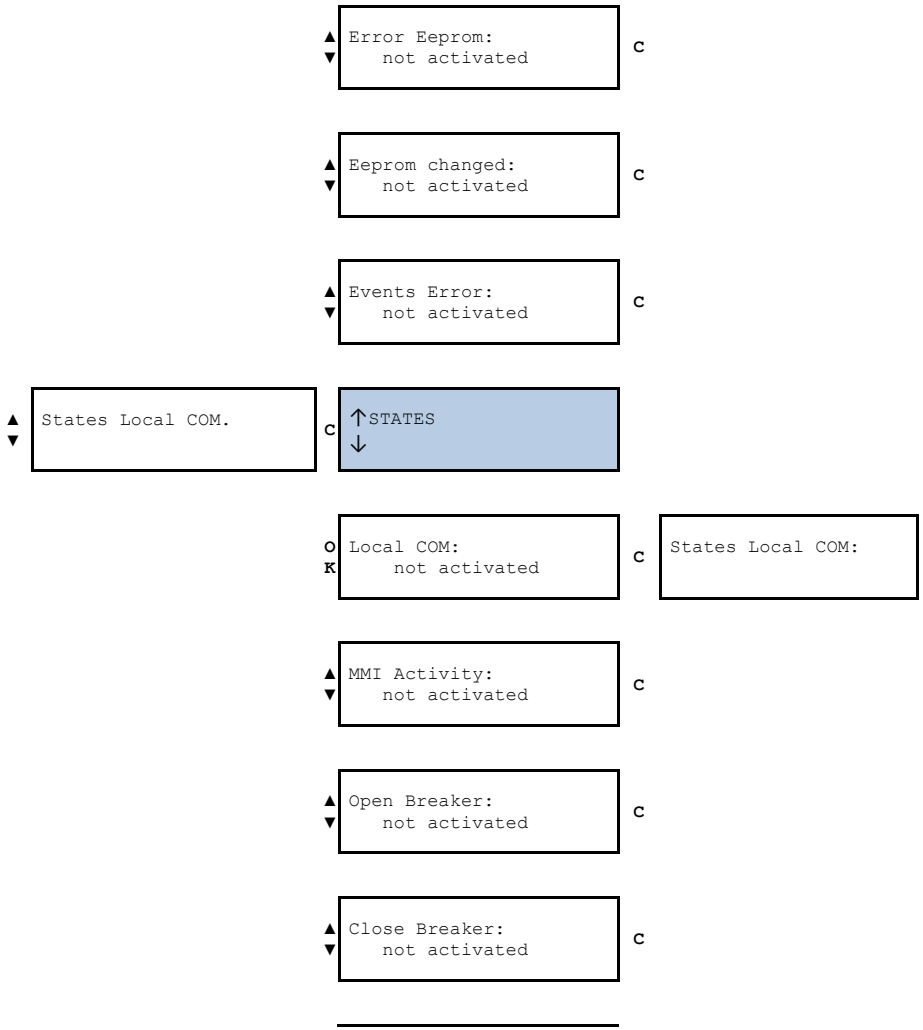
7.7.9. States Menu

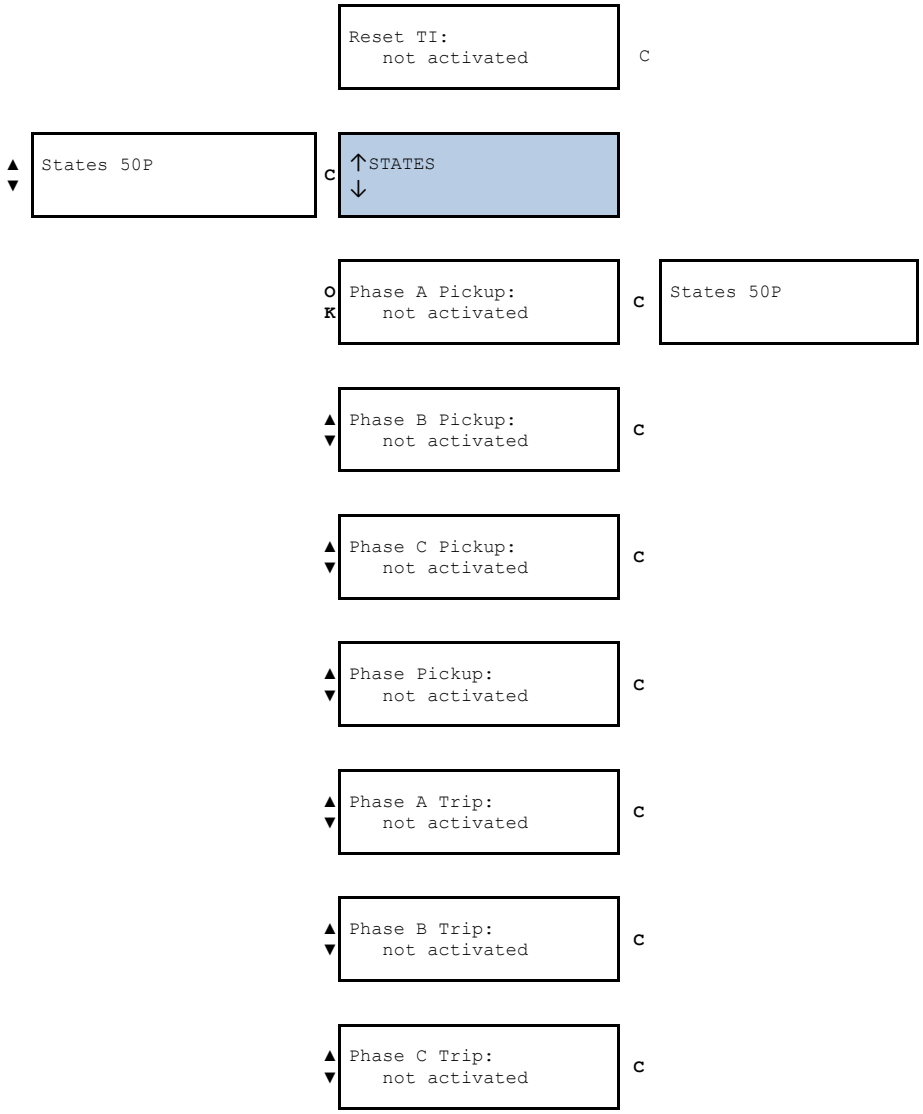
From the standby mode screen, press the “OK” key to access the first line of menus. Use the “▲” and “▼” keys to position the cursor over the “STATE” screen and press “OK”. This takes you to the state group line. Use the “▲” and “▼” keys to position the cursor over a group of states, and press the “OK” key to access the states that belong to this group. Use the “▲” and “▼” keys to browse through the different states. The information shows whether or not each state is active. The message “>Activations present” appears under the name of the group in the state group menus if any of the states in that group are active.

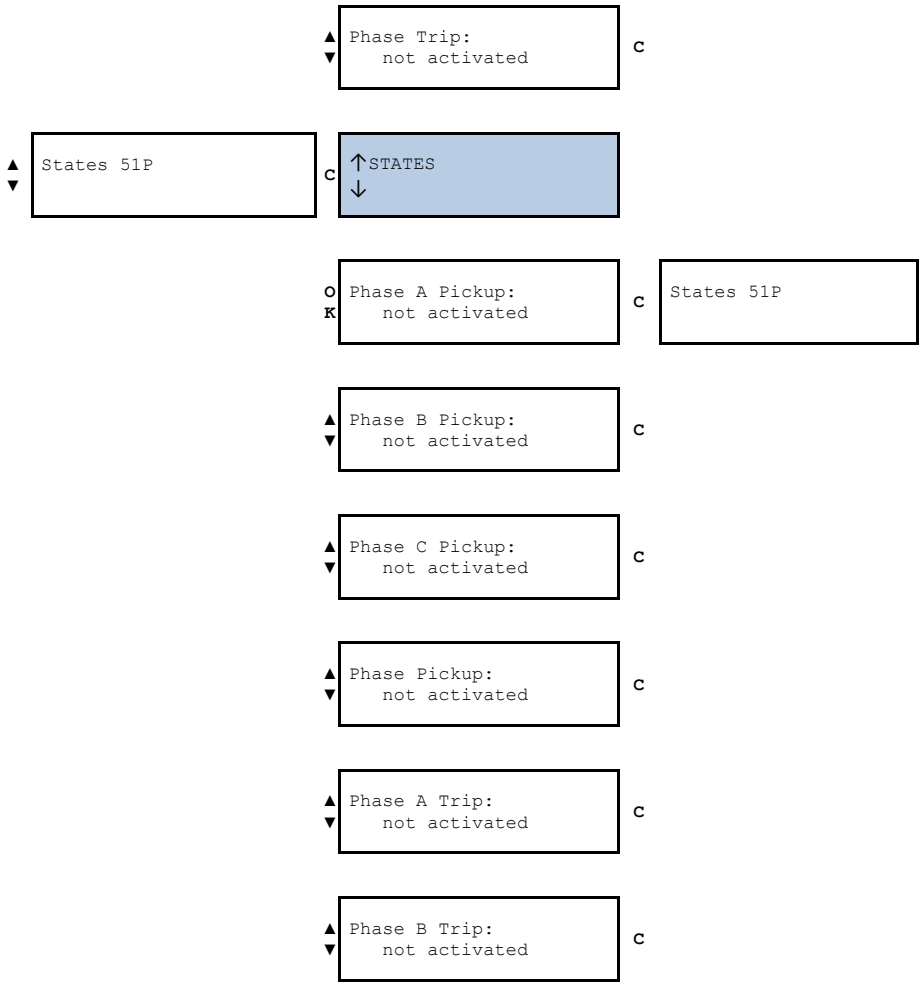
The method for navigating through the state menu is shown graphically below.

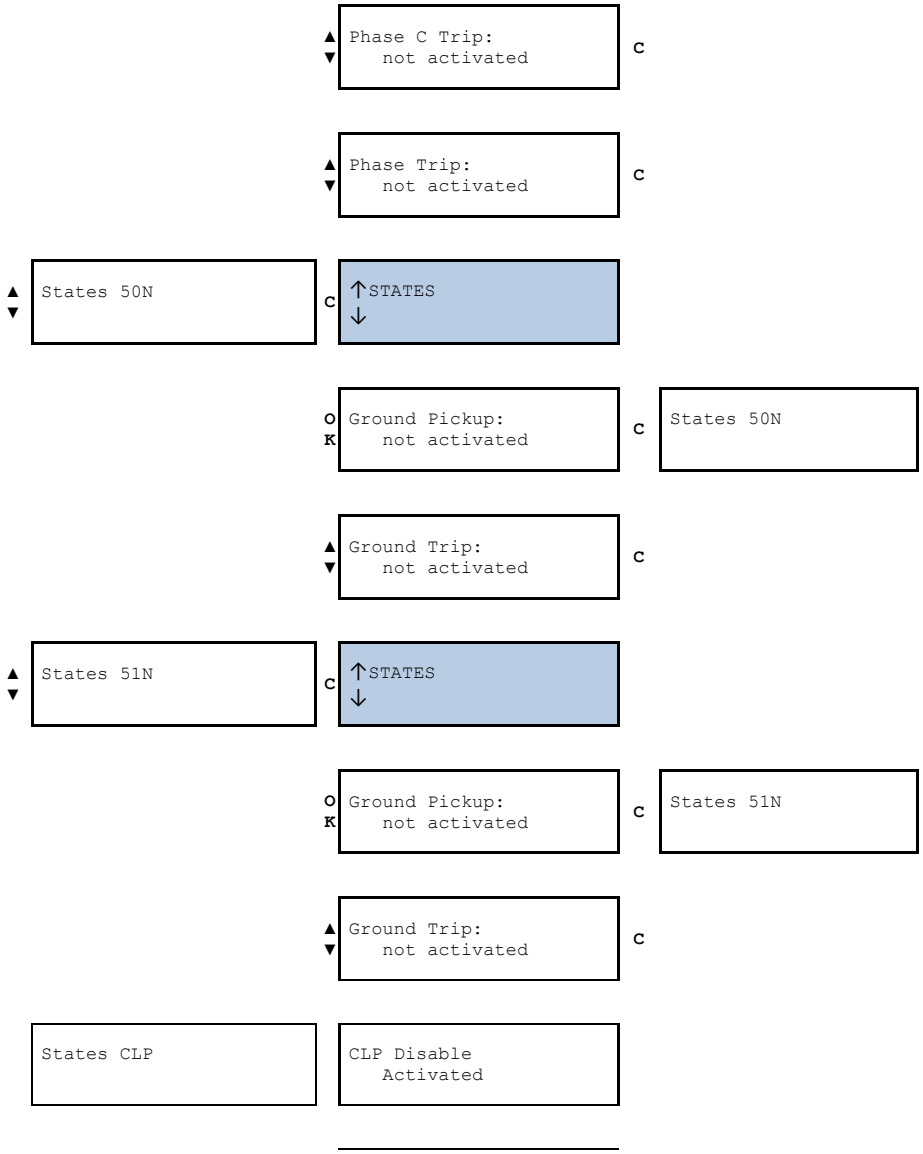


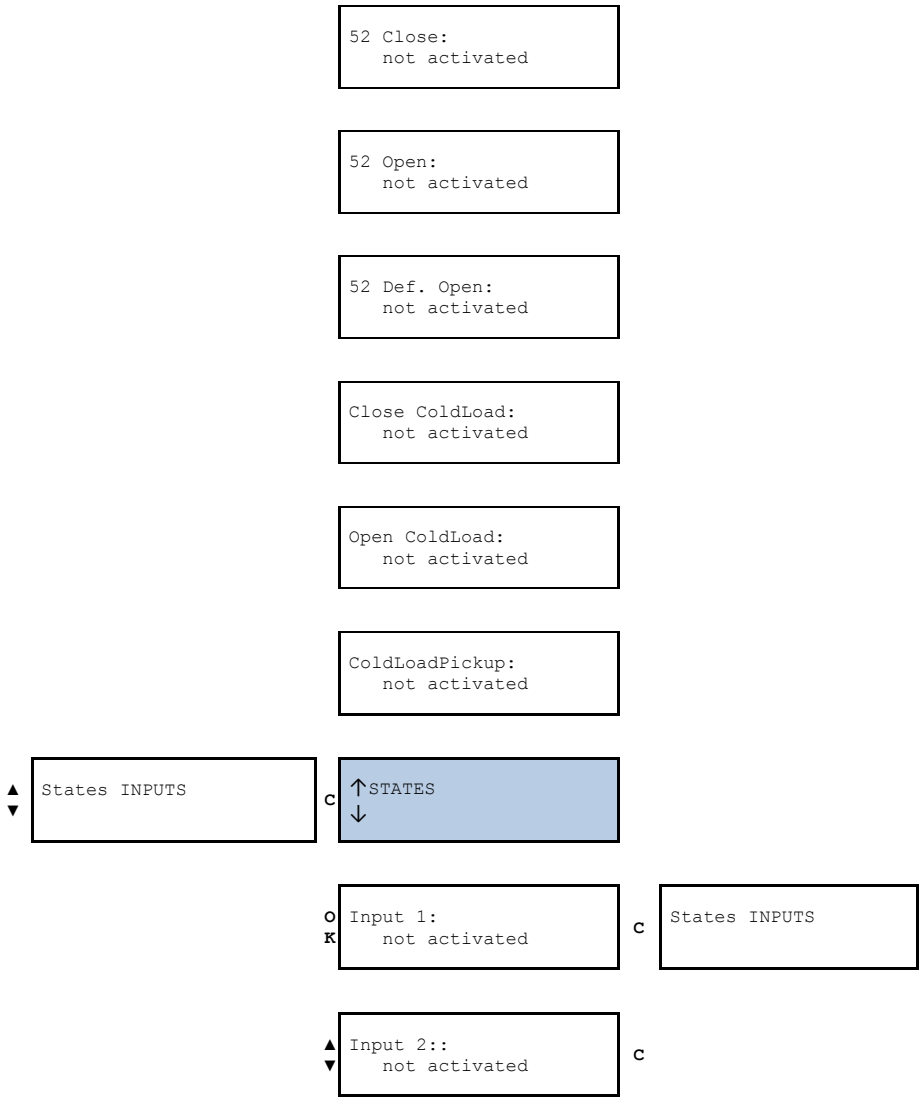

External Trip:
not activated
50 Hz:
<<ACTIVATED>>
Trip Blocking:
not activated
Measurement Error:
not activated
Ready:
<<ACTIVATED>>
Set Data/Time:
not activated
Settings changed
Not activated
Local communication:
not activated
Factory Settings:
not activated

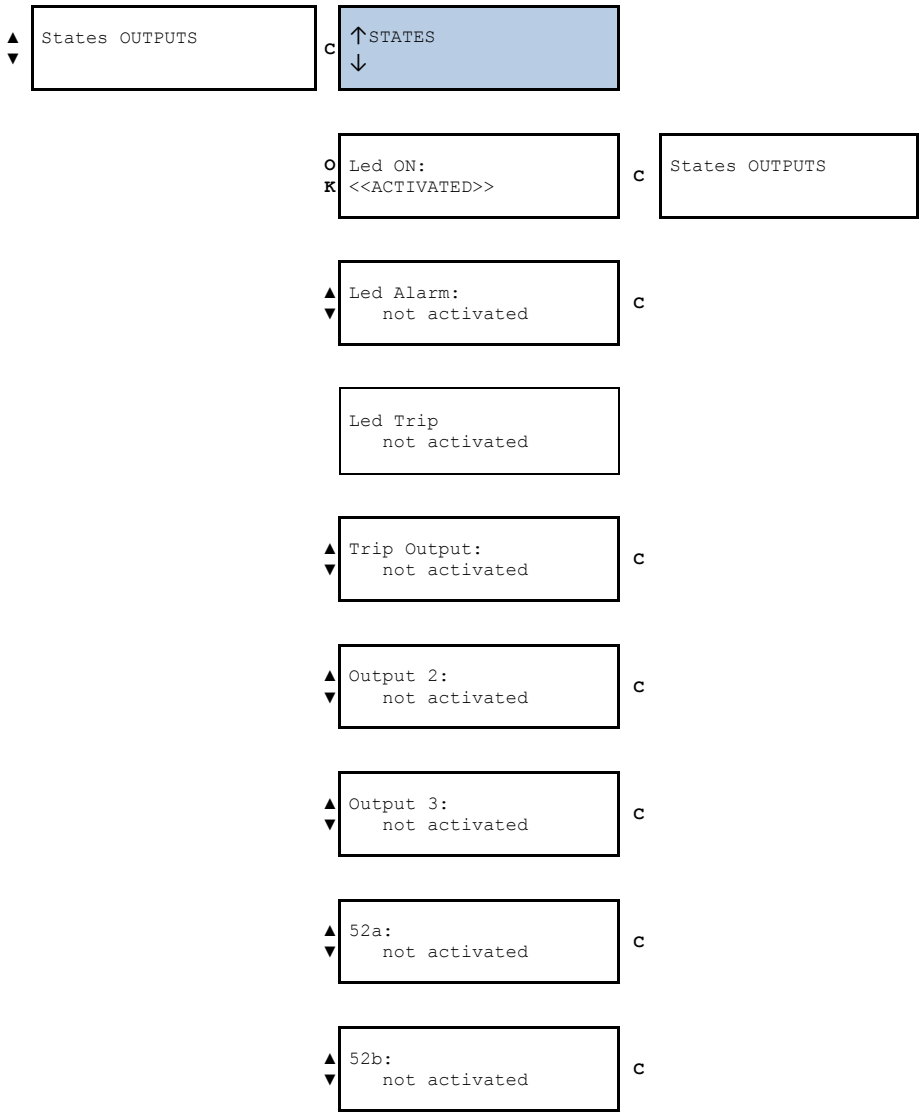

▲
▼
Error Eeprom:
not activated
C
▲
▼
Eeprom changed:
not activated
C
▲
▼
Events Error:
not activated
C
▲
▼
States Local COM.
C
↑STATES
↓
OK
Local COM:
not activated
C
States Local COM:
▲
▼
MMI Activity:
not activated
C
▲
▼
Open Breaker:
not activated
C
▲
▼
Close Breaker:
not activated
C

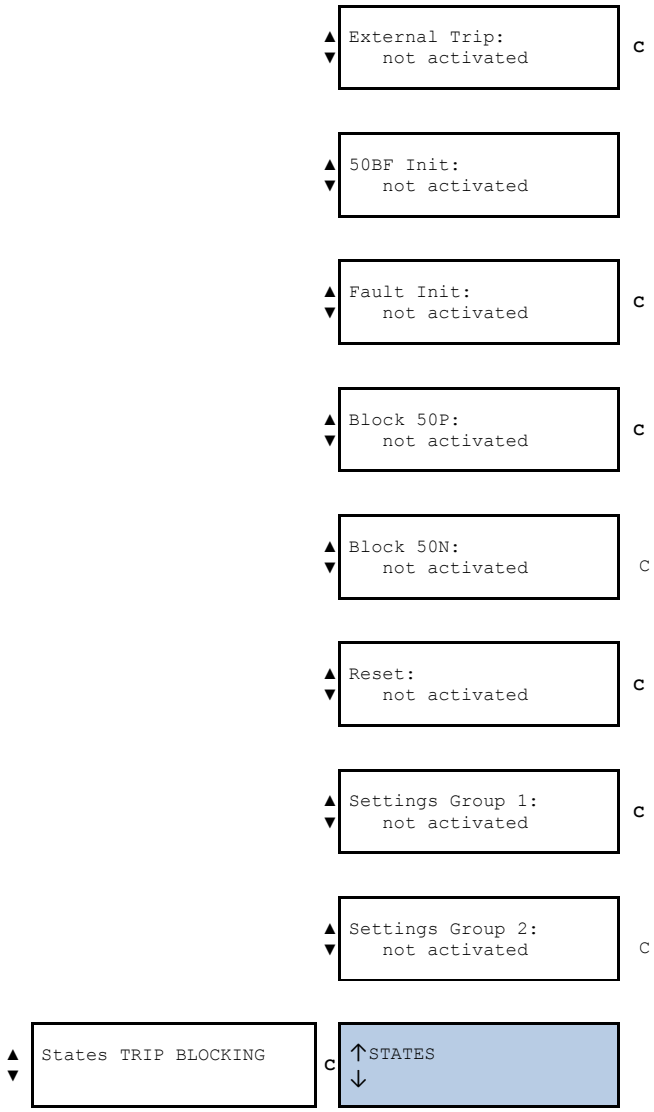

Reset TI:
not activated
C
▲
▼
States 50P
C
↑STATES
↓
OK
Phase A Pickup:
not activated
C
States 50P
▲
▼
Phase B Pickup:
not activated
C
▲
▼
Phase C Pickup:
not activated
C
▲
▼
Phase Pickup:
not activated
C
▲
▼
Phase A Trip:
not activated
C
▲
▼
Phase B Trip:
not activated
C
▲
▼
Phase C Trip:
not activated
C

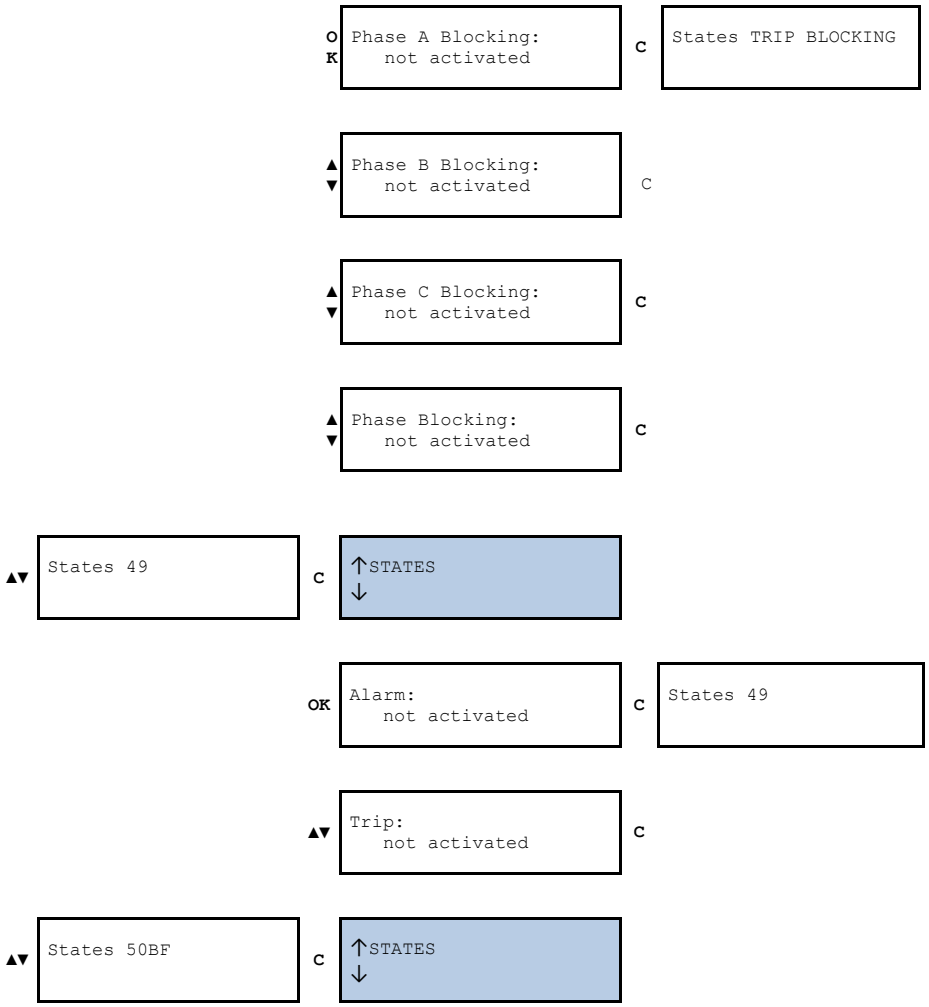

▲
▼
Phase Trip:
not activated
C
▲
▼
States 51P
C
↑STATES
↓
OK
Phase A Pickup:
not activated
C
States 51P
▲
▼
Phase B Pickup:
not activated
C
▲
▼
Phase C Pickup:
not activated
C
▲
▼
Phase Pickup:
not activated
C
▲
▼
Phase A Trip:
not activated
C
▲
▼
Phase B Trip:
not activated
C

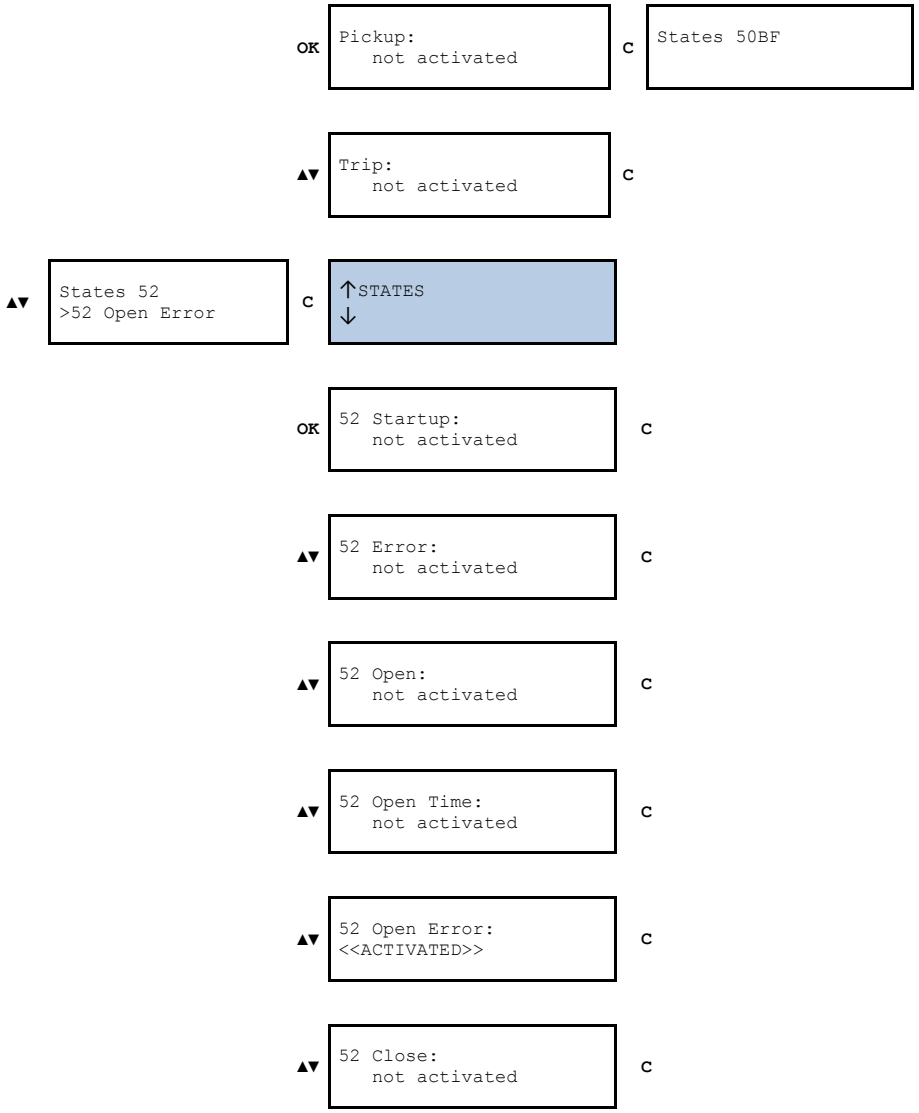

▲
▼
Phase C Trip:
not activated
C
▲
▼
Phase Trip:
not activated
C
▲
▼
States 50N
C
↑STATES
↓
OK
Ground Pickup:
not activated
C
States 50N
▲
▼
Ground Trip:
not activated
C
▲
▼
States 51N
C
↑STATES
↓
OK
Ground Pickup:
not activated
C
States 51N
▲
▼
Ground Trip:
not activated
C
States CLP
CLP Disable
Activated


52 Close:
not activated
52 Open:
not activated
52 Def. Open:
not activated
Close ColdLoad:
not activated
Open ColdLoad:
not activated
ColdLoadPickup:
not activated
▲
▼
States INPUTS
C
↑STATES
↓
OK
Input 1:
not activated
C
States INPUTS
▲
▼
Input 2::
not activated
C

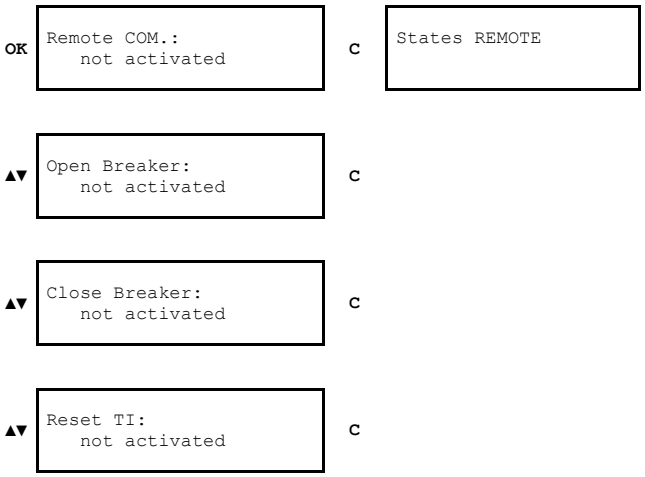

▲
▼
States OUTPUTS
C
↑STATES
↓
O
K
Led ON:
<<ACTIVATED>>
C
States OUTPUTS
▲
▼
Led Alarm:
not activated
C
Led Trip
not activated
▲
▼
Trip Output:
not activated
C
▲
▼
Output 2:
not activated
C
▲
▼
Output 3:
not activated
C
▲
▼
52a:
not activated
C
▲
▼
52b:
not activated
C


External Trip:
not activated
C
50BF Init:
not activated
Fault Init:
not activated
C
Block 50P:
not activated
C
Block 50N:
not activated
C
Reset:
not activated
C
Settings Group 1:
not activated
C
Settings Group 2:
not activated
C
States TRIP BLOCKING
C
↑STATES
↓


OK
Phase A Blocking:
not activated
C
States TRIP BLOCKING
▲
▼
Phase B Blocking:
not activated
C
▲
▼
Phase C Blocking:
not activated
C
▲
▼
Phase Blocking:
not activated
C
▲▼
States 49
C
↑STATES
↓
OK
Alarm:
not activated
C
States 49
▲▼
Trip:
not activated
C
▲▼
States 50BF
C
↑STATES
↓


OK
Pickup:
not activated
C
States 50BF
▲▼
Trip:
not activated
C
▲▼
States 52
>52 Open Error
C
↑STATES
↓
OK
52 Startup:
not activated
C
▲▼
52 Error:
not activated
C
▲▼
52 Open:
not activated
C
▲▼
52 Open Time:
not activated
C
▲▼
52 Open Error:
<<ACTIVATED>>
C
▲▼
52 Close:
not activated
C


▲▼
52 Close Time:
not activated
C
▲▼
52 Close Error:
not activated
C
▲▼
Open Num. Alarm:
<<ACTIVATED>>
C
▲▼
I2t Alarm:
<<ACTIVATED>>
C
▲▼
Too Many Trips:
not activated
C
▲▼
52A contact:
not activated
C
▲▼
52B contact:
not activated
C
▲▼
States REMOTE
C
↑STATES
↓



7.7.10. Settings Menu

From the standby mode screen, press the “OK” key to access the first line of menus. Use the “▲” and “▼” keys to position the cursor over the “SETTINGS” screen and press “OK”. This takes you to the 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.

Press the “◄” key to access the general settings from the "SETTINGS" screen.

The general setting "Equipment name" can be viewed from the HMI, but it can only be modified by using the SICom program.

The value of the "TI Phase ratio” and “TI Neutral ratio” in 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 500/5, the setting would be 100.

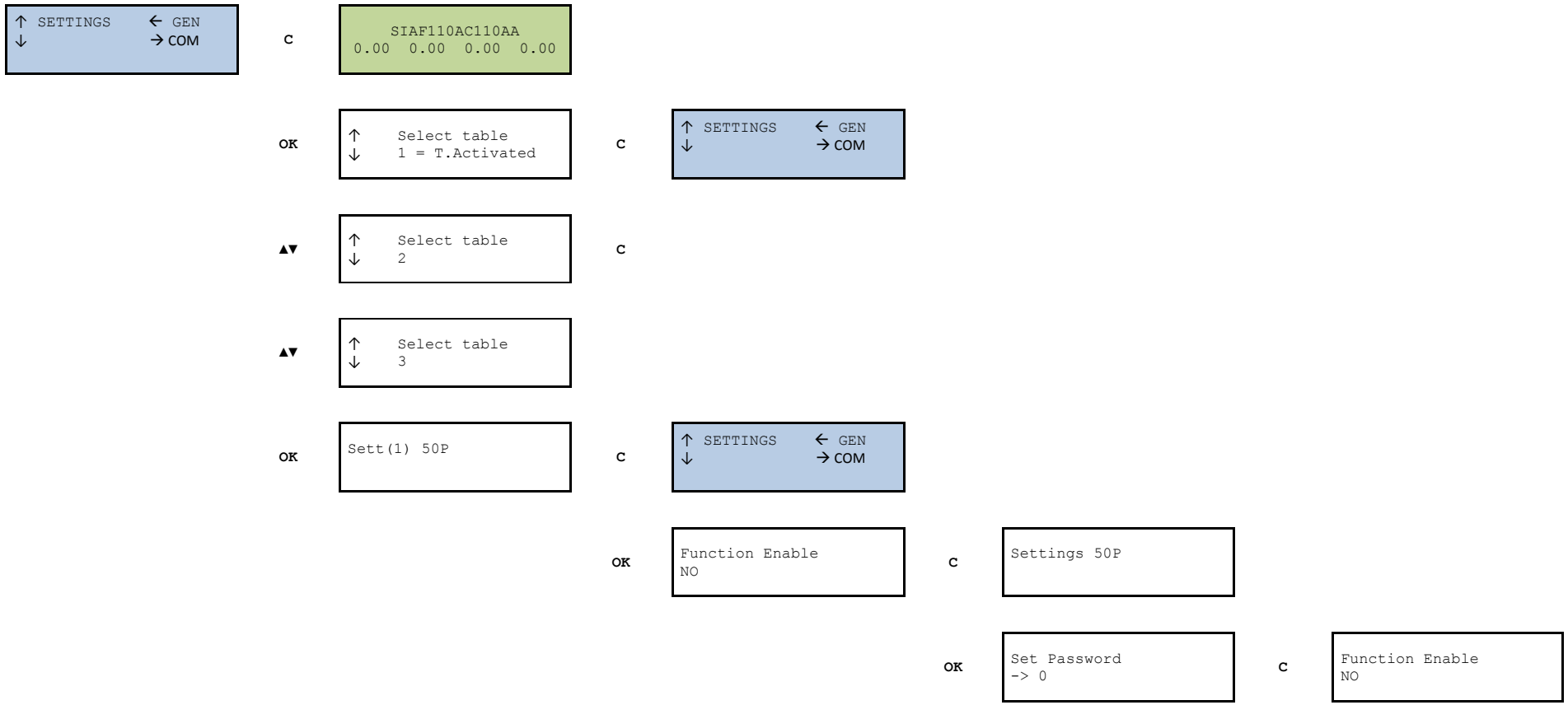
The frequency is selected for each model. The value is read only.

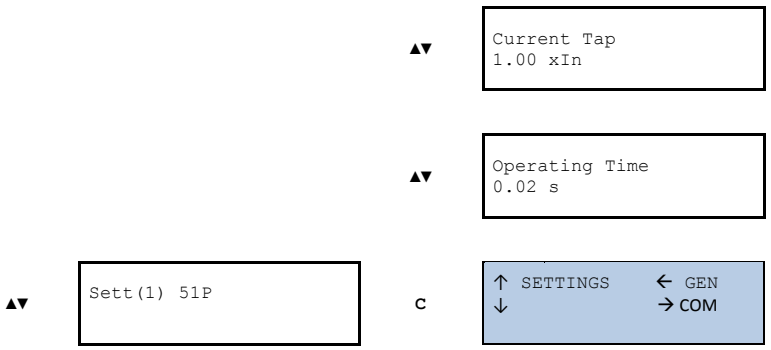
It is necessary to enter a password to change a setting for the first time. The settings can be changed after entering the password, until returning either manually or automatically to the standby mode screen. The system returns automatically to the standby mode screen if no key is pressed for five minutes.

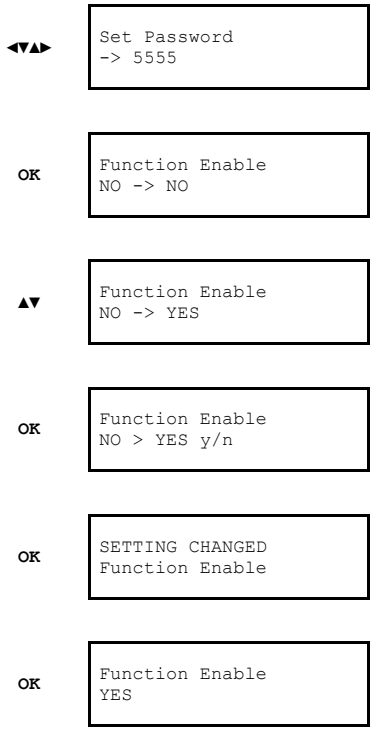
The factory setting password for the equipment is 5555. This password can be changed using the SICom program.

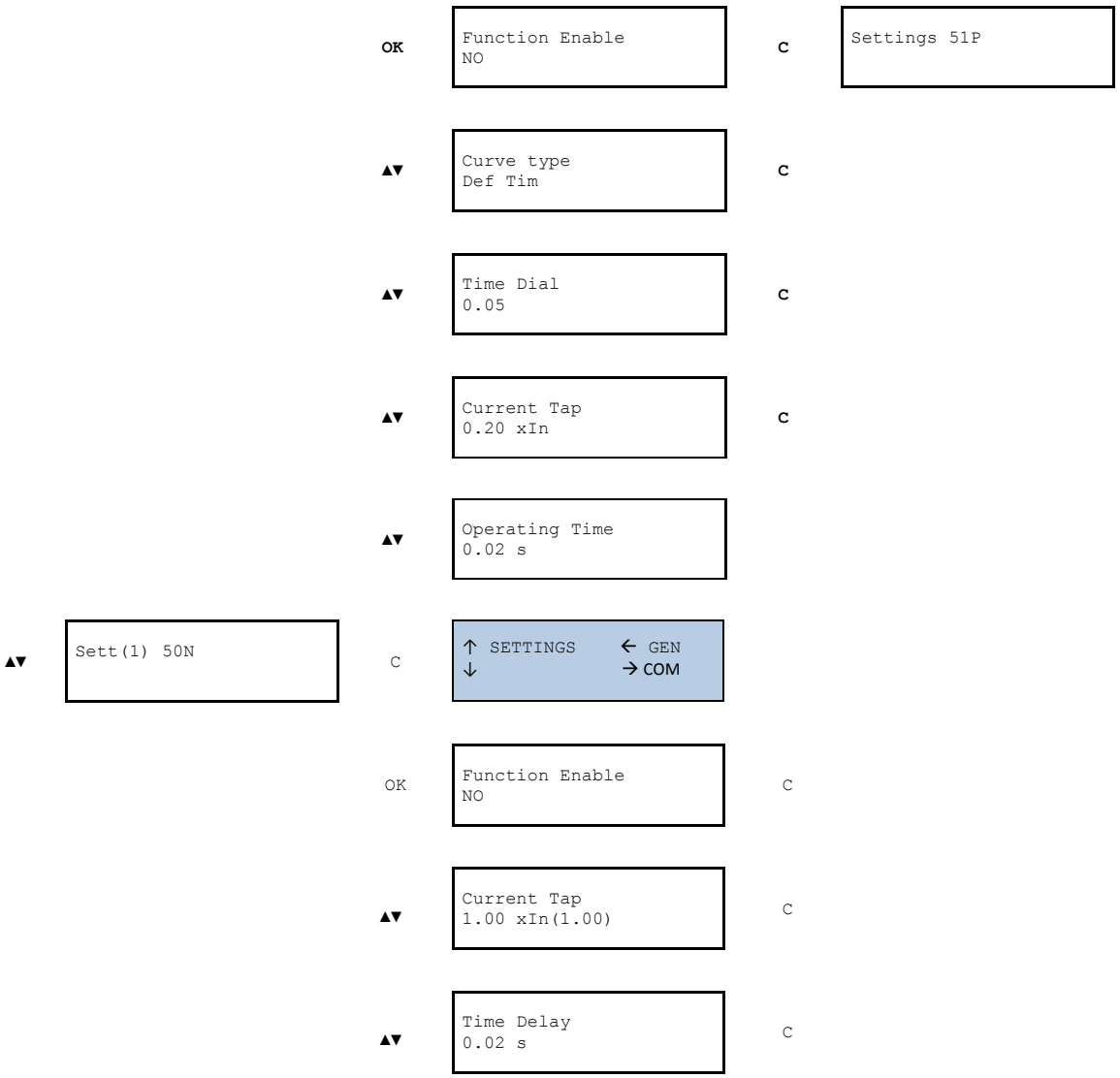
The keys ▲, ▼, ◄ and ► are used to enter the password. ▲ and ▼ are used to introduce a value or a character, and the ◄ and ► keys are used to move from one character to another. If it is necessary to change one of the password characters or numbers due to an error, press "**C**" to delete it. Press "**OK**"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

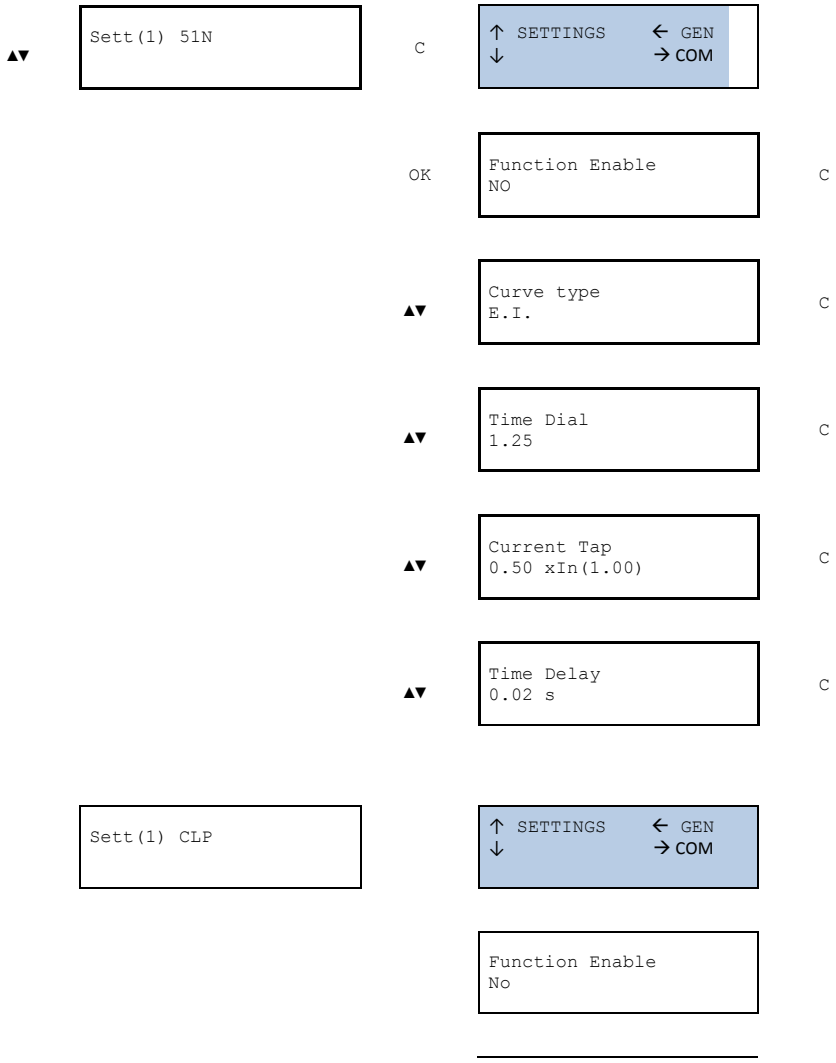
The method for navigating through the settings menu and the sequence to follow to change a setting are shown graphically below:

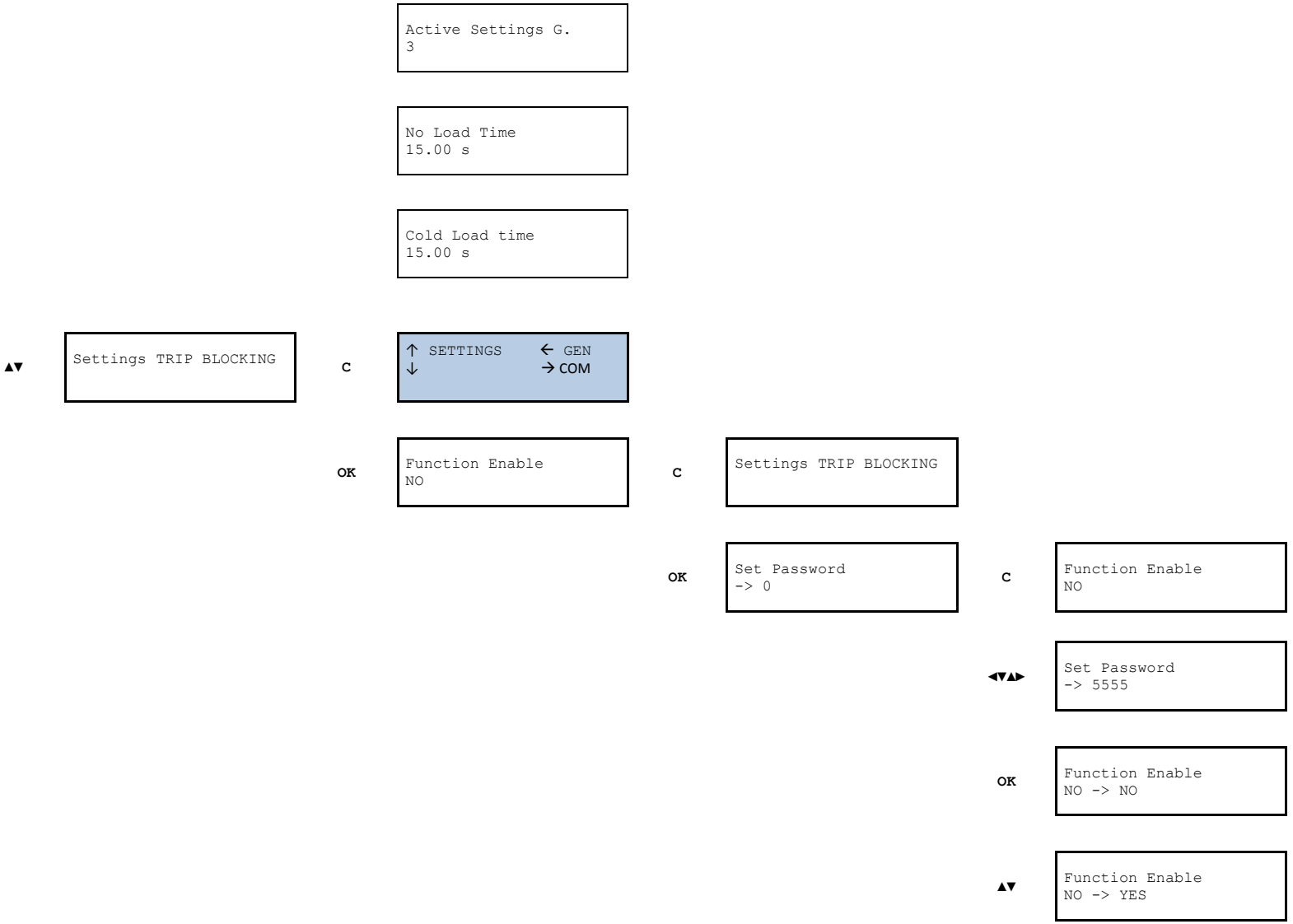


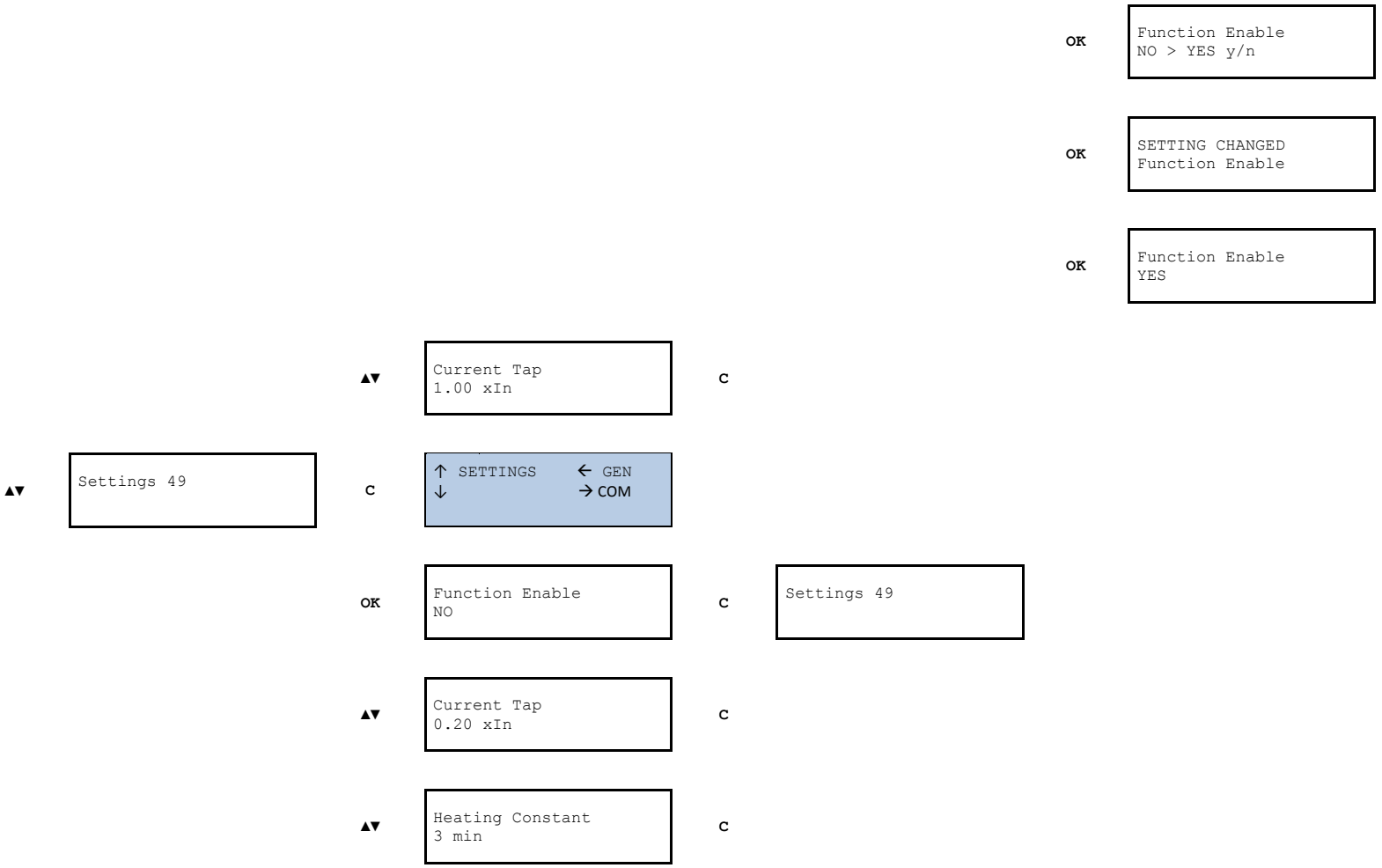

▲▼
Current Tap
1.00 xIn
C
▲▼
Operating Time
0.02 s
C
▲▼
Sett(1) 51P
C
↑ SETTINGS
↓
← GEN
→ COM

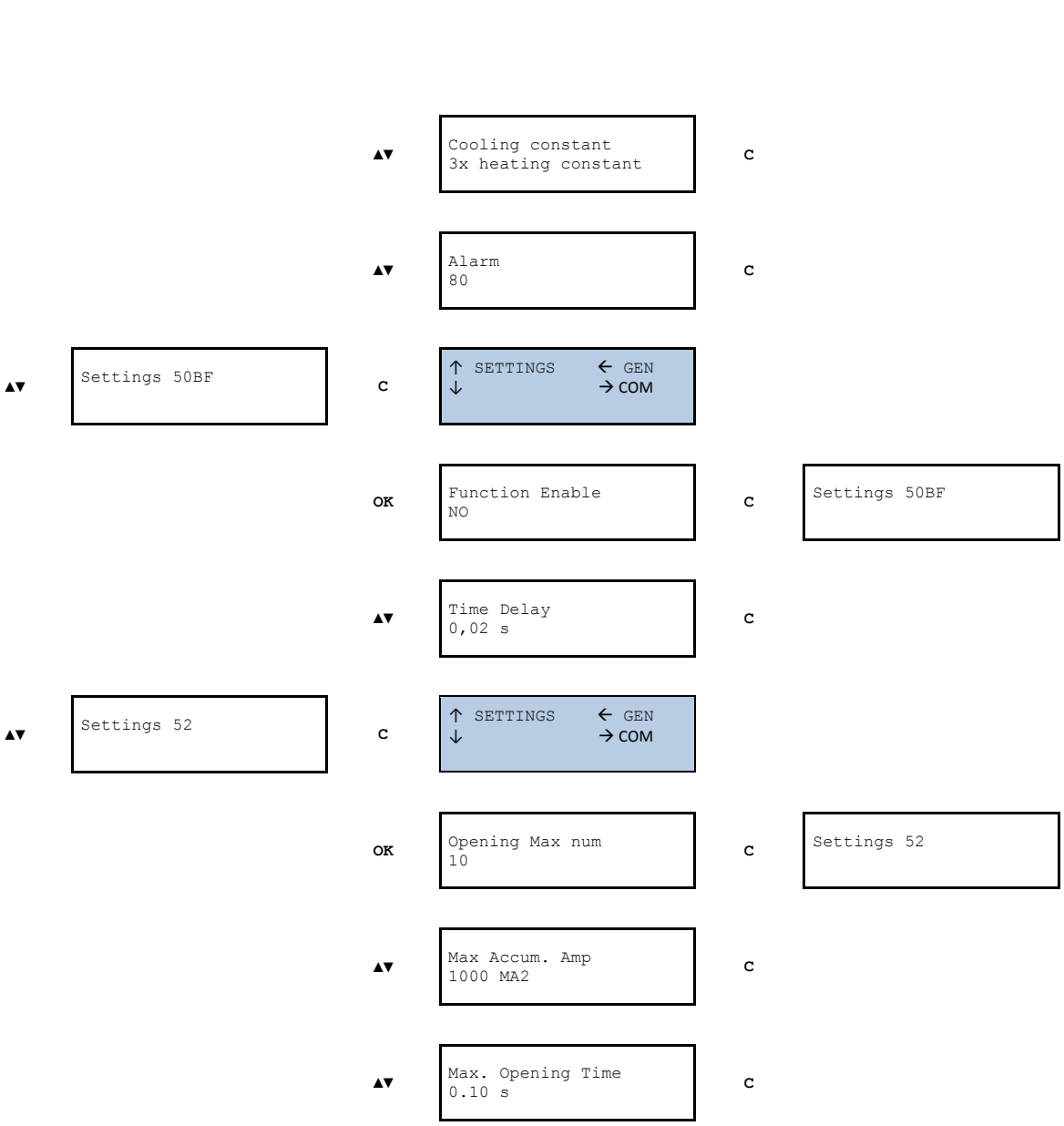

◄▼▲►
Set Password
-> 5555
OK
Function Enable
NO -> NO
▲▼
Function Enable
NO -> YES
OK
Function Enable
NO > YES y/n
OK
SETTING CHANGED
Function Enable
OK
Function Enable
YES

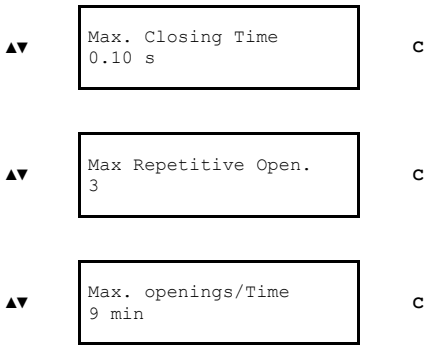

OK
Function Enable
NO
C
Settings 51P
▲▼
Curve type
Def Tim
C
▲▼
Time Dial
0.05
C
▲▼
Current Tap
0.20 xIn
C
▲▼
Operating Time
0.02 s
▲▼
Sett(1) 50N
C
↑ SETTINGS
← GEN
↓
→ COM
OK
Function Enable
NO
C
▲▼
Current Tap
1.00 xIn(1.00)
C
▲▼
Time Delay
0.02 s
C


▲▼
Sett(1) 51N
C
↑ SETTINGS ← GEN
↓ → COM
OK
Function Enable
NO
C
▲▼
Curve type
E.I.
C
▲▼
Time Dial
1.25
C
▲▼
Current Tap
0.50 xIn(1.00)
C
▲▼
Time Delay
0.02 s
C
Sett(1) CLP
↑ SETTINGS ← GEN
↓ → COM
Function Enable
No

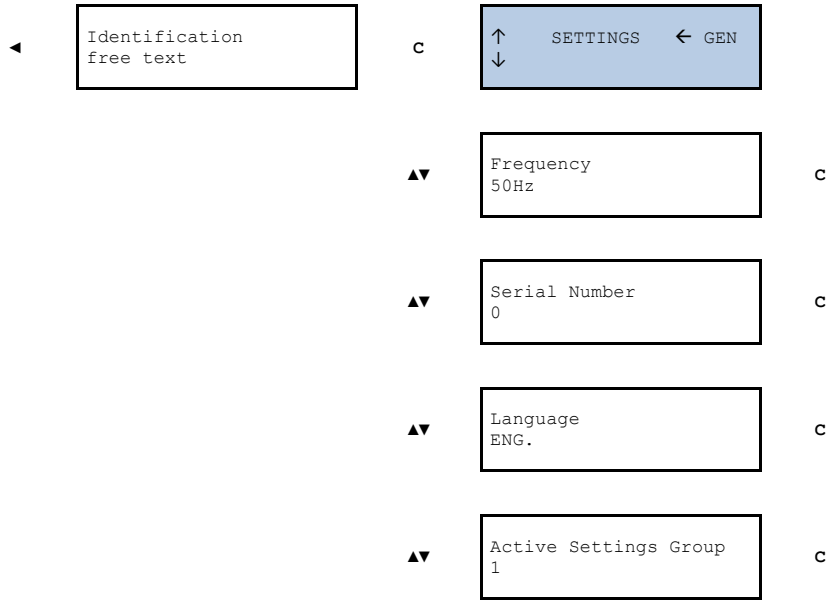

Active Settings G.
3
No Load Time
15.00 s
Cold Load time
15.00 s
▲▼
Settings TRIP BLOCKING
C
↑ SETTINGS ← GEN
↓ → COM
OK
Function Enable
NO
C
Settings TRIP BLOCKING
OK
Set Password
-> 0
C
Function Enable
NO
◄▼▲►
Set Password
-> 5555
OK
Function Enable
NO -> NO
▲▼
Function Enable
NO -> YES

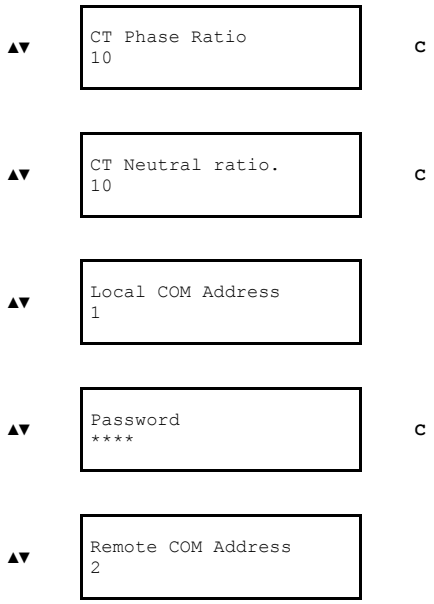

OK
Function Enable
NO > YES y/n
OK
SETTING CHANGED
Function Enable
OK
Function Enable
YES
▲▼
Current Tap
1.00 xIn
C
▲▼
Settings 49
C
↑ SETTINGS
← GEN
↓
→ COM
OK
Function Enable
NO
C
Settings 49
▲▼
Current Tap
0.20 xIn
C
▲▼
Heating Constant
3 min
C


Cooling constant
3x heating constant
C
▲▼
Alarm
80
C
▲▼
Settings 50BF
C
↑ SETTINGS ← GEN
↓ → COM
▲▼
Function Enable
NO
OK
C
Settings 50BF
Time Delay
0,02 s
▲▼
C
Settings 52
C
↑ SETTINGS ← GEN
↓ → COM
▲▼
Opening Max num
10
OK
C
Settings 52
Max Accum. Amp
1000 MA2
▲▼
C
Max. Opening Time
0.10 s
▲▼
C



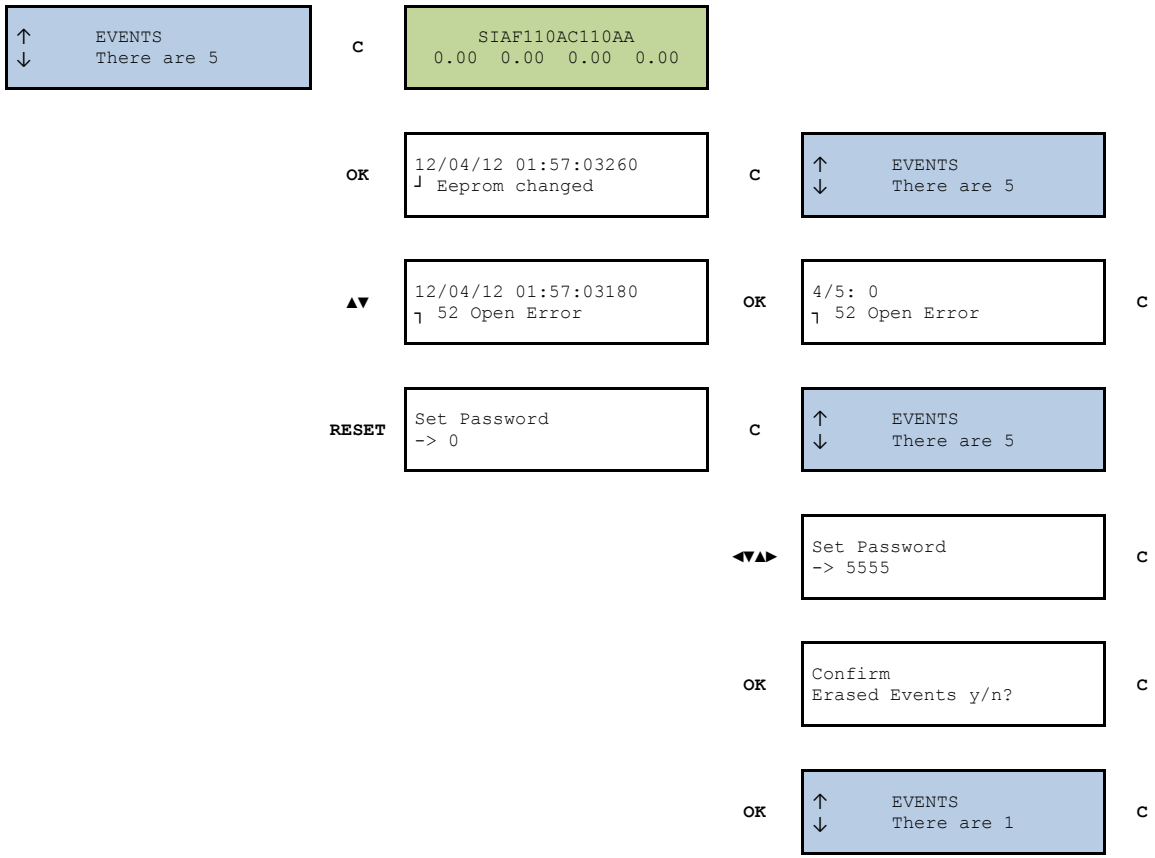
To access the general settings from the “SETTINGS” menus, press “◄”




▲▼
CT Phase Ratio
10
C
▲▼
CT Neutral ratio.
10
C
▲▼
Local COM Address
1
▲▼
Password
****
C
▲▼
Remote COM Address
2

7.7.11. 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.

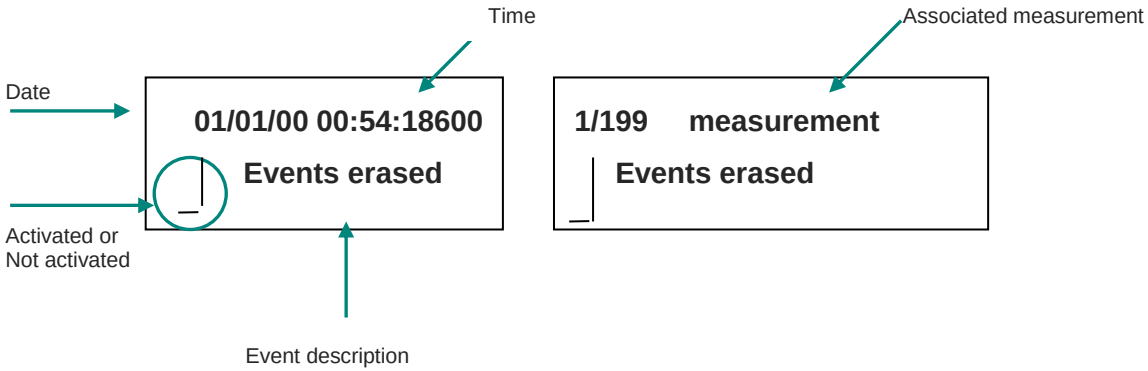


The "┘" and "┐" shows the event has been caused by the activation or reset of the associated state.

To delete the events buffer, position the cursor over the events menu and press and hold the "RESET" key, until there is only one event shown. This one event is "Deleted events".

Each event contains the following information:

- Date-time
- Description of the event
- Size of the events buffer
- Position of the event within the list of events
- Events generated by a state activation or reset
- Associated measurement (if it has one)



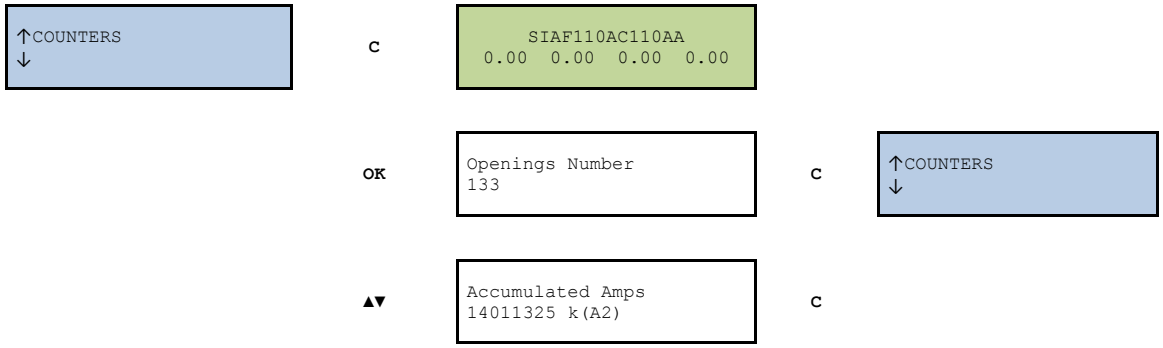
7.7.12. Counters Menu

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 counters. The information displayed below the meter name is its value.

The password must be entered before attempting to change a counter for the first time. Meter changes are allowed once the password has been entered, until the standby mode screen is returned to automatically or manually. The system returns automatically to the standby mode screen if no key is pressed for five minutes.

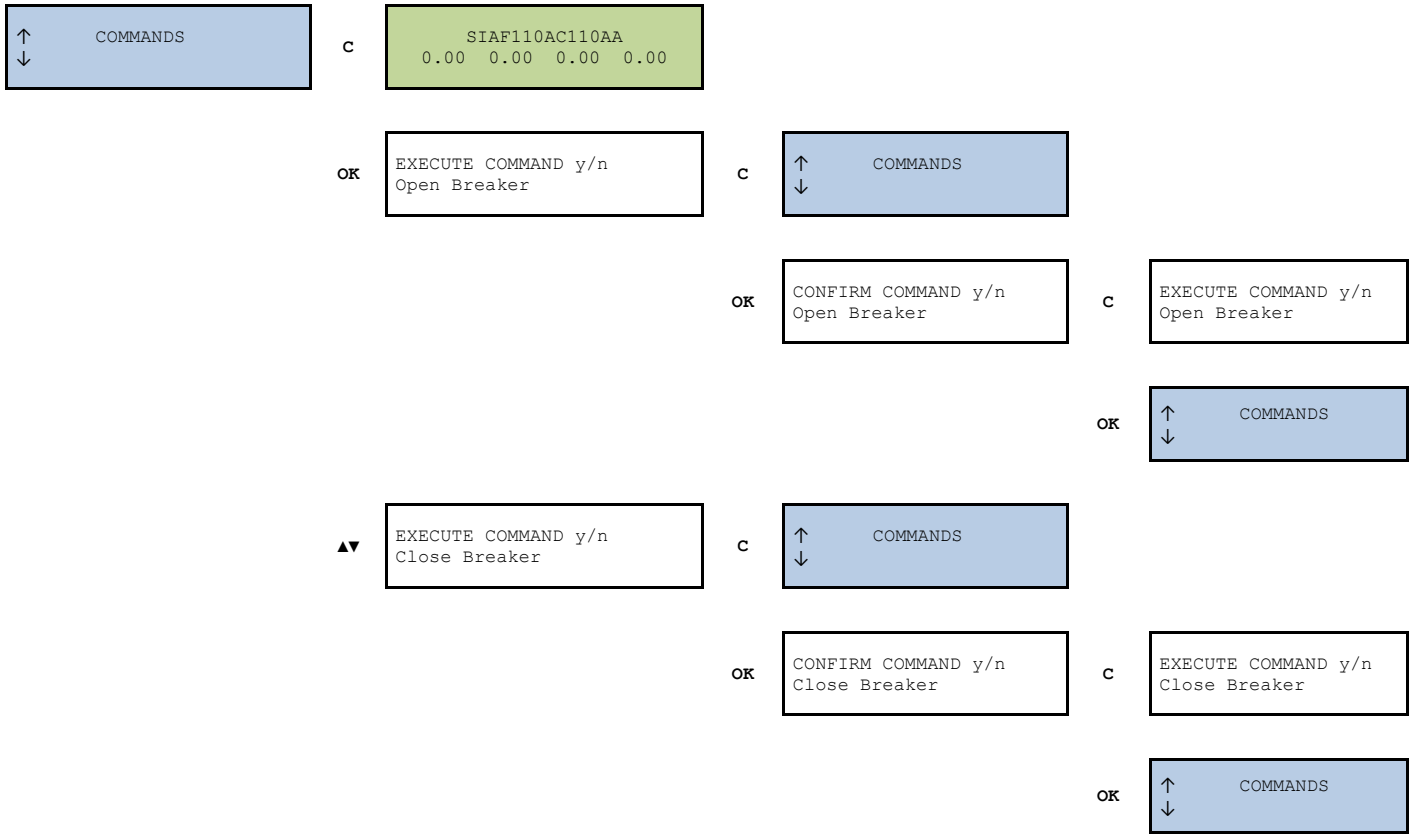
The factory setting password for the equipment is 5555. The password can be changed using the SICom program.

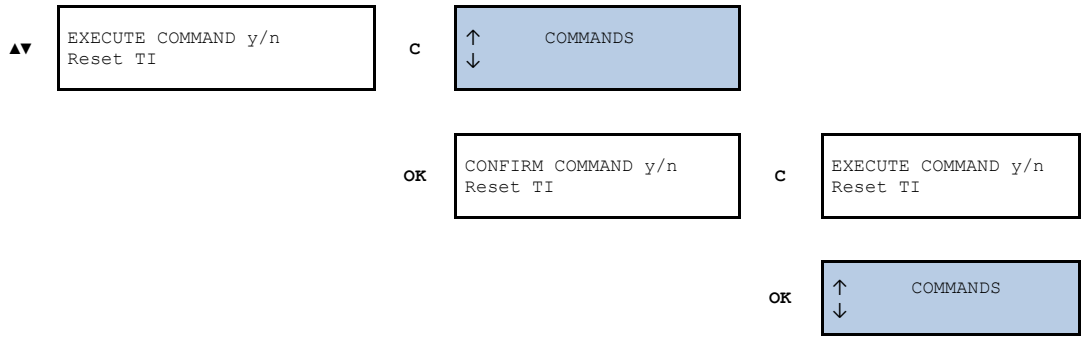
The keys ▲, ▼, ◄ and ► are used to enter the password. ▲ and ▼ are used to introduce a value or a character, and the ◄ and ► keys are used to move from one character to another. If it is necessary to change one of the password characters or numbers due to an error, press "C" to delete it. Press "OK”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



7.7.13. Commands Menu

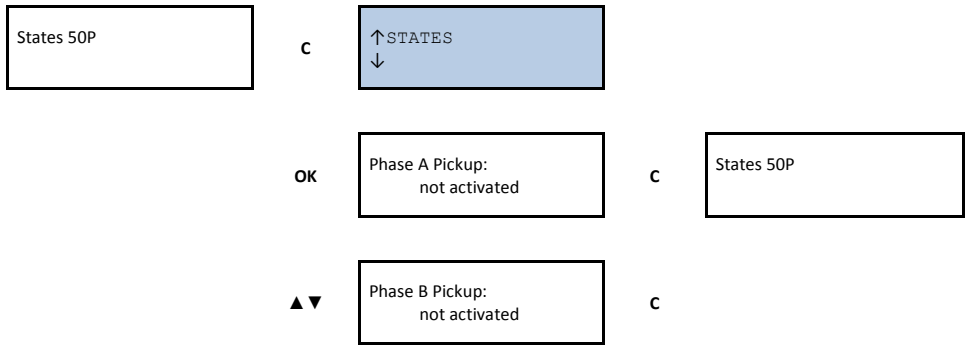
The first line of menus can be accessed from the standby mode screen by pressing the “OK” key. Use the “▲” and “▼” keys to move the cursor through the different screens until it is positioned over the "COMMANDS" screen. Press "OK" and use the “▲” and “▼” keys to view the different possible commands.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

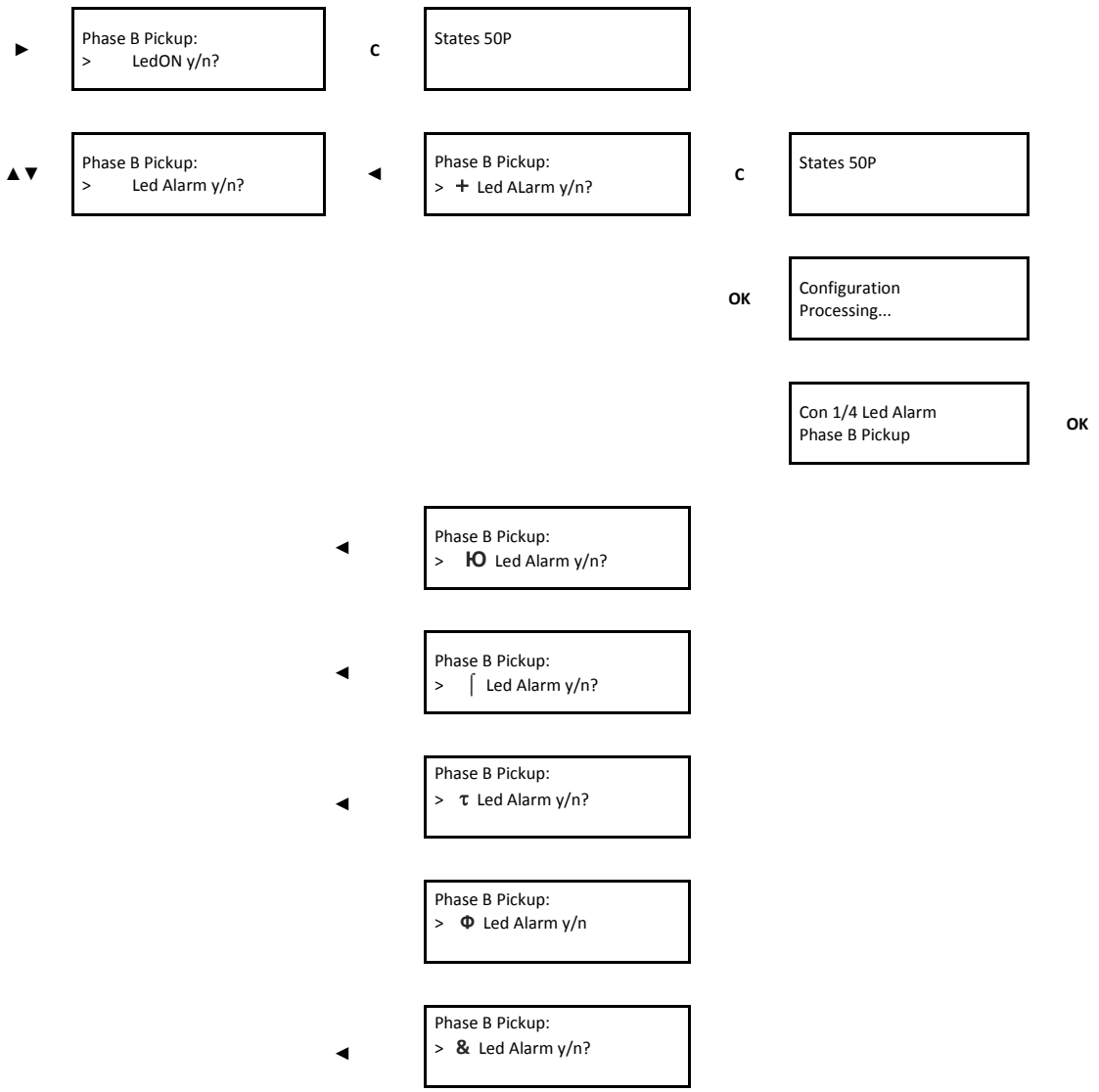


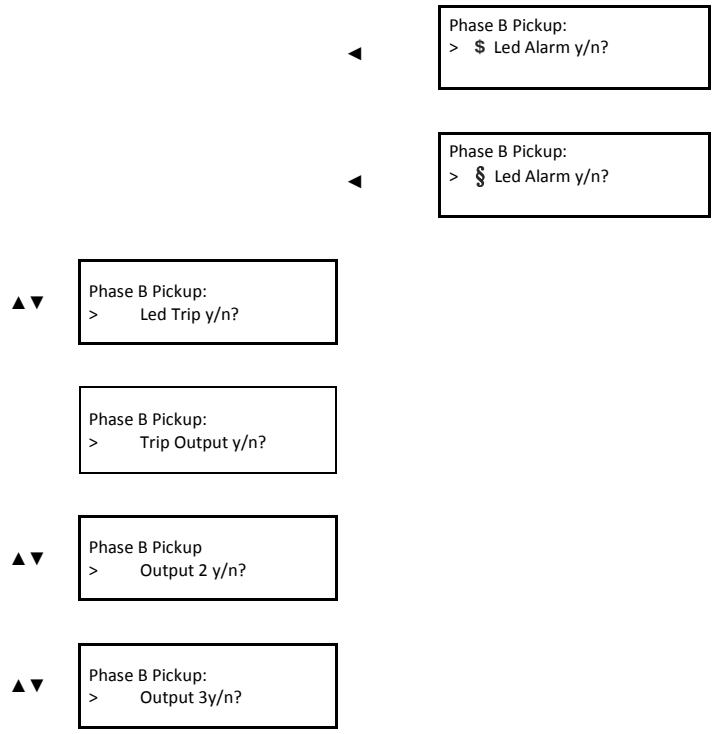


7.7.14. PLC and Output Configuration Menu

To assign an instantaneous state to a physical output, browse through the STATE menu to find the desired instantaneous state. When the state appears, press ► to enter the output configuration menu. Use the "▲" and "▼" keys in this menu to find the desired physical output. Then it is necessary to assign the logical gate. To do it, it is necessary to press ◄. Finally it is necessary to confirm the choice by pressing "OK". After, the confirmation is displayed on the screen; the index of 1 to 4 associated to the instantaneous state within the physical output configuration is displayed. Go up through the menu levels by pressing the "C" key.




►
Phase B Pickup:
> LedON y/n?
C
States 50P
▲▼
Phase B Pickup:
> Led Alarm y/n?
◄
Phase B Pickup:
> + Led ALarm y/n?
C
States 50P
OK
Configuration
Processing...
Con 1/4 Led Alarm
Phase B Pickup
OK
◄
Phase B Pickup:
> Ю Led Alarm y/n?
◄
Phase B Pickup:
> ⌠ Led Alarm y/n?
◄
Phase B Pickup:
> τ Led Alarm y/n?
Phase B Pickup:
> Φ Led Alarm y/n
◄
Phase B Pickup:
> & Led Alarm y/n?



To view or remove the instantaneous states assigned to a physical output, go to the “OUTPUT STATE" menu. When the output current state (activated or deactivated) is displayed, press the "OK” key to replace this current state reading with the first instantaneous state that is associated with the output, along with its index number from 1 to 4. The “▲” and “▼” keys can be used in this menu to browse all of the states (up to 4) that are associated with a physical output.

Press and hold the “RESET” key while viewing any of the instantaneous states associated with the output and its index number from 1 to 4 to remove the association with the physical output.

8. MODBUS RTU PROTOCOL

This document describes the steps to follow to read and write data on the SIA-F relay, as per the ModBus/RTU protocol. This memory map is only valid for one piece of equipment and one version of the memory. The positions of existing objects in the memory remain fixed from one version to the next, but new objects will naturally have new addresses which will, in turn, remain fixed in future versions. The memory map is described further on.

The standard ModBus/RTU protocol is used, so any program or PC can communicate easily with the equipment.

The SIA-F always acts as a slave, which means that it never initiates communications. The master is always responsible for initiating communications.

Only a subset of the ModBus/RTU functions is implemented:

- Reading function 3.
- Writing function 16.

The ModBus/RTU protocol is independent from the hardware. Therefore, the physical layer can exist in different hardware configurations: RS232, RS485, fiber optic or Ethernet.

Specifically, the relay has a front RS232 port and, as an option, a rear RS485 port. The data stream in any of the configurations is “half-duplex”.

Each byte of data is transmitted asynchronously and is made up of: 1 start bit, 8 data bits, 1 stop bit and 1 parity bit, if this is how it is programmed. Therefore, the data has 10 or 11 bits, depending on whether or not it includes parity.

When the equipment has a single front port, the address can be configured but the rest of the parameters are fixed: the speed is 19200, without parity and with 1 stop bit.

If the equipment is fitted with two switched ports, one front and one rear, the following features can be configured: speed (1200, 2400, 4800, 9600 or 19200), parity (even, odd or no parity), the stop bits (1 or 2) and the address (1 to 247).

The master must know the address of the slave that it is going to communicate with. No unit will act on requests from the master if the message is not addressed to them. The exception is when the 0 address, or “broadcast” address, is used, in which case the relay will act but will not send an answer of any type.

Communications are made in packages or frames, which are groups of data that are sent asynchronously. The master transmits a frame to the slave, and the slave then replies with another frame (except in the case of “broadcast” messages).

The end of the frame is marked by a dead time or silence time in the communication medium. The length of this time of silence varies depending on the transmission speed, as it is equivalent to 3 characters.

The following table shows the generic package format that is valid for transmission and reception. However, each function has its own peculiarities, as will be described further on.

8.1. ModBus packaged format

CUSTOMER ADDRESS	1 byte	Each device on a communication bus must have a unique address, otherwise two different units could reply simultaneously to the same request. All ports of the relay will use this address which can be set a value between 1 and 247. When the master transmits a frame with the slave address to 0 indicates a Broadcast. All the slaves in the communications bus will carry out the requested action, but no one will reply to the master. The Broadcast will only be accepted to write, as it makes no sense to make a read request in the Broadcast, as no one will reply this request.
FUNCTION CODE	1 byte	This is one of the function codes supported by the equipment. In this case, the only function codes supported are 3 to read and 16 to write. When the slave has to reply with an exception one of these frames, it is indicated by putting 1 in the most important bit of the correspondent function. Thus, an exception for the function 3 will be indicated with a 83 as a function code; and an exception for the function code 16 or 0x10 in hexadecimal, will be indicated with an 0x90.
DATA	N bytes	This part consists of a variable number of bytes, depending on the function code. It may include: addresses, data lengths, settings, commands or exception codes sent by the user.
CRC	2 bytes	Control code of two bytes. The ModBus/RTU includes a 16 bit CRC in each frame, to detect errors. If the slave detects an erroneous frame, based on a CRC that is not correct, it won't take any action, nor will reply anything to the master. The management of the CRC is LSB-MSB.
DEAD TIME	Necessary time to transmit 3,5 Bytes	A frame is terminated when nothing is received for a period of 3,5 bytes. It means: 15 ms at 2400 bps 2 ms at 19200 bps ...etc.

8.2. Function codes

HEX DEC CODE	MODBUS NAME	DEFINITION	COMMENT
0x03 3	Read Holding Registers	Reading of Any Value	This function allows the master to read 1 or more consecutive addresses of a relay. The registers always are of 16 bits, with the most important byte at first. The maximum number of registers to be read in a package is 60.
0x10 16	Preset Multiple Registers	Script	This function allows to write one or more registers that represent one or more settings. The registers are values of 2 bytes of length, transmitted with the most important byte at first. The maximum number of register to be written in a package is 60.

8.3. Exemptions and error answers

The error codes defined by the ModBus protocol are as follows:

01	**ILLEGAL FUNCTION**	The slave does not support any function with the function code received in this message.
02	**ILLEGAL DATA ADDRESS**	The master is trying to do an operation in a wrong address.
03	**ILLEGAL DATA VALUE**	The slave has detected that the value sent by the master is not valid.
04	**SLAVE DEVICE FAILURE**	Indicates an error occurred in the slave while trying to execute the request of the master.
05	**ACKNOWLEDGE**	Generic recognition.
06	**SLAVE DEVICE BUSY**	The slave is busy and unable to perform the required operation.
07	**NEGATIVE ACKNOWLEDGE**	Generic non-recognition.

8.4. Data type

TYPE	LENGTH	DESCRIPTION
UCHAR	1/2	Integer without sign of 1 byte
BYTE	1/2	Integer with sign of 1 byte
BIT16	1	Gathered bits type, groups of 16. E. g.: 0x1A41 = 0001101001000001b
BIT32	2	Gathered bits type, groups of 32.
ENUM	1	Integer without sign of 16 bits. Each of the values that the integer can be will have a correspondence in the auxiliary list of the database. I this list is the correspondence chain which must be shown for each of the values. Memory will only receive an integer value. E. g.: 0, 1 Correspondence to “CLOSED”, “OPEN”
DENUM	2	Integer without sign of 32 bits
UINT	1	Integer without sign of 2 bytes
INT	1	Integer with sign of 2 bytes
LONG	2	Integer without sign of 4 bytes
FLOAT	2	Number in floating decimal point “Float” of 4 bytes
ASCIIxx	xx/2	String: Length variable character chain. Final of String marked with ‘\0’. E. g.: “ABC” 0x41x42x43x00….
FH	5	Year(UINT).month(UCHAR).day(UCHAR).hour(UCHAR).minutes(UCHAR).seconds(UCHAR).hundredth(UCHAR).thousandth(UINT)
EVENT2	10	Criteria Directory(UINT).Event Identifier(UINT).Value(UINT).Associated Measure(float).Date and Time(FH)
EVENTO2	11	Antiquity(UINT).Event(EVENT2)

When a data format takes up more than 1 byte, it is always sent, firstly the most significant BYTE and lastly the lowest significant BYTE by communications.

DENUMCURVE	0	IEC 60255-151 inverse
	1	IEC 60255-151 very inverse
	2	IEC 60255-151 extremely inverse
	3	Definite time
DENUM 5060Hz	0	60Hz
	1	50Hz
DENUM NOYES	0	NO
	1	YES
DENUMBAUD	0	4800 bauds
	1	9600 bauds
	2	19200 bauds
	3	38400 bauds
DENUM LANGUAGE	0	English
	1	Spanish
	2	Depending on model

8.5. Memory map of SIA-F

Function	Description	Start address	Number of registries	Format	
16	Write the Directory of Event	1	1	UINT	
16	Write the number of the Setting List	6	1	UNIT	
03	Read of Model and Version	100	44	ASCII88	
16	Write access code	168	2	UCHAR4	See Passwords and Access Levels
03 y 16	Date and Time	170	5	FH	
16	Selection of Command	200	1	UINT	See commands map
16	Confirmation of Command	201	1	UINT	See commands map
03 y 16	Counters	202	2	CONT	See counters map

03 y 16	Counters	204	2	CONT	See counters map
16	Test state	250	2	BIT32	See test state map
03	Serial number	252	2	LONG	
03	Equipment identifier	254	44	ASCII88	
03	Primary measurement	300	2	FLOAT	MEASUREMENT_IA
03	Primary measurement	302	2	FLOAT	MEASUREMENT _IB
03	Primary measurement	304	2	FLOAT	MEASUREMENT _IC
03	Primary measurement	306	2	FLOAT	MEASUREMENT _IN
03	Primary measurement	308	2	FLOAT	MEASUREMENT _TI
03	Primary measurement	310	2	FLOAT	MEASUREMENT _IMAX
03	Read and Delete the oldest Event	400	11	EVENTO2	See events list
03	One event reading	410	11	EVENTO2	See events list
16	Delete All Events	420	1	dummy	
03	State reading	500	2	BIT32	General states map
03	State reading	502	2	BIT32	Local communication states map
03	State reading	504	2	BIT32	50P function map
03	State reading	506	2	BIT32	51P function map
03	State reading	508	2	BIT32	50G function map
03	State reading	510	2	BIT32	51G function map
03	State reading	512	2	BIT32	Inputs map
03	State reading	514	2	BIT32	Outputs map
03	State reading	516	2	BIT32	Trip blocking function map
03	State reading	518	2	BIT32	50BF function map
03	State reading	520	2	BIT32	52 function map
03	State reading	522	2	BIT32	49 function map
03	State reading	524	2	BIT32	Remote communication states map
03 y 16	Setting	600	10	ASCII20	Equipment identifier
03	Setting	610	2	DENUM 5060Hz	Frequency
03	Setting	612	2	LONG	Serial number

03 y 16	Setting	614	2	DENUM LANGUAGE	Language
03 y 16	Setting	616	2	LONG	Active group
03 y 16	Setting	618	2	FLOAT	CT phase ratio
03 y 16	Setting	620	2	FLOAT	CT neutral ratio
03 y 16	Setting	622	2	LONG	Local address
03 y 16	Setting	624	2	ASCII4	Password[4]
03 y 16	Setting	626	2	LONG	Remote address
03 y 16	Setting	628	2	DENUMBAUD	Remote baudrate
03 y 16	Setting	630	2	DENUM NOSI	F50P Permission
03 y 16	Setting	632	2	FLOAT	F50P Tap
03 y 16	Setting	634	2	FLOAT	F50P Operating time
03 y 16	Setting	636	2	DENUM NOSI	F51P Permission
03 y 16	Setting	638	2	DENUMCURVA	F51P Curve
03 y 16	Setting	640	2	FLOAT	F51P Dial
03 y 16	Setting	642	2	FLOAT	F51P Tap
03 y 16	Setting	644	2	FLOAT	F51P Definite time
03 y 16	Setting	646	2	DENUM NOSI	F50G Permission
03 y 16	Setting	648	2	FLOAT	F50G Tap
03 y 16	Setting	650	2	FLOAT	F50G Operating time
03 y 16	Setting	652	2	DENUM NOSI	F51G Permission
03 y 16	Setting	654	2	LONG	F51G Curve
03 y 16	Setting	656	2	FLOAT	F51G Dial
03 y 16	Setting	658	2	FLOAT	F51G Tap
03 y 16	Setting	660	2	FLOAT	F51G Definite time
03 y 16	Setting	662	2	DENUM NOSI	F49 Permission
03 y 16	Setting	664	2	FLOAT	F49 Tap
03 y 16	Setting	666	2	LONG	F49 Heating constant
03 y 16	Setting	668	2	LONG	F49 cooling constant
03 y 16	Setting	670	2	LONG	F49 Alarm
03 y 16	Setting	672	2	DENUM NOSI	Blocking trip permission

03 y 16	Setting	674	2	FLOAT	Blocking trip tap
03 y 16	Setting	676	2	DENUM NOSI	F50BF Permission
03 y 16	Setting	678	2	FLOAT	F50BF Operating time
03 y 16	Setting	680	2	LONG	F52 Max openings number
03 y 16	Setting	682	2	LONG	F52 Max amperes number
03 y 16	Setting	684	2	FLOAT	F52 Max opening time
03 y 16	Setting	686	2	FLOAT	F52 Max closing time
03 y 16	Setting	688	2	LONG	F52 Excess openings number
03 y 16	Setting	690	2	FLOAT	F52 Excess openings time
16	Confirm setting	800	10		Equipment identifier
16	Confirm setting	810	2		Frequency
16	Confirm setting	812	2		Serial number
16	Confirm setting	814	2		Language
16	Confirm setting	816	2		Active group
16	Confirm setting	818	2		CT phase ratio
16	Confirm setting	820	2		CT neutral ratio
16	Confirm setting	822	2		Local address
16	Confirm setting	824	2		Password[4]
16	Confirm setting	826	2		Remote address
16	Confirm setting	828	2		Remote Baudrate
16	Confirm setting	830	2		F50P Permission
16	Confirm setting	832	2		F50P Tap
16	Confirm setting	834	2		F50P Operating time
16	Confirm setting	836	2		F51P Permission
16	Confirm setting	838	2		F51P Curve
16	Confirm setting	840	2		F51P Dial
16	Confirm setting	842	2		F51P Tap
16	Confirm setting	844	2		F51P Definite time
16	Confirm setting	846	2		F50G Permission
16	Confirm setting	848	2		F50GTap
16	Confirm setting	850	2		F50G Operating time

16	Confirm setting	852	2		F51G Permission
16	Confirm setting	854	2		F51G Curve
16	Confirm setting	856	2		F51G Dial
16	Confirm setting	858	2		F51G Tap
16	Confirm setting	860	2		F51G Definite time
16	Confirm setting	862	2		F49 Permission
16	Confirm setting	864	2		F49 Tap
16	Confirm setting	866	2		F49 Heating constant
16	Confirm setting	868	2		F49 cooling constant
16	Confirm setting	870	2		F49 Alarm
16	Confirm setting	872	2		Blocking trip permission
16	Confirm setting	874	2		Blocking trip tap
16	Confirm setting	876	2		F50BF Permiso
16	Confirm setting	878	2		F50BF Tiempo de Operacion
16	Confirm setting	880	2		F50BF Permission
16	Confirm setting	882	2		F50BF Operating time
16	Confirm setting	884	2		F52 Max openings number
16	Confirm setting	886	2		F52 Max amperes number
16	Confirm setting	888	2		F52 Max opening time
16	Confirm setting	890	2		F52 Max closing time

8.6. Commands Map

2	Open Circuit breaker
3	Close circuit breaker
8	Reset thermal image

8.7. Examples of ModBus frames

8.7.1. Writing the access password “5555” to equipment nº 1

Address	01
Function	10
H start address	00
L start address	A8
Number of H registers	00
Number of L registers	02
Number of bytes	04
Password	35,35,35,35
Checksum H	4A
Checksum L	50

And SIA respond OK:

Address	01
Function	10
H start address	00
L start address	A8
Number of H registers	00
Number of L registers	02
Number of bytes	04
Checksum H	29
Checksum L	93

9. COMMISSIONING

9.1. Checklist for Commissioning

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

9.2. Electrostatic discharge

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

9.3. Visual Inspection

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

9.4. Earthing

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

9.5. 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.

9.6. Auxiliary power

If an SIA-F relay with auxiliary power is required, this must be specified on the order reference. The amount of auxiliary power required for the SIA-F relay should be checked: 110-230 Vac 50/60 Hz or 90-300 Vdc or 24-48 Vdc.

9.7. Front communications port

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

9.8. 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 5.10.**
- 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.

10. APPENDIX

10.1. Identification

Date : .....

Manager : .....

Substation : .....

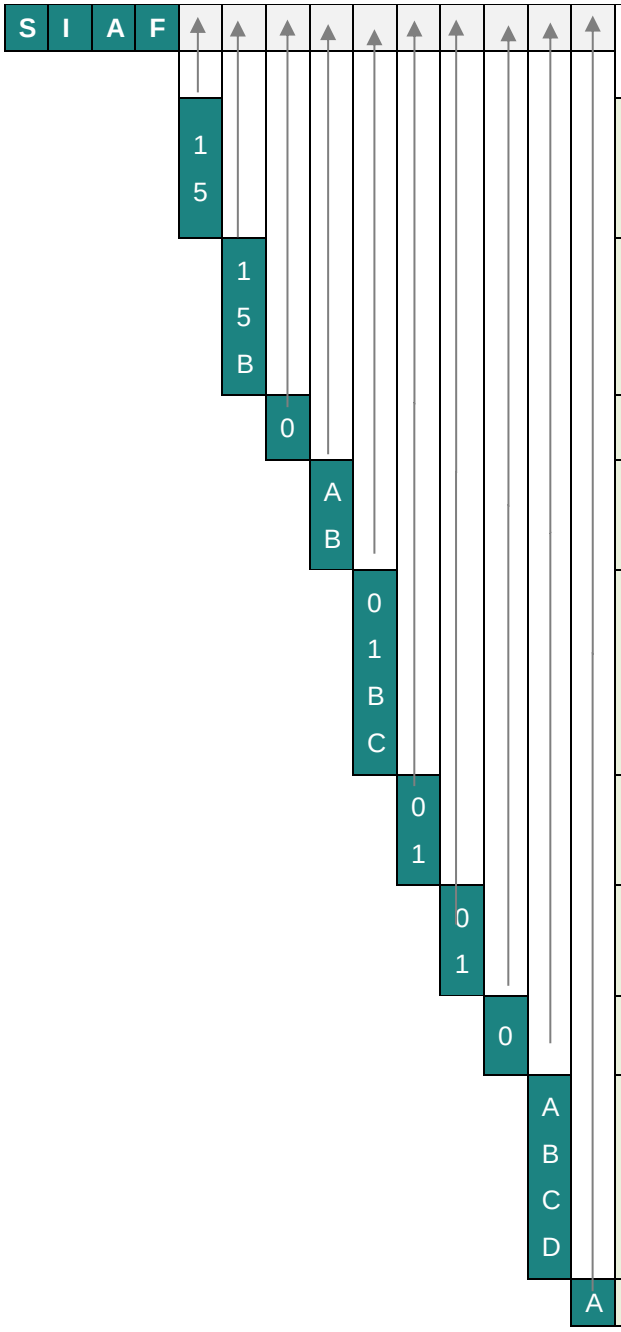
Circuit : .....

Model : .....

Serial n^{o}. : .....

Software Versions : .....

Model: .....



MODEL SELECTION TABLE Example: SIAF550B0000AA
1 A phase measurement 5 A phase measurement
1 A neutral measurement 5 A neutral measurement 0,2 A neutral measurement
Defined in general settings
24- 48 Vdc 90 Vdc – 300 Vdc / 110 Vac – 230 Vac
- +52+50BF+49 + Trip block for switch disconnector + Trip block for switch disconnector+52+50BF+49
Frontal USB +rear RS485
3 led´s + trip output + 2 inputs + 2 outputs (configurable)
-
English, Spanish and German English, Spanish and Turkish English, Spanish and French English, Spanish and Russian
-

10.2. Checks

Cabling check: ❒

Box earth: ❒

Vaux value: ❒

10.3. Test menu

On LED:	❒	Trip Output	❒
Alarm LED:	❒	Output 2:	❒
Trip LED:	❒	Output 3:	❒

10.4. Register of commissioning settings

Password: ……

Identification: ……

CT Ratio

Phase CT Ratio: ……

Neutral CT Ratio: ……

50P

Permission ❒ Enabled ❒ Disabled

Tap..... x In

Operating Time: ..... s

50N/G

Permission ❒ Enabled ❒ Disabled

Tap..... x In

Operating Time: ..... s

50/51P

Permission ❒ Enabled ❒ Disabled

Tap..... x In

IEC curve ❒ Inverse ❒ Very Inverse ❒ Extrem. Inverse ❒ Definite time

Dial .....

Operating Time …… s

50/51N/G

Permission ❒ Enabled ❒ Disabled

Tap..... x In

IEC curve ❒ Inverse ❒ Very Inverse ❒ Extrem. Inverse ❒ Definite time

Dial…….....……..

Operating Time…..……. s

49

Permission ❒ Enabled ❒ Disabled

Tap……..…… x In

ζ heating: ……. min

ζ cooling: ……. ζ heating

Alarm: …… %

50BF

Permission ❒ Enabled ❒ Disabled

Operating time ……..… s

Trip blocking

Permission ❒ Enabled ❒ Disabled

Blocking level.....…… x In

Circuit breaker

Excessive number of openings ….....……

Excessive accumulated amps….....……

Opening time….....……

Closing time….....……...

Excessive repeated openings …….....……..

Time of repeated openings ….....……

10.5. Output configuration

	OUTPUT	LOGICAL GATE	BINARY STATES
LEDs	LED On		
	LED Alarm		
	LED Trip		
PHYSICAL OUTPUTS	Trip output		
	Output 2		
	Output 3		
LOGICAL SIGNALS	52a logical signal		
	52b logical signal		
	External trip logical signal		
	50BF start logical signal		
	Fault start logical signal		
	50P Block logical signal		
	50N/G Block logical signal		
	Reset logical signal		
	Active group 1 logical signal		
	Active group 2 logical signal		

10.6. Comments

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Person in charge of commissioning……..……..……..Date……..……

Maintenance performed on the…….. by ……..……..

NOTES:

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