
# SIL-V

**Voltage, frequency and synchronism 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 eliability 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 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.

## 1.5. Storage

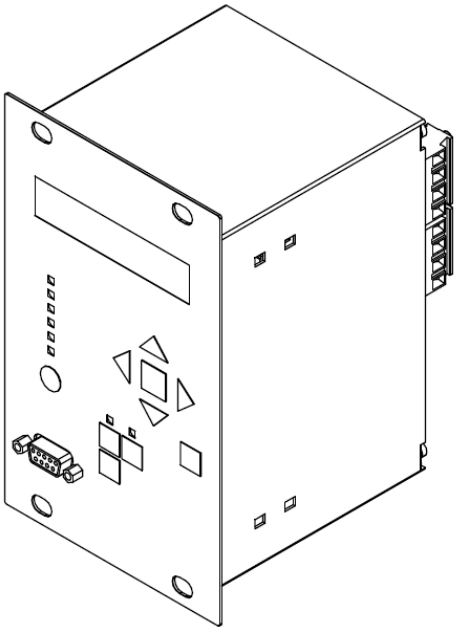
If the relays are not going to be installed immediately, they must be stored in a dust- and humidity free environment after the visual inspection has been performed.

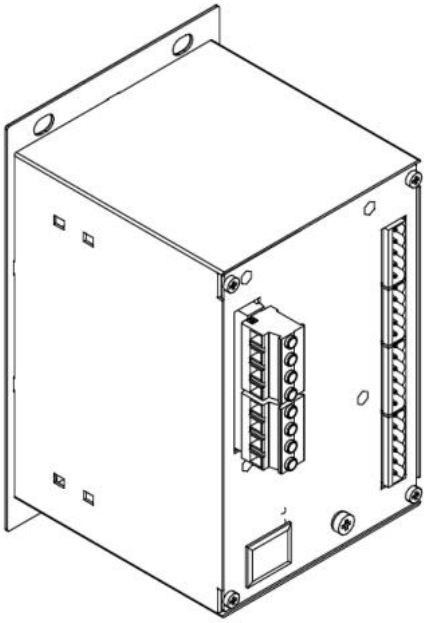
## 1.6. Recycling

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.

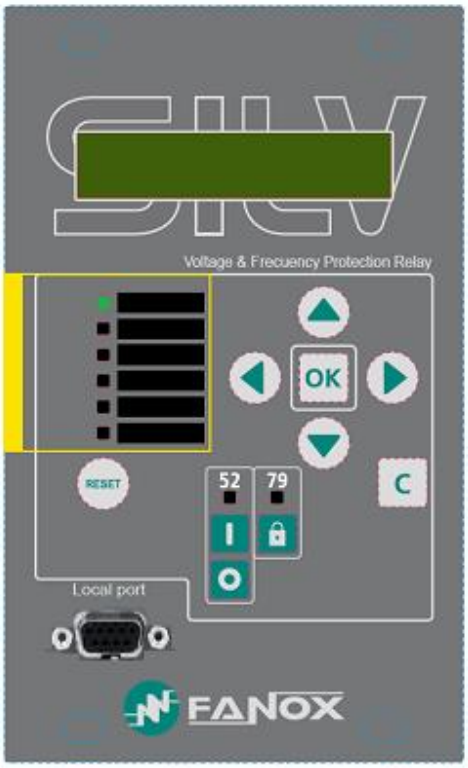
This product must be disposed of in a safe way. It should not be incinerated or brought into contact with water sources like rivers, lakes, etc…

# 2. DIMENSIONS AND CONNECTION DIAGRAMS

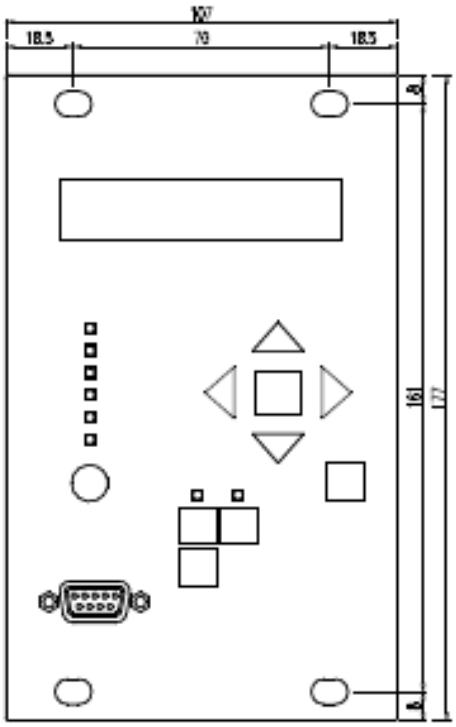


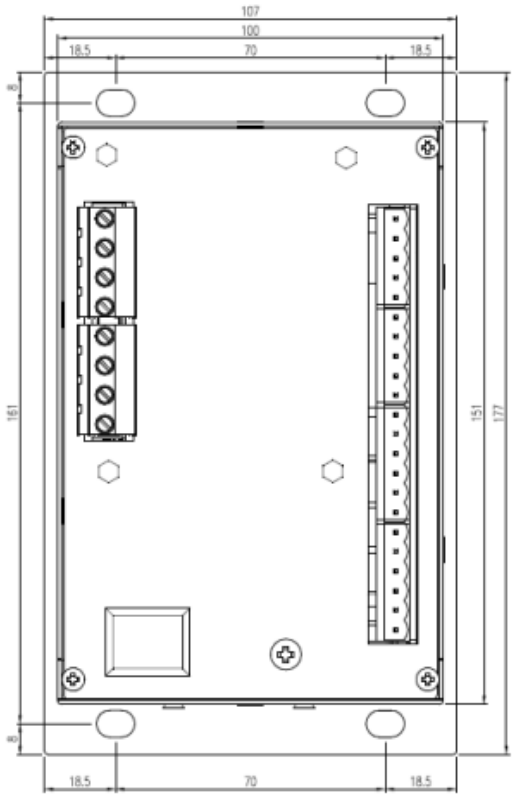


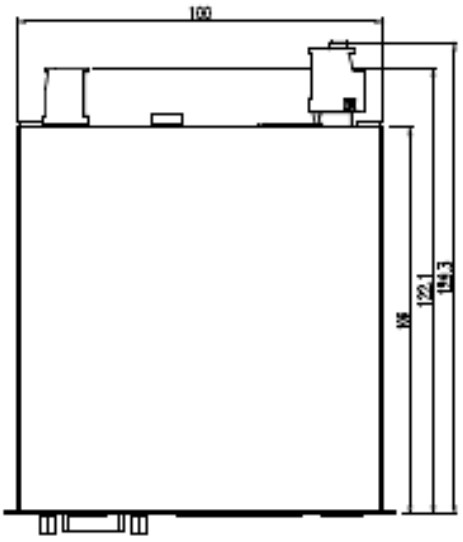
## 2.1. Equipment front view



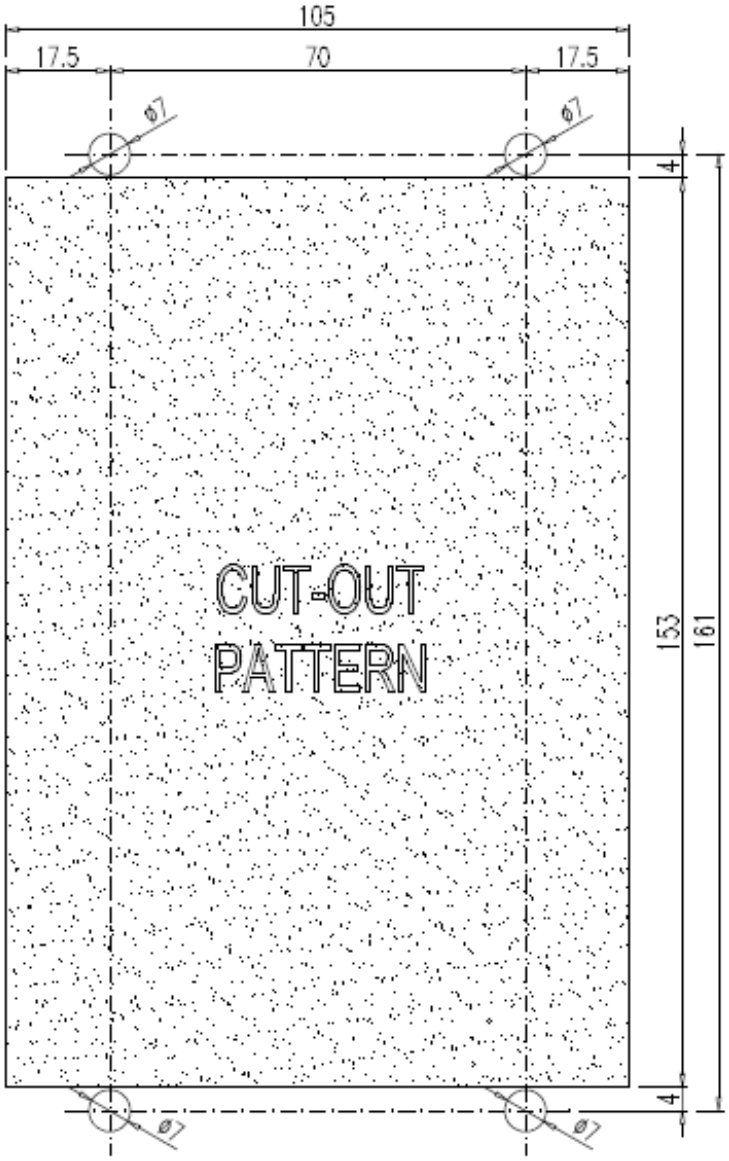
## 2.2. Equipment dimensions



## 2.3. Cut-out pattern



## 2.4. Connection diagrams

In SIL-V relay it is important to take into account the connection type is configurable by the user. Depending on model the following options are available:

**SILVxxxx0xxxxx:**

**Using voltage transformers**

3 VT configuration (phase-neutral)

3 VT configuration (phase-neutral) + residual voltage

3VT configuration (phase-phase) + residual voltage

2VT configuration (phase-phase) + residual voltage

**Connecting the relay directly to Low Voltage line**

Phase to neutral configuration (250-480 V)

**SILVxxxx2xxxxx:**

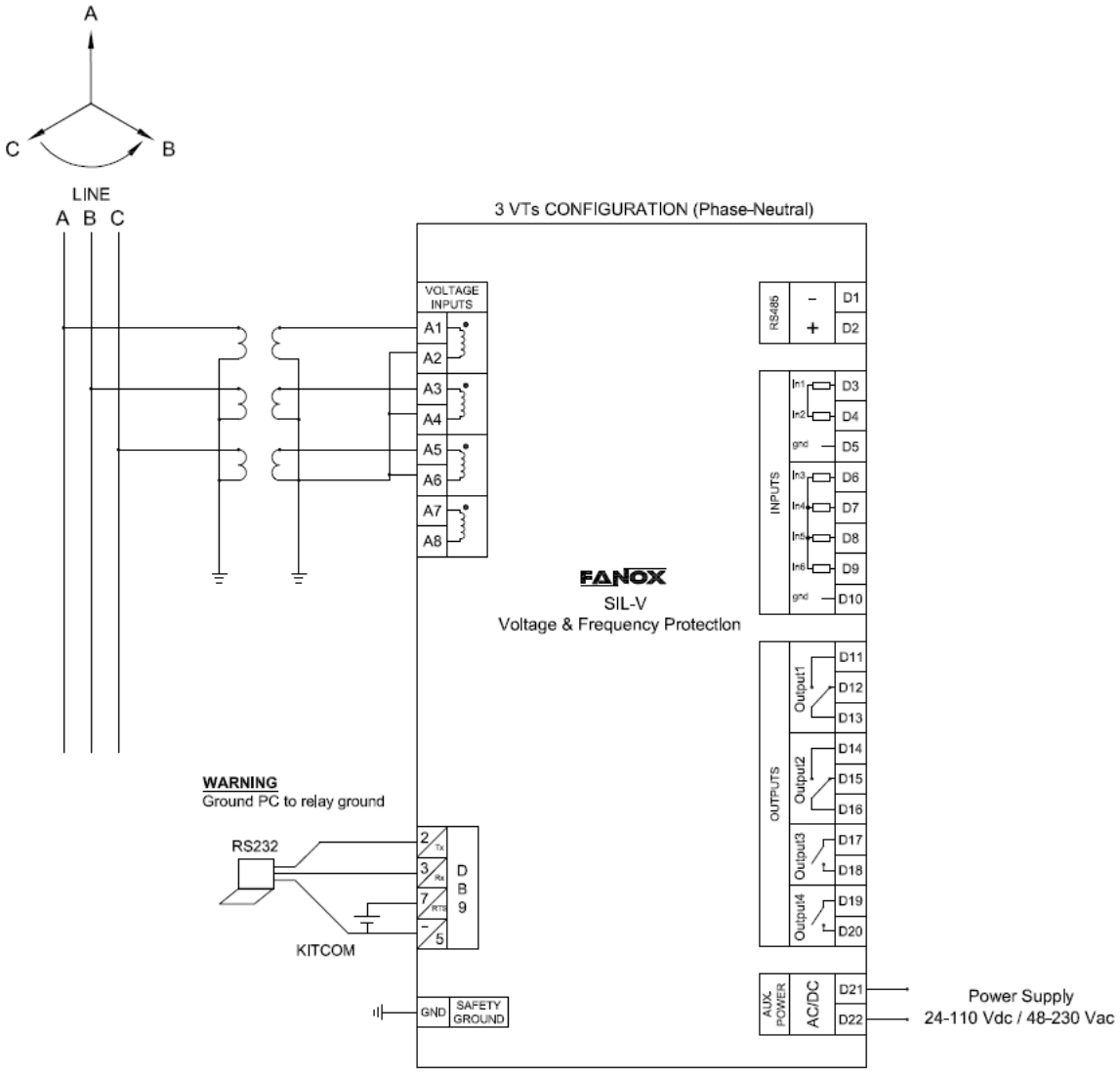
**Using voltage transformers**

3 VT configuration (phase-neutral) + busbar voltage

**Connecting the relay directly to Low Voltage line**

Phase to neutral configuration

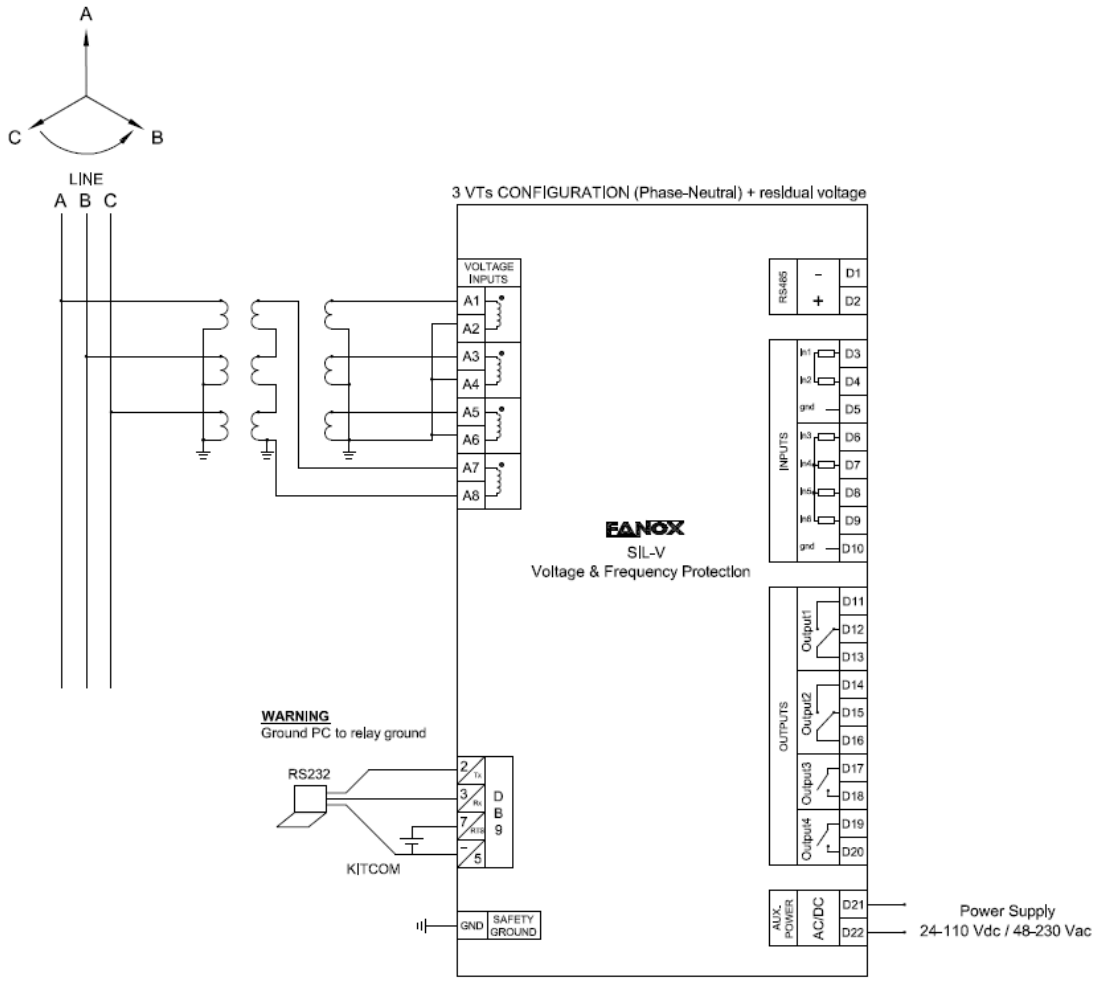
## 3 VT configuration (phase-neutral)



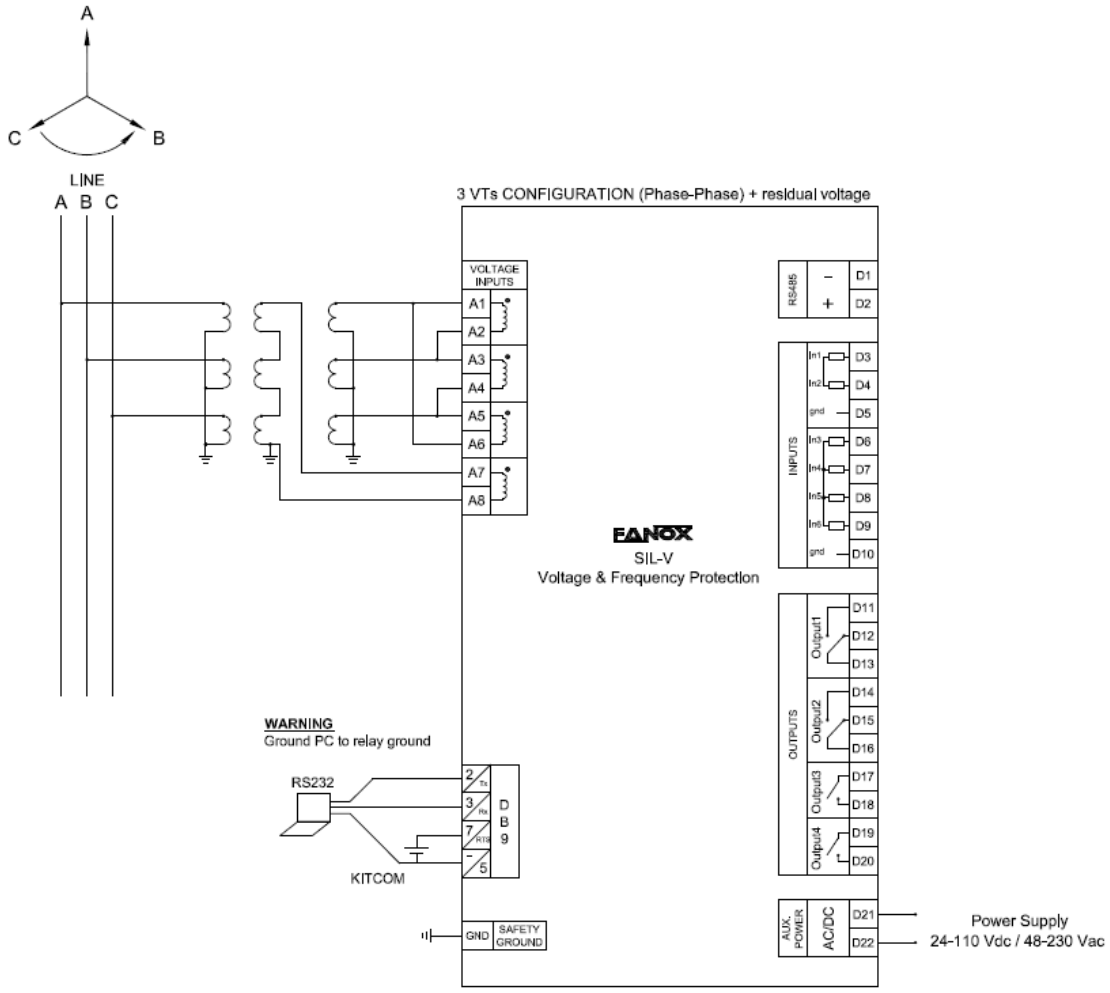
**3 VT configuration (phase-neutral) + residual voltage (SILVxxxx0xxxxx)**

**or**

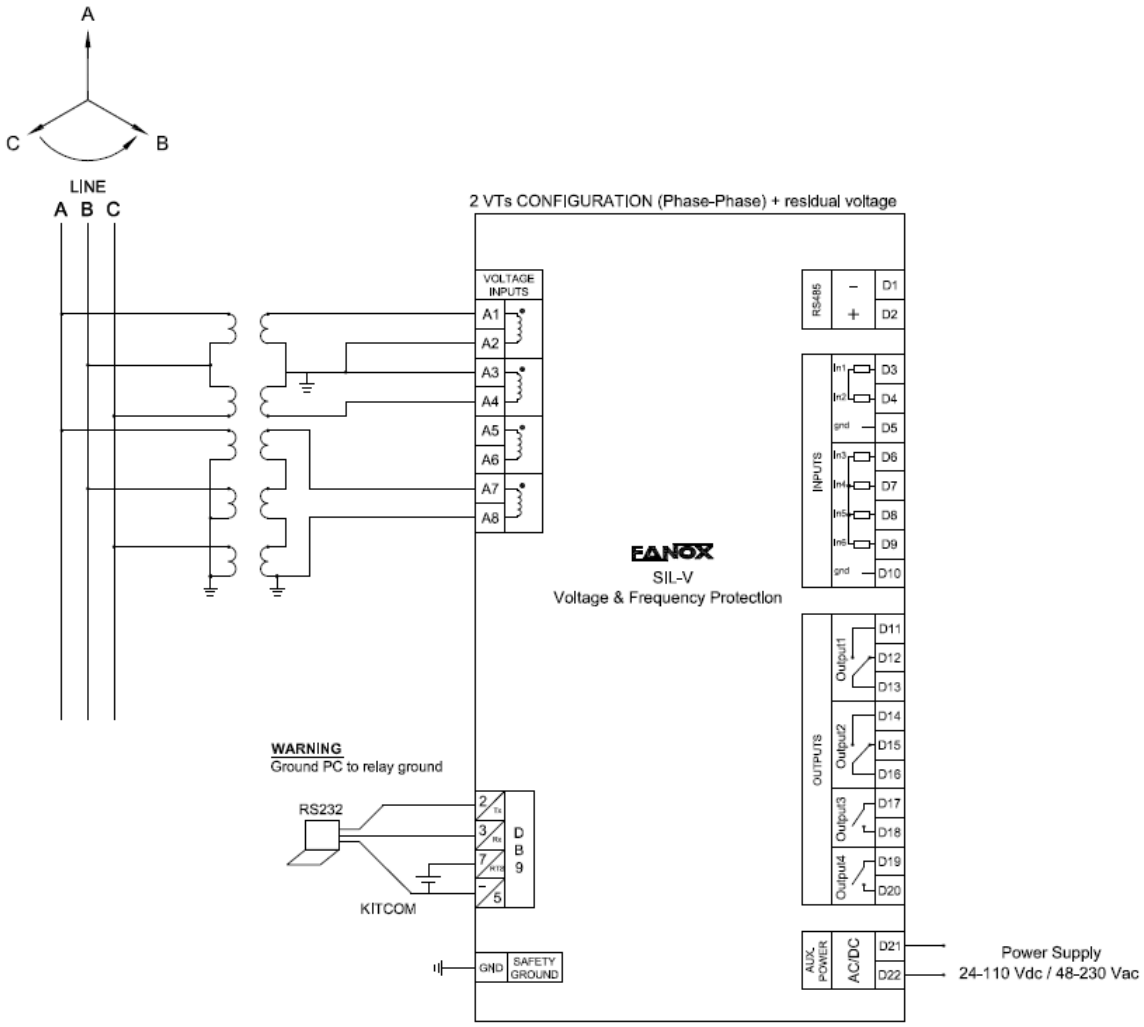
**3 VT configuration (phase-neutral) + busbar voltage (SILVxxxx2xxxxx)**



## 3VT configuration (phase-phase) + residual voltage



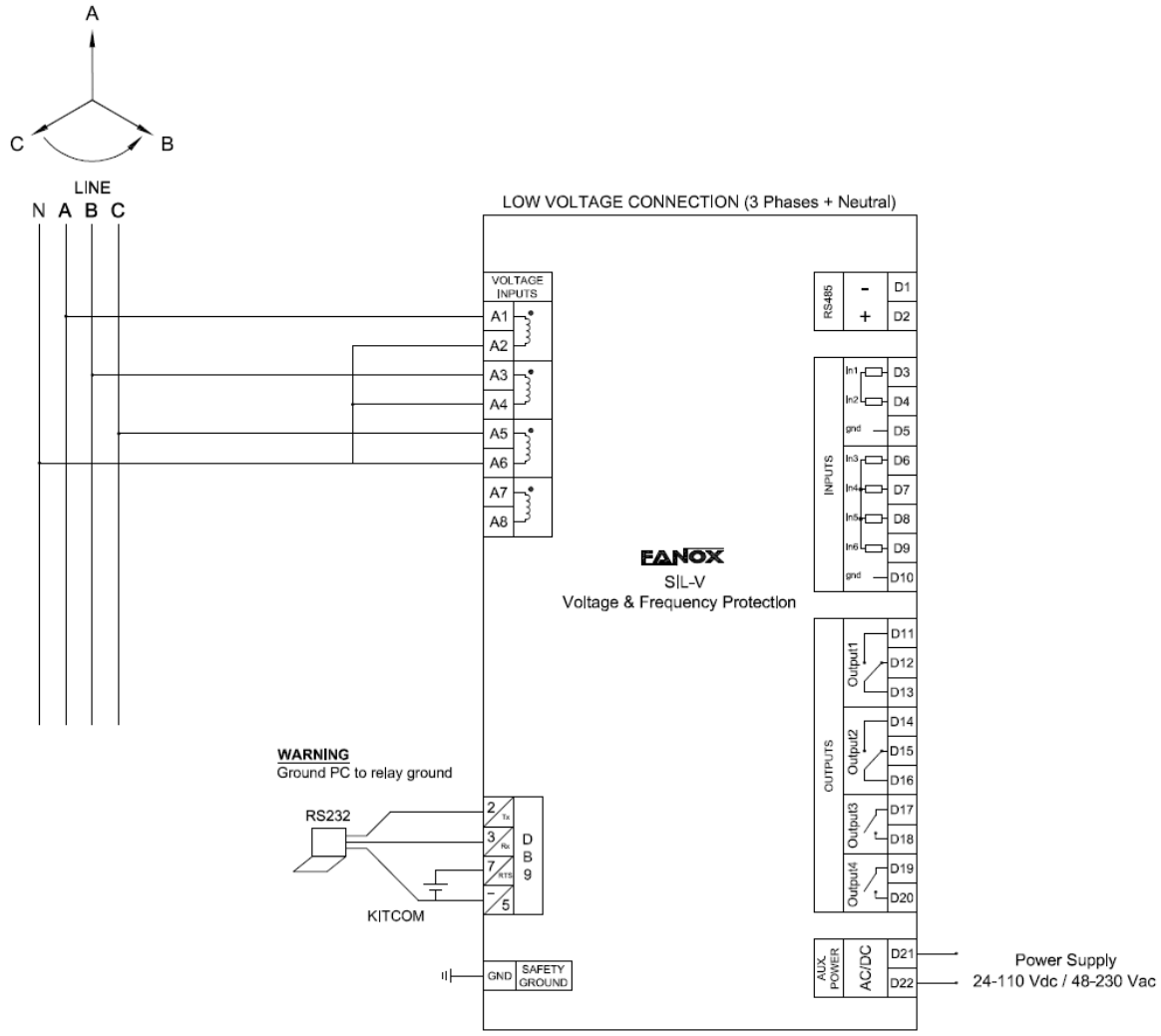
## 2VT configuration (phase-phase) + residual voltage



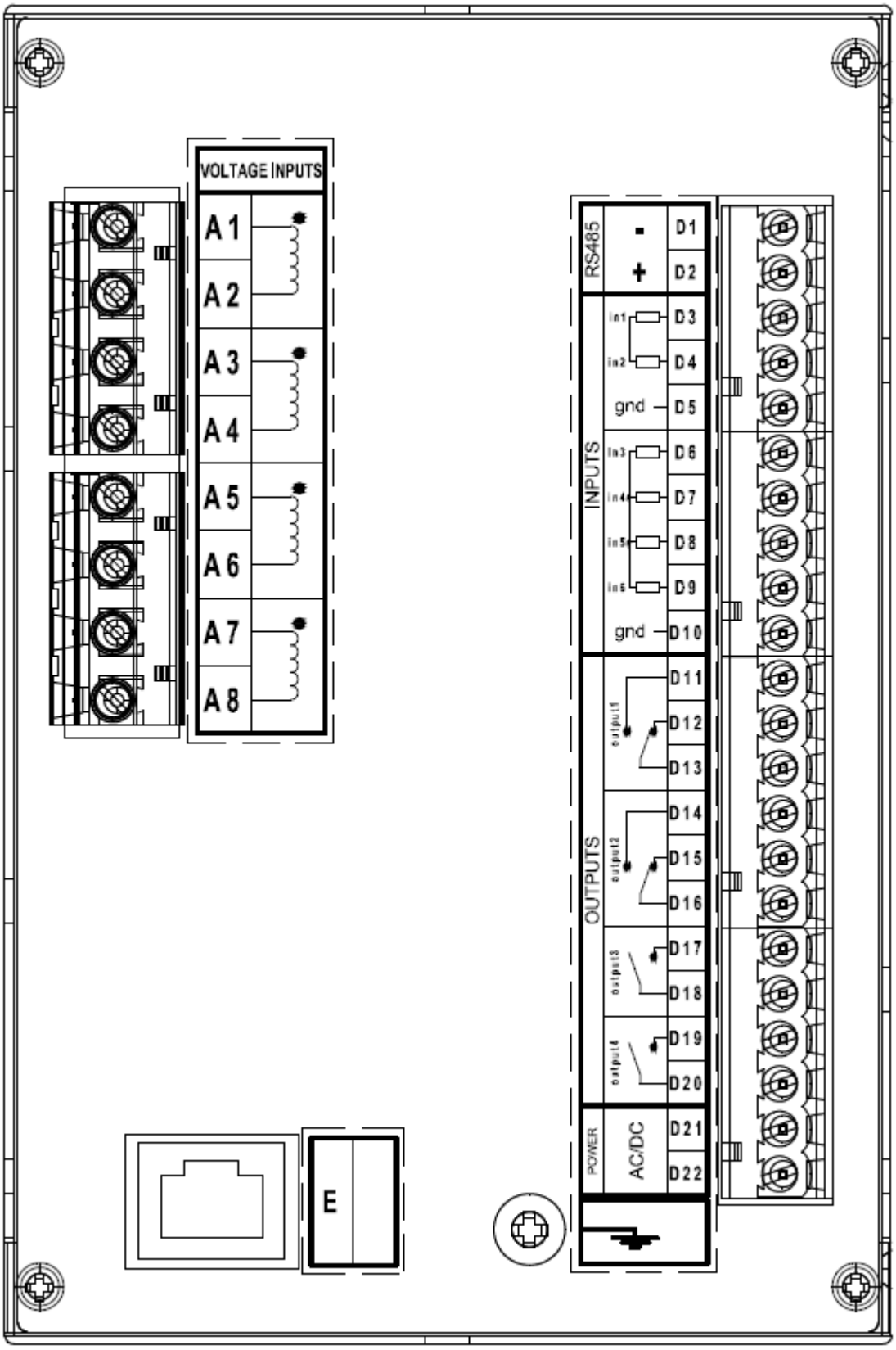
## Connecting the relay directly to Low Voltage line

### SILVxxxx0xxxxx and SILVxxxx2xxxxx

### Phase to neutral configuration (250-480 V)



## 2.5. Terminals



| | |
|---|---|
| **D1** | + RS485 Modbus RTU or IEC60870-103 selectable by settings (*) |
| **D2** | – RS485 Modbus RTU or IEC60870-103 selectable by settings (*) |
| **D3** | Digital input 1 |
| **D4** | Digital input 2 |
| **D5** | Common inputs 1 and 2 |
| **D6** | Digital input 3 |
| **D7** | Digital input 4 |
| **D8** | Digital input 5 |
| **D9** | Digital input 6 |
| **D10** | Common digital inputs 3, 4, 5 and 6 |
| **D11** | Digital 1 common output |
| **D12** | NC digital output 1 |
| **D13** | NO digital output 1 |

| | |
|---|---|
| **D14** | Digital 2 common output |
| **D15** | NC digital output 2 |
| **D16** | NO digital output 2 |
| **D17-D18** | NO digital output 3 |
| **D19-D20** | NO digital output 4 |
| **D21** | + Auxiliary voltage. |
| **D22** | - Auxiliary voltage. |
| **A1-A2** | Phase A voltage measurement |
| **A3-A4** | Phase B voltage measurement |
| **A5-A6** | Phase C voltage measurement |
| **A7-A8** | Neutral or busbar phase B voltage measurement |
| **E** | IEC 61850, DNP3.0 or IEC60870-104 depending on model (*) |

(*) When the model is chosen it is very important to choose the communications protocols correctly. If “RS485” port with selectable protocol is chosen then “E” communications module is not available. If “E” communications module is chosen then “RS485” port works with Modbus RTU protocol (it is not possible to chose between Modbus RTU and IEC60870-5-103)

# 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 SIL family of products to carry out this function.

The SIL-V relay is designed to protect the transformers and electrical machines. HV, MV and LV distribution systems and for decoupling, load shedding and loss of main (islanding) protectioon.

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. Description

Power is supplied with an auxiliary voltage, equal to 24-110 Vdc/48-230Vac. Apart from the voltage protection functions and frequency protection functions, the relay provides phase imbalance, circuit breaker fault function, trip circuit supervision and optionally syncronism supervision.

It is also fitted with a re-closer. This automated control shall permit closure (up to five attempts) with the possibility of programming each reclosing time. It can be blocked by various means, from the keyboard with a separate key, to the remote communications.

All models include a circuit breaker management, which monitors the state of the circuit breaker, the number of openings 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 circuit breaker close and open commands from the HMI, with different keys, and via the communications port (either locally or remotely).

The SIL-V equipment has 6 inputs and 4 outputs that can be set by the user:

The SIL-V 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 interference. These levels are the same as those established for primary substations.

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

As well as the 6 keys to navigate the menus, there are also special keys:

- Reset. To reset the signals and events.
- 79 lock. This locks and unlocks the recloser.
- Circuit breaker I/O. This serves to control the circuit breaker.

The SIL-V is fitted with 8 configurable leds on the front of the relay.

The SIL-V has storage for up to 200 events, allowing any registered incidents to be analysed.

To facilitate problem solving, and as a wide range of fault events may arise (recloser and reverse criteria) that may not be entirely detected by the oscillography as this is time limited, and as event recording consists on more general information, with the possibility of fault specific information being lost, the equipment includes a fault report record. This report allows the last 20 faults to be recorded with a capacity of 24 events per fault.

In order to facilitate the analysis of events, it is fitted with oscillography records. SIL-V is fitted with 5 oscillographic registers, each one with 88 cycles (1 second at 50 Hz, 0.833 seconds at 60 Hz). 3 prefault cycles and 85 postfault cycles. The oscillography start can be configured by the user. Each oscillography record shows the phase and neutral voltages (or busbar phase B) and up to 64 digital channels, which include start-ups and trips, the protection functions, inputs, outputs, etc. The COMTRADE format is used (IEEE C37.111-1991).

Voltage measurements are performed using RMS values, with an accuracy of 2% over a range of ±20% over the nominal voltage and 4% over the rest of the range.

SIL-V offers two different types of connection to the line, through voltage transformers use or connecting directly to the low voltage line (in this case voltage transformers are not required).

It has two communications ports: one front port (RS232) and one rear port. The RS232 port allows a PC to be connected and the equipment to be monitored using the SICom program in WINDOWS XP, WINDOWS 7 or WINDOWS 8 (supplied by FANOX).

The rear communication ports are designed for different functions. While one is used for control, principally including the alarm and control functions, the other is designed for specific protection personnel consultations, with the possibility of consulting and changing, adjustment, or downloading of events and oscillography, all without affecting the control part operation. Depending on model, there are the following options respect to rear ports:

1. One rear port (RS485, FOP or FOC) with selectable communication protocols (selectable by settings) between IEC60870-103 and Modbus RTU.
2. One rear port RS485 with Modbus RTU protocol and one rear port (RJ45 or FOC) with IEC61850, DNP3.0 or IEC60870-104, depending on model.

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

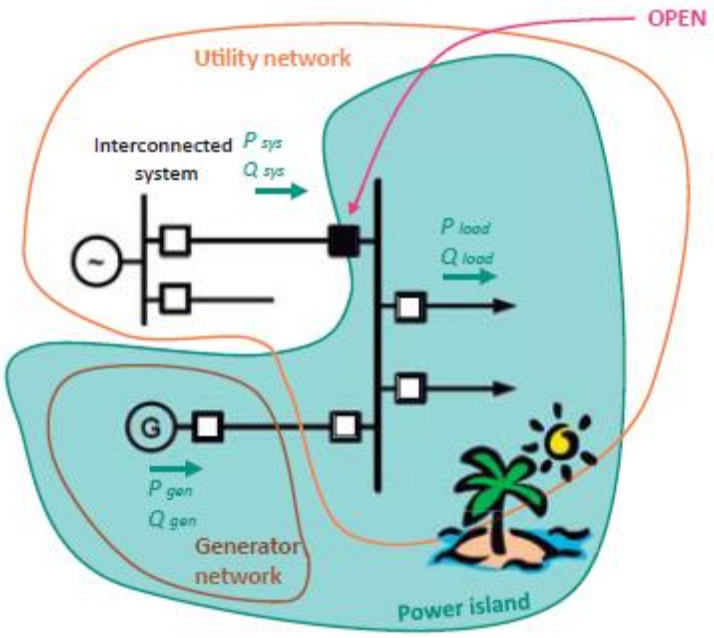
The protective functions provided, easy-to-use interface, low amount of maintenance and simple integration make the SIL-V a precise and practical solution for protecting transformers or electrical machines. HV, MV and LV distribution systems and for decoupling, load shedding and loss ofmain (islanding) protection.

Loss of main (islanding) detection:

Loss of mains occurs when part of the public utility network loses connection with the rest of the system. If this situation is not detected, then the generator could remain connected, causing a safety hazard within the network.

Automatic reconnection of the generator to the network may occur, causing damage to the generator and to the network.

SIL-V protection detects this situation thanks to its voltage and frequency functions focused on the Rate of change of frequency (ROCOF) method:



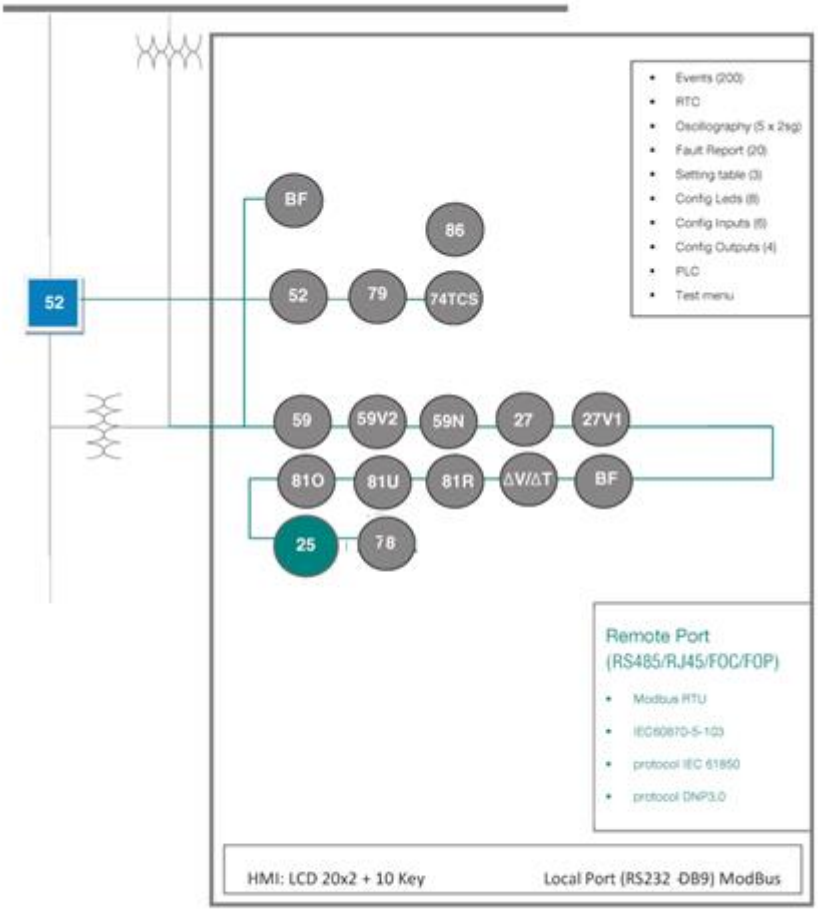

The main features of the equipment are listed below, and these features will be explained in the rest of the manual:

| Function | Description | SIL-V |
|---|---|---|
| **Protection** | | |
| **25** | Synchronism | 1 (Optional) |
| **27** | Undervoltage | 2 |
| **27V1** | Positive sequence undervoltage | 1 |
| **59** | Phase Overvoltage | 2 |
| **47** | Negative Sequence Overvoltage | 1 |
| **59N** | Neutral overvoltage | 2 |
| **ΔV/ΔT** | Rate of change of Voltage | 1 |
| **74TCS** | Trip circuit supervision | 1 |
| **78** | Out of step (vector shift) | 1 |
| **81O/U** | Overfrequency/Underfrequency | 4 |
| **81R** | Rate of change of frequency | 2 |
| **52** | Circuit breaker monitoring | ✓ |
| **BF** | Breaker failure | 1 |
| **86** | Trip output lockout | ✓ |
| **79** | Recloser | ✓ (Up to 5 attempts) |
| **Circuit Breaker** | | |
| **52** | Status and control of the circuit breaker | ✓ |
| | Counter to record the number of openings | ✓ |
| | Maximum openings in a time window | ✓ |

| Function | Description | SIL-V |
|---|---|---|
| **Measurements** | | |
| | Phase RMS voltages with a precision of 2% in a band of ±20% when compared to the rated voltage, and 4% in the rest of the range. (V-A, V-B, V-C) | ✓ |
| | Residual voltage (V-R) | Depending on model |
| | Negative sequence voltage (V-2) | ✓ |
| | Positive sequence voltage (V-1) | ✓ |
| | Maximum voltage (Vmax) | ✓ |
| | Minimum voltage (Vmin) | ✓ |
| | 3V-0 (sum of V-A, V-B and V-C) | ✓ |
| | Busbar voltage (V-BB) | Depending on model |
| | Rate of change of phase A voltage respect to the time (dVA/dt) | ✓ |
| | Rate of change of phase B voltage respect to the time (dVB/dt) | ✓ |
| | Rate of change of phase C voltage respect to the time (dVC/dt) | ✓ |
| | Rate of change of frequency respect to time (df/dt) | ✓ |
| | Line frequency | ✓ |
| | Bar frequency | Depending on model |
| | Frequency difference between phase B line and phase B bar (depending on model) | Depending on model |
| | Phase difference between phase B line voltage and busbar voltage (depending on model) | Depending on model |
| **Inputs and outputs** | | |
| Inputs | Secondary rated voltage | Low scale: 110-250 V (measurement: 3-250 volts)<br>High Scale: 250-480 V (measurement: 12-1000 volts) |
| | Analog Inputs | 4 inputs for Voltage measurement (depending on model: 3 phases + residual voltage or 3 phases + busbar voltage) |
| | Digital inputs | 6 configurable digital inputs |
| Outputs | Digital outputs | 4 configurable outputs: 2 (NO/NC) + 2 (NO) |

| Function | Description | SIL-V |
|---|---|---|
| **Communication** | | |
| | LOCAL Communication | ✓: 1 Local port RS232: ModBus RTU |
| | REMOTE Communication | ✓ (Optional)<br>Remote ports with the following options:<br>1 Remote port RS485: ModBus RTU or IEC 60870-5-103 (by general settings)<br>1 Remote port RS485: ModBus RTU + 1 RJ45: IEC61850, DNP3.0 or IEC 60870-104 (depending on model) |
| **HMI** | | |
| | SICom programme for Windows | ✓ |
| | Setting-up the session: 4 access levels with configurable passwords | ✓ |
| | HMI: LCD, 20x2 | ✓ |
| | 6 keys + 1 reset button + 2 keys for 52 control + 1 separate key for 79 Locking | ✓ |
| | LED Indicators | 8 leds: All configurable |
| **Power** | | |
| | Auxiliary voltage . | 24-110 Vdc./48-230 Vac |
| **Monitoring and Recording** | | |
| | Events saved in the non-volatile FRAM* memory | 200 events |
| | Oscillography records in the non-volatile FRAM memory | 5 Records (88 cycles per record)<br>20 fault reports (24 events each one) |
| | Real-Time Clock (RTC 1 millisecond) | ✓ |
| | Test menu | ✓ |
| | Self-diagnosis | ✓ |
| **Adjustments Table** | | |
| | By general settings<br>By Inputs | 3 setting tables |
| **Mechanical** | | |
| | Dimensions | 4U x $^{1}/_{4}$rack |

## 3.3. Functional Diagram



## 3.4. Selection & Ordering data

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **SIL-V** | | | | | | | | | | **PROTECTION FUNCTIONS**<br>27(2) + 27V1 + 59(2) + 59V2 + 59N(2) + ΛV/ΛT + 74TCS + BF + 52 + 79 + 81O/U(4) + 81R(2) + 78 + 86 |
| | 0 | | | | | | | | | **PHASE MEASUREMENT**<br>Defined by Setting: |
| | | 0 | | | | | | | | **NEUTRAL MEASUREMENT**<br>Defined by Setting: |
| | | | 0 | | | | | | | **NET FREQUENCY**<br>Defined by Setting: 50Hz or 60Hz |
| | | | | C | | | | | | **POWER SUPPLY**<br>24-110 Vdc / 48-230 Vac |
| | | | | | 0<br>2 | | | | | **ADDITIONAL FUNCTIONS**<br>-<br>+ 25 |
| | | | | | | A<br>B<br>C<br>D<br>E<br>F<br>G<br>H<br>I | | | | **REAR COMMUNICATIONS**<br>RS485. by Setting : ModBus or IEC 60870-5-103<br>ModBus (RS485) + IEC61850 (RJ45)<br>ModBus (RS485) + DNP3.0 (RJ45)<br>ModBus (RS485) + IEC60870-5-104 (RJ45)<br>FOC. Defined by Setting : ModBus or IEC 60870-5-103<br>ModBus (RS485) + FOC. IEC61850<br>ModBus (RS485) + FOC. DNP3.0<br>ModBus (RS485) + FOC. IEC60870-5-104<br>FOP. Defined by Setting : ModBus or IEC 60870-5-103 |
| | | | | | | | 1 | | | **INPUTS-OUTPUTS**<br>6 Inputs + 4 Outputs. Configurable. |
| | | | | | | | | 2 | | **MECHANICS**<br>4U x ¼rack |
| | | | | | | | | | A<br>B<br>C<br>D<br>E | **LANGUAGE**<br>English, Spanish and German<br>English, Spanish and Turkish<br>English, Spanish and French<br>English, Spanish and Russian<br>English, Turkish and Russian |
| | | | | | | | | | | A **ADAPTATION** |

# 4. PROTECTION FUNCTIONS

## 4.1. Function 27. Definite-time phase undervoltage

There are two independent phase undervoltage functions.

This protection function is adjusted using four parameters:

| Function | Description | Minimum | Maximum | Step | Unit | Default |
|---|---|---|---|---|---|---|
| 27_1<br>27_2 | **Definite-time phase undervoltage** | | | | | |
| | Permission | - | - | Yes/No | - | No |
| | Pickup | 3,0 | 555,0 | 0,1 | V | 10,0 |
| | Operating time | 0,02 | 300,0 | 0,01 | s | 1,40 |
| | Reset time | 0,02 | 300,00 | 0,01 | s | 0,20 |

The operating time is completely independent of the measured phase voltage, such that should the phase voltage goes down the set value during the same amount of time or more than the set one, the protection function acts (trips) and there it is not restored until the measured value of the phase voltage exceeds the voltage set point during adjusting reset time.

The function pick up occurs at 100% of the adjusted input and the dropout at 105%. The reset type is temporized and reset time is adjusted with reset time parameter.

The accuracy of the operating time is the adjusted time ±30ms or ± 0.5% (greater of both).

## 4.2. Function 27V1. Definite-time positive sequence undervoltage

This protection function is adjusted using four parameters:

| Function | Description | Minimum | Maximum | Step | Unit | Default |
|---|---|---|---|---|---|---|
| 27V1 | **Definite-time positive sequence undervoltage** | | | | | |
| | Permission | - | - | Yes/No | - | No |
| | Pickup | 3,0 | 555,0 | 0,1 | V | 10,0 |
| | Operating time | 0,02 | 300,0 | 0,01 | s | 1,40 |
| | Reset time | 0,02 | 300,00 | 0,01 | s | 0,20 |

The operating time is completely independent of the measured positive sequence voltage, such that should the positive sequence voltage goes down the set value during the same amount of time or more than the set one, the protection function acts (trips) and there it is not restored until the measured value of the positive sequence voltage exceeds the voltage set point during adjusting reset time.

The function pick up occurs at 100% of the adjusted input and the dropout at 105%. The reset type is temporized and reset time is adjusted with reset time parameter.

The accuracy of the operating time is the adjusted time ±30ms or ± 0.5% (greater of both).

## 4.3. Function 59. Definite-time phase overvoltage

There are two independent phase overvoltage functions

This protection function is adjusted using four parameters:

| Function | Description | Minimum | Maximum | Step | Unit | Default |
|---|---|---|---|---|---|---|
| 59_1<br>59_2 | **Definite-time phase overvoltage** | | | | | |
| | Permission | - | - | Yes/No | - | No |
| | Pickup | 6,0 | 999,0 | 0,1 | V | 10,0 |
| | Operating time | 0,02 | 300,0 | 0,01 | s | 1,00 |
| | Reset time | 0,02 | 300,0 | 0,01 | s | 0,20 |

The operating time is completely independent from the measured phase voltage, such that if the phase voltage exceeds the adjusted value for a period of time equal to or higher than the pre-established value, the protection function actuates (trips) and does not reset itself until the measured phase voltage value drops below the pre-established voltage point during adjusting reset time.

The function activates at 100% of the adjusted input and deactivates at 95%. Reset is temporized and reset time is adjusted with reset time parameter.

The accuracy of the operating time is the adjusted time ±30ms or ± 0.5% (greater of both).

## 4.4. Function 59N. Definite-time neutral overvoltage

There are two independent neutral overvoltage functions

This protection function is adjusted using four parameters:

| Function | Description | Minimum | Maximum | Step | Unit | Default |
|---|---|---|---|---|---|---|
| 59N_1<br>59N_2 | **Definite-time neutral overvoltage** | | | | | |
| | Permission | - | - | Yes/No | - | No |
| | Pickup | 6,0 | 999,0 | 0,1 | V | 10,0 |
| | Operating time | 0,02 | 300,0 | 0,01 | s | 1,00 |
| | Reset time | 0,02 | 300,00 | 0,01 | s | 0,20 |

The operating time is completely independent of the measured neutral voltage, such that should the neutral voltage exceed the set value during the same amount of time or more than the set one during Operating time, the protection function acts (trips) and there it is not restored until the measured value of the neutral voltage drops below the voltage set point during adjusting reset time.

The function pick up occurs at 100% of the adjusted input and the dropout at 95%. The reset type is temporized and reset time is adjusted with reset time parameter.

The accuracy of the operating time is the adjusted time ±30ms or ± 0.5% (greater of both).

✋**NOTE**: Depending on the configuration the neutral voltage can be measured or calculated:

In case of “phase –neutral+Vr” , “phase-phase + Vr” or “2VT + Vr” configurations the neutral is measured (although the relay also calculates the voltage, it is taken into account the measured neutral voltage (residual voltage)).

In case of “Phase-neutral” or “phase-neutral +Vbb” configurations the neutral voltage is not measured and it is used the calculated neutral voltage (vectorial sum of phases voltages) to work with this protection function.

## 4.5. Function 47. Definite-time negative sequence overvoltage

This protection function is adjusted using four parameters:

| Function | Description | Minimum | Maximum | Step | Unit | Default |
|---|---|---|---|---|---|---|
| **47** | **Definite-time negative sequence overvoltage** | | | | | |
| | Permission | - | - | Yes/No | - | No |
| | Pickup | 6,0 | 999,0 | 0,1 | V | 10,0 |
| | Operating time | 0,02 | 300,0 | 0,01 | s | 1,00 |
| | Reset time | 0,02 | 300,0 | 0,01 | s | 0,20 |

The operating time is completely independent from the measured negative sequence voltage, such that if the negative sequence voltage exceeds the adjusted value for a period of time equal to or higher than the pre-established value, the protection function actuates (trips) and does not reset itself until the measured negative sequence voltage value drops below the pre-established voltage point during adjusting reset time.

The function activates at 100% of the adjusted input and deactivates at 95%. Reset is temporized and reset time is adjusted with reset time parameter.

The accuracy of the operating time is the adjusted time ±30ms or ± 0.5% (greater of both).

## 4.4. Function ΔV/Δt. Rate of change of voltage

Rate of change of voltage protects the circuit against voltage variations. This protection function can be set by using the following parameters:

| Group | Description | Minimum | Maximum | Step | Unit | Default |
|---|---|---|---|---|---|---|
| **ΔV/Δt** | **Inverse time neutral overvoltage** | | | | | |
| | Permission | - | - | Yes/No | - | No |
| | Type | - | - | Decrement/Increment | - | Decrement |
| | Activation level | 1 | 200 | 1 | V/s | 1 |
| | Operating time | 1.00 | 40,00 | 0,01 | s | 1,0 |
| | Reset time | 0,02 | 300.00 | 0,01 | s | 1,00 |

The accuracy of the operating time is the adjusted time ±60ms or ± 5% (greater of both).

## 4.5. Function 81O/U. Overfrequency and underfrecuency protection

There are four protection units of the variation in frequency. Each one of them has an adjustment which determines whether the unit acts as overfrequency or underfrequency. The reaction time of the unit is determined by the set operating time.

In case the unit acts like overfrequency, activation of the function occurs at 100% frequency level set and is reset when the measured frequency is 50 mHz lower than set start level.

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

The reset is temporized and the reset time is determined by the reset time setting.

The frequency measurement is done from the voltage of phase B. It takes a minimum of 45 volts at this stage for 81 functions to be operational. If the measured phase voltage is less than 45 volts, it activates a state bit indicating function blocked. When the frequency measurement is again valid, function begins in the start state with all bits and counters reset.

This protection function is adjusted by setting five different parameters:

| Function | Description | Minimum | Maximum | Step | Unit | Default |
|---|---|---|---|---|---|---|
| **81_1** | **Overfrequency or Underfrequency** | | | | | |
| **81_2** | Permission | - | - | Yes/No | - | No |
| **81_3** | Type | - | - | (1*) | - | Overfrequency |
| **81_4** | Activation level | 45.00 | 65.00 | 0.01 | Hz | 50.20 |
| | Operating time | 0.06 | 300.00 | 0.01 | s | 0.15 |
| | Reset time | 0,02 | 300,00 | 0,01 | s | 0,20 |

(1*) Overfrequency or Underfrequency

The frequency measurement is an average value of the frequency measured during 8 cycles. The tripping time will be the adjusted value plus the necessary time to achieve the measure during 8 cycles

## 4.6. Function 81R. Frequency rate of change

The frequency measurement is done from the voltage of phase B. It takes a minimum of 45 volts at this stage for 81R functions to be operational. If the measured phase voltage is less than 45 volts, it activates a state bit indicating function blocked. When the frequency measurement is again valid, function begins in the start state with all bits and counters reset.

This protection function is adjusted by setting five different parameters:

| Function | Description | Minimum | Maximum | Step | Unit | Default |
|---|---|---|---|---|---|---|
| 81_1R<br>81_2R | **Frequency rate of change** | | | | | |
| | Permission | - | - | Yes/No | - | No |
| | Type | - | - | (1*) | - | Increment |
| | Activation level | 0.1 | 5.0 | 0.1 | Hz/s | 1.5 |
| | Operating time | 0.06 | 40.0 | 0.1 | s | 0.06 |
| | Reset time | 0,06 | 300,00 | 0,01 | s | 0.30 |

(1*) Increment or Decrement

The operating time is completely independent from the operating voltage that flows through the equipment

If increment type is selected and the frequency increases at a higher rate than the value specified by “activation level” setting during the operating time the function trips.

If decrement type is selected and the frequency decreases at a higher rate than the value specified by “activation level” setting during the operating time the function trips.

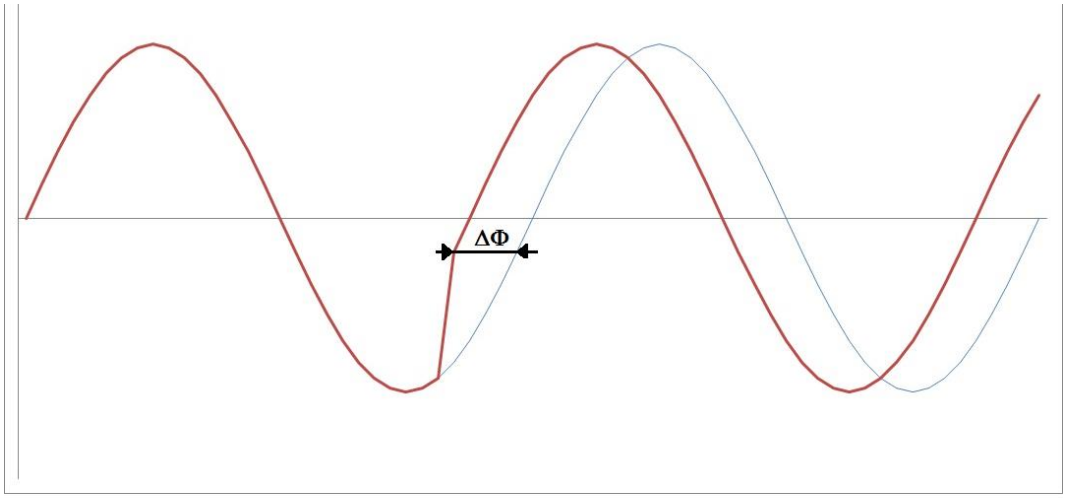
The rate of change of frequency measurement is an average value of the rate of change of frequency measured during 8 cycles. The tripping time will be the adjusted value plus the necessary time to achieve the measure during 8 cycles.

## 4.7. Function 78. Out of step (vector shift)

The relay has two Out-of-Step elements to detect perturbations on the system and to disconnect the generators connected to it. This detection is based on phase B voltage passing by zero.
The frequency measurement is done from the voltage of phase B. It takes a minimum of 45 volts at this stage for 78 functions to be operational. If the measured phase voltage is less than 45 volts, it activates a state bit indicating function blocked. When the frequency measurement is again valid, function begins in the start state with all bits and counters reset.

This protection function is adjusted by setting three different parameters:

| Function | Description | Minimum | Maximum | Step | Unit | Default |
|---|---|---|---|---|---|---|
| **78** | **Out of step** | | | | | |
| | Permission | - | - | Yes/No | - | No |
| | Level | 1 | 25 | 1 | ° | 10 |
| | Reset time | 0,02 | 300,00 | 0,01 | s | 0,20 |




If Δϕ exceeds the value adjusted in “level” setting, the function activates (trips) immediately. The accuracy is ± 5 °.

## 4.6. Function 52. Circuit Breaker monitoring

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

| Group | Description | Minimum | Maximum | Step | Unit | Default |
|---|---|---|---|---|---|---|
| **52** | **Circuit breaker monitoring** | | | | | |
| | Maximum number of openings | 1 | 10000 | 1 | - | 10 |
| | Opening time | 0,02 | 30,0 | 0,01 | s | 0,10 |
| | Closing time | 0,02 | 30,0 | 0,01 | s | 0,10 |
| | Maximum repeated openings | 1 | 10000 | 1 | - | 3 |
| | Time of maximum repeated openings | 1,00 | 300,0 | 0,01 | min | 9,00 |

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

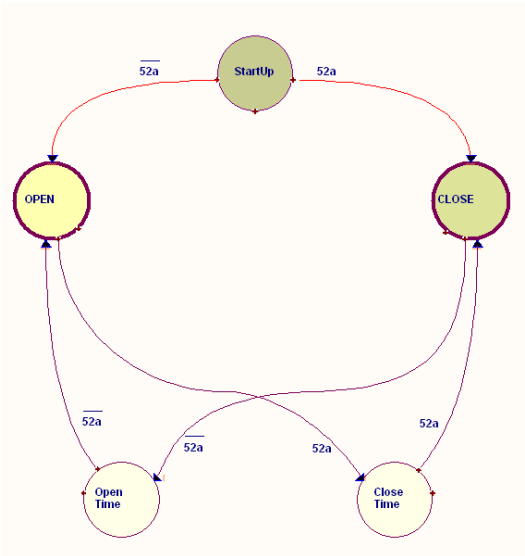
This function provides information about the circuit breaker status and if any maintenance alarm has been activated.

The following statuses are associated with this function:

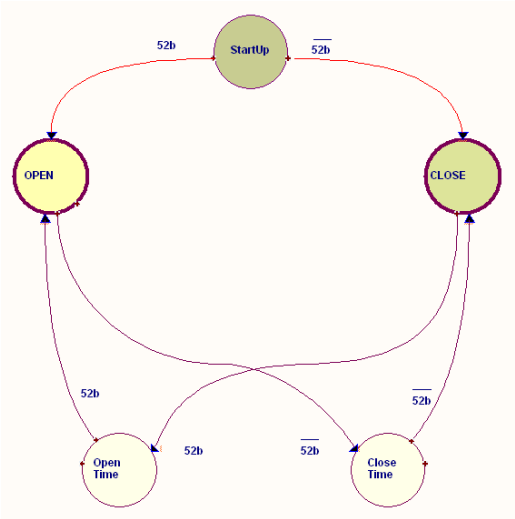
| Function | Status | Description |
|---|---|---|
| 52 | Start | Energized/Deenergized<br>These are the different statuses of the circuit breaker automatic control |
| | Error | |
| | Open | |
| | Opening time | |
| | Opening fault | |
| | Closed | |
| | Closing time | |
| | Closing fault | |
| | No. of configured openings exceeded | Activated if the counter that measures the number of openings exceeds the "Maximum number of openings" setting |
| | Repeated Trips | Activated the number of openings exceeds the setting in "Maximum repeated openings" for the time set in "Time of maximum repeated openings" |

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

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

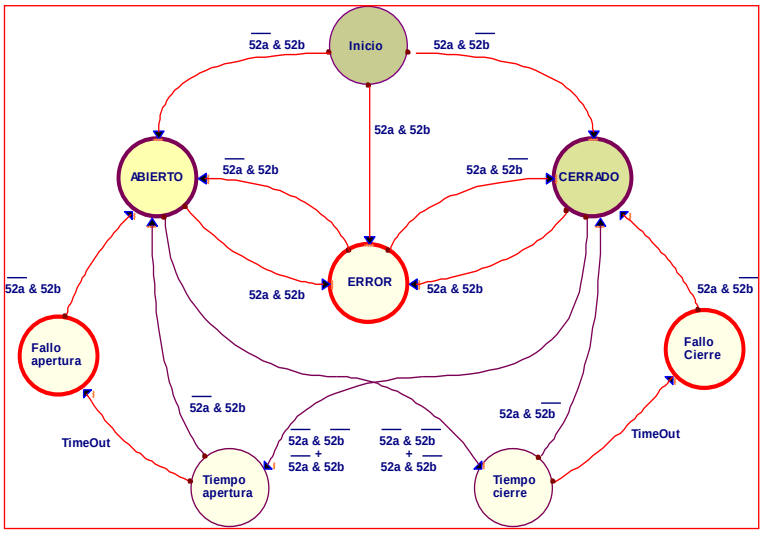


If only the circuit breaker 52b contact is available, it should be wired to the corresponding physical input. This physical input is then assigned to the "52b Input" logical input. The 52a logical input is calculated internally as the negative of 52b. The circuit breaker performance is shown in the following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




If both 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's automaton is considered as having eight statuses: Start, open, closed, error, opening time, opening fault, closing time and closing fault.

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



There are two signals related with the circuit breaker closure, these signal are Manual close init and manual close enable. The first signal will permit the manual closure (through the HMI or through communications) a the second one, will permit to configure an external condition to get the circuit breaker closure. The default configuration is as follows:

Manual close init→Local close breaker, IEC60870-5-103 close breaker and Remote modbus close breaker.

Manual close enable→Not configured

### 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 commands menu or using the HMI's specific keypad or from local or remote communications. In order that the command related to the key can run, the menu must be in standby mode.

To carry out commands from the remote communications (ModBus or IEC60870-5-103 for LPCT model (SIL-VXX) and ModBus, IEC60870-5-103, IEC61850 or DNP 3.0 for standard SIL-V) the equipment must be in TELECONTROL mode. (see the telecontrol section).

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

### 4.7.2. Counter to register the number of openings

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

This counter is associated with the "Maximum number of openings" setting. When the number of openings exceeds this preset value, the "Maximum number of openings" status is activated and its corresponding event is generated.

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

### 4.7.3. Maximum openings in a time window

As well as counting the number of times the circuit breaker opens, the SIL-V 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" status is activated and its corresponding event is generated.

This alarm resets itself, when the corresponding time is exceeded with less trips than those indicated.

## 4.7. BF Circuit Breaker opening fault

This function settings are as follows:

| Group | Description | Minimum | Maximum | Step | Unit | Default |
|---|---|---|---|---|---|---|
| **BF** | **Circuit breaker opening fault** | | | | | |
| | Permission | - | - | Yes/No | - | No |
| | Opening fault time | 0,02 | 1,00 | 0,01 | s | 0,2 |

When the “BF init” status is activated, 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 “BF init” status has been reset.

There is a “BF init logical signal” to start the open fault from an external protection. The “BF init” is configurable by user. The default configuration is shown below:

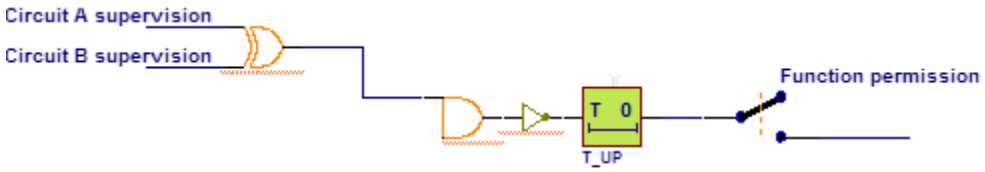
- General trip

## 4.8. 74TCS. Trip circuit supervision

This function permits monitoring of the circuit breaker trip circuits.

This functionality is achived through configurable digital inputs.

It is verified the continuity of the coils.




This function settings are as follows:

| Group | Description | Minimum | Maximum | Step | Unit | Default |
|---|---|---|---|---|---|---|
| **74TCS** | **Trip circuit supervision** | | | | | |
| | Permission | - | - | Yes/No | - | No |
| | Operating time | 0,02 | 300,00 | 0,01 | s | 2,00 |

## 4.9. 79 Autorecloser

The reclosing function recloses the circuit breaker after a fault. It has a five reclosing capacity, following which the unit shall be Locked or in “Lockout” mode.

The reclose device can be permitted or prohibited, depending on whether or not this function is required. Prohibited must not be confused with locked. Prohibited means that the recloser shall never be in operation, regardless of the controls performed on it. A locked recloser means that the recloser is not operative, but either because it has reached the end of the reclosing cycle, or a fault has been detected, or someone has performed a control procedure on it.

There is a final permission which serves to indicate that recloser that it must wait a period of time before closure. In this time, there is usually an external condition, such as closure synchronism, and this condition in from an external input.

Each reclosing cycle has its own specific Operating time that can be set. Apart from these times, a further three times must be set:

- Hold times. This is the time the reclosing device waits for an external condition for closure.
- Replacement time. This is the Hold time for the recloser for a final closure. If during this time, there is another trip, the recloser count will increase.
- Final opening time The is the time used by the recloser to declare that the circuit breaker is finally open. In this case, the recloser understands that the opening was manual or via remote control, and no reclosing is necessary. On exceeding this time, the recloser shall switch to locked mode.

The reclosing function settings are shown below:

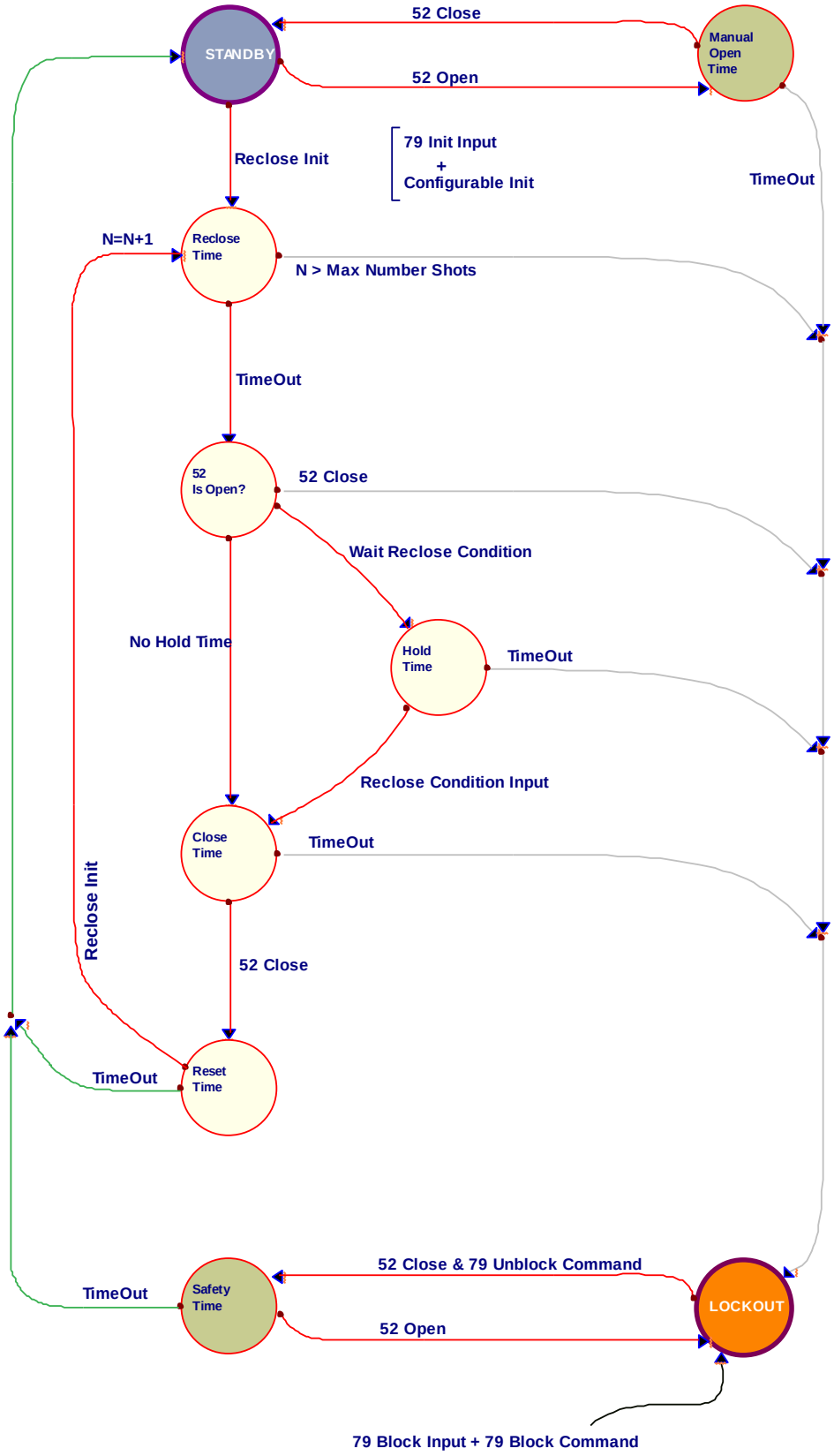
| Group | Description | Minimum | Maximum | Step | Unit | Default |
|---|---|---|---|---|---|---|
| 79 | **Reclosing device** | | | | | |
| | Permission | - | - | Yes/No | - | No |
| | Hold permission | - | - | Yes/No | - | No |
| | Number of reclosings | 1 | 5 | 1 | - | 3 |
| | Reclose 1 time | 0,02 | 300,00 | 0,01 | s | 0,30 |
| | Reclose 2 time | 0,02 | 300,00 | 0,01 | s | 3,00 |
| | Reclose 3 time | 0,02 | 300,00 | 0,01 | s | 180,00 |
| | Reclose 4 time | 0,02 | 300,00 | 0,01 | s | 180,00 |
| | Reclose 5 time | 0,02 | 300,00 | 0,01 | s | 180,00 |
| | Hold time | 0,02 | 300,00 | 0,01 | s | 10,00 |
| | Replacement time | 0,02 | 300,00 | 0,01 | s | 10,00 |
| | Final Opening Time | 0,02 | 300,00 | 0,01 | s | 10,00 |

It must be possible to lock the recloser, particularly is maintenance tasks are carried out on the substation. To this end there are various SIL-V locking and unlocking possibilities:

- **From the HMI**. There is a specific key marked 79, plus a specific signal led, allowing recloser operation, locking or unlocking it. In order that the command related to the key can run, the menu must be in standby mode.
- **From the HMI.** This command can be executed from the control menu.
- **From two pulse inputs.** If the substation is equipped with a conventional remote control, two pulse outputs are usually assigned, where one locks the recloser and the other locks it.
- **Via protocol.** This is performed via any means of communication. This is carried out as if it were a control, and the normal conditions of any control must be met. For example, if we are operating from the HMI, it is understood that the relay is in local mode, whereby if a Lock/Unlock command is received via remote control this shall be ignored.
- **From a level input.** In this case the recloser monitors the status of the input. This may be of use if the company has a handle with a key.

In the first four cases, the equipment stores the lock situation in the non-volatile memory, as the last control must be know for a possible re-start.

The auto-recloser´s start up is shown in the following figure: There are two stable conditions here, Standby and Lockout, the other conditions are transient.


STANDBY
52 Close
52 Open
Manual Open Time
Reclose Init
79 Init Input + Configurable Init
TimeOut
N=N+1
Reclose Time
N > Max Number Shots
TimeOut
52 Is Open?
52 Close
Wait Reclose Condition
No Hold Time
Hold Time
TimeOut
Reclose Condition Input
Close Time
TimeOut
Reclose Init
52 Close
TimeOut
Reset Time
52 Close & 79 Unblock Command
TimeOut
Safety Time
52 Open
LOCKOUT
79 Block Input + 79 Block Command

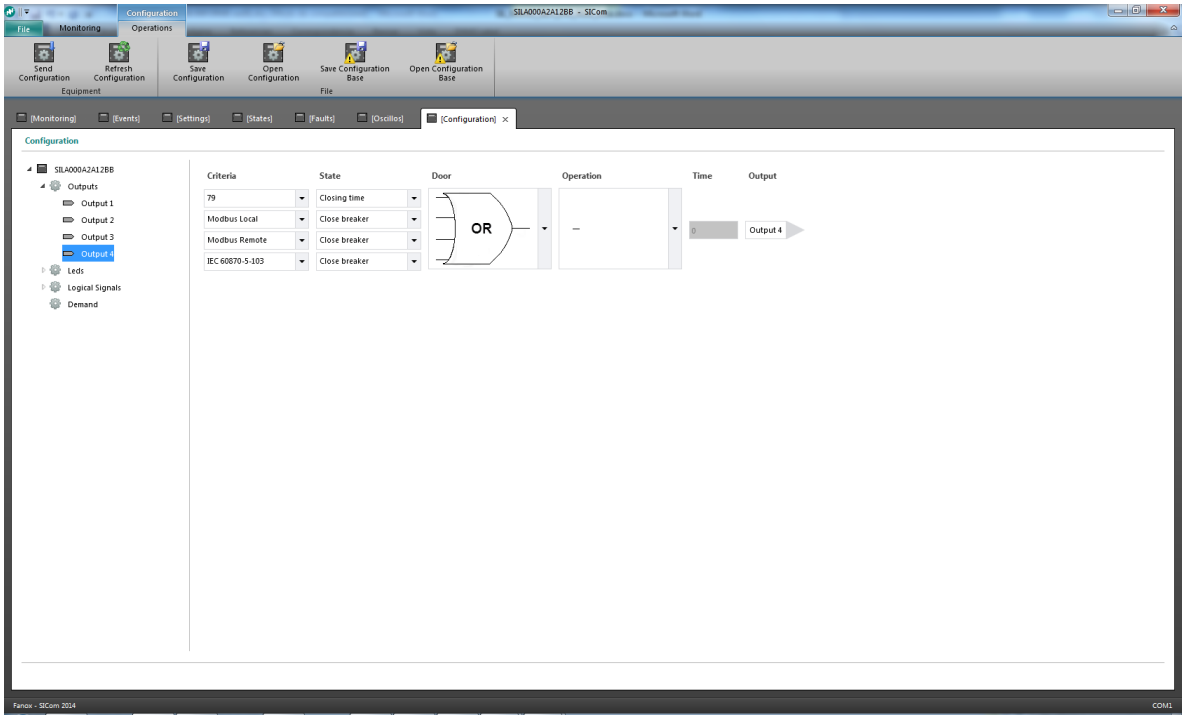
On standby. The recloser can leave this mode via three conditions:

- Recloser lock, via a command.
- Manual or remote control opening of the circuit breaker. In this situation it shall await the final opening of the same, and then it shall switch to lock mode.
- Circuit breaker trip. This shall start the reclosing cycles. This start may arise either from the trip itself, or from an external input if external protection is fitted.

When locked. The recloser shall switch from this condition as a result of two different conditions:

- Manual or remote control closing of the circuit breaker. In this case it shall switch to safety time. If, during this time, there is a trip, it shall revert to Lockout.
- Unlocking of the recloser. Via a command.

Of all the remaining conditions, it is interesting to know that the recloser sends a closure command whilst it is in the Close Time condition, and for this reason if you wish to programme an output on said command, the output must be set to the 79 closing time bit.




The “79 init” status is an adjustable logical signal. The “79 init” is configurable by user. The default configuration is shown below:

- General trip

### 4.10.1. Counter to record the number of reclosings

The SIL-V equipment is fitted with a counter that records the number of reclosings.

## 4.10. Function 25. Synchronism protection function

The synchro-check function is designed to give a time window in which the voltage in both sides of the switch are in sync. The conditions that the voltage of both ends of the switchgear must have to assert that there is synchronization are:

- Same module
- Same phase
- Same frequency

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

- LLLB (Live Line - Live Bar), live line - live bar
- LLDB (Live Line - Dead Bar), live line - dead bus
- DLLB (Death Line - Live Bar), dead line - live bar
- DLDB (Death Line - Dead Bar), dead line - dead bus

The settings associated with this unit voltage monitoring are:

| Function | Description | Minimum | Maximum | Step | Unit | Default |
|---|---|---|---|---|---|---|
| **25** | **Synchronism. Line and bar voltage supervision unit** | | | | | |
| | Dead Tap | 3,0 | 555,0 | 0,1 | V | 30,0 |
| | Live Tap | 6,0 | 999,0 | 0,1 | V | 50,0 |
| | Voltage supervision time | 0,02 | 300,00 | 0,01 | s | 3,00 |
| | Line-Bar voltage difference | 4,0 | 50,0 | 0,1 | V | 8,0 |
| | Line-Bar phase difference | 2,0 | 90,0 | 0,1 | º | 2,0 |
| | Line-Bar frequency difference | 0,06 | 10,00 | 0,01 | Hz | 0,5 |
| | Synchrocheck time | 0,02 | 300,00 | 0,01 | s | 1,00 |

A time during which it is confirmed that the end is dead or live to be sure it is not a temporary situation is specified

When the line and the bar are alive is the time to check the conditions of voltage magnitude, phase difference and frequency difference between line voltage and bar voltage to allow the closure. It is verified that these conditions of voltage magnitude, phase difference and frequency difference is maintained over a set time (synchrocheck time), to verify that it is not a temporary situation. Please, take into account the synchronism depends on three measures; voltage masure and phase measure are achieved in 1 cycle but frequency measure can need 8 cycles to achieve a stable measure, so the synchrocheck time should be set according to this concept.

If these conditions of synchronism are mantains during synchronism time, we will have switch close permission.

The sync function generates the following bits:

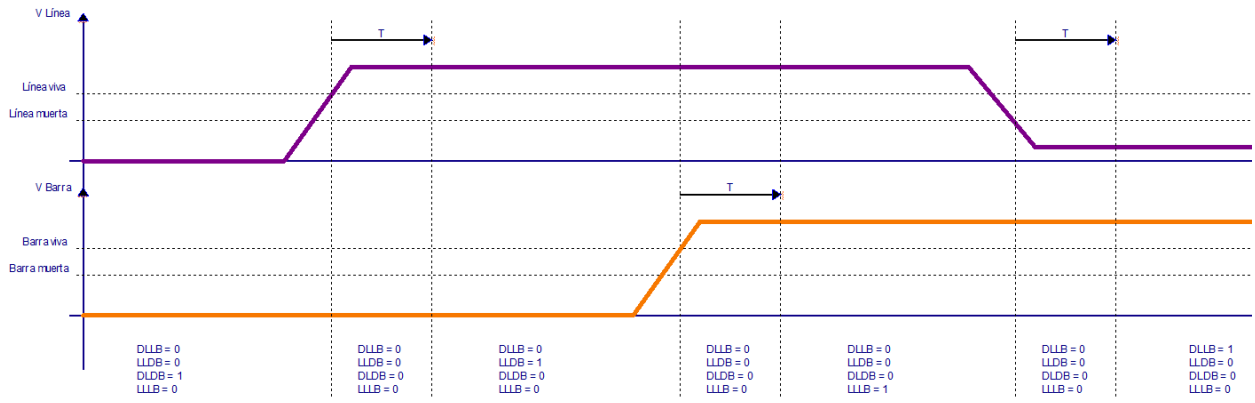
| 25 | Sincronismo |
|---|---|
| | LLLB: Live line, live bar |
| | LLDB: Live line, dead bar |
| | DLLB: Dead line, live bar |
| | DLDB: Dead line, dead bar |
| | Module difference |
| | Frequency difference |
| | Phase difference |

LLLB, LLDB, DLDB and DLLB bits indicate the status of the line and the bar regardless of the operation permissions statuses.

The line and bar voltage monitoring unit sets the dead or alive state of the line and bar. Transitions from dead to live and vice versa are timed with a user adjustable time. During the transition the line or bar is in undefined state. At such moments, as seen in the logical diagram of the algorithm, the closing permission is not activated.

Once the voltage exceeds the live state level, a timer is started during which we turn to undefined state until the timer ends. At this moment, indicates the live status of the bar or line.

When the voltage falls below the level of dead state, a timer is started during which we turn to undefined state until the timer ends. At this moment, indicates the dead status of the bar or line.



### 4.10.1. Syncronism (25) and manual closure (52)

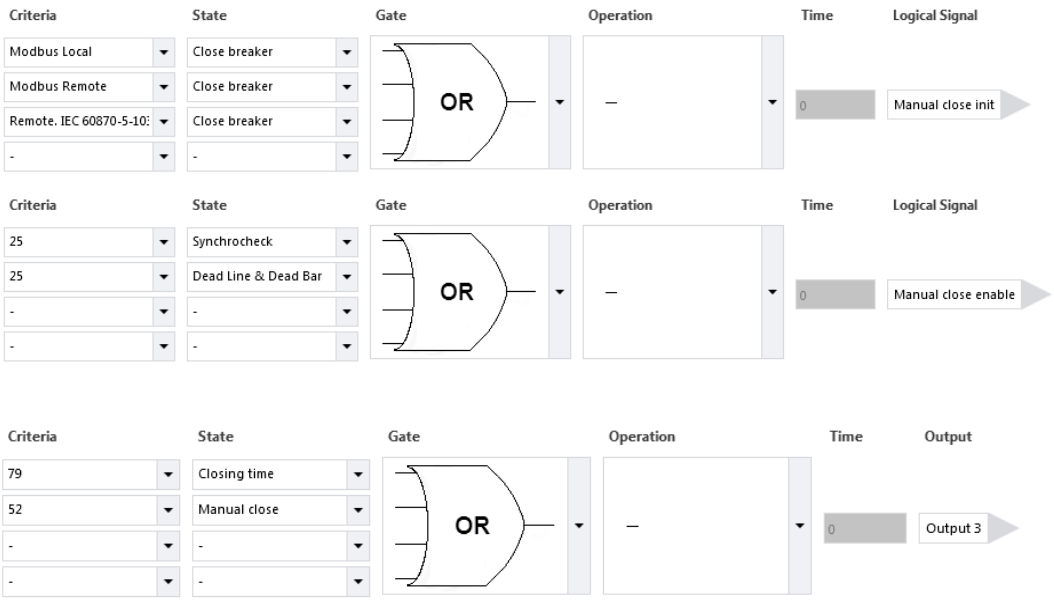
For the manual closure of 52 function is supervised by the sync function, it is necessary to associate the "Permission of closure " status of sync function to the logical signal "Manual close enable" to the desired state of the synchronism function.

It is shown an example where the manual close is desired when there is synchronism condition or the line and the bar are dead (DLDB).

**CONFIGURATION:**

- **Manual closure init** logical signal→one of the commands of **close breaker** (via local HMI/SICom or via communications Modbus/IEC60870-5-103)
- **Manual closure enable** logical signal→**synchronism** condition or **DLDB** condition
- **Physical output** (in this example output 3)→**Manual closure** condition and **recloser** condition.

(in this case the output 3 should be connected to the closing coil of the circuit breaker)



### 4.10.2. Synchronism (25) and recloser (79)

For the circuit breaker is closed when recloser command (79) is permitted, it is necessary to associate the logical signal “79 enable” to the desired state of the synchronism function. It is also necessary to permit the “hold permission” setting. The settings of recloser when there is synchronism are shown below:

Table 1

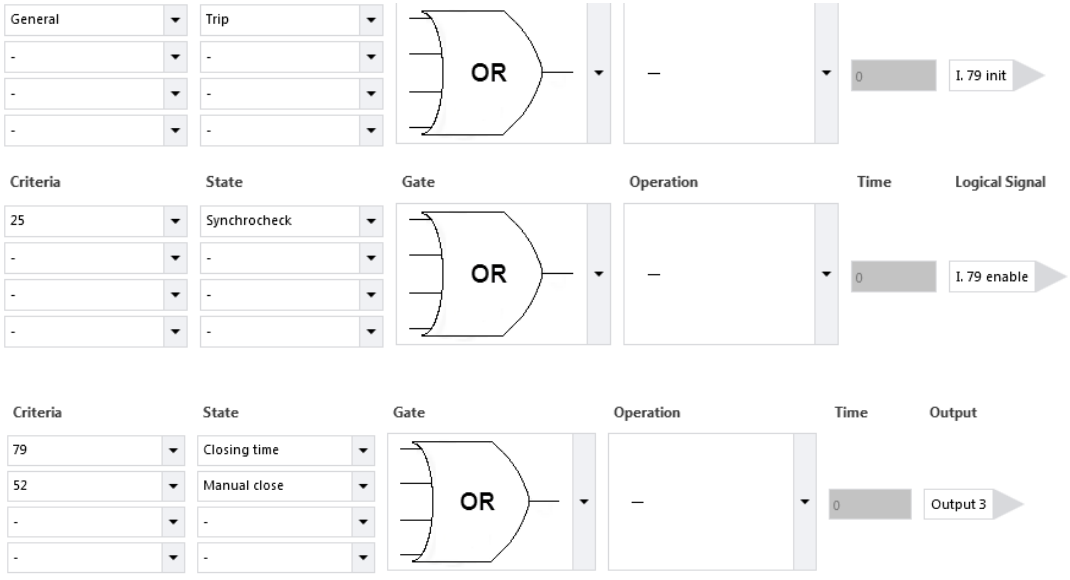
79

| | |
|---|---|
| Permission | Yes |
| Hold permission | Yes |
| Number of reclosings | 1 |
| Reclose 1 time | 0.2 |
| Reclose 2 time | 1 |
| Reclose 3 time | 2 |
| Reclose 4 time | 3 |
| Reclose 5 time | 5 |
| Hold time | 1 |
| Reset time | 1 |
| Final opening time | 1 |

**CONFIGURATION:**

- 79 Init logical signal→General trip
- 79 Enable logical signal→Synchronism condition
- A physical output (output 3 in this example)→recloser closing condition and manual closing condition

(in this case the output 3 should be connected to the closing coil of the circuit breaker)



## 4.11. 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 | Step | Unit | Default |
|---|---|---|---|---|---|---|
| | **General Settings** | | | | | |
| | Equipment identifier | - | - | - | - | "SIL-V" |
| | Frequency | - | - | 60/50 | Hz | 50 |
| | *Serial number* | - | - | - | - | *0* |
| | Language | - | - | - | - | English |
| | Active table | 1 | 3 | 1 | - | 1 |
| | Connection type | | | (1*) | | 3VT (P-N) + Vr |
| | Nominal voltage (phase-phase) | 110 | 480 | 1 | V | 110 |
| | VT transformation ratio | 1.0 | 3000.0 | 0.1 | - | 1 |
| | Local Modbus address | 1 | 247 | 1 | - | 1 |
| | Remote address (*) | 1 | 247 | 1 | - | 3 |
| | Remote baudrate (*) | 4800 | 38400 | - | bauds | 19200 |
| | Remote protocol (*) | | | (2*) | | IEC60870-5-103 |

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

(2*) Modbus RTU or IEC60870-5-103 only in SILVxxxxxA(E,I)xxxx models.

(*) Remote communication parameters depend on model (protocol options:IEC60870-5-103 or Modbus RTU or IEC6185, DNP3.0 or IEC60870-5-104)

1. **Equipment Identifier**. This is an ASCII text, for equipment identification. Normally protection equipment is associated with a specific line or position, and this setting is used for this identification. It is important that this field is filled in correctly, as the information regarding events and oscillography are accompanied with this information.

2. **Frequency**. It is possible to select the frequency by general settings

3. **Serial number** is a read only setting

4. **Language**. The SIL equipment is capable of displaying their messages in four languages, with English in all cases. Consult the list of models to find out which are available

5. **Active table**: see Settings Table.

6. **Connection type**: it is possible to choose the connection type.

   Model SILVxxxx0xxxxx the options are as follows:
   - Phase-neutral
   - Phase-neutral + Residual voltage
   - Phase-phase + Residual voltage
   - 2VTs + Residual voltage

   Model SILVxxxx2xxxxx the options are as follows:
   - Phase-neutral + Busbar voltage

7. **Nominal voltage**: it is possible to select the phase- to- phase nominal voltage. It is possible to obtain the measure through voltage transformers selecting in this setting the secondary of those transformers (110-250 volts), or connecting the relay directly to the low voltage line (250-480 volts). In this last case the measurement range is from 12 volts till 1000 volts.

8. **Voltage transformer transformation ratio** setting allows the measurements of the primary values from the protection transformer to be viewed.

9. **Communication settings** (address of front port and address and speed of rear ports): see Communications

Serial number is a read only setting

The rest of the settings can be changed either from the HMI or through communications.

Any change of settings, involves the reset of the functions, whether or not activated.

## 4.13. Settings table

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

- Changing the active settings table. 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.

| | |
|---|---|
| **00** | This situation is governed by the active table settings. |
| **01** | Table 1 |
| **10** | Table 2 |
| **11** | Table 3 |

In 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.

# 5. MONITORING AND CONTROL

## 5.1. Frequency and voltage measurements

The relay shows the measurements independently of the type connection, this is, the measurements are displayed with phase-phase or phase-neutral connection.

- Phase r.m.s. voltages (V-A, V-B, V-C)
- Residual r.m.s. voltage (V-R) depending on model
- Busbar voltage (V-BB) depending on model
- Negative sequence voltage (V-2)
- Positive sequence voltage (V-1)
- Maximum voltage
- Minimum voltage
- Rate of change of voltage in each phase (dVA/dt, dVB/dt, dVC/dt)
- Rate of change of frequency (df/dt)
- Phase B line frequency
- Phase B bar frequency (depending on model)
- Frequency difference between phase B line and phase B bar (depending on model)
- Phase difference between phase B line voltage and busbar voltage (depending on model)

In the following table the SIL-V measurement ranges are shown:

| Phase range | Nominal voltage (phase to phase) |
|---|---|
| 3 - 250 V | < 250 V (from 110 to 250 volts) |
| 12 - 1000 V | > 250 V (from 250 to 480 volts) |

## 5.1. Counters

The following counters are provided:

1 Number of openings of the circuit breaker

2 Number of shots

## 5.2. Statuses and Events

The statuses are given by real-time information generated by the equipment. Some states are understood as levels, and others (trips) are too quick to be displayed in real time.

| Group | Status |
|---|---|
| General | **General status** |
| | Trip |
| | 50 Hz |
| | Trip Block enable |
| | Measurement error |
| | Ready |
| | Change of settings |
| | Time and date synchronisation |
| | Local Activity |
| | Factory Settings |
| | Error Eeprom |
| | Eeprom changed |
| | Events error |
| | Reset |
| | Pickup |
| | Phase A Pickup |
| | Phase B Pickup |
| | Phase C Pickup |
| | Ground Pickup |
| | Phase A Trip |
| | Phase B Trip |
| | Phase C Trip |
| | Ground Trip |
| | Phase Trip |
| | Line frequency block |
| | Bus bar frequency block |

| Group | Status |
|---|---|
| 27_1 | **Level 1 phase instantaneous undervoltage** |
| | 27_1 Phase A Pickup |
| | 27_1 Phase B Pickup |
| | 27_1 Phase C Pickup |
| | 27_1 Pickup |
| | 27_1 Phase A trip |
| | 27_1 Phase B trip |
| | 27_1 Phase C trip |
| | 27_1 Trip |
| 27_2 | **Level 2 phase instantaneous undervoltage** |
| | 27_2 Phase A Pickup |
| | 27_2 Phase B Pickup |
| | 27_2 Phase C Pickup |
| | 27_2 Pickup |
| | 27_2 Phase A trip |
| | 27_2 Phase B trip |
| | 27_2 Phase C trip |
| | 27_2 Trip |
| 27V1 | **Positive sequence undervoltage** |
| | 27V1 Pickup |
| | 27V1 Trip |

| Group | Status |
|---|---|
| 59_1 | **Level 1 phase instantaneous overvoltage** |
| | 59_1 Phase A Pickup |
| | 59_1 Phase B Pickup |
| | 59_1 Phase C Pickup |
| | 59_1 Pickup |
| | 59_1 Phase A trip |
| | 59_1 Phase B trip |
| | 59_1 Phase C trip |
| | 59_1 Trip |
| 59_2 | **Level 2 phase instantaneous overvoltage** |
| | 59_2hase A Pickup |
| | 59_2 Phase B Pickup |
| | 59_2 Phase C Pickup |
| | 59_2 Pickup |
| | 59_2 Phase A trip |
| | 59_2 Phase B trip |
| | 59_2 Phase C trip |
| | 59_2 Trip |
| 59N_1 | **Level 1 neutral instantaneous overvoltage** |
| | 59N_1 Phase A Pickup |
| | 59N_1 Phase B Pickup |
| | 59N_1 Phase C Pickup |
| | 59N_1 Pickup |
| | 59N_1 Phase A trip |
| | 59N_1 Phase B trip |
| | 59N_1 Phase C trip |
| | 59N_1 Trip |

| Group | Status |
|---|---|
| 59N_2 | **Level 2 neutral instantaneous overvoltage** |
| | 59N_2 Phase A Pickup |
| | 59N_2 Phase B Pickup |
| | 59N_2 Phase C Pickup |
| | 59N_2 Pickup |
| | 59N_2 Phase A trip |
| | 59N_2 Phase B trip |
| | 59N_2 Phase C trip |
| | 59N_2 Trip |
| 47 | **Negative seuence overvoltage** |
| | 47 Pickup |
| | 47 Trip |
| ΔV/Δt | **Voltage rate of change** |
| | ΔV/Δt Phase A Pickup |
| | ΔV/Δt Phase B Pickup |
| | ΔV/Δt Phase C Pickup |
| | ΔV/Δt Pickup |
| | ΔV/Δt Phase A trip |
| | ΔV/Δt Phase B trip |
| | ΔV/Δt Phase C trip |
| | ΔV/Δt Trip |
| 81O/U_1 | **Level 1: Over/Underfrequency** |
| | 81_1 Pickup |
| | 81_1 Trip |
| 81O/U_2 | **Level 2: Over/Underfrequency** |
| | 81_2 Pickup |
| | 81_2 Trip |

| Group | Status |
|---|---|
| 81O/U_3 | **Level 3: Over/Underfrequency** |
| | 81_3 Pickup |
| | 81_3 Trip |
| 81O/U_4 | **Level 4: Over/Underfrequency** |
| | 81_4 Pickup |
| | 81_4 Trip |
| 81R_1 | **Level 1: Frequency rate of change** |
| | 81R_1 Pickup |
| | 81R_1 Trip |
| 81R_2 | **Level 2: Frequency rate of change** |
| | 81R_2 Pickup |
| | 81R_2 Trip |
| 78 | **Out of step (vector shift)** |
| | 78 Trip |
| 52 | **Circuit breaker supervision** |
| | 52 Start |
| | 52 Error |
| | 52 Open |
| | 52 Opening time |
| | 52 Opening fault |
| | 52 Closed |
| | 52 Closing time |
| | 52 Closing fault |
| | 52 Excessive openings |
| | 52 Excessive openings in a time window |
| | 52 a Status |
| | 52 b Status |
| | Manual close |

| Group | Status |
|---|---|
| BF | **Breaker failure** |
| | BF Pickup |
| | BF Trip |
| 74TCS | **Trip circuit supervision** |
| | 74TCS Pickup |
| | 74TCS Alarm |
| 79 | **Recloser** |
| | 79 Standby |
| | 79 Reclosing time |
| | 79 Open |
| | 79 Hold time |
| | 79 Closing time |
| | 79 Reset time. |
| | 79 Lock out |
| | 79 Safety time |
| | 79 Final opening time |
| | 79 Enabled |
| 25 | **Synchronism** |
| | Synchrocheck |
| | DLDB: Dead line, dead bar |
| | DLLB: Dead line, lived bar |
| | LLDB: Lived line, dead bar |
| | LLLB: Lived line, lived bar |
| | Module difference |
| | Frequency difference |
| | Phase difference |

| Group | Status |
|---|---|
| **Inputs** | **Digital Inputs** |
| | Input 1 |
| | Input 2 |
| | Input 3 |
| | Input 4 |
| | Input 5 |
| | Input 6 |
| **Outputs** | **Digital Outputs** |
| | Output 1 |
| | Output 2 |
| | Output 3 |
| | Output 4 |
| **Leds** | **Leds** |
| | Led-1 |
| | Led-2 |
| | Led-3 |
| | Led-4 |
| | Led-5 |
| | Led-6 |
| | Led-79 |
| | Led-52 |

| Group | Status |
|---|---|
| Logic | **Logical signals** |
| | 52a |
| | 52b |
| | External trip |
| | BF init |
| | Fault init |
| | Manual close init |
| | Manual close enable |
| | Reset |
| | Settings group 1 |
| | Settings group 2 |
| | 79 Init |
| | 79 Enable |
| | Level lock 79 |
| | Pulse lock 79 |
| | Pulse unlock 79 |
| | Continuity coil A |
| | Continuity coil B |
| | Logical signal 1 |
| | Logical signal 2 |
| Local | **Local communication** |
| | Local communication |
| | HMI Activity |
| | Open circuit breaker |
| | Close circuit breaker |
| | Pulse Lock 79 |
| | Pulse Unlock 79 |
| | Local control |
| | Telecontrol |
| | Reset |

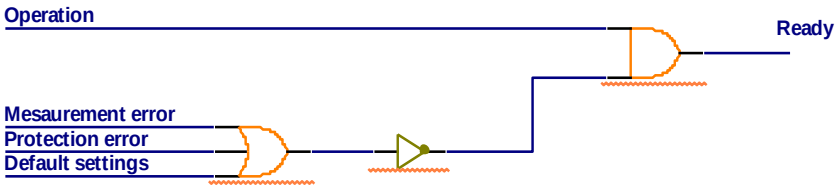
| Group | Status |
|---|---|
| Remote | **Remote Modbus** |
| | Remote communication |
| | Open circuit breaker |
| | Close circuit breaker |
| | Pulse Lock 79 |
| | Pulse Unlock 79 |
| | Local control |
| | Telecontrol |
| | Reset |
| IEC60870-5-103 | **IEC60870-5-103** |
| | IEC60870-5-103 communication |
| | Open circuit breaker |
| | Close circuit breaker |
| | Pulse Lock 79 |
| | Pulse Unlock 79 |
| | Local control |
| | Telecontrol |
| | Reset |

In conditions 52 and 79, a bit is assigned to each condition of the automaton, so that if the oscillography must be observed, the evolution of this automaton can be seen.

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.

The **Ready bit** agglutinates correct relay operation and has the following logic:




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

**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.

**Setting change:** This activates when the settings are changed.

**Date-time adjustment:** This activates when the date-time are synchronised.

**Local:** this is the sum of the "HMI activity" and "Local communication" bits from the "Local communication" status group

**Default 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 control and telecontrol:** It is enabled or there is no telecontrol.

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.

Events have the following structure:

| | |
|---|---|
| **Identifier** | Unique event identifier: e.g.: 51_1.4 = 27V1 PICKUP |
| **Value** | ON(Activated) /OFF(Deactivated):<br>an event is generated for Activation and deActivation |
| **Year** | |
| **Month** | |
| **Day** | |
| **Time** | |
| **Minutes** | |
| **Seconds** | |
| **Milliseconds** | |

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

| Group | Bit | Event | Status | Event | Cause | Measurement |
|---|---|---|---|---|---|---|
| **General** | | | | | | |
| | Bit-00 | 01 | Trip | Trip | Activation/Deactivation | - |
| | Bit-03 | 07 | 50 Hz | - | - | - |
| | Bit-04 | 08 | Trip Block enable | Trip Block enable | Activation/Deactivation | - |
| | Bit-05 | 16 | Measurement error | Measurement error | Activation/Deactivation | - |
| | Bit-06 | 17 | Ready | Ready | Activation/Deactivation | - |
| | Bit-07 | 19 | Change of settings | Change of settings | Activation/Deactivation | - |
| | Bit-08 | 21 | Set date/time | Set date/time | Activation | - |
| | Bit-09 | 22 | Local Control | Local Control | Activation/Deactivation | - |
| | Bit-10 | 23 | Factory Settings | Factory Settings | Activation/Deactivation | - |
| | Bit-11 | 24 | Error Eeprom | Error Eeprom | Activation/Deactivation | - |
| | Bit-12 | 28 | Eeprom changed | Eeprom changed | Activation/Deactivation | - |
| | Bit-13 | - | Events error | - | - | - |
| | Bit-15 | 15 | Reset | Reset | Activation | - |
| | Bit-16 | | Pickup | - | - | - |
| | Bit-17 | | Phase A Pickup | - | - | - |
| | Bit-18 | | Phase B Pickup | - | - | - |
| | Bit-19 | | Phase C Pickup | - | - | - |
| | Bit-20 | | Ground Pickup | - | - | - |
| | Bit-21 | | Phase A Trip | - | - | - |
| | Bit-22 | | Phase B Trip | - | - | - |
| | Bit-23 | | Phase C Trip | - | - | - |
| | Bit-24 | | Ground Trip | - | - | - |
| | Bit-27 | - | Phase Trip | - | - | - |
| | Bit-29 | 60 | Line frequency block | Line frequency block | Activation/Deactivation | Voltage |
| | Bit-30 | 61 | Bar ferquency block | Bar ferquency block | Activation/Deactivation | Voltage |
| | Bit-14 | 30 | - | Fault report | Activation | Fault report NO. |
| | - | 32 | - | Events deleted | Activation | - |
| | - | 47 | - | Active setting group | Activation | Setting group NO. |

| Group | Bit | Event | Status | Event | Cause | Measurement |
|---|---|---|---|---|---|---|
| **Oscillography** | | | | | | |
| | - | 1 | - | V-A | Activation | Phase voltage |
| | - | 2 | - | V-B | Activation | Phase voltage |
| | - | 3 | - | V-C | Activation | Phase voltage |
| | - | 4 | - | V-R or V-BB (depends on model) | Activation | Neutral voltage |
| | - | 15 | - | Tap | Activation | Function tap |
| | - | 16 | - | Reports erased | Activation | - |
| **Level 1 phase instantaneous undervoltage** | | | | | | |
| **27_1** | Bit-00 | 1 | 27_1 Phase A pickup | 27_1 Phase A pickup | Activation/Deactivation | Phase A voltage |
| | Bit-01 | 2 | 27_1 Phase B pickup | 27_1 Phase B pickup | Activation/Deactivation | Phase B voltage |
| | Bit-02 | 3 | 27_1 Phase C pickup | 27_1 Phase C pickup | Activation/Deactivation | Phase C voltage |
| | Bit-03 | 4 | 27_1 pickup | 27_1 pickup | Activation/Deactivation | - |
| | Bit-08 | 5 | 27_1 Phase A trip | 27_1 Phase A trip | Activation | Phase A voltage |
| | Bit-09 | 6 | 27_1 Phase B trip | 27_1 Phase B trip | Activation | Phase B voltage |
| | Bit-10 | 7 | 27_1 Phase C trip | 27_1 Phase C trip | Activation | Phase C voltage |
| | Bit-11 | 8 | 27_1 Trip | 27_1 Trip | Activation | - |
| **Level 2 phase instantaneous undervoltage** | | | | | | |
| **27_2** | Bit-00 | 1 | 27_2 Phase A pickup | 27_2 Phase A pickup | Activation/Deactivation | Phase A voltage |
| | Bit-01 | 2 | 27_2 Phase B pickup | 27_2 Phase B pickup | Activation/Deactivation | Phase B voltage |
| | Bit-02 | 3 | 27_2 Phase C pickup | 27_2 Phase C pickup | Activation/Deactivation | Phase C voltage |
| | Bit-03 | 4 | 27_2 pickup | 27_2 pickup | Activation/Deactivation | - |
| | Bit-08 | 5 | 27_2 Phase A trip | 27_2 Phase A trip | Activation | Phase A voltage |
| | Bit-09 | 6 | 27_2 Phase B trip | 27_2 Phase B trip | Activation | Phase B voltage |
| | Bit-10 | 7 | 27_2 Phase C trip | 27_2 Phase C trip | Activation | Phase C voltage |
| | Bit-11 | 8 | 27_2 Trip | 27_2 Trip | Activation | - |

| Group | Bit | Event | Status | Event | Cause | Measurement |
|---|---|---|---|---|---|---|
| **Positive sequence undervoltage** | | | | | | |
| **27V1** | Bit-04 | 01 | 27V1 Pickup | 27V1 Pickup | Activation/Deactivation | Positive sequence voltage |
| | Bit-12 | 02 | 27V1 Trip | 27V1 Trip | Activation/Deactivation | Positive sequence voltage |
| **Level 1: Phase instantaneous overvoltage** | | | | | | |
| **59_1** | Bit-00 | 1 | 59_1 Phase A pickup | 59_1 Phase A pickup | Activation/Deactivation | Phase A voltage |
| | Bit-01 | 2 | 59_1 Phase B pickup | 59_1 Phase B pickup | Activation/Deactivation | Phase B voltage |
| | Bit-02 | 3 | 59_1 Phase C pickup | 59_1 Phase C pickup | Activation/Deactivation | Phase C voltage |
| | Bit-03 | 4 | 59_1 pickup | 59_1 pickup | Activation/Deactivation | - |
| | Bit-08 | 5 | 59_1 Phase A trip | 59_1 Phase A trip | Activation | Phase A voltage |
| | Bit-09 | 6 | 59_1 Phase B trip | 59_1 Phase B trip | Activation | Phase B voltage |
| | Bit-10 | 7 | 59_1 Phase C trip | 59_1 Phase C trip | Activation | Phase C voltage |
| | Bit-11 | 8 | 59_1 Trip | 59_1 Trip | Activation | - |
| **Level 2: Phase instantaneous overvoltage** | | | | | | |
| **59_2** | Bit-00 | 1 | 59_2 Phase A pickup | 59_2 Phase A pickup | Activation/Deactivation | Phase A voltage |
| | Bit-01 | 2 | 59_2 Phase B pickup | 59_2 Phase B pickup | Activation/Deactivation | Phase B voltage |
| | Bit-02 | 3 | 59_2 Phase C pickup | 59_2 Phase C pickup | Activation/Deactivation | Phase C voltage |
| | Bit-03 | 4 | 59_2 pickup | 59_2 pickup | Activation/Deactivation | - |
| | Bit-08 | 5 | 59_2 Phase A trip | 59_2 Phase A trip | Activation | Phase A voltage |
| | Bit-09 | 6 | 59_2 Phase B trip | 59_2 Phase B trip | Activation | Phase B voltage |
| | Bit-10 | 7 | 59_2 Phase C trip | 59_2 Phase C trip | Activation | Phase C voltage |
| | Bit-11 | 8 | 59_2 Trip | 59_2 Trip | Activation | - |
| **Level 1 neutral instantaneous overvoltage** | | | | | | |
| **59N_1** | Bit-04 | 01 | 59N_1 pickup | 59N_1 pickup | Activation/Deactivation | Neutral voltage |
| | Bit-12 | 02 | 59N_1 Trip | 59N_1 Trip | Activation/Deactivation | Neutral voltage |
| **Level 2 neutral instantaneous overvoltage** | | | | | | |
| **59N_2** | Bit-04 | 01 | 59N_2 pickup | 59N_2 pickup | Activation/Deactivation | Neutral voltage |
| | Bit-12 | 02 | 59N_2 Trip | 59N_2 Trip | Activation/Deactivation | Neutral voltage |

| Group | Bit | Event | Status | Event | Cause | Measurement |
|---|---|---|---|---|---|---|
| **Negative sequence overvoltage** | | | | | | |
| **47** | Bit-04 | 01 | 47 pickup | 47 pickup | Activation/Deactivation | Negative sequence voltage |
| | Bit-12 | 02 | 47 Trip | 47 Trip | Activation/Deactivation | Negative sequence voltage |
| Rate of change of voltage | | | | | | |
| **ΔV/Δt** | Bit-00 | 1 | ΔV/Δt Phase A pickup | ΔV/Δt Phase A pickup | Activation/Deactivation | Voltage difference |
| | Bit-01 | 2 | ΔV/Δt Phase B pickup | ΔV/Δt Phase B pickup | Activation/Deactivation | Voltage difference |
| | Bit-02 | 3 | ΔV/Δt Phase C pickup | ΔV/Δt Phase C pickup | Activation/Deactivation | Voltage difference |
| | Bit-03 | 4 | ΔV/Δt pickup | ΔV/Δt pickup | Activation/Deactivation | Voltage difference |
| | Bit-08 | 5 | ΔV/Δt Phase A trip | ΔV/Δt Phase A trip | Activation | Voltage difference |
| | Bit-09 | 6 | ΔV/Δt Phase B trip | ΔV/Δt Phase B trip | Activation | Voltage difference |
| | Bit-10 | 7 | ΔV/Δt Phase C trip | ΔV/Δt Phase C trip | Activation | Voltage difference |
| | Bit-11 | 8 | ΔV/Δt Trip | ΔV/Δt Trip | Activation | Voltage difference |
| **Level 1: Over/Underfrequency** | | | | | | |
| **81O/U_1** | Bit-04 | 01 | 81_1 Pickup | 81_1 Pickup | Activation/Deactivation | Frequency |
| | Bit-12 | 02 | 81_1 Trip | 81_1 Trip | Activation/Deactivation | Frequency |
| **Level 2: Over/Underfrequency** | | | | | | |
| **81O/U_2** | Bit-04 | 01 | 81_2 Pickup | 81_2 Pickup | Activation/Deactivation | Frequency |
| | Bit-12 | 02 | 81_2 Trip | 81_2 Trip | Activation/Deactivation | Frequency |
| **Level 3: Over/Underfrequency** | | | | | | |
| **81O/U_3** | Bit-04 | 01 | 81_3 Pickup | 81_3 Pickup | Activation/Deactivation | Frequency |
| | Bit-12 | 02 | 81_3 Trip | 81_3 Trip | Activation/Deactivation | Frequency |
| **Level 4: Over/Underfrequency** | | | | | | |
| **81O/U_4** | Bit-04 | 01 | 81_4 Pickup | 81_4 Pickup | Activation/Deactivation | Frequency |
| | Bit-12 | 02 | 81_4 Trip | 81_4 Trip | Activation/Deactivation | Frequency |
| **Level 1: Rate of change of frequency** | | | | | | |
| **81R_1** | Bit-04 | 01 | 81R_1 Pickup | 81R_1 Pickup | Activation/Deactivation | Frequency |
| | Bit-12 | 02 | 81R_1 Trip | 81R_1 Trip | Activation/Deactivation | Frequency |

| Group | Bit | Event | Status | Event | Cause | Measurement |
|---|---|---|---|---|---|---|
| **Level 2: Rate of change of frequency** | | | | | | |
| **81R_2** | Bit-04 | 01 | 81R_2 Pickup | 81R_2 Pickup | Activation/Deactivation | Frequency |
| | Bit-12 | 02 | 81R_2 Trip | 81R_2 Trip | Activation/Deactivation | Frequency |
| **Out of step (vector shift)** | | | | | | |
| **78** | Bit-12 | 02 | 48 Trip | 78 Trip | Activation/Deactivation | Frequency |
| **Recloser** | | | | | | |
| **79** | Bit-00 | 01 | 79 Standby | 79 Standby | Activation/Deactivation | - |
| | Bit-01 | 02 | 79 Reclosing time | 79 Reclosing time | Activation | Auto-reclosing No. |
| | Bit-02 | 03 | 79 Open | 79 Open | Activation | Reclose No. |
| | Bit-03 | 04 | 79 Hold time | 79 Hold time | Activation | Auto-reclosing No. |
| | Bit-04 | 05 | 79 Closing time | 79 Closing time | Activation | Auto-reclosing No. |
| | Bit-05 | 06 | 79 Reset time | 79 Reset time. | Activation | Reclose No. |
| | Bit-06 | 07 | 79 Lockout | 79 Lockout | Activation/Deactivation | Reclose No. |
| | Bit-07 | 08 | 79 Safety time | 79 Safety time | Activation | Reclose No. |
| | Bit-08 | 09 | 79 Final opening time | 79 Final opening time | Activation | - |
| | Bit-09 | - | 79 Enabled | - | - | - |
| **Breaker failure** | | | | | | |
| **BF** | Bit-04 | 01 | BF Pickup | BF Pickup | Activation/Deactivation | - |
| | Bit-12 | 02 | BF Trip | BF Trip | Activation/Deactivation | - |
| **Trip circuit supervision** | | | | | | |
| **74TCS** | Bit-04 | 01 | 74TCS Pickup | 74TCS Pickup | Activation/Deactivation | - |
| | Bit-12 | 02 | 74TCS Alarm | 74TCS Alarm | Activation/Deactivation | - |

| Group | Bit | Event | Status | Event | Cause | Measurement |
|---|---|---|---|---|---|---|
| **Circuit Breaker monitoring** | | | | | | |
| **52** | Bit-00 | 01 | 52 Start | 52 Start | Deactivation | - |
| | Bit-01 | 02 | 52 Error | 52 Error | Activation/Deactivation | - |
| | Bit-02 | 03 | 52 Open | 52 Open | Activation/Deactivation | Opening Time |
| | Bit-03 | 04 | 52 Opening time | 52 Opening time | Activation | - |
| | Bit-04 | 05 | 52 Opening error | 52 Opening error | Activation/Deactivation | Opening Time |
| | Bit-05 | 06 | 52 Closed | 52 Closed | Activation/Deactivation | Closing time |
| | Bit-06 | 07 | 52 Closing time | 52 Closing time | Activation | - |
| | Bit-07 | 08 | 52 Closing error | 52 Closing error | Activation/Deactivation | Closing time |
| | Bit-08 | 09 | 52 Excessive total openings | 52 Excessive total openings | Activation/Deactivation | - |
| | Bit-10 | 11 | 52 Excessive openings in a time window | 52 Excessive openings in a time window | Activation/Deactivation | - |
| | Bit-11 | 12 | 52 a | 52 a | Activation/Deactivation | - |
| | Bit-12 | 13 | 52 b | 52 b | Activation/Deactivation | - |
| | Bit-13 | 14 | Manual close | Manual close | | |
| **Synchronism** | | | | | | |
| **25** | Bit-00 | 01 | Synchrocheck | Synchrocheck | Activation/Deactivation | Voltage |
| | Bit-01 | 02 | DLDB: Dead line, dead bar | DLDB: Dead line, dead bar | Activation/Deactivation | Voltage |
| | Bit-02 | 03 | DLLB: Dead line, lived bar | DLLB: Dead line, lived bar | Activation/Deactivation | Voltage |
| | Bit-03 | 04 | LLDB: Lived line, dead bar | LLDB: Lived line, dead bar | Activation/Deactivation | Voltage |
| | Bit-04 | 05 | LLLB: Lived line, lived bar | LLLB: Lived line, lived bar | Activation/Deactivation | Voltage |
| | Bit-05 | 06 | Module difference | Module difference | Activation/Deactivation | Voltage |
| | Bit-06 | 07 | Frequency difference | Frequency difference | Activation/Deactivation | Voltage |
| | Bit-07 | 08 | Phase difference | Phase difference | Activation/Deactivation | Voltage |

| Group | Bit | Event | Status | Event | Cause | Measurement |
|---|---|---|---|---|---|---|
| **Inputs** | | | | | | |
| | Bit-00 | 17 | Input 1 | Input 1 | Activation/Deactivation | - |
| | Bit-01 | 18 | Input 2 | Input 2 | Activation/Deactivation | - |
| | Bit-02 | 19 | Input 3 | Input 3 | Activation/Deactivation | - |
| | Bit-03 | 20 | Input 4 | Input 4 | Activation/Deactivation | - |
| | Bit-04 | 21 | Input 5 | Input 5 | Activation/Deactivation | - |
| | Bit-05 | 22 | Input 6 | Input 6 | Activation/Deactivation | - |
| **Outputs** | | | | | | |
| | Bit-08 | 01 | Output 1 | Output 1 | Activation/Deactivation | - |
| | Bit-09 | 02 | Output 2 | Output 2 | Activation/Deactivation | - |
| | Bit-10 | 03 | Output 3 | Output 3 | Activation/Deactivation | - |
| | Bit-11 | 04 | Output 4 | Output 4 | Activation/Deactivation | - |
| **Leds** | | | | | | |
| | Bit-00 | - | Led 1 | - | - | - |
| | Bit-01 | - | Led 2 | - | - | - |
| | Bit-02 | - | Led 3 | - | - | - |
| | Bit-03 | - | Led 4 | - | - | - |
| | Bit-04 | - | Led 5 | - | - | - |
| | Bit-05 | - | Led 6 | - | - | - |
| | Bit-06 | - | Led 52 | - | - | - |
| | Bit-07 | - | Led 79 | - | - | - |

| Group | Bit | Event | Status | Event | Cause | Measurement |
|---|---|---|---|---|---|---|
| **Logic** | | | | | | |
| | Bit-13 | 18 | 52 a | 52 a | Activation/Deactivation | - |
| | Bit-14 | 19 | 52 b | 52 b | Activation/Deactivation | - |
| | Bit-15 | 22 | External trip | External trip | Activation/Deactivation | - |
| | Bit-16 | 07 | BF Init | BF Init | Activation/Deactivation | - |
| | Bit-17 | 08 | Fault Init | Fault Init | Activation/Deactivation | - |
| | Bit-18 | 20 | Manual close init | Manual close init | Activation/Deactivation | - |
| | Bit-19 | 21 | Manual close enable | Manual close enables | Activation/Deactivation | - |
| | Bit-20 | 23 | Reset | Reset | Activation/Deactivation | - |
| | Bit-21 | 24 | Settings group 1 | Settings group 1 | Activation/Deactivation | - |
| | Bit-22 | 25 | Settings Group 2 | Settings Group 2 | Activation/Deactivation | - |
| | Bit-23 | 06 | 79 Init | 79 Init | Activation/Deactivation | - |
| | Bit-24 | 17 | 79 Enable | 79 Enable | Activation/Deactivation | - |
| | Bit-25 | 27 | Level lock 79 | Level lock 79 | Activation/Deactivation | - |
| | Bit-26 | 28 | Pulse Lock 79 | Pulse Lock 79 | Activation/Deactivation | - |
| | Bit-27 | 29 | Pulse Unlock 79 | Pulse Unlock 79 | Activation/Deactivation | - |
| | Bit-28 | 30 | 74TCS Continuity A | 74TCS Continuity A | Activation/Deactivation | - |
| | Bit-29 | 31 | 74TCS Continuity B | 74TCS Continuity B | Activation/Deactivation | - |
| | Bit-30 | - | Logical signal 1 | - | - | - |
| | Bit 31 | - | Logical signal 2 | - | - | - |
| **Remote Modbus** | | | | | | |
| | Bit-00 | - | Remote communication | - | - | -- |
| | Bit-17 | 02 | Open circuit breaker | Open circuit breaker | Activation | Command identifier |
| | Bit-18 | 03 | Close circuit breaker | Close circuit breaker | Activation | Command identifier |
| | Bit-19 | 04 | Pulse Lock 79 | Pulse Lock 79 | Activation | Command identifier |
| | Bit-20 | 05 | Pulse Unlock 79 | Pulse Unlock 79 | Activation | Command identifier |
| | Bit-21 | 06 | Local control | Local control | Activation | Command identifier |
| | Bit-22 | 07 | Telecontrol | Telecontrol | Activation | Command identifier |
| | Bit-23 | 09 | Reset | Reset | Activation | Command identifier |

| Group | Bit | Event | Status | Event | Cause | Measurement |
|---|---|---|---|---|---|---|
| **IEC60870-5-103** | | | | | | |
| | Bit-00 | - | IEC60870-5-103 com | - | -- | - |
| | Bit-17 | 02 | Open circuit breaker | Open circuit breaker | Activation | Command identifier |
| | Bit-18 | 03 | Close circuit breaker | Close circuit breaker | Activation | Command identifier |
| | Bit-19 | 04 | Lock 79 | Lock 79 | Activation | Command identifier |
| | Bit-20 | 05 | Unlock 79 | Unlock 79 | Activation | Command identifier |
| | Bit-21 | 06 | Local control | Local control | Activation | Command identifier |
| | Bit-22 | 07 | Telecontrol | Telecontrol | Activation | Command identifier |
| | Bit-23 | 09 | Reset | Reset | Activation | Command identifier |
| **Local communication** | | | | | | |
| | Bit-00 | - | Local COM. | - | - | - |
| | Bit-01 | - | HMI Activity | - | - | - |
| | Bit-17 | 02 | Open circuit breaker | Open circuit breaker | Activation | Command identifier |
| | Bit-18 | 03 | Close circuit breaker | Close circuit breaker | Activation | Command identifier |
| | Bit-19 | 04 | Lock 79 | Lock 79 | Activation | Command identifier |
| | Bit-20 | 05 | Unlock 79 | Unlock 79 | Activation | Command identifier |
| | Bit-21 | 06 | Local control | Local control | Activation | Command identifier |
| | Bit-22 | 07 | Telecontrol | Telecontrol | Activation | Command identifier |
| | Bit-23 | 09 | Reset | Reset | Activation | Command identifier |

## 5.3. Fault reports

A fault report is a record of specific events in the period of time when a fault occurs. On the one hand, an oscillography record is very extensive information, but only short regarding time for a significant number of faults. Also, event recording can be filled with general events, which provide no information of a fault (tables 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 20 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 Pickup and a fault end, and these must be clearly established.

Twenty fault reports are generated and they are registered in non-volatile FRAM memory. From the HMI, by pressing key "◄" or by navigating through the menus, you will gain access to fault reports. The information displayed is as follows:

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

The fault Pickup is the same as that of the oscillography, i.e. an oscillography shall always be associated to the fault report. The fault end shall depend on whether the recloser is active. If the recloser is prohibited, when all Pickup ups disappear it is understood that the fault has disappeared (this includes the circuit breaker fault). With the recloser permitted, the fault end is given by the final condition of the recloser, regardless of whether it has been successful or it has become blocked. As a general rule, the following logic shall provide the fault end.

## 5.4. Real-Time Clock (RTC)

For events, oscillographies and alarms the protection equipment required a clock for date and time stamping. This clock must keep the date and time even with no power supply, for up to 72 hours (With the capacity charged beforehand).

If there is an events queue, and the clock is synchronised with a date and time prior to the last stored event, the relay does not reorder the queue, but rather it stores the new events after the events already in the queue.

This clock can be synchronised with another clock in various ways:

- **From the HMI.** In this case the date and time can be entered using a keyboard. The relay will save a new event indicating that it has been synchronised.
- **By protocol.** There are two options in this case:
    - **Local protocol.** The performance is identical to the HMI, the relay synchronises the date and time and executes a new synchronisation event.
    - **Remote protocols.** These protocols can include continuous synchronisation sections. For this reason, the execution of synchronisation events is inappropriate.

## 5.5. Oscillography

The SIL-V relay stores 5 oscillographic records, with a resolution of 16 samples/cycle and a size of 88 cycles. The first three of these cycles correspond to pre-fault.

The oscillography is downloaded by communications through the front or rear port using the Modbus protocol (the protocol is documented in this manual). The SICom communications program allows the oscillograph to be downloaded and saved in COMTRADE format (IEEE C37.111-1991).

The following information is included in each oscillographic record:

| Number | Analog channels |
|---|---|
| **1** | Phase A voltage |
| **2** | Phase B voltage |
| **3** | Phase C voltage |
| **4** | Neutral voltage or bar voltage (depending on model) |

This voltage is already in volts.

As well as the analogue magnitudes, the relay saves 64 digital records, with the same precision as 16 cycle samples. These 64 bits shall contain the following:

| No. | Digital channels |
|---|---|
| 1 | 27_1 Trip |
| 2 | 27_2Trip |
| 3 | 59_1 Trip |
| 4 | 59_2 Trip |
| 5 | 59_N1 Trip |
| 6 | 59_N2 Trip |
| 7 | 81_1 Trip |
| 8 | 81_2 Trip |
| 9 | 81_3 Trip |
| 10 | 81_4 Trip |
| 11 | 81R_1 Trip |
| 12 | 81R_2 Trip |
| 13 | 27V1 Trip |
| 14 | 47 Trip |
| 15 | 78 Trip |
| 16 | dV/dt Trip |
| 17 | External trip |
| 18 | General trip |
| 19 | General pickup |
| 20 | Input 1 |
| 21 | Input 2 |
| 22 | Input 3 |
| 23 | Input 4 |
| 24 | Input 5 |
| 25 | Input 6 |
| 26 | Output 1 |
| 27 | Output 2 |
| 28 | Output 3 |
| 29 | Output 4 |
| 30 | BF Pickup |

| No. | Digital channels |
|---|---|
| 31 | BF Trip |
| 32 | 74TCS Alarm |
| 33 | Manual close init |
| 34 | Manual close Enable |
| 35 | 52 Open |
| 36 | 52 Close |
| 37 | 79 Init |
| 38 | 79 Enable |
| 39 | 79 Standby |
| 40 | 79 Lockout |
| 42 | 79 Reclose time |
| 42 | 27_1 Pickup |
| 43 | 27_2 Pickup |
| 44 | 59_1 Pickup |
| 45 | 59_2 Pickup |
| 46 | 59N_1 Pickup |
| 47 | 59N_2 Pickup |
| 48 | 81_1 Pickup |
| 49 | 81_2 Pickup |
| 50 | 81_3 Pickup |
| 51 | 81_4 Pickup |
| 52 | 81R_1 Pickup |
| 53 | 81R_2 Pickup |
| 54 | 27V1 Pickup |
| 55 | 47 Pickup |
| 56 | dV/dt Pickup |
| 57 | DLDB (*) |
| 58 | DLLB (*) |
| 59 | LLDB (*) |
| 60 | LLLB (*) |

| No. | Digital channels |
|---|---|
| 61 | Voltage difference (*) |
| 62 | Frequency difference (*) |
| 63 | Phase difference (*) |
| 64 | Synchrocheck (*) |

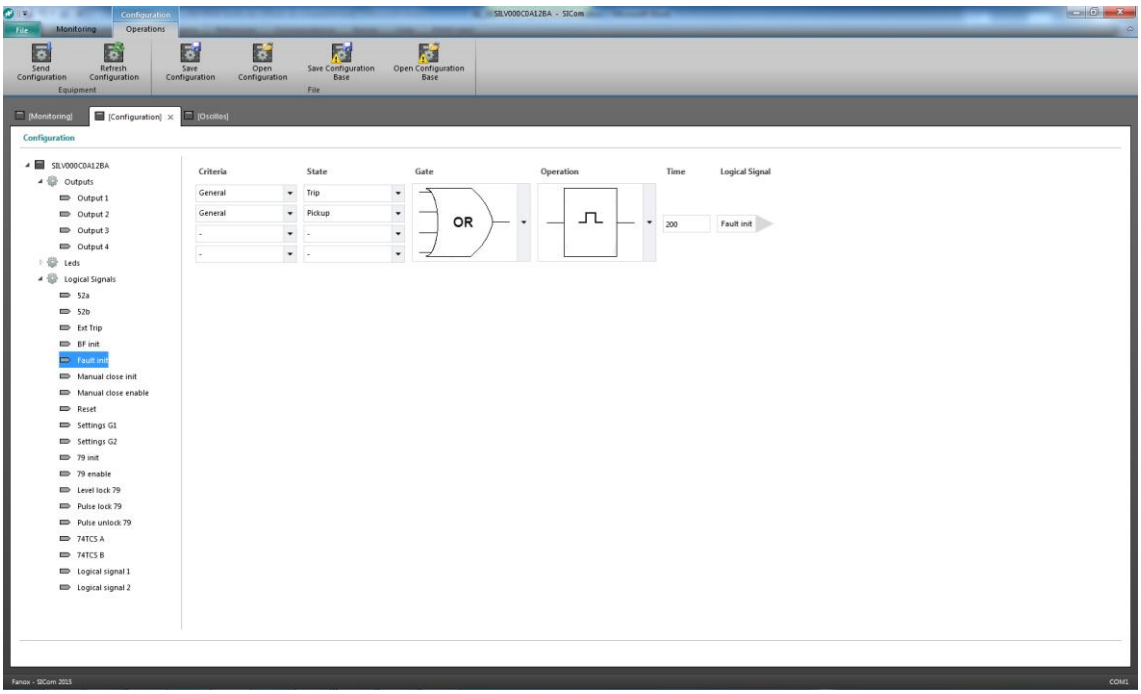
(*) Available only in SILVxxxx2xxxxx model

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

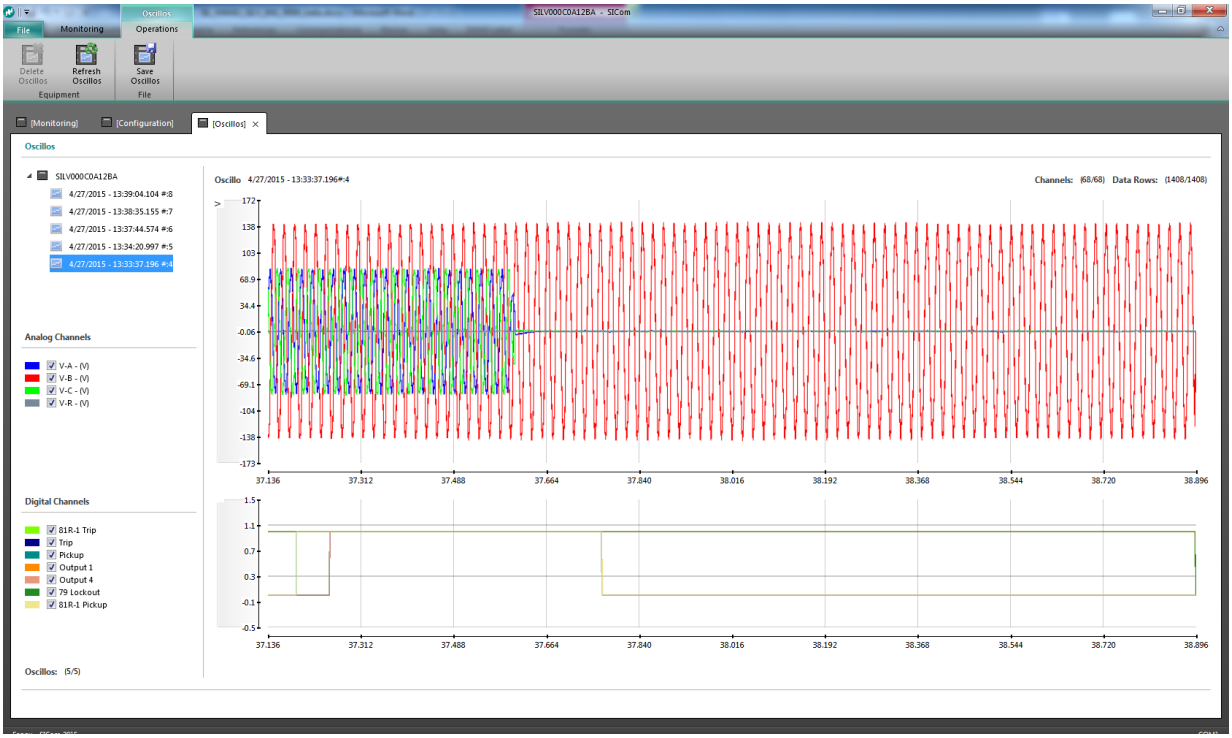
Shown below is the format of a COMTRADE header file, generated by the SICom program:

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

*****************************************************************

Cycles pre-fault = 3
Total cycles = 88
Analog channels = 4
Digital channels = 64
Oscillo = 1
Date/Time = 12/5/2014 - 09:52:18.570

*****************************************************************
```

An oscillography is started when the "fault init" state is activated; this is a configurable logical signal. The default configuration is as follows:



It is possible to visualize the oscillography using SICom software




Using SICom software, it is possible to save the oscillo as a COMTRADE file

## 5.7. Configurable Inputs

The SIL-V has 6 digital inputs that can be set by the user. These inputs can be configured from the HMI, or by using the SICom program.

The inputs are configured by associating the logical inputs with the physical input that they require, or else no association is made if that logical input is not in use. Therefore, a single physical input can be associated with more than one logical input.

SIL-V logical signals are as follows:

| Logical inputs | Description |
|---|---|
| **Input 52 a** | Circuit breaker contact a |
| **Input 52 b** | Circuit breaker contact b |
| **External trip** | External trip start. If a pulse of more than 20 ms is received (to avoid false signals), a 200 ms pulse is generated to be used in the trip output. |
| **BF init** | Start of circuit breaker fault through external protection |
| **Fault init** | Oscillography Start |
| **Manual close init** | Initial condition to close circuit breaker |
| **Manual close enable** | Permission to close circuit breaker |
| **Reset** | Reset leds and physical outputs |
| **Settings froup 1** | Active table assignment |
| **Settings group 2** | Active table assignment |
| **79 init** | Start of 79 through external protection |
| **79 Enable** | Permission to close 79 |
| **Level Lock 79** | Lock of 79 through a level input |
| **Pulse Lock 79** | Lock of 79 through a pulse input of an RTU |
| **Pulse Unlock 79** | Unlock of 79 through a pulse input of a RTU |
| **74TCS coil A** | Circuit supervision with coil A |
| **74TCS coil b** | Circuit supervision with coil B |
| **Logical signal 1** | Free logical signal |
| **Logical signal 2** | Free logical signal |

## 5.8. Configurable Outputs

SIL-V is fitted with 4 digtal outputs. The outputs can be configured from the HMI or through the SICom program.

The configuration of the outputs is described in point *5.9 Programmable Logic Control*

## 5.9. Programmable Logic Control

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

Physical inputs are the real inputs of the device. SIL-V device has 6 physical inputs. These inputs are translated to 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. SIL-V has 4 outputs and 8 configurable leds, 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 1 |
| | LED 2 |
| | LED 3 |
| | LED 4 |
| | LED 5 |
| | LED 6 |
| | LED 52 |
| | LED 79 |
| **PHYSICAL OUTPUTS** | Output 1 |
| | Output 2 |
| | Output 3 |
| | Output 4 |
| **LOGICAL SIGNALS** | 52a |
| | 52b |
| | External Trip |
| | BF start |
| | Fault start |

| | |
|---|---|
| | Manual close init |
| | Manual close enable |
| | Reset |
| | Settings group 1 |
| | Settings group 2 |
| | Continuity A |
| | Continuity B |
| | Logical signal 1 |
| | Logical signal 2 |

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.

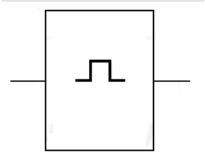
For each output there is a LOGICAL GATE. It can perform a logical operation up to 4 binary states to obtain other binary result.

In V3 of the PLC the LOGICAL GATES that are supported by SIL-V are:

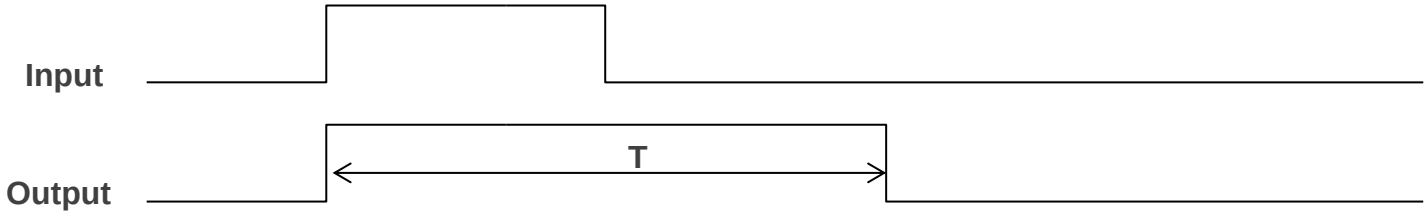
| LOGICAL GATE | HMI SYMBOL |
|---|---|
| OR4 | + |
| NOR4 | τ |
| OR4_LACTH | c |
| NOR4_LACTH | Φ |
| OR4_PULSES | J |
| AND4 | & |
| NAND4 | § |
| AND4_PULSES | $ |
| OR_TIMER_UP | O |
| NOR_TIMER_UP | P |
| AND_TIMER_UP | Q |
| NAND_TIMER_UP | R |
| OR_PULSE | o |
| NOR_PULSE | p |
| AND_PULSE | q |
| NAND_PULSE | r |

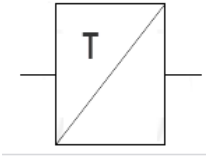
In the SICom the logic is as follows:

## Logical gate selection guide

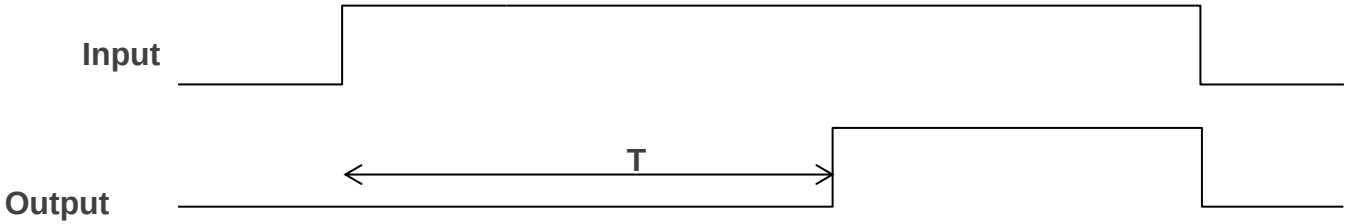


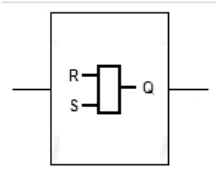
The configured signal will make a pulse of the adjusted milliseconds once the input signal is activated.



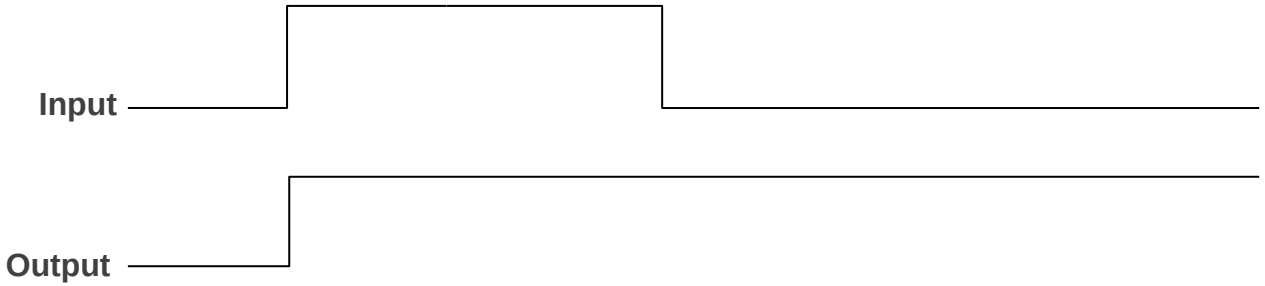



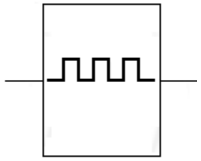

The configured signal waits the adjusted milliseconds to activate itself.



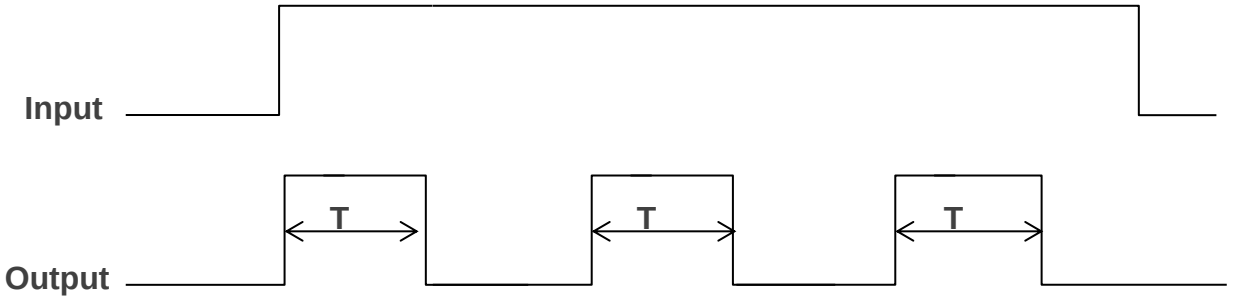



The configured signal will be activated till it is externally reset (command, reset key, communications…), though the input signal drops off.



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



By default, outputs configuration is:

| | OUTPUT | *LOGICAL GATE* | BINARY STATES |
|---|---|---|---|
| **LEDs** | LED 1 | *OR4_PULSES* | • Ready |
| | LED-2 | *OR4* | • General pick-up |
| | LED-3 | *OR4* | • Output 3 |
| | LED 4 | *OR4_LATCH* | • Output 4 |
| | LED 5 | *OR4_LACTH* | • 74TCS Alarm |
| | LED 6 | *OR4_LACTH* | • BF Trip |
| | LED 52 | *OR4* | • 52 Closed |
| | LED 79 | *OR4* | • 79 Standby |
| **PHYSICAL OUTPUTS** | Output 1 | *OR4* | • Ready |
| | Output 2 | *OR4* | • BF Trip |
| | Output 3 | *OR4* | • 52 manual close<br>• 79 Closing time |
| | Output 4 | *OR4* | • General trip<br>• Local open breaker<br>• Rremote Modbus open breaker<br>• 60870-5-103 Open breaker |

| | | | |
|---|---|---|---|
| **LOGICAL SIGNALS** | 52a | *OR4* | • Input-6 |
| | 52b | *OR4* | • Input-5 |
| | External Trip | *OR4* | • Input-4 |
| | BF start | *OR4* | • General trip |
| | Fault init | *OR4_PULSE* | • General trip<br>• General pick-up |
| | Manual close init | *OR4* | • Local close breaker<br>• Remote close breaker<br>• IEC60870-5-103 close breaker |
| | Manual close enable | *Not configured* | - |
| | Reset | *OR4_PULSE* | • Local reset<br>• Remote modbus reset<br>• IEC60870-5-103 reset |
| | Settings group 1 | *Not configured* | - |
| | Settings group 2 | *Not configured* | - |
| | 79 Init | *OR4* | • General trip |
| | 79 Enable | *Not configured* | - |
| | 79 Block | *Not configured* | - |
| | Lock 79 | *Not configured* | - |
| | Unlock 79 | *Not configured* | - |
| | Continuity A | *OR4* | • Input-1 |
| | Continuity B | *OR4* | • Input-2 |
| | Logical signal 1 | *Not configured* | - |
| | Logical signal 2 | *Not configured* | - |

We are going to use a configuration as an example:

| OUTPUT | LOGICAL GATE | BINARY STATES | DESCRIPTIONS |
|---|---|---|---|
| LED 1 | *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 2 | *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 3 | *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. |
| Output 1 | *OR4* | • Local opening<br>• 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 | *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 | *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. |
| BF Init | *OR4* | • Local opening<br>• Remote opening<br>• General trip | When a general trip has occurred or when 52a opening command is carried out from local communications start BF logical output will be activated and it will be used to initiate the detection of breaker failure by 50BF function. |
| Fault Init | *OR4_LACTH* | • General trip | When general trip is activated, fault start logical output will be activated and it will generate a new fault register. |

## 5.10. 86 Function. Trip Output Lockout

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

## 5.11. Self-diagnosis

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

The following general considerations are applicable:

- Communications between different CPUs are confirmed by the corresponding integrity checks. In the case of continuous faults, the equipment shall be re-picked up.
- The settings details are confirmed with the corresponding checks. Also, the settings tables are folded and the relay can operate with one table damaged but not with two damaged.
- There is a WatchDog mechanism between the different main CPUs, as well as on the CPUs themselves. Loss of activity on any of these will result in the resetting of the equipment, and this will be recorded as an event.

The following status 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, a table is corrupt. |
| **Event error** | Problem in the events recording |

On the other hand, a default settings error indicates that the relay is operating with default settings, whereby it will not trip (check that the relay alarm is activated with default settings).

## 5.12. Commands

| | HMI | Local Com. ModBus | Remote com: Modbus IEC 60870-5-103 IEC61850 DNP 3.0 |
|---|---|---|---|
| **52 open** | ✓ | ✓ | ✓ |
| **52 close** | ✓ | ✓ | ✓ |
| **Pulse Lock 79** | ✓ | ✓ | ✓ |
| **Pulse Unlock 79** | ✓ | ✓ | ✓ |
| **Local control** | ✓ | ✓ | - |
| **Telecontrol** | ✓ | ✓ | - |
| **Reset** | ✓ | ✓ | ✓ |

To carry out commands from the remote communications (ModBus, IEC60870-5-103, IEC61850 or DNP 3.0 depending on model) the equipment must be in TELECONTROL mode.

Operations can be performed from the HMI or from local communications (ModBus), regardless of whether or not the equipment is in telecontrol.

## 5.13. Telecontrol

The equipment can only be set to telecontrol or local control from the HMI or through communications software (SICOM).

If telecontrol is used, it is recommended to configure a led to display when telecontrol is permitted and when it is not.

## 5.14. Date-time synchronisation

The equipment can be synchronised from the HMI or by using communications.

## 5.15. Test program

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

| | | |
|---|---|---|
| **led-1** | Deactivated | Led-1 deactivated |
| | Activated | Led-1 activated |
| **led-2** | Deactivated | Led-2 deactivated |
| | Activated | Led-2 activated |
| **led-3** | Deactivated | Led-3 deactivated |
| | Activated | Led-3 activated |
| **led-4** | Deactivated | Led-4 deactivated |
| | Activated | Led-4 activated |
| **led-5** | Deactivated | Led-5 deactivated |
| | Activated | Led-5 activated |
| **led-6** | Deactivated | Led-6 deactivated |
| | Activated | Led-6 activated |
| **led-79** | Deactivated | Led-79 deactivated |
| | Activated | Led-79 activated |
| **led-52** | Deactivated | Led-52 deactivated |
| | Activated | Led-52 activated |
| **Output 1** | Deactivated | Output 1 deactivated |
| | Activated | Output 1 activated |
| **Output 2** | Deactivated | Output 2 deactivated |
| | Activated | Output 2 activated |
| **Output 3** | Deactivated | Output 3 deactivated |
| | Activated | Output 3 activated |
| **Output 4** | Deactivated | Output 4 deactivated |
| | Activated | Output 4 activated |

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.

The inputs check can be seen in the conditions menu.

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

## 5.16. Power supply

The equipment power consumption is less than 4 watts.

The supply guarantees between ±20% of the auxiliary voltage. Outside this range the relay could operate, but this is not guaranteed. It is used a power supply of 24-110 Vdc/48-230 Vac.

Supply from the front is designed for fine tuning, or situations where the auxiliary voltage is not guaranteed. In these cases, complete relay operation is not guaranteed, particularly regarding outputs.

# 6. TECHNICAL SPECIFICATIONS AND STANDARD

## 6.1. Technical specifications

| | |
|---|---|
| **27_1**<br>**27_2** | Function permission : yes/no |
| | Operating range: 3 to 555V (step 0.1 V) |
| | Operating time: 0.02 to 300 s (step 0.01 s) |
| | Reset time: 0.02 to 300 s (step 0.01 s) |
| | Activation level: 100% |
| | Deactivation level: 105% |
| | Temporized deactivation |
| | Timing accuracy: ±30 ms or ± 0.5% (greater of both). |
| **27V1** | Function permission : yes/no |
| | Operating range: 3 to 555V (step 0.1 V) |
| | Operating time: 0.02 to 300 s (step 0.01 s) |
| | Reset time: 0.02 to 300 s (step 0.01 s) |
| | Activation level: 100% |
| | Deactivation level: 105% |
| | Temporized deactivation |
| | Timing accuracy: ±30 ms or ± 0.5% (greater of both). |
| **59_1**<br>**59_2** | Function permission : yes/no |
| | Operating range: 6 to 999V (step 0.1 V) |
| | Operating time: 0.02 to 300 s (step 0.01 s) |
| | Reset time: 0.02 to 300 s (step 0.01 s) |
| | Activation level: 100% |
| | Deactivation level: 95% |
| | Temporized deactivation |
| | Timing accuracy: ±30 ms or ± 0.5% (greater of both). |

| | |
|---|---|
| **59N_1**<br>**59N_2** | Function permission : yes/no |
| | Operating range: 6 to 999V (step 0.1 V) |
| | Operating time: 0.02 to 300 s (step 0.01 s) |
| | Reset time: 0.02 to 300 s (step 0.01 s) |
| | Activation level: 100% |
| | Deactivation level: 95% |
| | Temporized deactivation |
| | Timing accuracy: ±30 ms or ± 0.5% (greater of both). |
| **47** | Function permission : yes/no |
| | Operating range: 6 to 999V (step 0.1 V) |
| | Operating time: 0.02 to 300 s (step 0.01 s) |
| | Reset time: 0.02 to 300 s (step 0.01 s) |
| | Activation level: 100% |
| | Deactivation level: 95% |
| | Temporized deactivation |
| | Timing accuracy: ±30 ms or ± 0.5% (greater of both). |
| **ΔV/Δt** | Function permission : yes/no |
| | Type: Increment or Decrement |
| | Activation level: 1 to 200 V/s (step 1 V/s) |
| | Operating time: 1.00 to 40.00 s (step 0.01 s) |
| | Reset time: 0.02 to 300 s (step 0.01 s) |
| | Timing accuracy: ±60 ms or ± 5% (greater of both). |
| **81_1**<br>**81_2**<br>**81_3**<br>**81_4** | Function permission : yes/no |
| | Type: Underfrequency or overfrecuency |
| | Operating range: 45.00 a 65.00 Hz (step 0.01 Hz) |
| | Operating time: 0.06 a 300 s (step 0.01 s) |
| | Reset time: 0.02 a 300 s (step 0.01 s) |
| | Blocked function if phase b voltage is lower than 45 volts |
| | Activation level: 100% |
| | Underfrequency reset level: activation level + 50mHz<br>Overfrequency reset level: activation level – 50 mHz |
| | Temporized deactivation |
| | The frequency measurement is an average value of the frequency measured during 8 cycles. The operating time will be the adjusted value plus a maximum of 160 ms (50Hz) or 133 ms (60 Hz) corresponding to the necessary 8 cycles to achieve the frequency measurement. |

| | |
|---|---|
| **81R_1**<br>**81R_2** | Function permission : yes/no |
| | Type: Incremento r Decrement |
| | Level: 0.1 to 5 Hz/s (step 0.1 Hz/s) |
| | Operating time: 0.06 to 40 s (step 0.01 s) |
| | Reset level: 0.06 to 300 s (step 0.01 s) |
| | Blocked function if phase b voltage is lower than 45 volts |
| | The frequency measurement is an average value of the frequency measured during 8 cycles. The operating time will be the adjusted value plus a maximum of 160 ms (50Hz) or 133 ms (60 Hz) corresponding to the necessary 8 cycles to achieve the frequency measurement. |
| **78_1**<br>**78_2** | Function permission : yes/no |
| | Level: 1 to 25. (step 1°) |
| | Reset time: 0.02 to 300 s (step 0.01 s) |
| | Level accuracy: ±0.5° |
| | Blocked function if phase b voltage is lower than 45 volts |
| **Circuit breaker monitoring** | Maximum number of openings: 1 a 10000 |
| | Opening time: 0.02 to 30 s (step 0.01 s) |
| | Closing time: 0.02 to 30 s (step 0.01 s) |
| | Excess repeated openings: 1 a 10000 |
| | Repeated openings excess time: 1 to 300 min |
| **BF** | Function permission : yes/no |
| | Opening failure time: 0.02 to 1.00 s (step 0. 01 s) |
| | Function start: configurable by the user |
| **74TCS** | Function permission: yes/no |
| | Operating time: 0.02 to 300 s (step 0.01 s) |
| | Trip continuity, in circuits A and B |
| | Configurable inputs |
| **79** | Function permission : yes/no |
| | Hold permission: yes/no |
| | Number of reclosings: 1 to 5 |
| | Reclosure times 1, 2, 3, 4, 5 : 0.02 to 300.00 s (step 0.01 s) |
| | Hold time: 0.02 to 300 s (step 0.01 s) |
| | Locking possibilities: pulse inputs, level inputs, commands. |
| | Replacement time: 0.02 to 300.00 s (step 0.01 s) |
| | Definitive opening time: 0.02 to 300 s (step 0.01 s) |

| | |
|---|---|
| **25 (*)** | Dead voltage level: 3 to 555 V (step 0.1 V) |
| | Live voltage level: 6 to 999 V (step 0.1 V) |
| | Voltage supervision time: 0.02 to 300 s (step 0.01 s) |
| | Line-Bar voltage difference:4 to 50 V (step 0.1 V) |
| | Line-Bar phase difference: 2 to 90 °(step 0.1 °) |
| | Line-Bar frequency difference: 0.06 to 10 Hz (step 0.01 Hz) |
| | Synchro temporization: 0.02 to 300 s (step 0.01 s) |
| | Phase B line voltage and busbar voltage. Modules and phases using DFT<br>Frequency using hardware circuit with the passing through zero detection. |
| | Permission signal minimum time 150 ms |
| **49T** | Available through configurable inputs |
| **Programmable logic control (PLC)** | OR4, NOR4, OR4_LATCH, NOR4_LATCH, OR4_PULSES, AND4_LATCH, NAND4_LATCH, AND4_PULSES, OR4_TIMER, NOR4_TIMER_UP, AND4_TIMER_UP, NAND4_TIMER_UP |
| **86** | Allows to latch (lock out) the contact trip due to programmable logic (PLC: OR_LATCH). |
| **Settings tables** | 3 settings tables |
| | Activated by general settings or by inputs |
| **RTC** | Capacitor charge time: 10 minutes |
| | Operation without auxiliary voltage: 72 hours |
| **Oscillography** | 16 samples/cycle |
| | Oscillo starting configuration |
| | 5 records: 3 cycles pre-fault and 85 post-fault |
| | COMTRADE IEEE C37.111-1991 |
| | 4 analogue channels and 64 digital channels |
| **Fault report** | 20 fault reports with 24 events in each |
| **6 configurable inputs** | The voltage of the inputs is the same as the auxiliary power supply |
| **4 configurable outputs** | 250 V AC – 8 A<br>30 V DC – 5 A |
| | Output 1 and output 2: Commuted ( NC + NO)<br>Output 3 and Output 4: NO |
| **Frequency** | 50/60Hz |

| | |
|---|---|
| **Voltage measurement** | Phase voltages (V-A, V-B, V-C), calculated neutral voltage (3V-0), residual voltage (V-R) (*), Busbar voltage (V-BB)(*), positive sequence voltage (V-1), negative sequence voltage (V-2), Maximum voltage (Vmax) and Minimum voltage (Vmin) |
| | Measurement range:<br>Low scale (rated voltage<250 V)→3-250 V<br>High scale (rated voltage>250V)→12-1000 V |
| **Frequency measurement** | Starting from phase B line voltage, passing through zero detection to line frequency<br>Starting from phase B busbar voltage, passing through zero detection to busbar frequency. |
| | Line Phase B frequency |
| | Frequency derivative respect to the time |
| | Busbar phase B frequency (*) |
| | Busbar and line frequency difference (*) |
| | Minimum voltage (to achieve the measurement): 40V |
| | Accuracy: ±0.01 Hz |
| **Communications** | LOCAL COMMUNICATION<br>1 Local port RS232: ModBus RTU |
| | REMOTE COMMUNICATION (*)<br>Remote ports with the following options :<br>• 1 Remote port RS485: ModBus RTU or IEC 60870-5-103 (by general settings)<br>• 1 Remote port RS485: ModBus RTU + 1 RJ45 port: IEC 61850, DNP3.0 or IEC 60870-104 |
| **Auxiliary power supply** | 24-110 Vdc /48-230 Vac ±20% |
| **Environmental conditions** | Operating temperature: -10 to 70ºC |
| | Storage temperature: -20 to 80 ºC |
| | Relative humidity: 95% |
| **Mechanical characteristics** | Metal case |
| | Panel mounting |
| | 1/4 Rack – 4 U |
| | IP-54 |

(*) Depending on model

## 6.3. Standards

| 1. EMC requirements | | |
|---|---|---|
| - Emission | | |
| 1.1. Radiated emission | IEC 60255-26<br>EN 55022<br>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<br>EN 55022<br>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<br>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<br>IEC 61000-4-2 | Level 4, Contact discharge ±8kV. Air discharge ±15kV |
| 1.5. Radiated radiofrequency electromagnetic fields | IEC 60255-26<br>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<br>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<br>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<br>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<br>IEC 61000-4-11<br>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<br>IEC 61000-4-17 | Level 4, Ripple 15%, 50Hz and 100Hz |
| 1.11. Power frequency magnetic field | IEC 60255-26<br>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<br>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<br>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<br>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 voltage 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<br>IEC 61850<br>IEC 60870-5-103<br>IEC 60870-5-104<br>DNP 3.0 | |
| **6. Climatic environmental requirements** | **IEC 60255-27** | |
| 6.1. Cold | IEC 60068-2-1 | Cold Operation Ab, -25ºC, 72h<br>Cold transport & Storage Ad, -40ºC, 72h |

| | | |
|---|---|---|
| 6.2 Dry heat | IEC 60068-2-2 | Dry Heat Operation Bb, +70ºC, 72h<br>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<br>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<br>IEC 60068-21-2 | Shock Response, Class 1, $5g_n$, Shock Withstands, Class 1, $15g_n$ |
| 7.3. Bump | IEC 60255-21-2<br>IEC 60068-21-2 | Bump, Class 1, $10g_n$ |
| 7.4. Seismic | IEC 60255-21-3<br>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<br>IEC 60529 | IP-54 |

# 6. COMMUNICATION AND HMI

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

| | | | |
|---|---|---|---|
| 1 | LOCAL (front) | RS232 | Modbus RTU |
| 2 | REMOTE (rear) | RS485 | Modbus RTU or IEC 60870-5-103 (by general settings) |
| 3 | REMOTE (rear) | RJ45 | IEC 61850 (Depending on model) |
| 4 | REMOTE (rear) | RJ45 | DNP 3.0 (Depending on model) |
| 5 | REMOTE (rear) | RJ45 | IEC60870-5-104 (Depending on model) |

## 7.1. Local communication port. RS232

The RS232 communications port is installed on the front of the equipment. The connector that is used is a DB-9 female – DCE. 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 PC earth should be connected to the same earth as the relay to avoid communication problems.

The RS232 communication is fitted with auxiliary voltage insulation, but no insulation with regards to the relay processors. Therefore, the connection cable between the pc and relay must not be very long so as to prevent possible electromagnetic interferences with the equipment.

## 6.2. Remote communications port

**SIL-V with 1 port RS485 for ModBus or for IEC60870-5-103**

In this case, there are 1 RS485 port, it is possible to select ModBus RTU protocol or IEC60870-5-103 protocol thanks to the general settings.The RS485 port output has two terminals (+,-), located on the rear of the equipment.

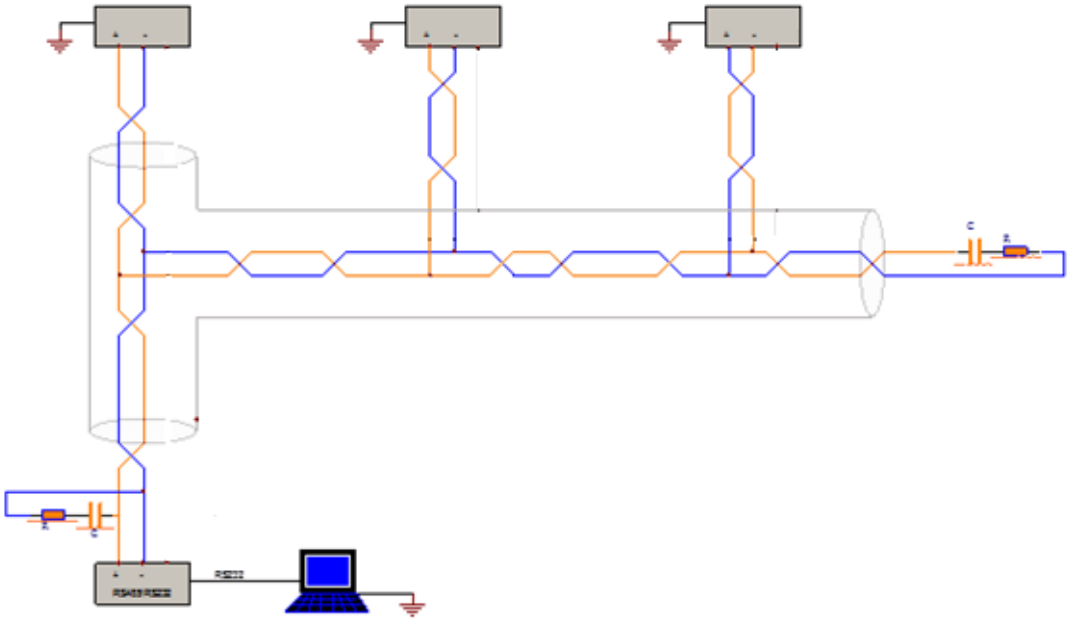
This port can be used to continuously monitor the equipment from a remote PC or SCADA system. Up to 32 relays can be connected to one bus; each device with a different modbus address. The equipment modbus address can be configured using the SIcom program.

To minimise 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.

Resistors should be used at each end if very long cables are used. The best solution for avoiding reflection is to install resistors at both ends of the cable. The ohm value of these resistors must be equal to the cable impedance value.

The RS485 communications are fitted with auxiliary voltage insulation, but no insulation between the various RS485 communication connectors. Fiber optics can be used in very aggressive environments, and they are connected by using the corresponding converters.

Connection diagram for a RS485 bus:



**SIL-V with one RS485 for Modbus RTU and one RJ45 port for IEC61850, DNP3.0 or IEC60870-5-104**

In this case there is one RS485 port for Modbus RTU (the protoco is fixed, not selectable by general setting and one RJ45 port for IEC 61850 protocol, for DNP 3.0 protocol or for IEC 60870-5-104 protocol depending on model.

## 6.3. LCD and keypad

The front of the SIL-V relay is fitted with an alphanumeric LCD screen, measuring 20x2. This screen provides the user with access to read information about the settings parameters, measurements, status and events. All of this information is arranged in a system of menus.

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

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

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

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

This is equipped with a specific key marked with 79, which permits operation on the recloser, locking and unlocking it.

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

## 6.4. SICom Communications program

The SIcom program, which works with the Windows® 2000/XP, Windows 7 and Windows 8 operating systems 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:

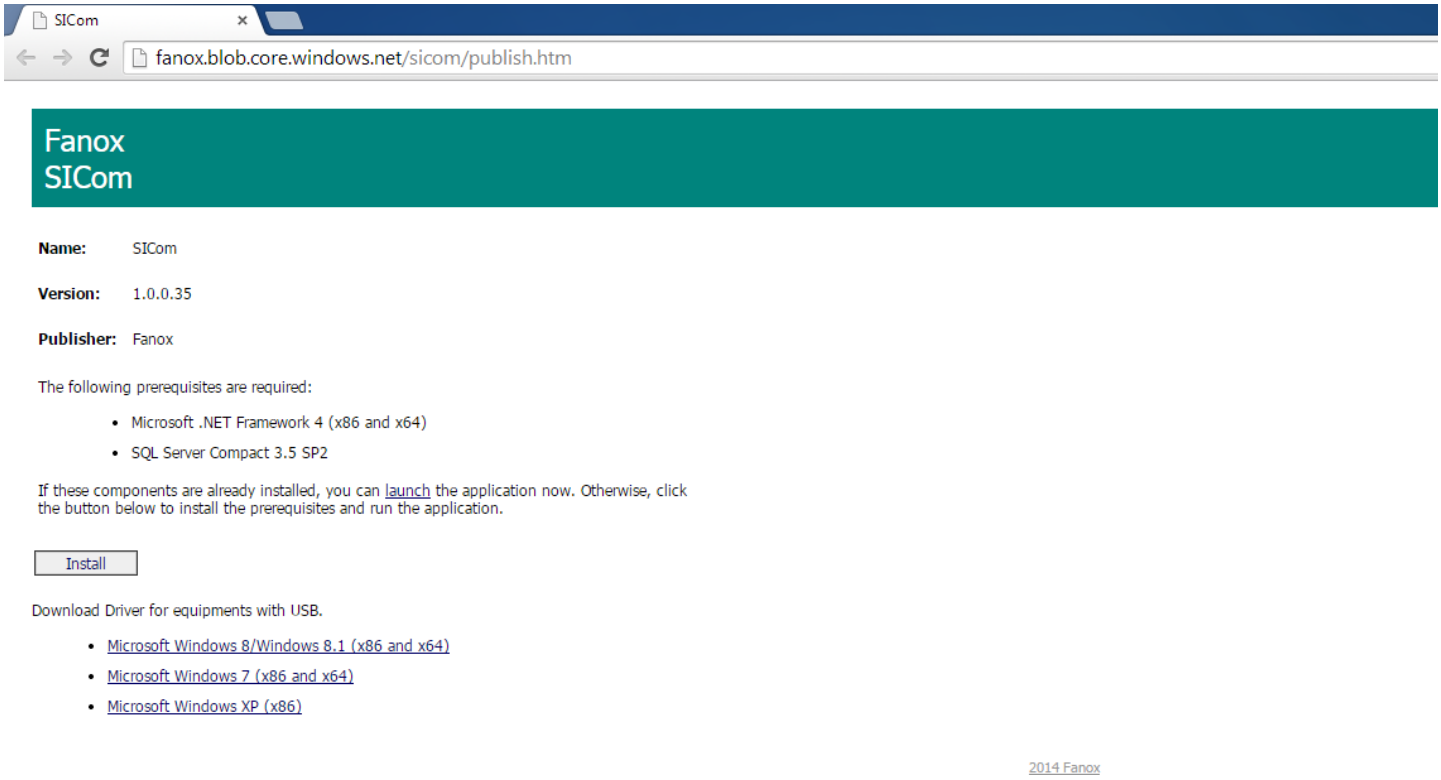
- Status reading
- Measurement reading
- Reading and changing settings
- Reading and changing configuration
- Reading and deleting events
- Changing the user passwords
- Loading settings files
- Loading configuration files
- Date-time synchronisation
- Checking the versions of the equipment
- Configuring the Modbus address
- Configuring and checking the demand

### 7.4.1 How to install SICOM Software

To install the SICom it is necessary the following link:

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

The link will open the next screen, where key “install” must be pressed:




The necessary drivers depending on the operative system can be downloaded from this page.

The update of the software does not required any user´s action, this is, if the computer is connected to Internet, SICom updates itself when it is started.

## 6.5. Setting up the session: Password and access levels

Users must identify themselves with a password in order to Pickup communications and to change the equipment settings or configuration using the HMI. Depending on the access level, it may or may not be possible to perform the operations shown on the table below.

| ACCESS LEVEL | Read-only permission: Status and measurements Settings Events | Permission to: Change settings Download and Delete the Events buffer | Permission to: Execute Commands | Permission to: Change Configuration | Permission to Change Protected Settings |
|---|---|---|---|---|---|
| 1 | YES | YES | NO | NO | YES |
| 2 | YES | YES | NO | NO | NO |
| 3 | YES | NO | YES | NO | NO |
| 4 | YES | YES | YES | NO | NO |
| 5 | YES | YES | YES | YES | NO |

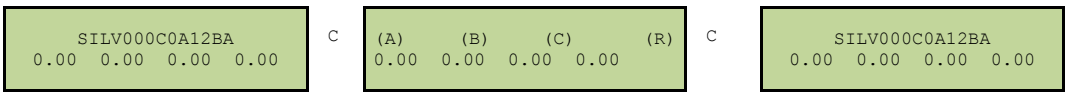
Four passwords and their associated levels of access are set up when the equipment is configured using the SIcom program. Four passwords and their associated levels of access are set up when the equipment is configured using the SIcom program. It is possible to change the passwords The password must have 4 characters. By default, the equipment is programmed with the following passwords and their associated levels:

| PASSWORD | ACCESS LEVEL |
|---|---|
| 2222 | 2 |
| 3333 | 3 |
| 4444 | 4 |
| 5555 | 5 |

## 7.6. Menus

### 7.6.1. Standby mode screen

The default screen shows the device model and the voltages in phase A, phase B, phase C, and residual or busbar voltage (depending on model). Press “OK” to select a menu: measurements, states, settings, and events. If the HMI is left in any state, it will return to the default screen after 5 minutes without any key being pressed.

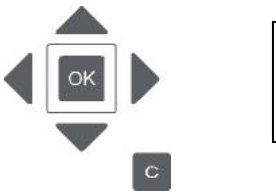



If any error is detected by the self-diagnosis, an error message appears in the second line (instead of the voltages) on the main screen, which can show any of the following information: (see inside self-diagnosis section).

- PROTECTION ERROR
- MEASUREMENT ERROR
- EEPROM ERROR
- EVENT ERROR

### 7.6.2. Last Trip screen

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




**Trip 59-1**

**07/04/15 13:51:44825**

The last trip screen will disappear when the “RESET” button is pressed and hold down.

### 7.6.3. Accessing the menus

The keys ▲, ▼, ◄ and ► are used to navigate through the different options and menus. The "**OK**" key is used to accept and to enter 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.

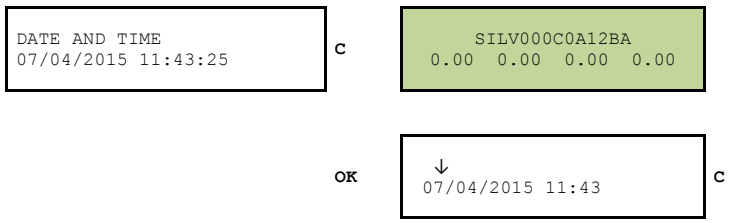
The keys ◄ and ► are used to navigate from one item to another within a parameter. The keys ▲ and ▼ are used to increase or decrease the value. If an invalid value is entered during the process, the "**C**" key can be used to delete it.

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

### 7.6.4. Date-Time Menu

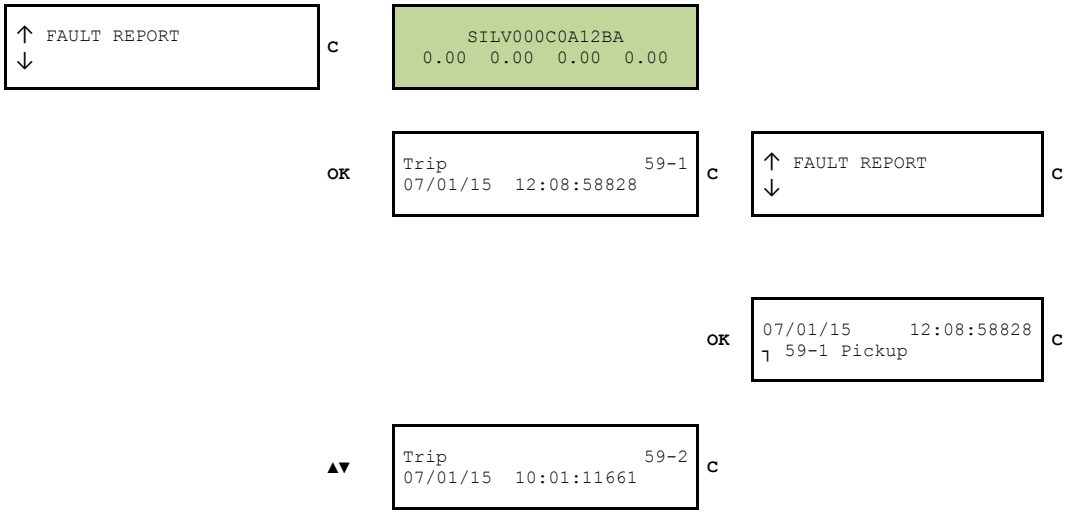
The date-time menu can be accessed by pressing the "►" key from the standby mode screen. From here, press the "OK" key to access the date-time modification screen. Use the "►" and "◄" keys to position the cursor over the digit that you want to change, and assign a value to this digit using the "▲" and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



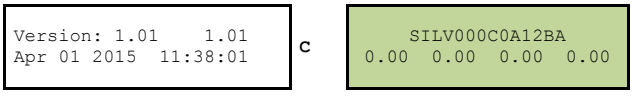
### 7.6.5. Fault report

From the "sleep" mode screen, press the "◄" key to access the fault report menu. It is possible to access to fault report menu navigating throug main menus too. Using the "▲" and "▼" keys we can move onto the report we wish to display, and, pressing "OK" provides access to the events each fault report contains.

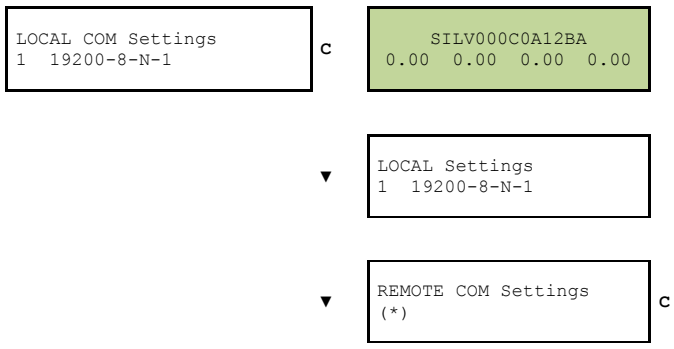



### 7.6.6. Communication parameters and versions

Pressing the "▲" provides access to the equipment versions:



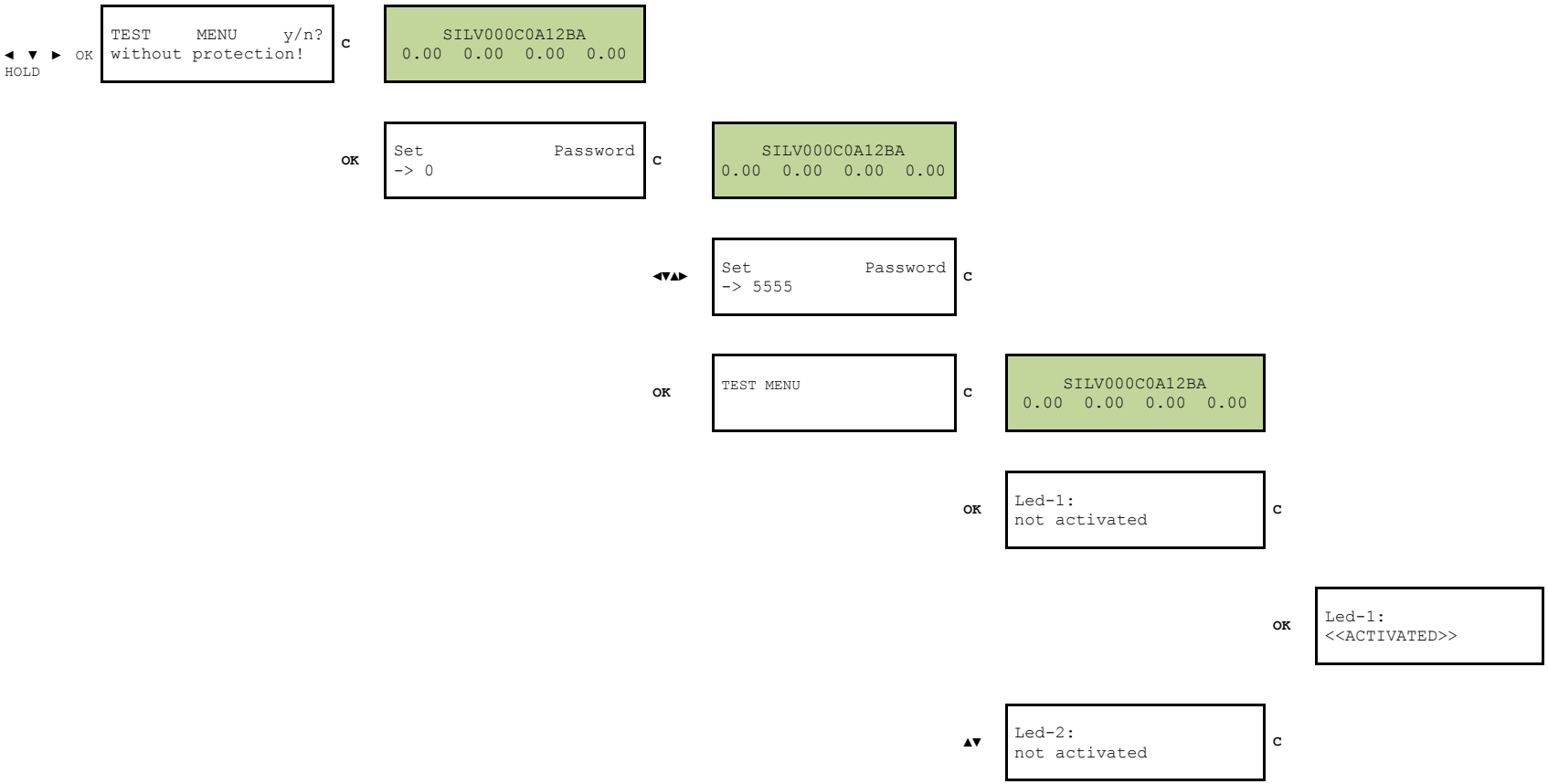

From the default screen, press and hold "▼" key to access to communications parameters:

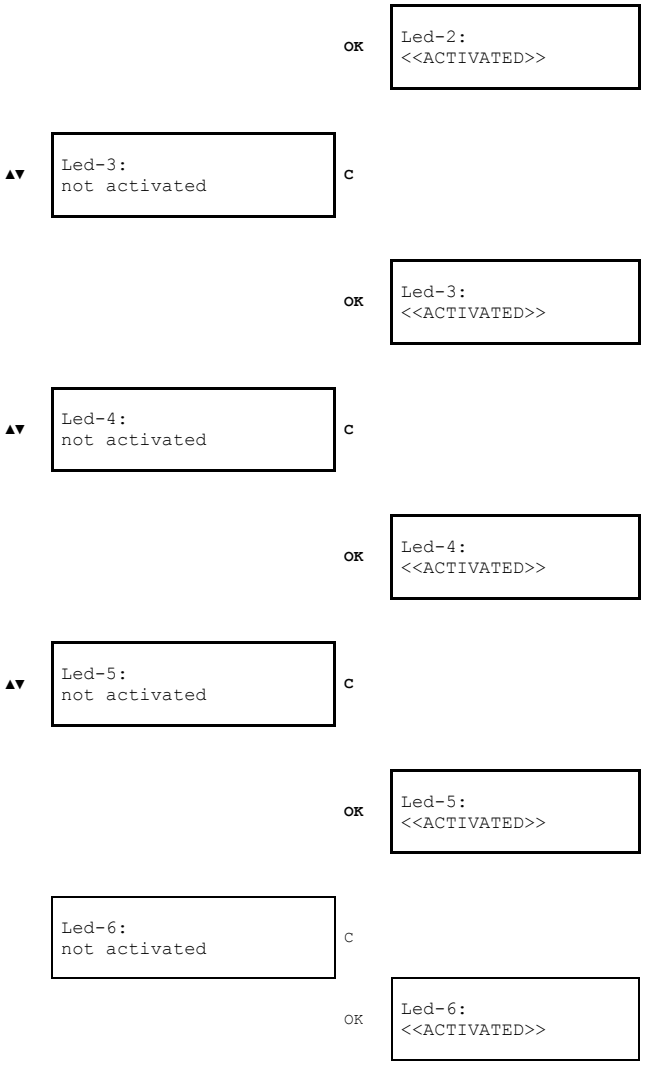


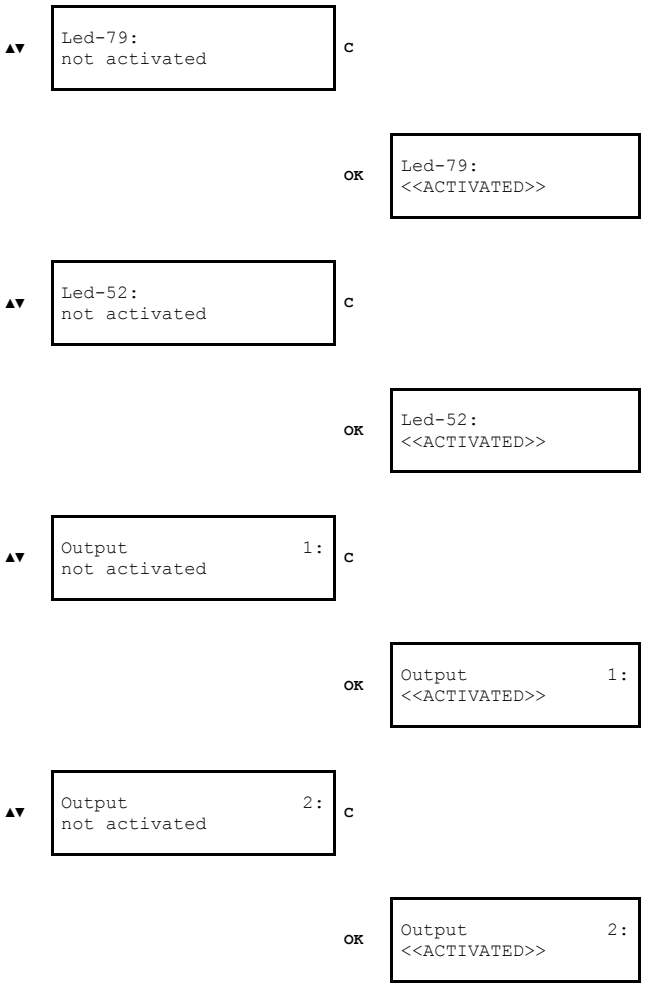

(*) REMOTE COM parameters depend on model ( the used protocol can be IEC61850, DNP3.0, IEC60870-5-104, Modbus or IEC60870-5-103 depending on model)

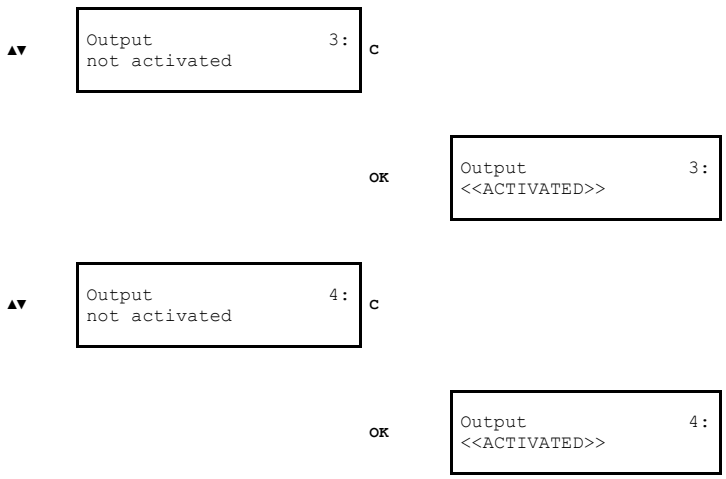
### 7.6.7. Test Menu

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-2:
<<ACTIVATED>>
▲▼
Led-3:
not activated
C
OK
Led-3:
<<ACTIVATED>>
▲▼
Led-4:
not activated
C
OK
Led-4:
<<ACTIVATED>>
▲▼
Led-5:
not activated
C
OK
Led-5:
<<ACTIVATED>>
Led-6:
not activated
C
OK
Led-6:
<<ACTIVATED>>


▲▼
Led-79:
not activated
C
OK
Led-79:
<<ACTIVATED>>
▲▼
Led-52:
not activated
C
OK
Led-52:
<<ACTIVATED>>
▲▼
Output 1:
not activated
C
OK
Output 1:
<<ACTIVATED>>
▲▼
Output 2:
not activated
C
OK
Output 2:
<<ACTIVATED>>

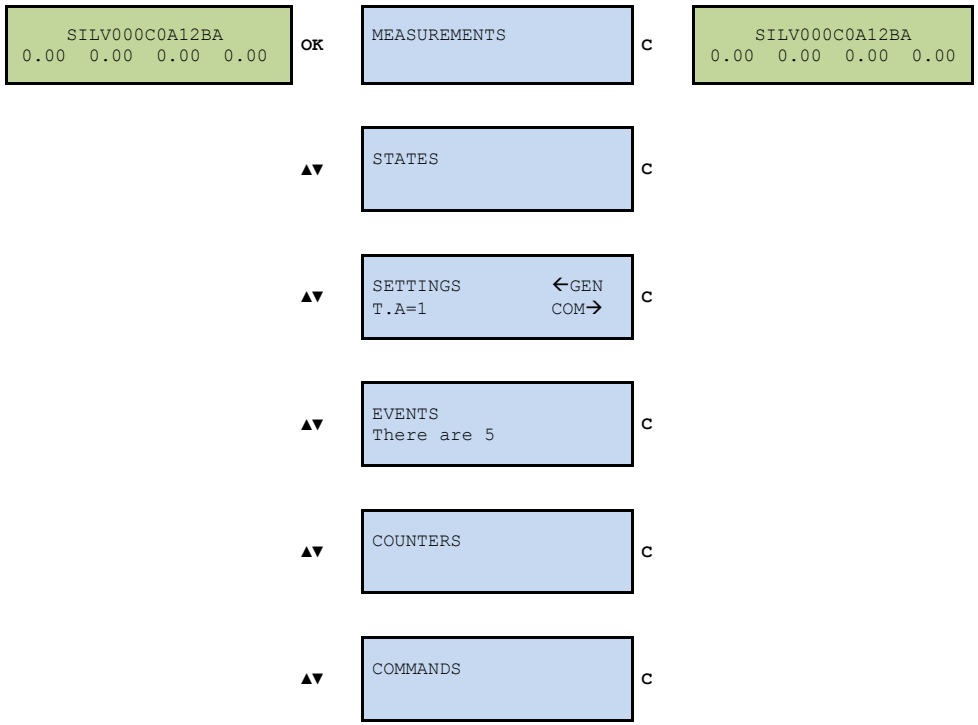



**NOTE :** Be careful when activating the output which is set to trip. When the equipment is installed it will open the circuit as if it were a trip.

### 7.6.8. Functional Menu

The SIL-V relay menu is split up into 6 main parts:

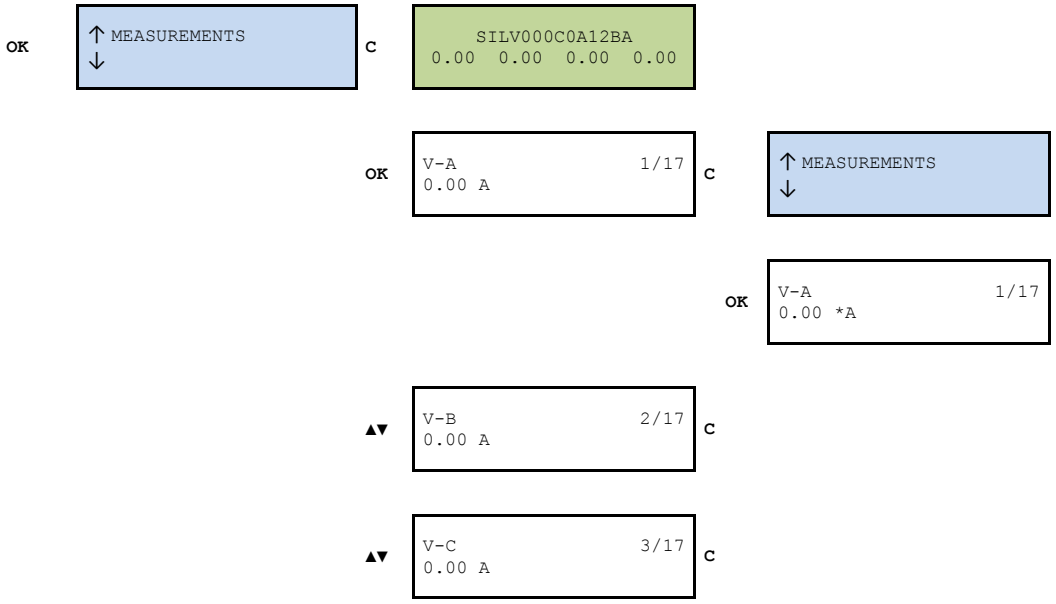
- Measurements.
- Status.
- Settings.
- Events.
- Counters.
- Commands.
- Fault report

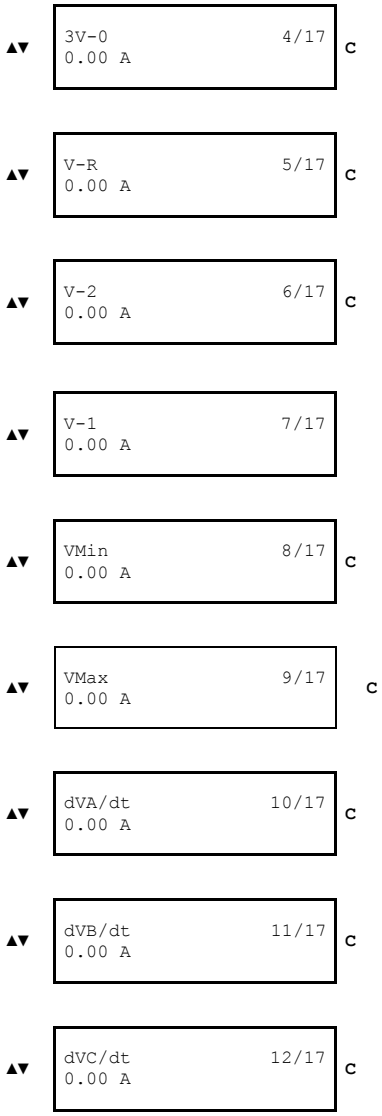


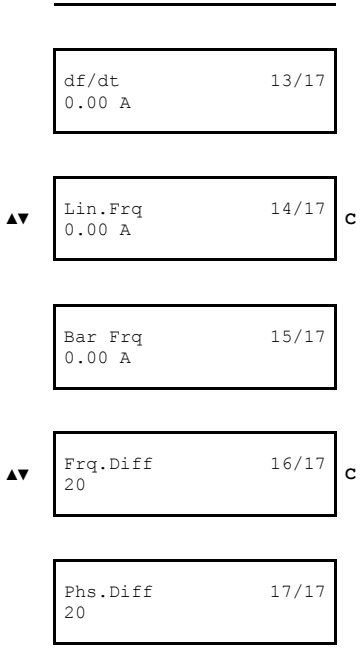

Press the "**OK**" key to access the second level from the main screen. Use the ▲ and ▼ keys to move from one menu section to another in the second level. Use the "**C**" key to return to a higher level.

### 7.6.9. Measurements Menu

From the standby mode screen, press the "OK" key to access the first line of menus. Use the "▲" and "▼" keys to position the cursor over the "MEASUREMENTS" screen and press "OK". Use the "▲" and "▼" keys to position the cursor over the measurement and to see its value.




▲▼
3V-0 4/17
0.00 A
c
▲▼
V-R 5/17
0.00 A
c
▲▼
V-2 6/17
0.00 A
c
▲▼
V-1 7/17
0.00 A
▲▼
VMin 8/17
0.00 A
c
▲▼
VMax 9/17
0.00 A
c
▲▼
dVA/dt 10/17
0.00 A
c
▲▼
dVB/dt 11/17
0.00 A
c
▲▼
dVC/dt 12/17
0.00 A
c

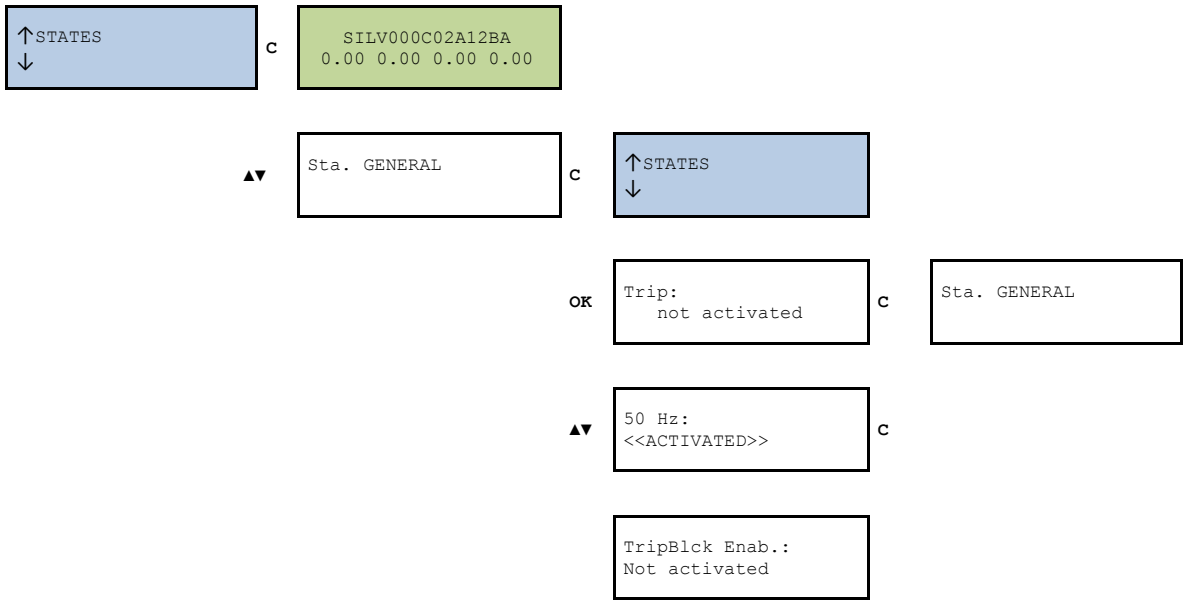

df/dt 13/17
0.00 A
▲▼
Lin.Frq 14/17
0.00 A
C
Bar Frq 15/17
0.00 A
▲▼
Frq.Diff 16/17
20
C
Phs.Diff 17/17
20

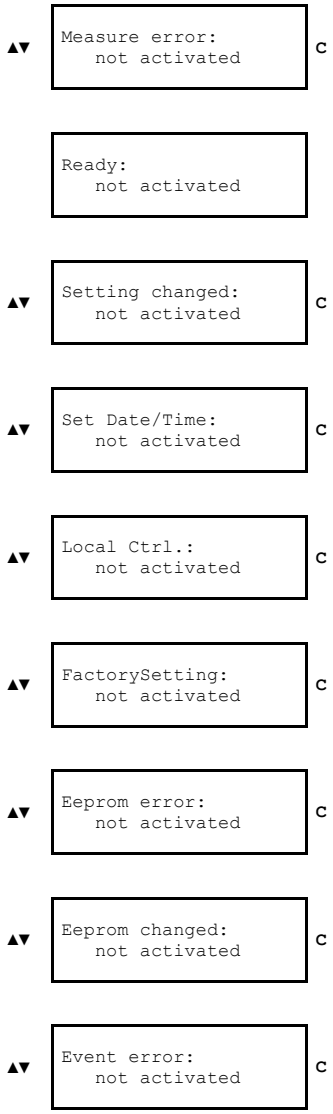
### 7.6.10. States Menu

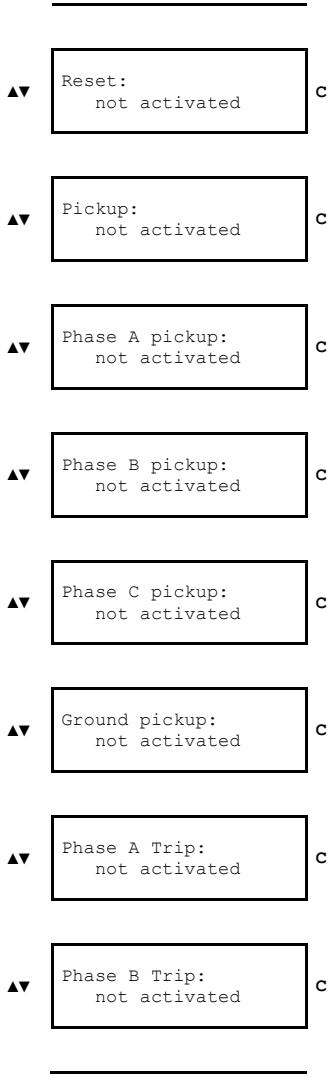
From the standby mode screen, press the “OK” key to access the first line of menus. Use the “▲” and “▼” keys to position the cursor over the “STATUS” screen and press “OK”. This takes you to the status groups line. Use the “▲” and “▼” keys to position the cursor over a group of statuses, and press the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

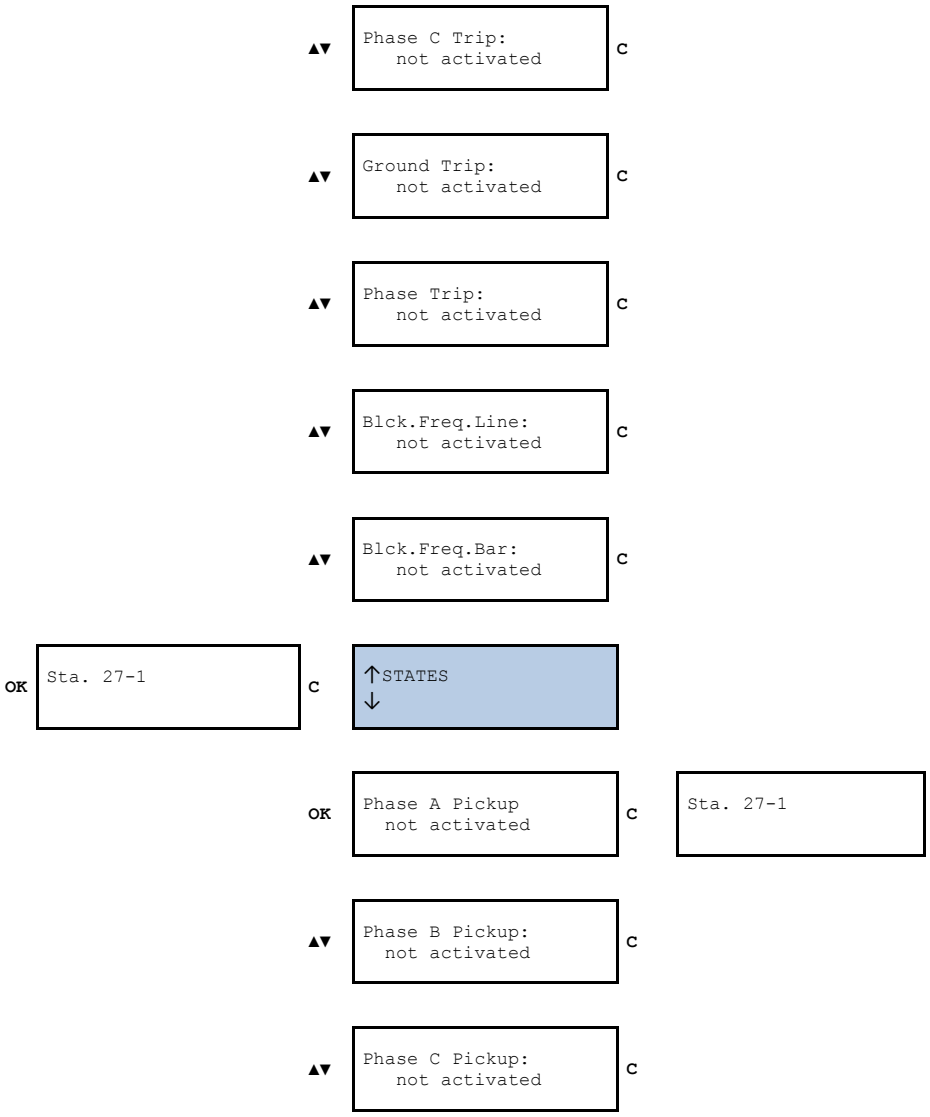
There is a quick way to access the GNAL Statuses from the SIL-V relay main screen. Press the ◄ key to jump directly to the third level of the menu; this takes the user directly from the main screen to the GNAL Statuses option.

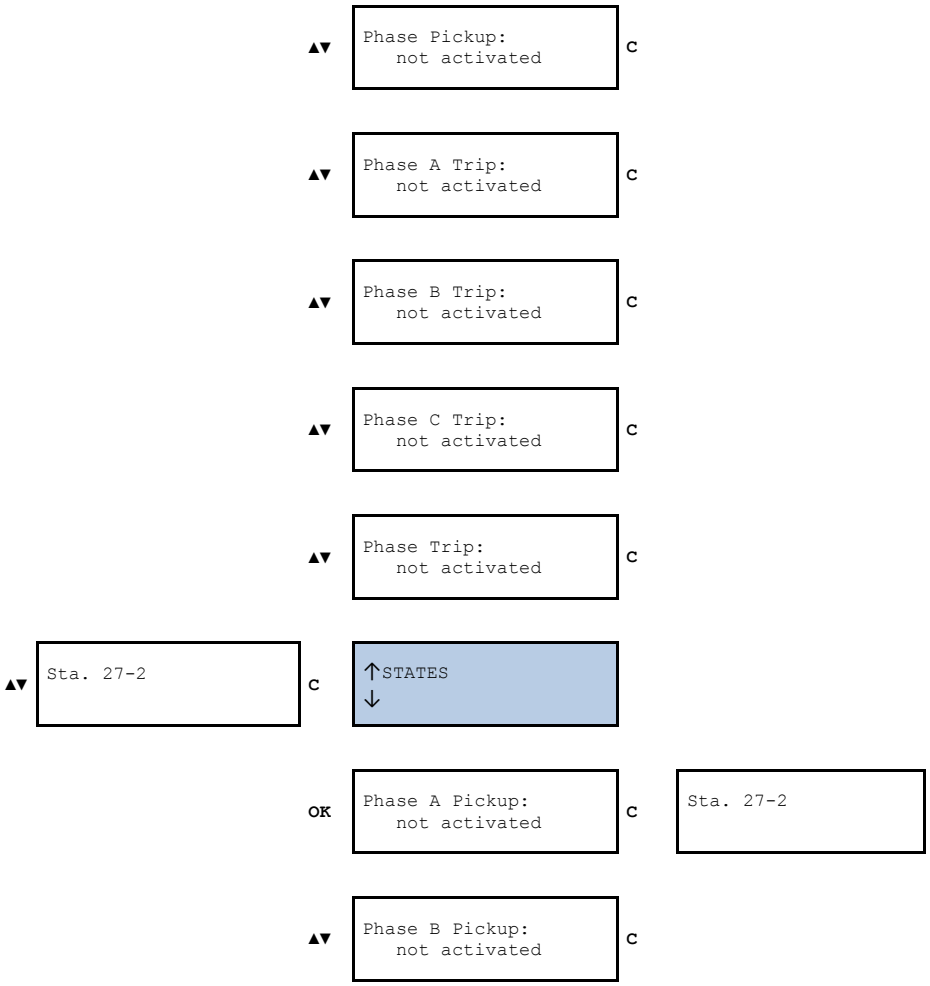
The method for navigating through the status menu is shown graphically below.

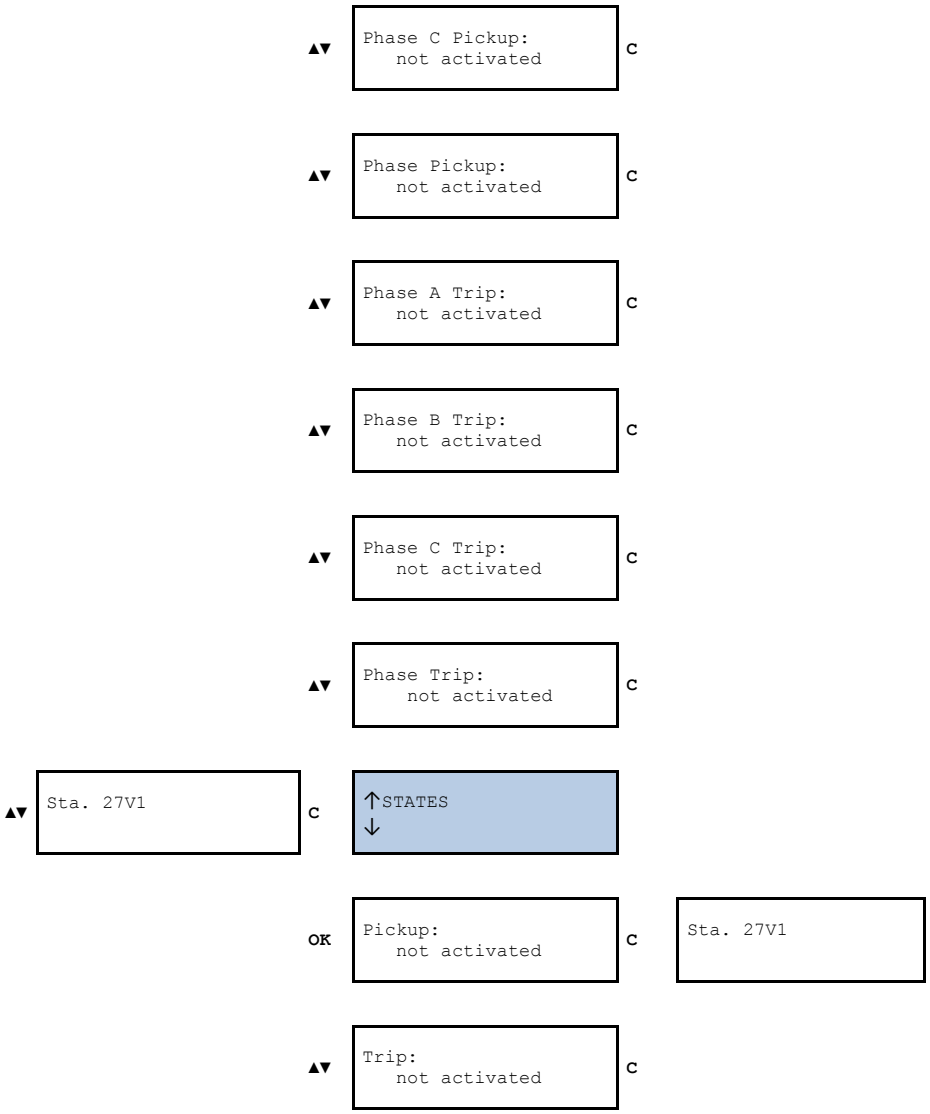


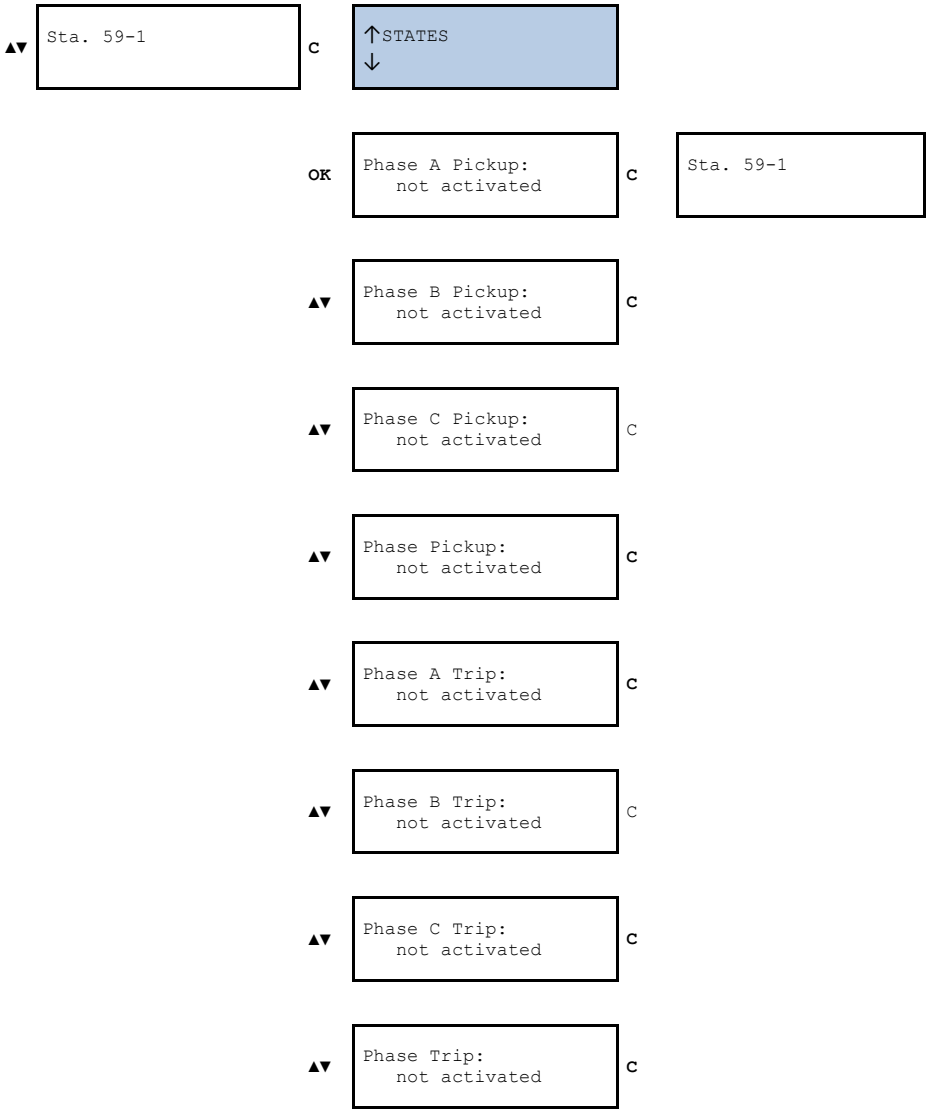

▲▼
Measure error:
not activated
C
Ready:
not activated
▲▼
Setting changed:
not activated
C
▲▼
Set Date/Time:
not activated
C
▲▼
Local Ctrl.:
not activated
C
▲▼
FactorySetting:
not activated
C
▲▼
Eeprom error:
not activated
C
▲▼
Eeprom changed:
not activated
C
▲▼
Event error:
not activated
C

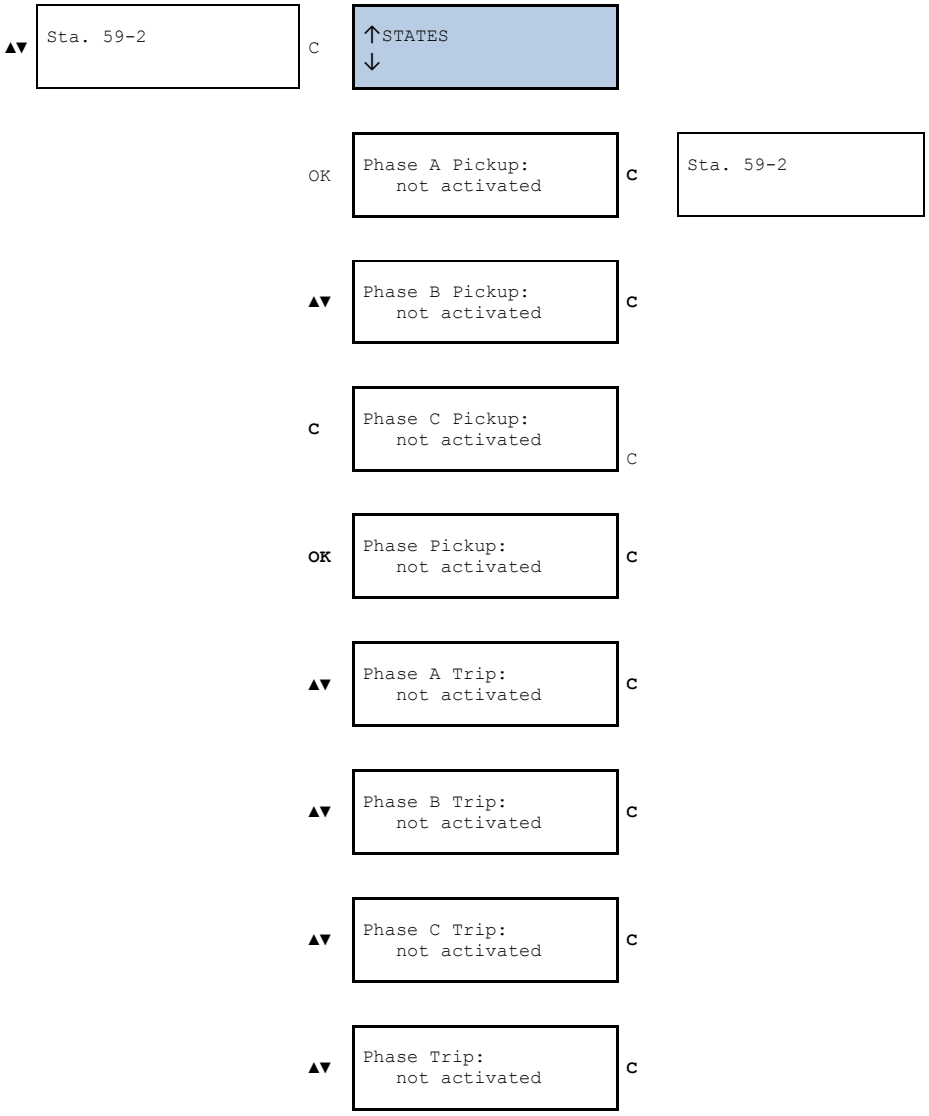

▲▼
Reset:
not activated
C
▲▼
Pickup:
not activated
C
▲▼
Phase A pickup:
not activated
C
▲▼
Phase B pickup:
not activated
C
▲▼
Phase C pickup:
not activated
C
▲▼
Ground pickup:
not activated
C
▲▼
Phase A Trip:
not activated
C
▲▼
Phase B Trip:
not activated
C

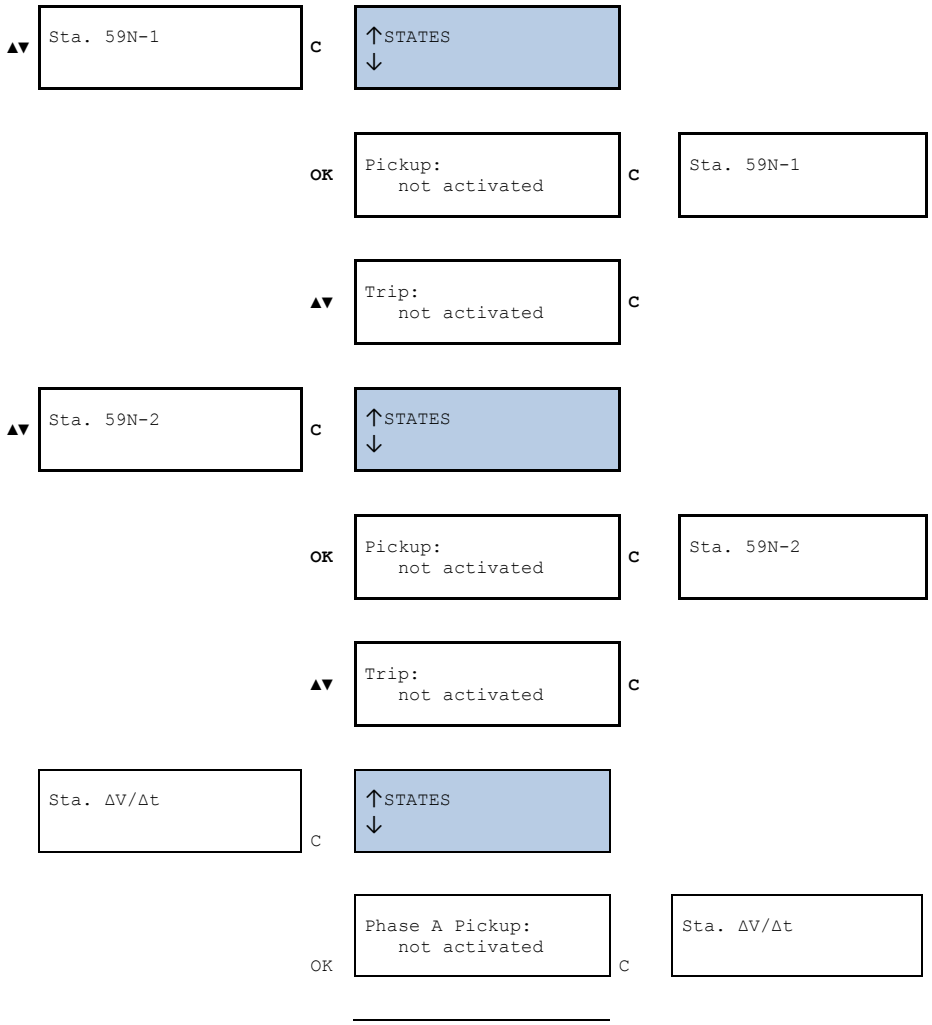

▲▼
Phase C Trip:
not activated
C
▲▼
Ground Trip:
not activated
C
▲▼
Phase Trip:
not activated
C
▲▼
Blck.Freq.Line:
not activated
C
▲▼
Blck.Freq.Bar:
not activated
C
OK
Sta. 27-1
C
↑STATES
↓
OK
Phase A Pickup
not activated
C
Sta. 27-1
▲▼
Phase B Pickup:
not activated
C
▲▼
Phase C Pickup:
not activated
C

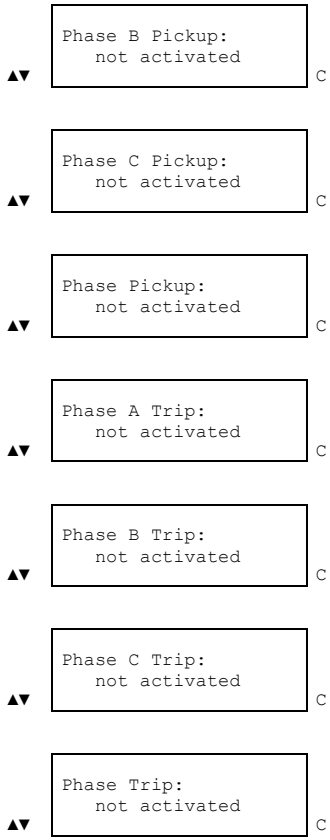

▲▼
Phase Pickup:
not activated
C
▲▼
Phase A Trip:
not activated
C
▲▼
Phase B Trip:
not activated
C
▲▼
Phase C Trip:
not activated
C
▲▼
Phase Trip:
not activated
C
▲▼
Sta. 27-2
C
↑STATES
↓
OK
Phase A Pickup:
not activated
C
Sta. 27-2
▲▼
Phase B Pickup:
not activated
C

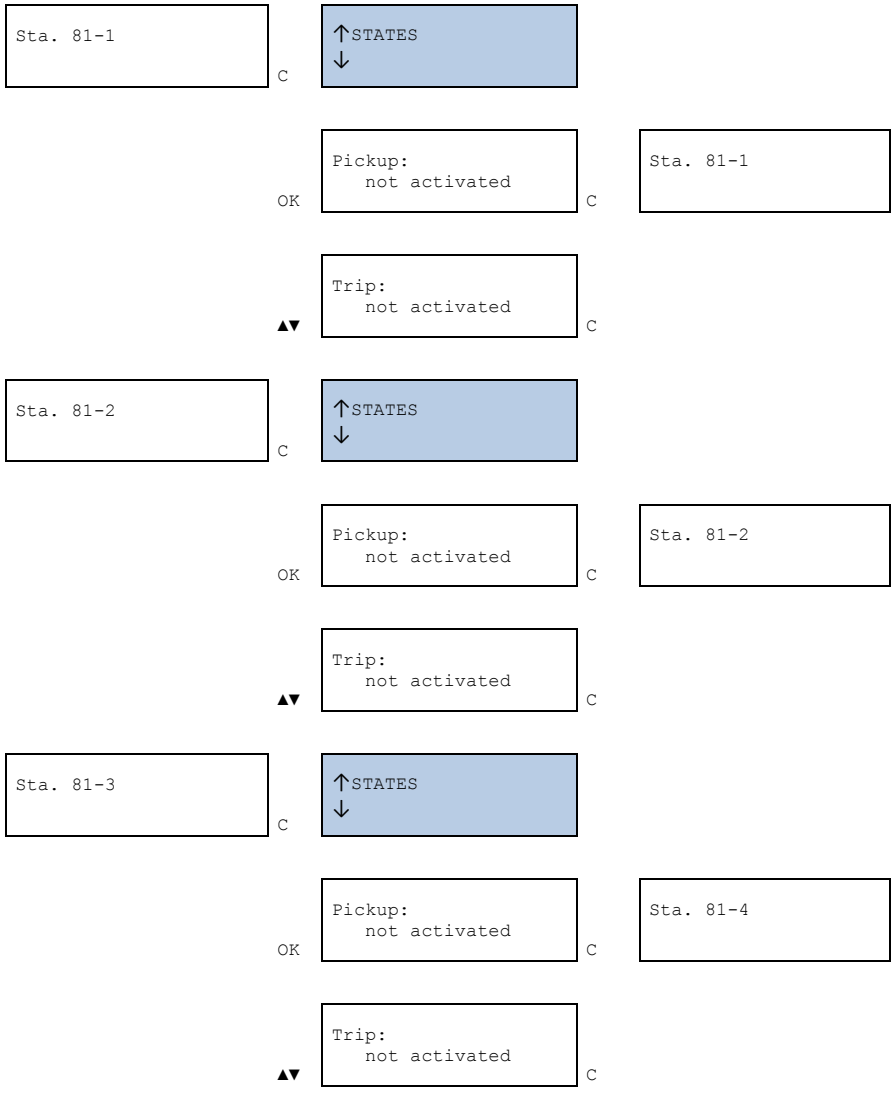

▲▼
Phase C Pickup:
not activated
C
▲▼
Phase Pickup:
not activated
C
▲▼
Phase A Trip:
not activated
C
▲▼
Phase B Trip:
not activated
C
▲▼
Phase C Trip:
not activated
C
▲▼
Phase Trip:
not activated
C
▲▼
Sta. 27V1
C
↑STATES
↓
OK
Pickup:
not activated
C
Sta. 27V1
▲▼
Trip:
not activated
C

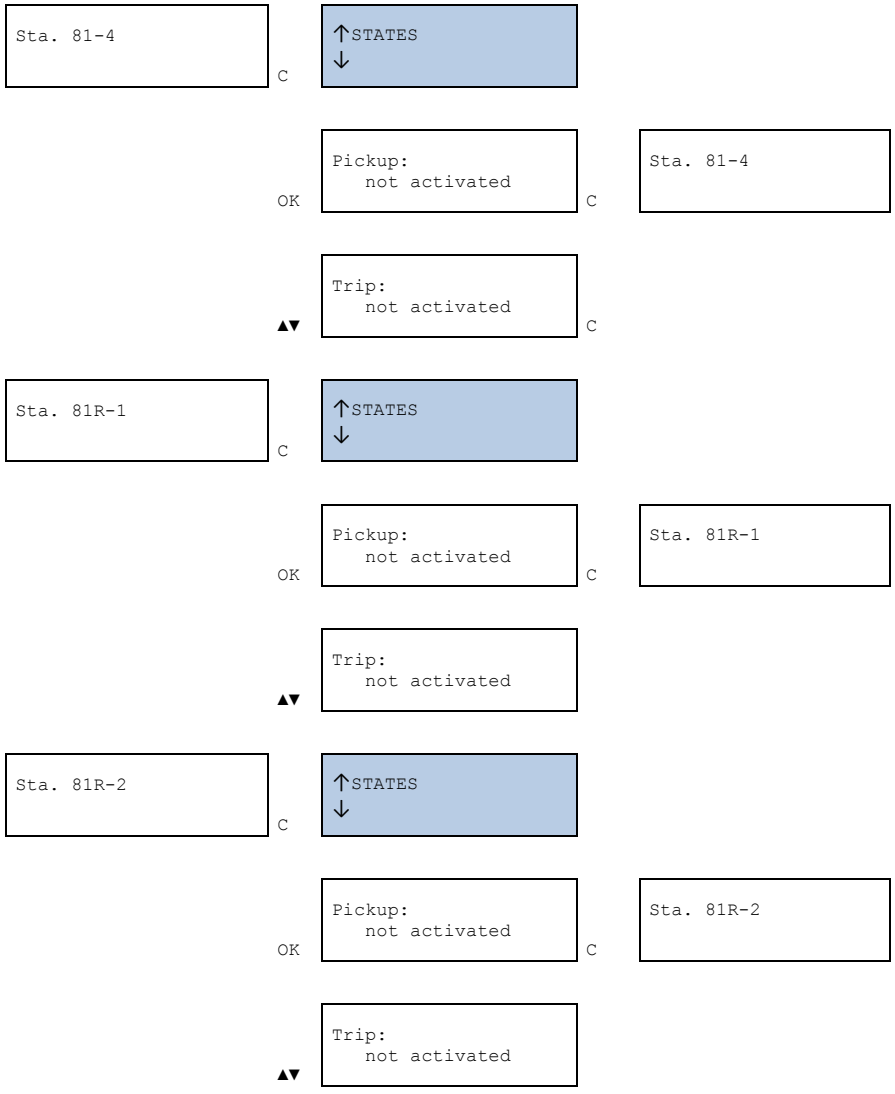

▲▼
Sta. 59-1
C
↑STATES
↓
OK
Phase A Pickup:
not activated
C
Sta. 59-1
▲▼
Phase B Pickup:
not activated
C
▲▼
Phase C Pickup:
not activated
C
▲▼
Phase Pickup:
not activated
C
▲▼
Phase A Trip:
not activated
C
▲▼
Phase B Trip:
not activated
C
▲▼
Phase C Trip:
not activated
C
▲▼
Phase Trip:
not activated
C

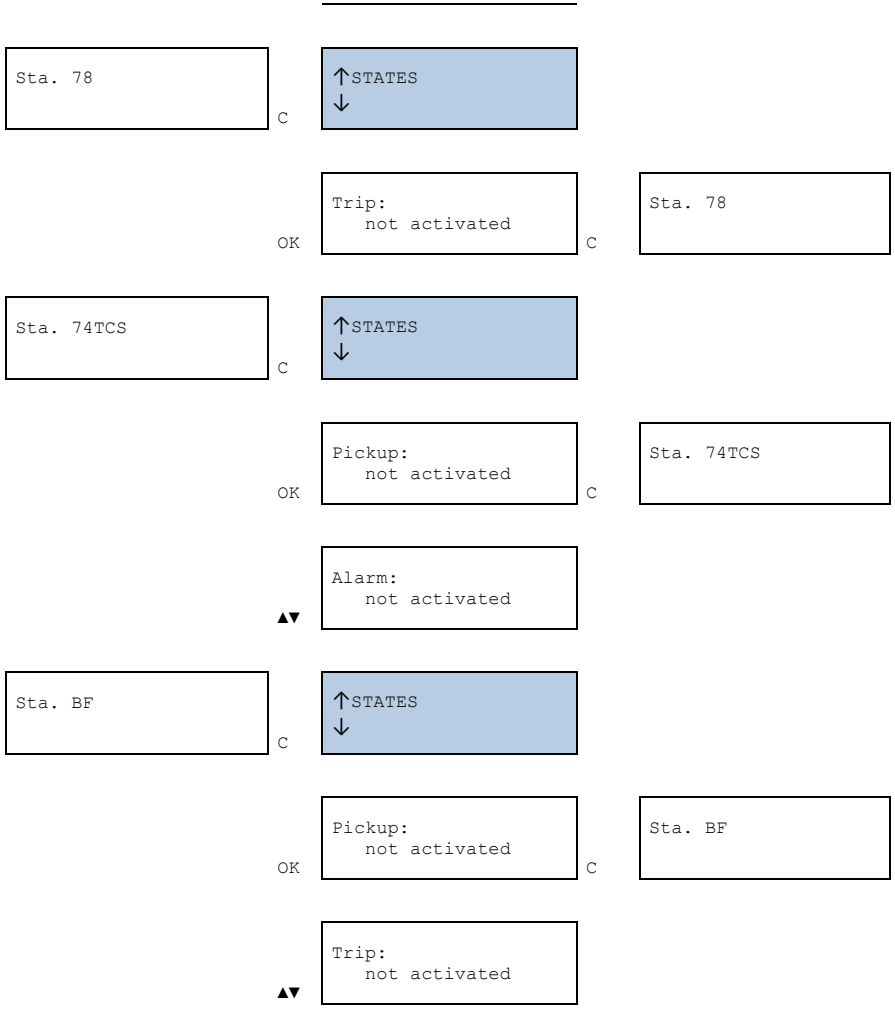

▲▼
Sta. 59-2
C
↑STATES
↓
OK
Phase A Pickup:
not activated
C
Sta. 59-2
▲▼
Phase B Pickup:
not activated
C
C
Phase C Pickup:
not activated
C
OK
Phase Pickup:
not activated
C
▲▼
Phase A Trip:
not activated
C
▲▼
Phase B Trip:
not activated
C
▲▼
Phase C Trip:
not activated
C
▲▼
Phase Trip:
not activated
C

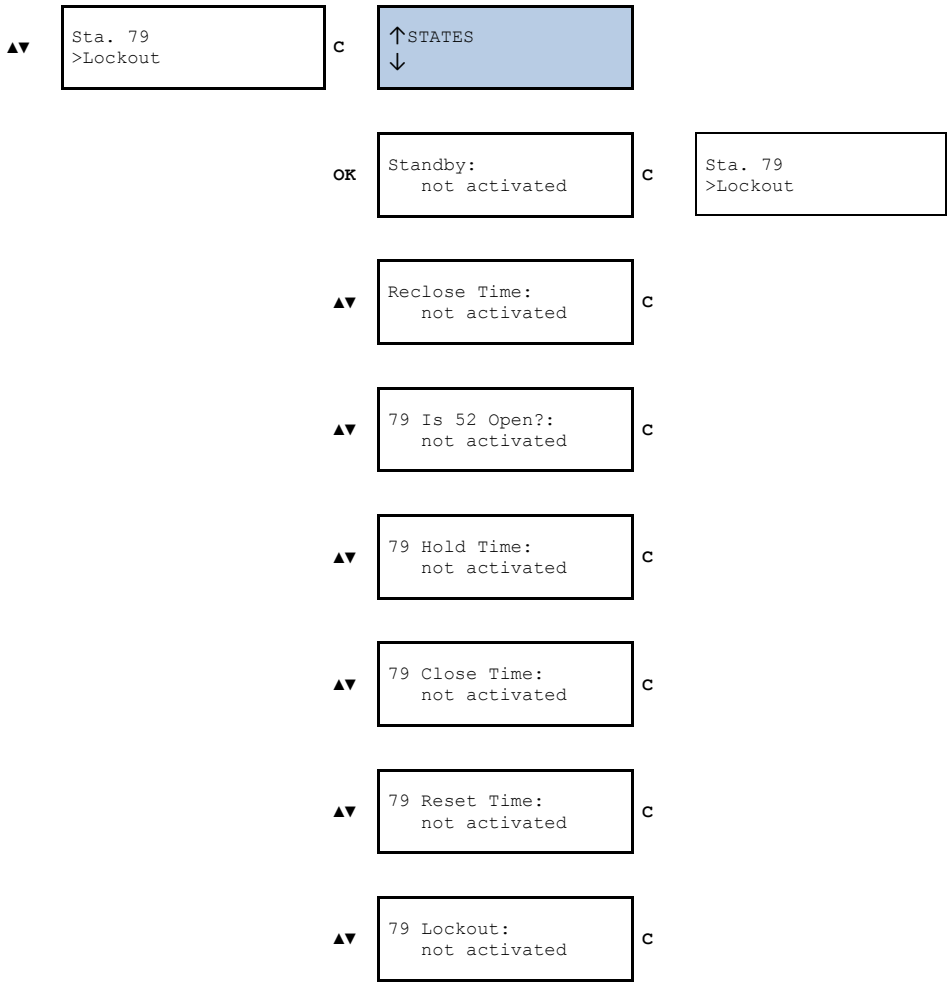

▲▼
Sta. 59N-1
C
↑STATES
↓
OK
Pickup:
not activated
C
Sta. 59N-1
▲▼
Trip:
not activated
C
▲▼
Sta. 59N-2
C
↑STATES
↓
OK
Pickup:
not activated
C
Sta. 59N-2
▲▼
Trip:
not activated
C
Sta. ΔV/Δt
C
↑STATES
↓
OK
Phase A Pickup:
not activated
C
Sta. ΔV/Δt

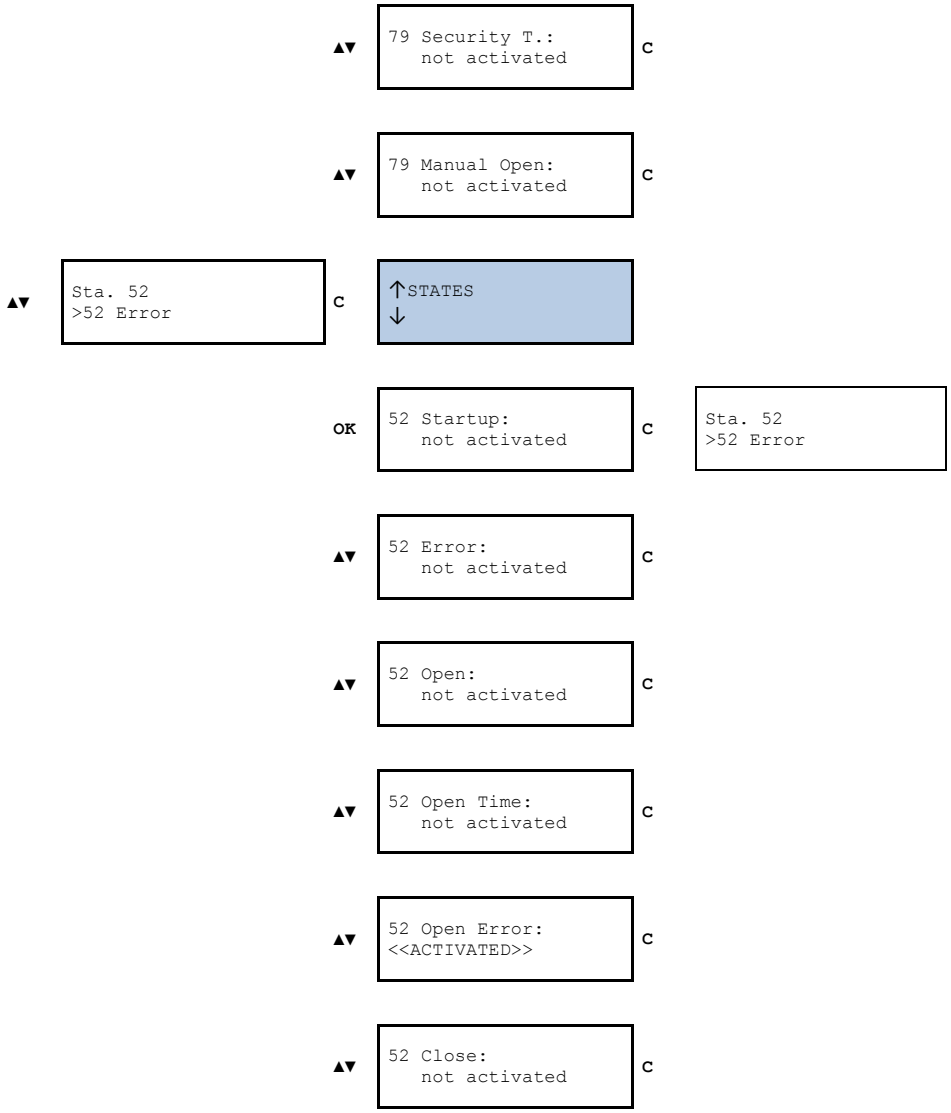

Phase B Pickup:
not activated
C
Phase C Pickup:
not activated
C
Phase Pickup:
not activated
C
Phase A Trip:
not activated
C
Phase B Trip:
not activated
C
Phase C Trip:
not activated
C
Phase Trip:
not activated
C

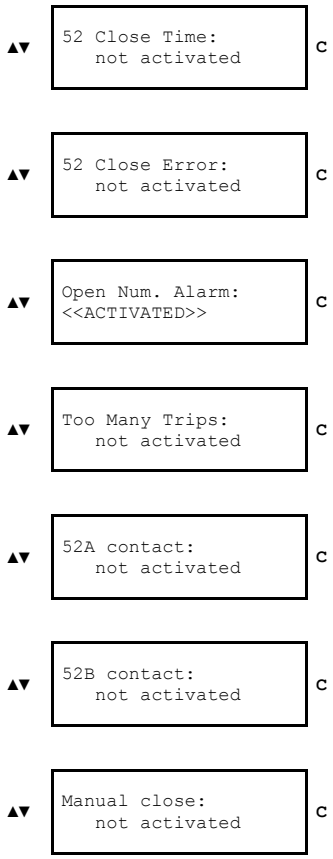

Sta. 81-1
C
↑STATES
↓
OK
Pickup:
not activated
C
Sta. 81-1
▲▼
Trip:
not activated
C
Sta. 81-2
C
↑STATES
↓
OK
Pickup:
not activated
C
Sta. 81-2
▲▼
Trip:
not activated
C
Sta. 81-3
C
↑STATES
↓
OK
Pickup:
not activated
C
Sta. 81-4
▲▼
Trip:
not activated
C

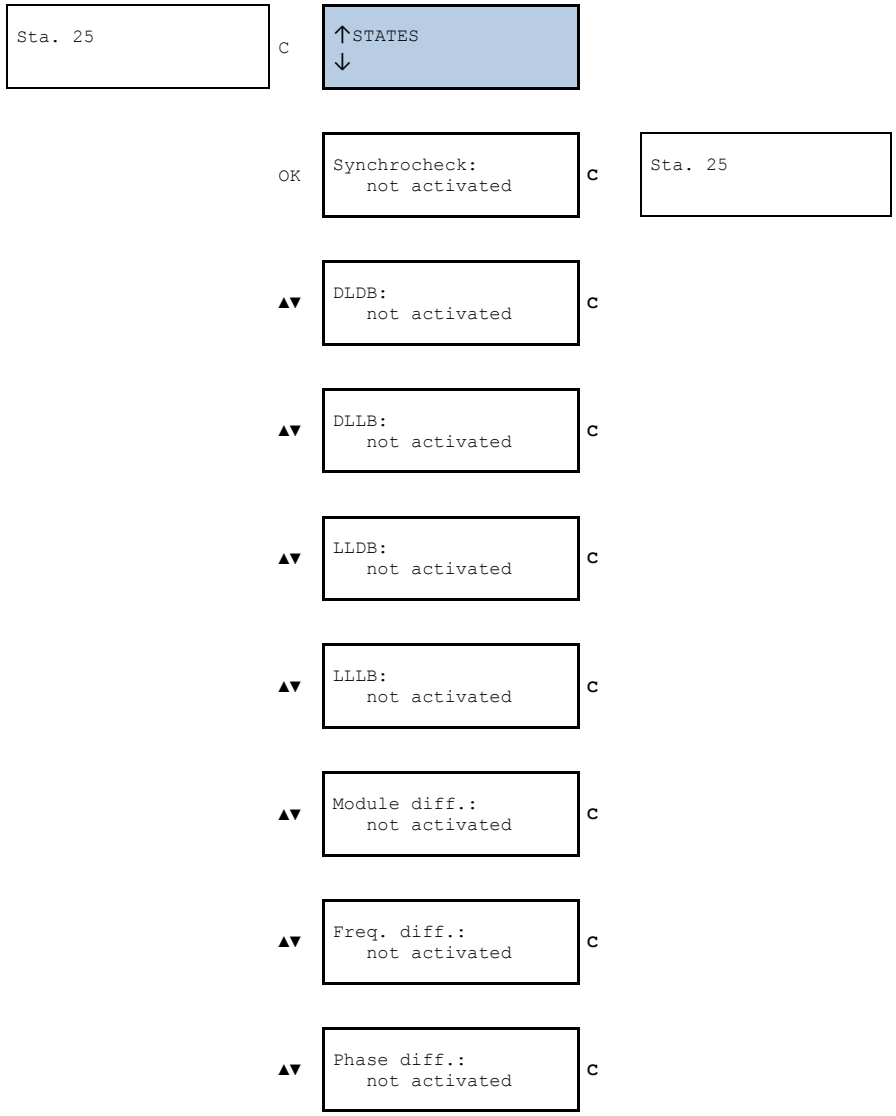

Sta. 81-4
C
↑STATES
↓
OK
Pickup:
not activated
C
Sta. 81-4
▲▼
Trip:
not activated
C
Sta. 81R-1
C
↑STATES
↓
OK
Pickup:
not activated
C
Sta. 81R-1
▲▼
Trip:
not activated
Sta. 81R-2
C
↑STATES
↓
OK
Pickup:
not activated
C
Sta. 81R-2
▲▼
Trip:
not activated

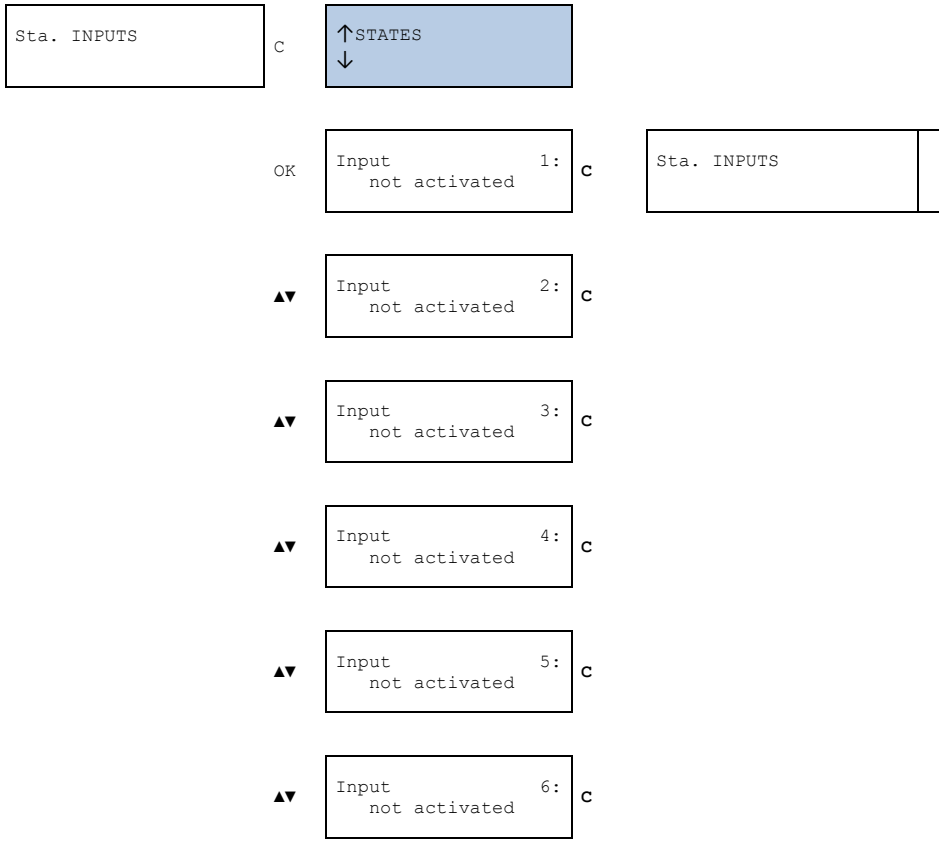

Sta. 78
C
↑STATES
↓
OK
Trip:
not activated
C
Sta. 78
Sta. 74TCS
C
↑STATES
↓
OK
Pickup:
not activated
C
Sta. 74TCS
▲▼
Alarm:
not activated
Sta. BF
C
↑STATES
↓
OK
Pickup:
not activated
C
Sta. BF
▲▼
Trip:
not activated

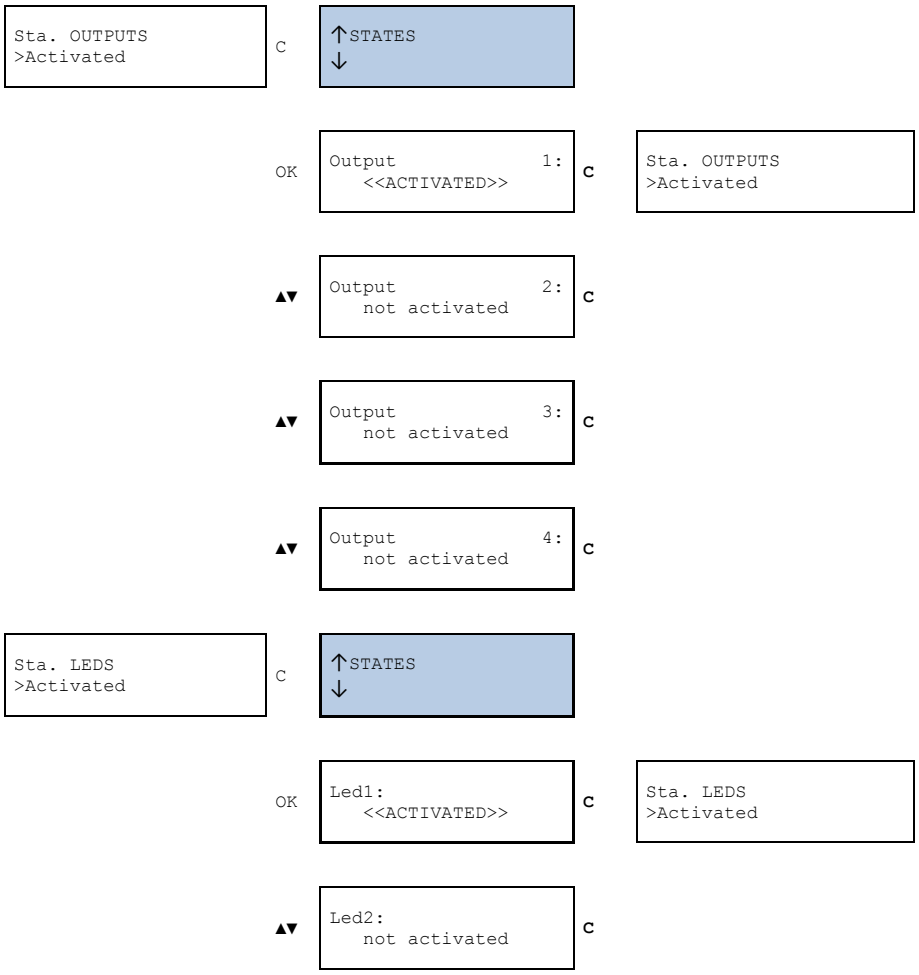

▲▼
Sta. 79
>Lockout
C
↑STATES
↓
OK
Standby:
not activated
C
Sta. 79
>Lockout
▲▼
Reclose Time:
not activated
C
▲▼
79 Is 52 Open?:
not activated
C
▲▼
79 Hold Time:
not activated
C
▲▼
79 Close Time:
not activated
C
▲▼
79 Reset Time:
not activated
C
▲▼
79 Lockout:
not activated
C

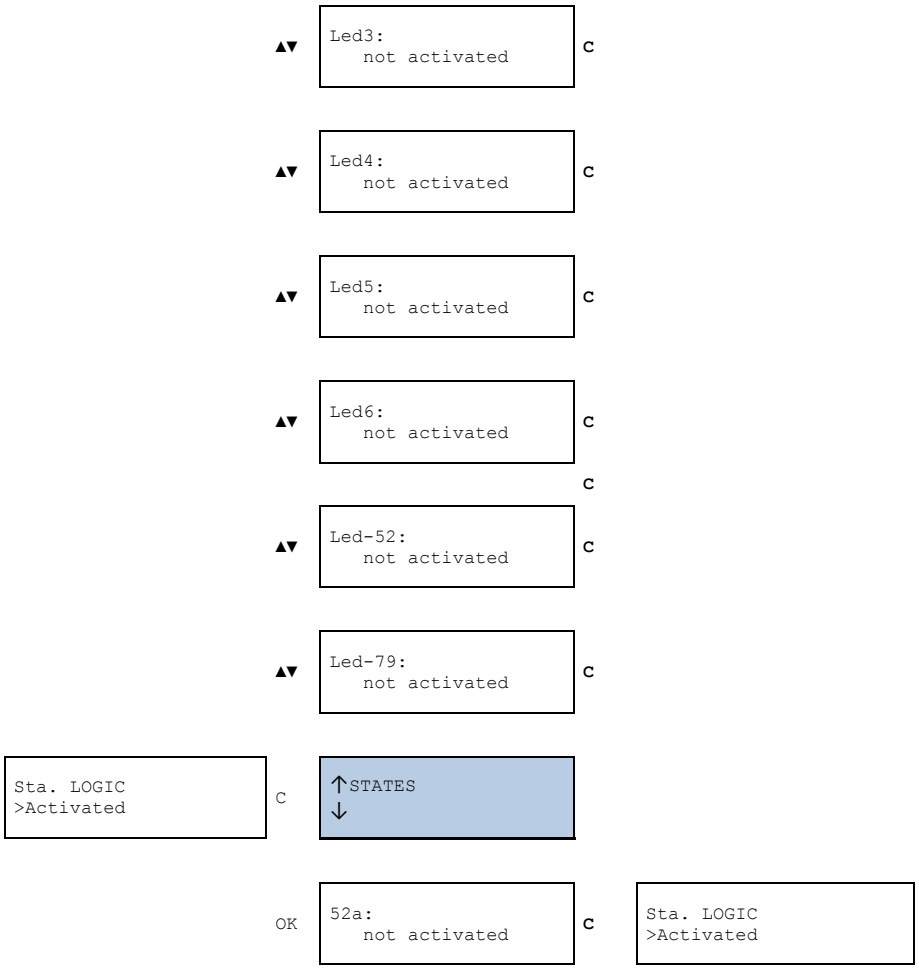

79 Security T.:
not activated
C
▲▼
79 Manual Open:
not activated
C
▲▼
Sta. 52
>52 Error
C
▲▼
↑STATES
↓
52 Startup:
not activated
C
OK
Sta. 52
>52 Error
52 Error:
not activated
C
▲▼
52 Open:
not activated
C
▲▼
52 Open Time:
not activated
C
▲▼
52 Open Error:
<<ACTIVATED>>
C
▲▼
52 Close:
not activated
C
▲▼

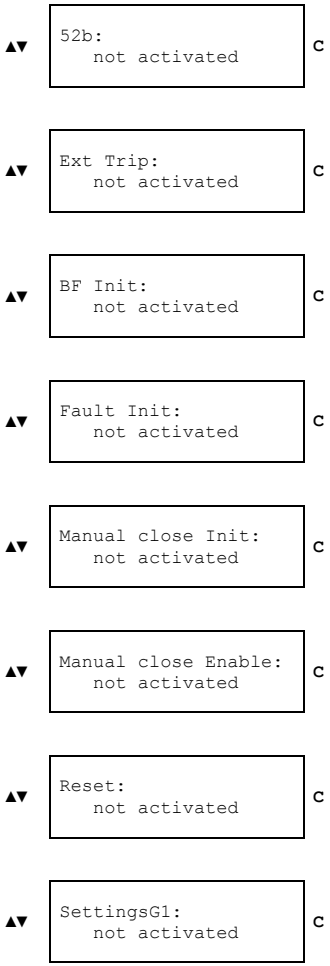

▲▼
52 Close Time:
not activated
C
▲▼
52 Close Error:
not activated
C
▲▼
Open Num. Alarm:
<<ACTIVATED>>
C
▲▼
Too Many Trips:
not activated
C
▲▼
52A contact:
not activated
C
▲▼
52B contact:
not activated
C
▲▼
Manual close:
not activated
C

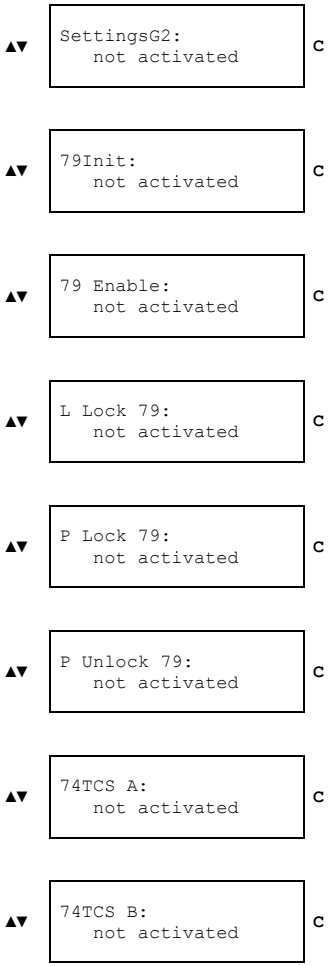

Sta. 25
C
↑STATES
↓
OK
Synchrocheck:
not activated
C
Sta. 25
▲▼
DLDB:
not activated
C
▲▼
DLLB:
not activated
C
▲▼
LLDB:
not activated
C
▲▼
LLLB:
not activated
C
▲▼
Module diff.:
not activated
C
▲▼
Freq. diff.:
not activated
C
▲▼
Phase diff.:
not activated
C

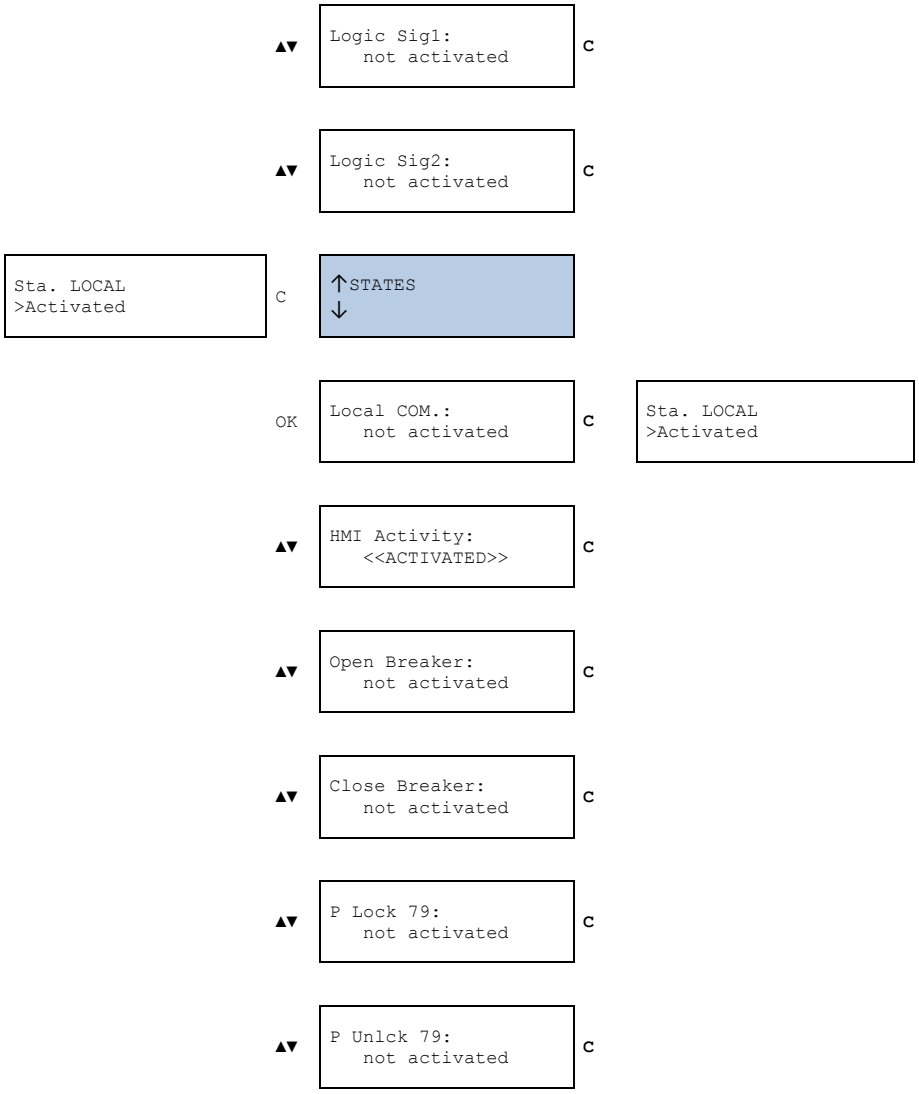

Sta. INPUTS
C
↑STATES
↓
OK
Input 1:
not activated
C
Sta. INPUTS
▲▼
Input 2:
not activated
C
▲▼
Input 3:
not activated
C
▲▼
Input 4:
not activated
C
▲▼
Input 5:
not activated
C
▲▼
Input 6:
not activated
C

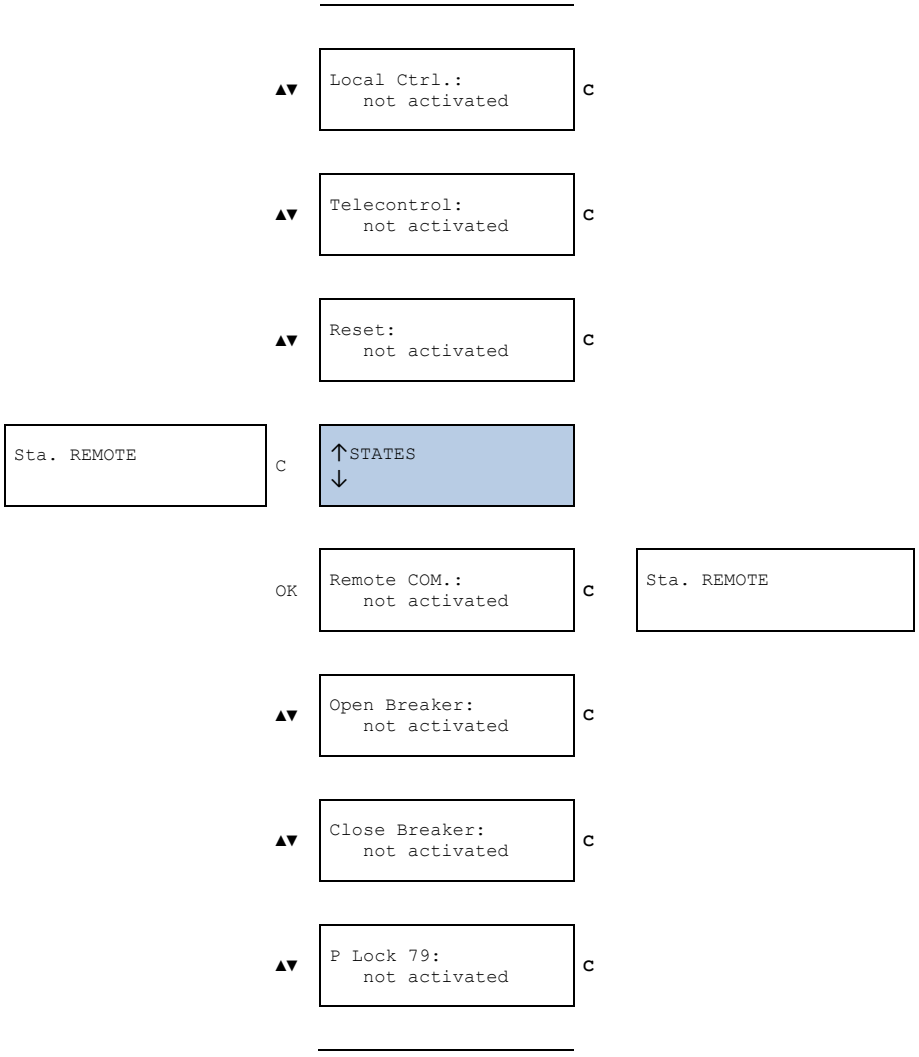

Sta. OUTPUTS
>Activated
C
↑STATES
↓
OK
Output 1:
<<ACTIVATED>>
C
Sta. OUTPUTS
>Activated
▲▼
Output 2:
not activated
C
▲▼
Output 3:
not activated
C
▲▼
Output 4:
not activated
C
Sta. LEDS
>Activated
C
↑STATES
↓
OK
Led1:
<<ACTIVATED>>
C
Sta. LEDS
>Activated
▲▼
Led2:
not activated
C

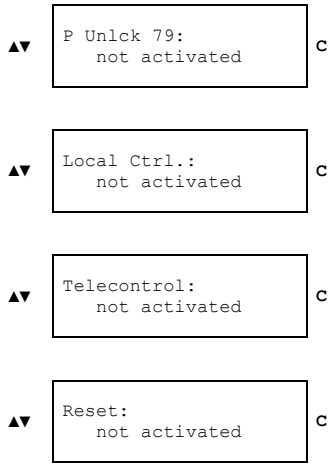

▲▼
Led3:
not activated
C
▲▼
Led4:
not activated
C
▲▼
Led5:
not activated
C
▲▼
Led6:
not activated
C
C
▲▼
Led-52:
not activated
C
▲▼
Led-79:
not activated
C
Sta. LOGIC
>Activated
C
↑STATES
↓
OK
52a:
not activated
C
Sta. LOGIC
>Activated


▲▼
52b:
not activated
C
▲▼
Ext Trip:
not activated
C
▲▼
BF Init:
not activated
C
▲▼
Fault Init:
not activated
C
▲▼
Manual close Init:
not activated
C
▲▼
Manual close Enable:
not activated
C
▲▼
Reset:
not activated
C
▲▼
SettingsG1:
not activated
C


▲▼
SettingsG2:
not activated
C
▲▼
79Init:
not activated
C
▲▼
79 Enable:
not activated
C
▲▼
L Lock 79:
not activated
C
▲▼
P Lock 79:
not activated
C
▲▼
P Unlock 79:
not activated
C
▲▼
74TCS A:
not activated
C
▲▼
74TCS B:
not activated
C


Logic Sig1:
not activated
Logic Sig2:
not activated
Sta. LOCAL
>Activated
↑STATES
↓
Local COM.:
not activated
Sta. LOCAL
>Activated
HMI Activity:
<<ACTIVATED>>
Open Breaker:
not activated
Close Breaker:
not activated
P Lock 79:
not activated
P Unlck 79:
not activated
▲▼
C
OK

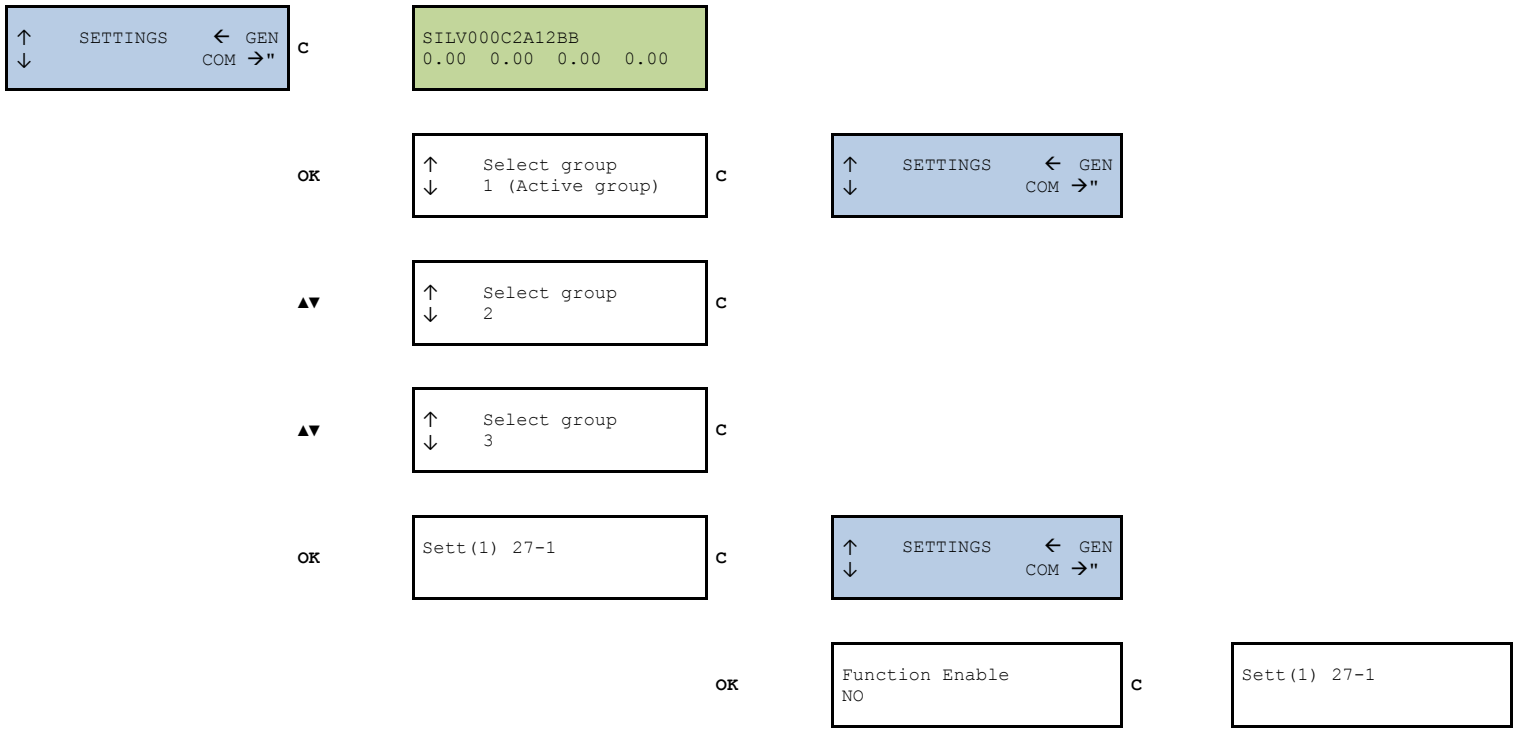

Local Ctrl.:
not activated
▲▼
C
Telecontrol:
not activated
▲▼
C
Reset:
not activated
▲▼
C
Sta. REMOTE
C
↑STATES
↓
OK
Remote COM.:
not activated
C
Sta. REMOTE
Open Breaker:
not activated
▲▼
C
Close Breaker:
not activated
▲▼
C
P Lock 79:
not activated
▲▼
C

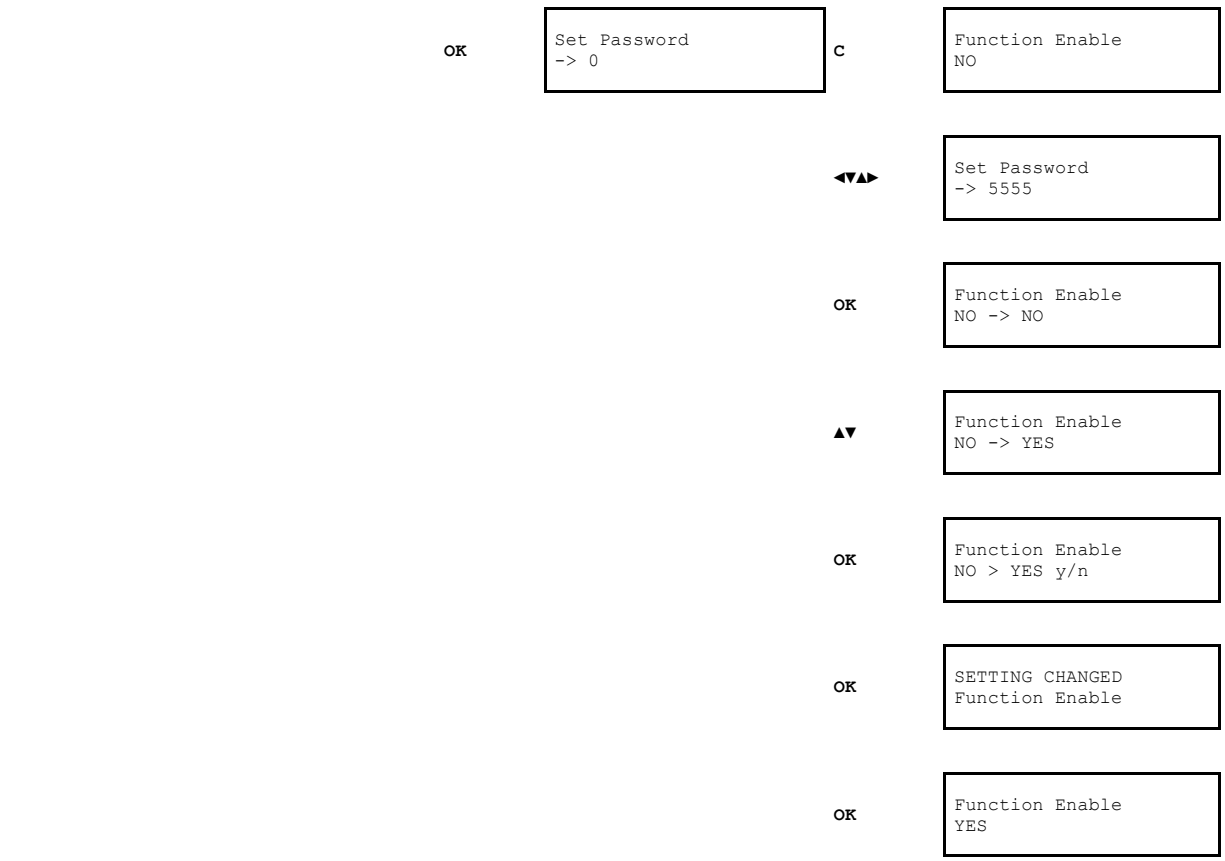


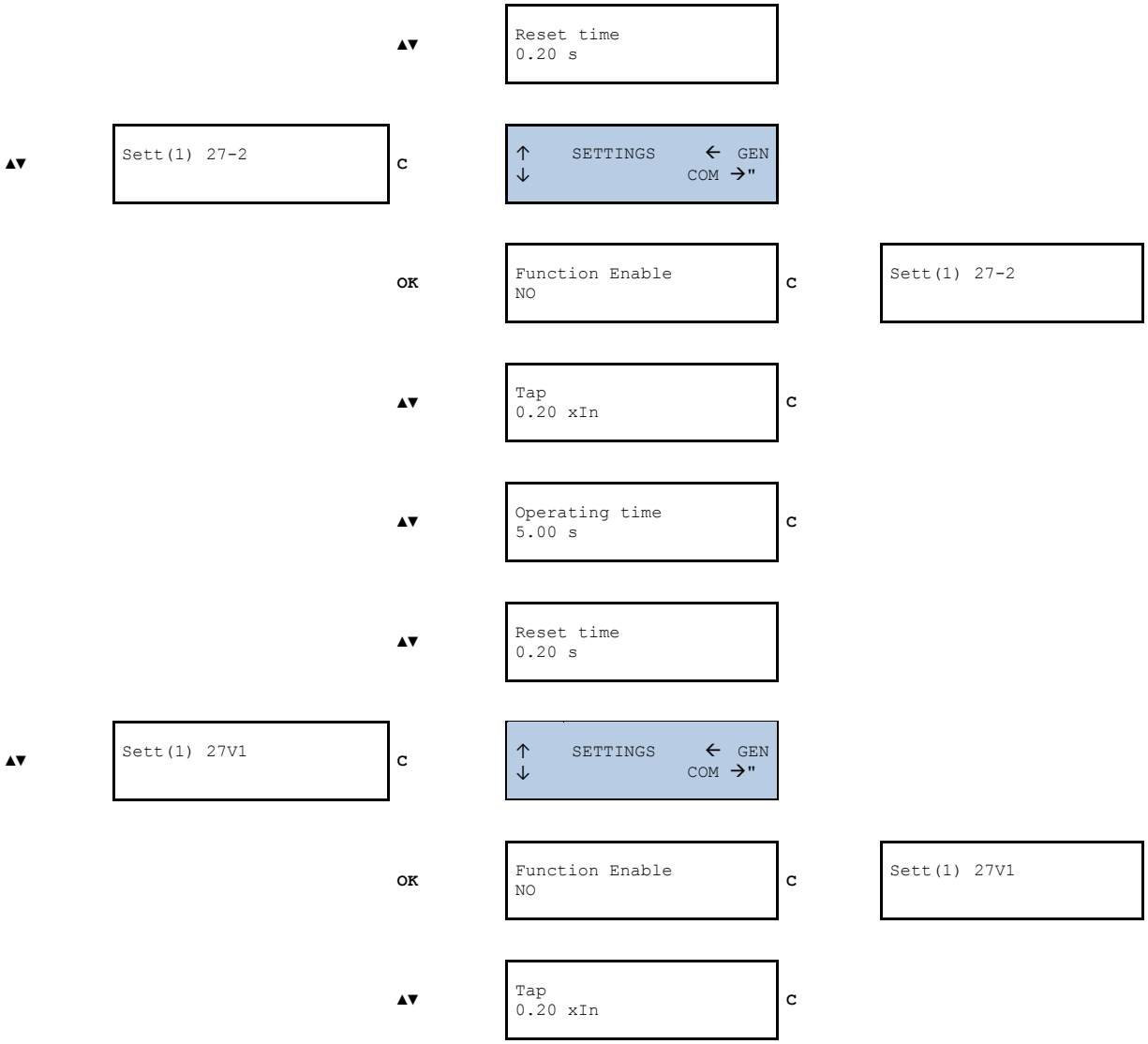

**NOTE: REMOTE COM can be ModBus, IEC60870-5-103, IEC61850, DNP3.0 or IEC60870-5-104 depending on model**

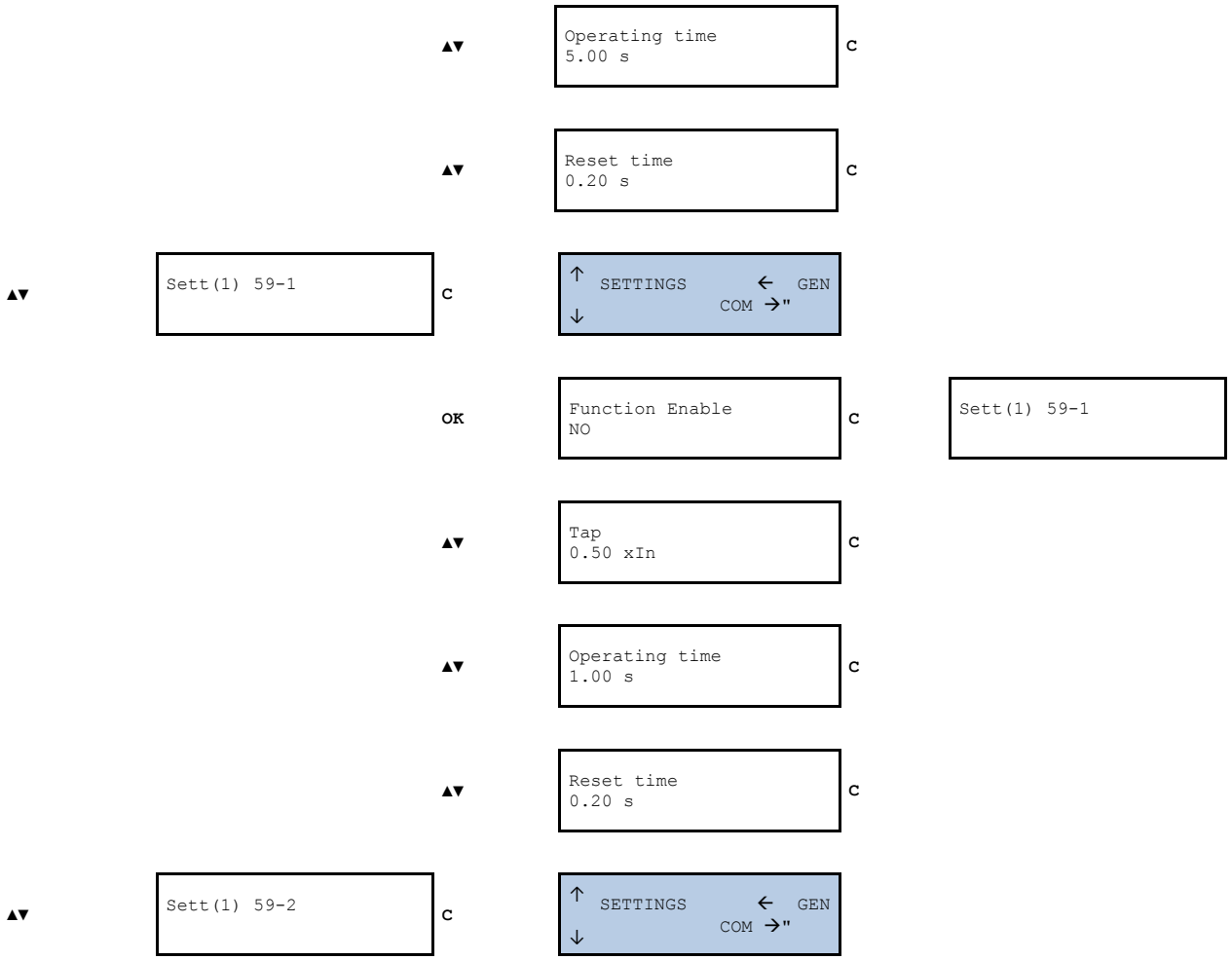
### 7.6.11. Settings Menu

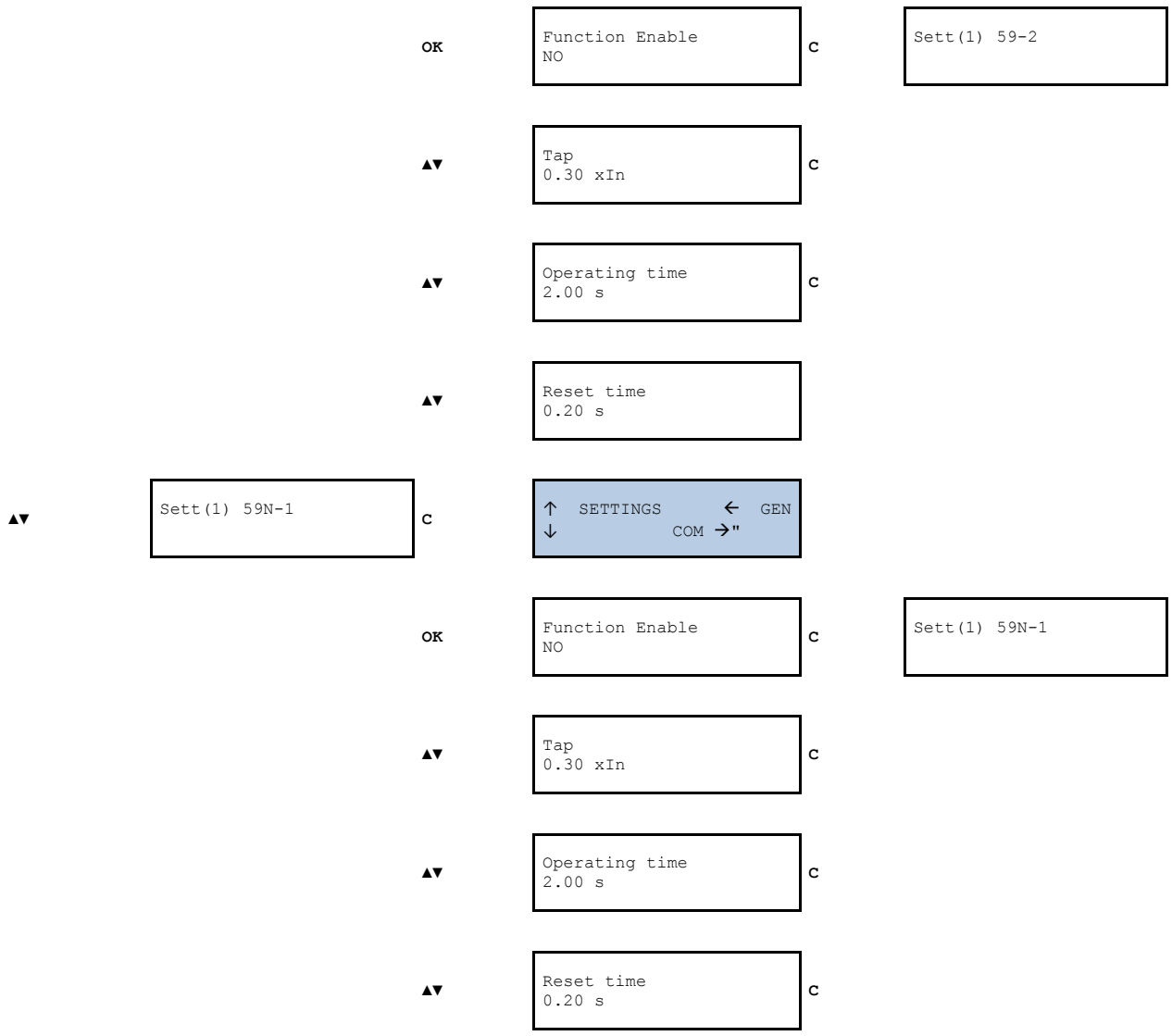
From the standby mode screen, press the “OK” key to access the first line of menus. Use the “▲” and “▼” keys to position the cursor over the “SETTINGS” screen and press “OK”. This takes you to the settings groups line. Use the “▲” and “▼” keys to position the cursor over a settings group, and press the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

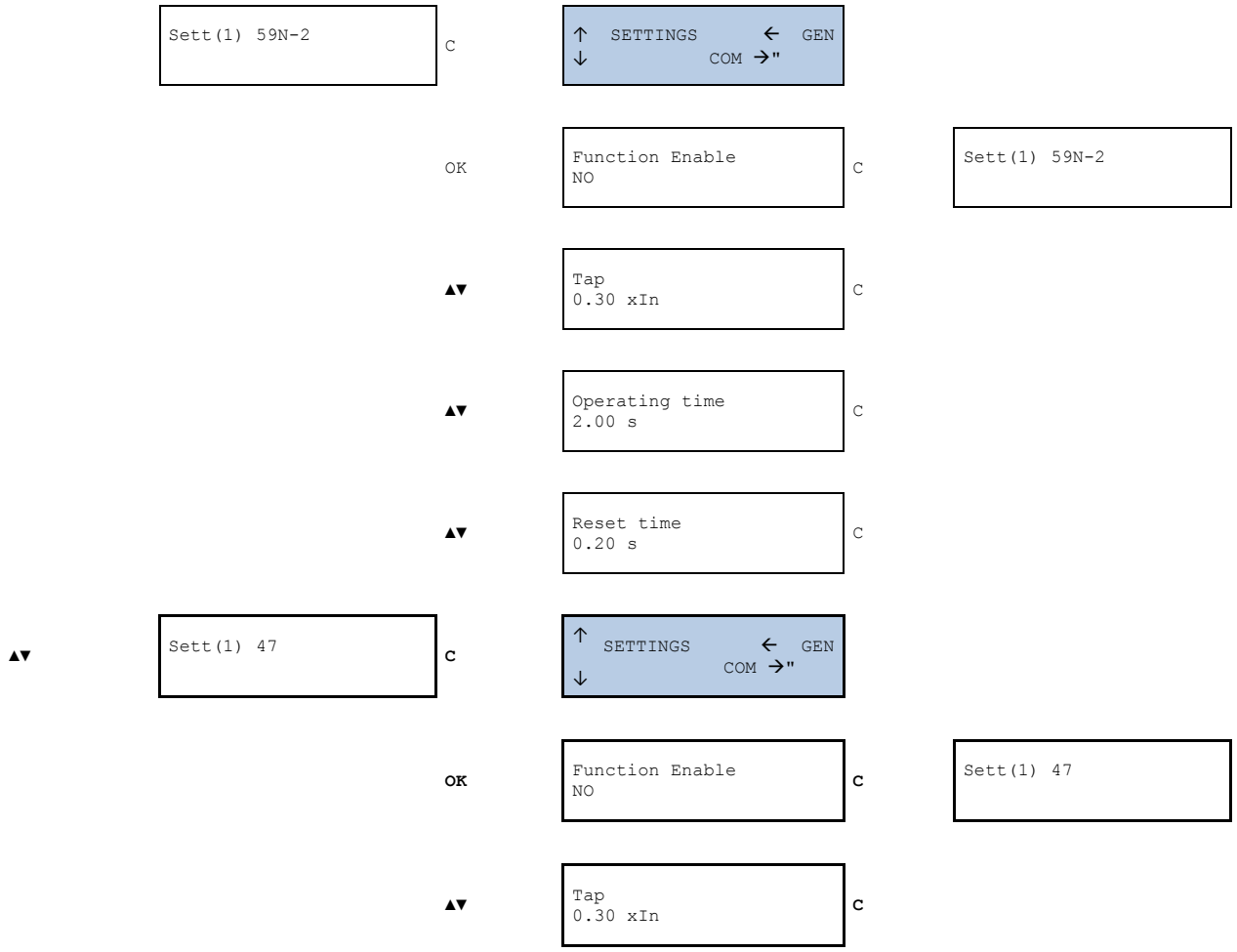


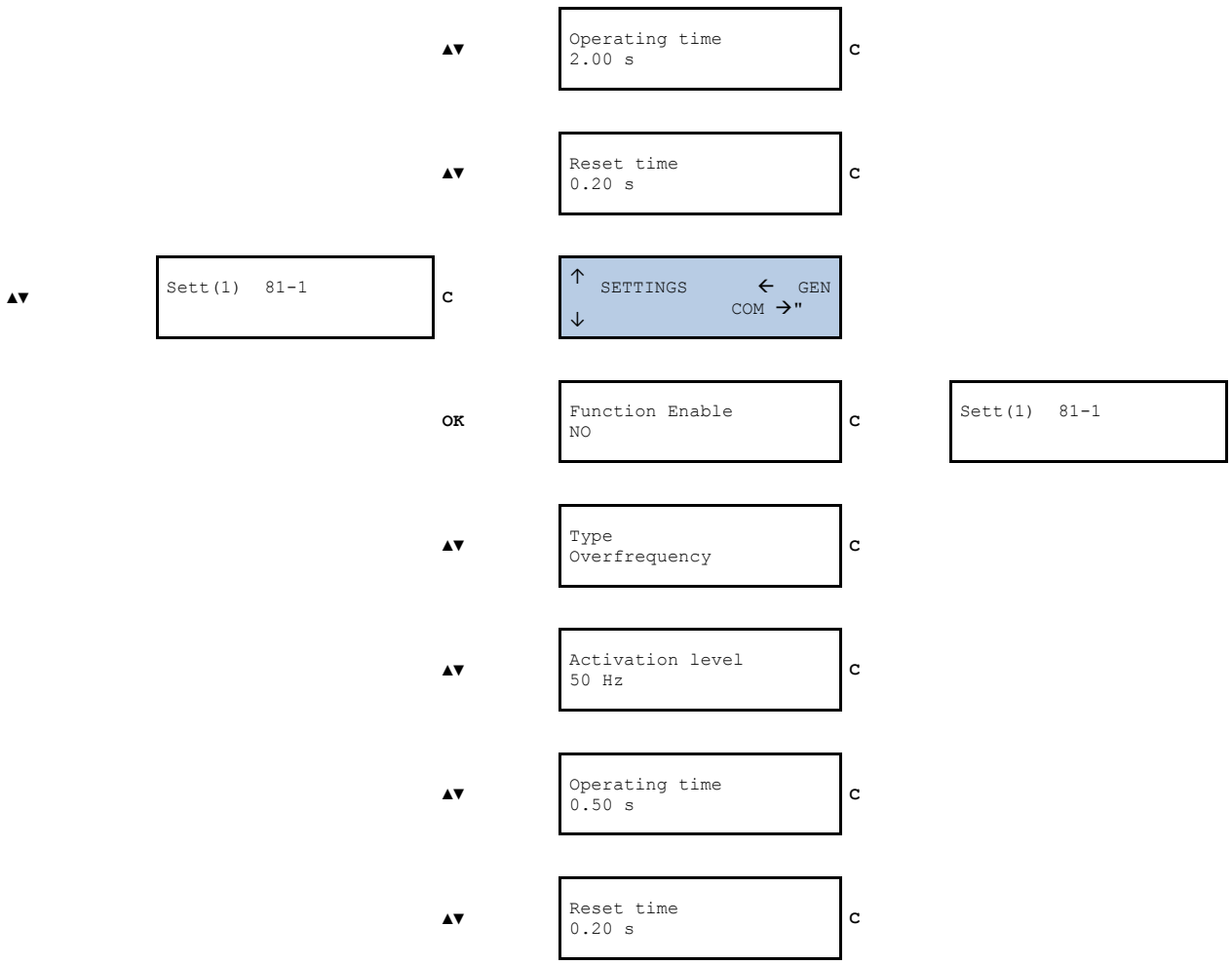

OK
Set Password
-> 0
C
Function Enable
NO
◄▼▲►
Set Password
-> 5555
OK
Function Enable
NO -> NO
▲▼
Function Enable
NO -> YES
OK
Function Enable
NO > YES y/n
OK
SETTING CHANGED
Function Enable
OK
Function Enable
YES
▲▼
Tap
1.00 xIn
C
▲▼
Operating time
0.02 s
C

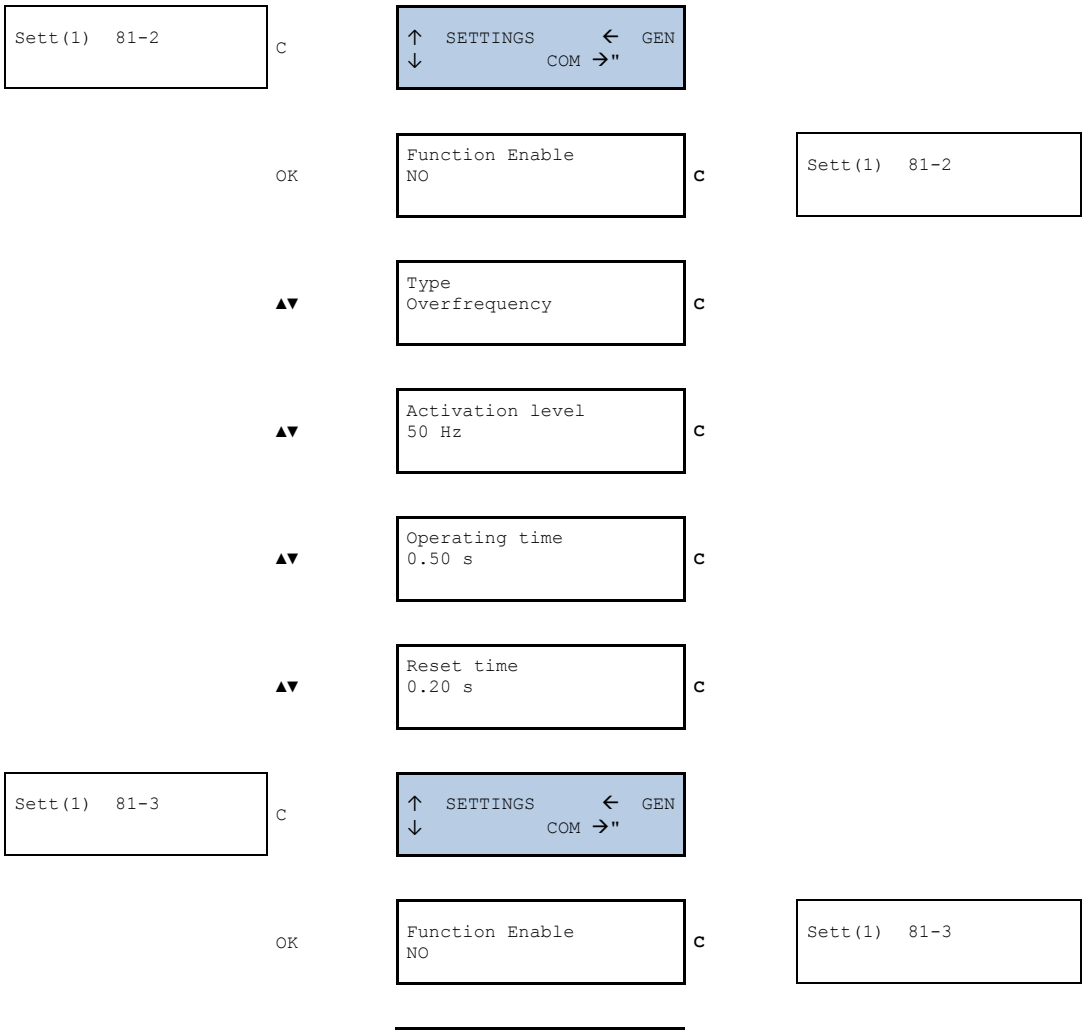

▲▼
Reset time
0.20 s
▲▼
Sett(1) 27-2
C
↑ SETTINGS ← GEN
↓ COM →"
OK
Function Enable
NO
C
Sett(1) 27-2
▲▼
Tap
0.20 xIn
C
▲▼
Operating time
5.00 s
C
▲▼
Reset time
0.20 s
▲▼
Sett(1) 27V1
C
↑ SETTINGS ← GEN
↓ COM →"
OK
Function Enable
NO
C
Sett(1) 27V1
▲▼
Tap
0.20 xIn
C

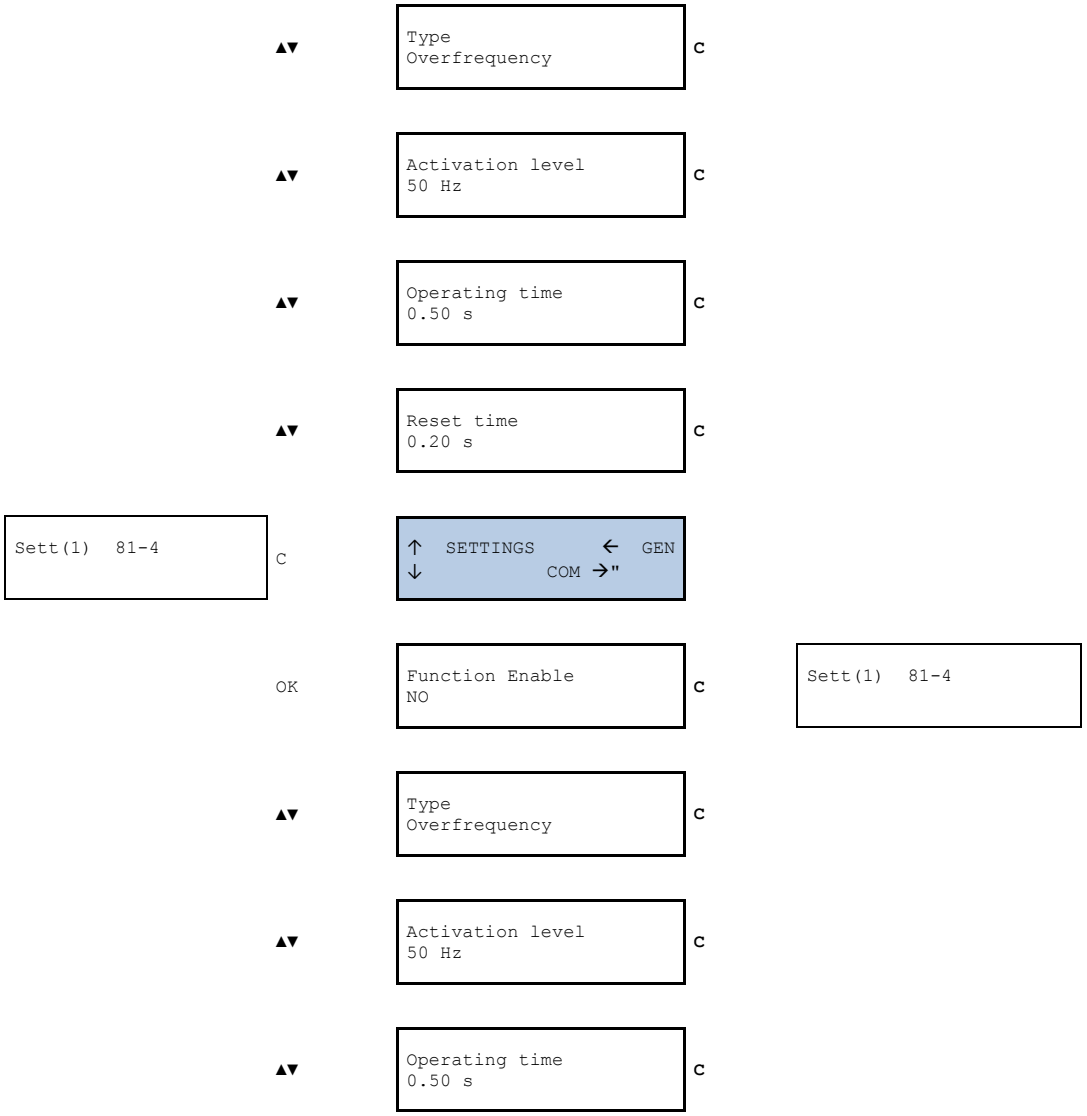

▲▼
Operating time
5.00 s
C
▲▼
Reset time
0.20 s
C
▲▼
Sett(1) 59-1
C
↑ SETTINGS ← GEN
↓ COM →"
OK
Function Enable
NO
C
Sett(1) 59-1
▲▼
Tap
0.50 xIn
C
▲▼
Operating time
1.00 s
C
▲▼
Reset time
0.20 s
C
▲▼
Sett(1) 59-2
C
↑ SETTINGS ← GEN
↓ COM →"

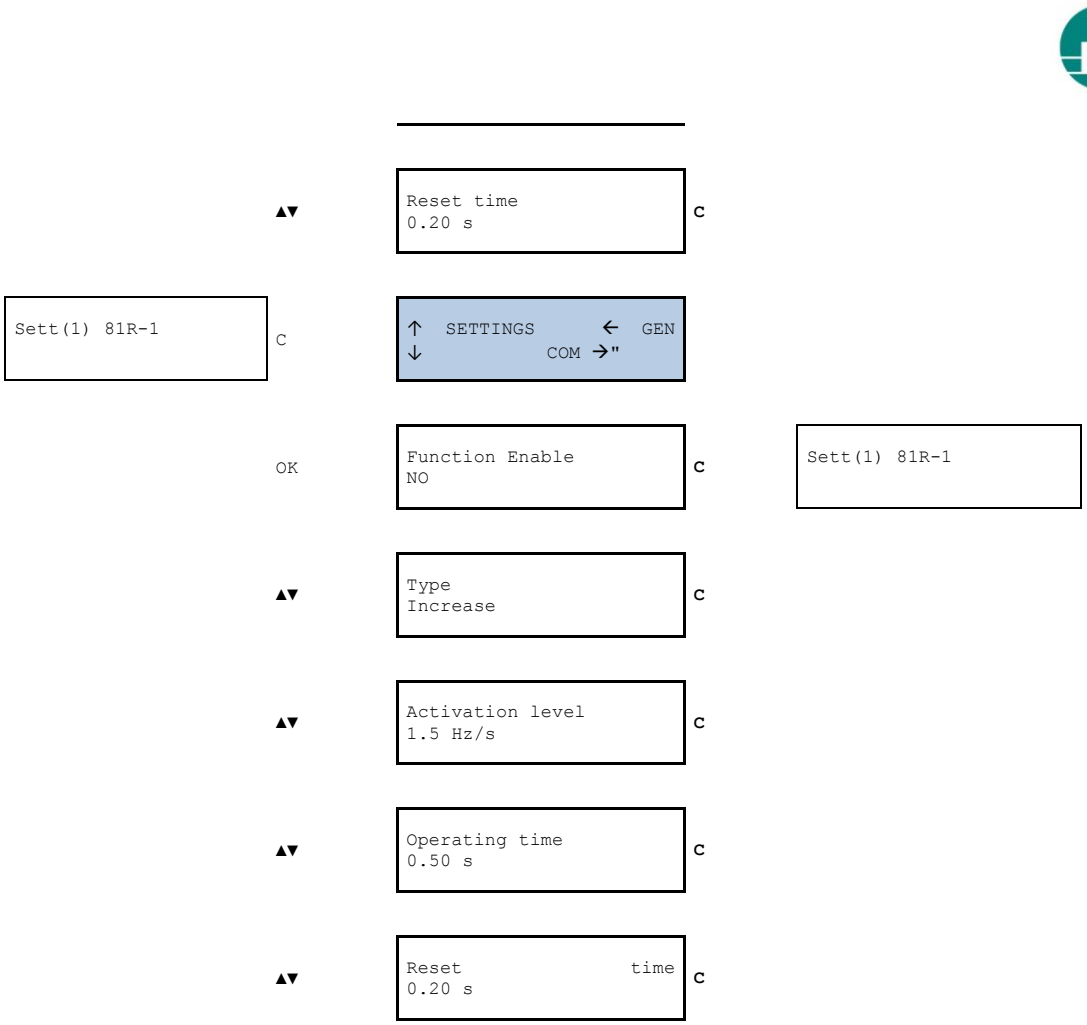

OK
Function Enable
NO
C
Sett(1) 59-2
▲▼
Tap
0.30 xIn
C
▲▼
Operating time
2.00 s
C
▲▼
Reset time
0.20 s
▲▼
Sett(1) 59N-1
C
↑ SETTINGS ← GEN
↓ COM →"
OK
Function Enable
NO
C
Sett(1) 59N-1
▲▼
Tap
0.30 xIn
C
▲▼
Operating time
2.00 s
C
▲▼
Reset time
0.20 s
C

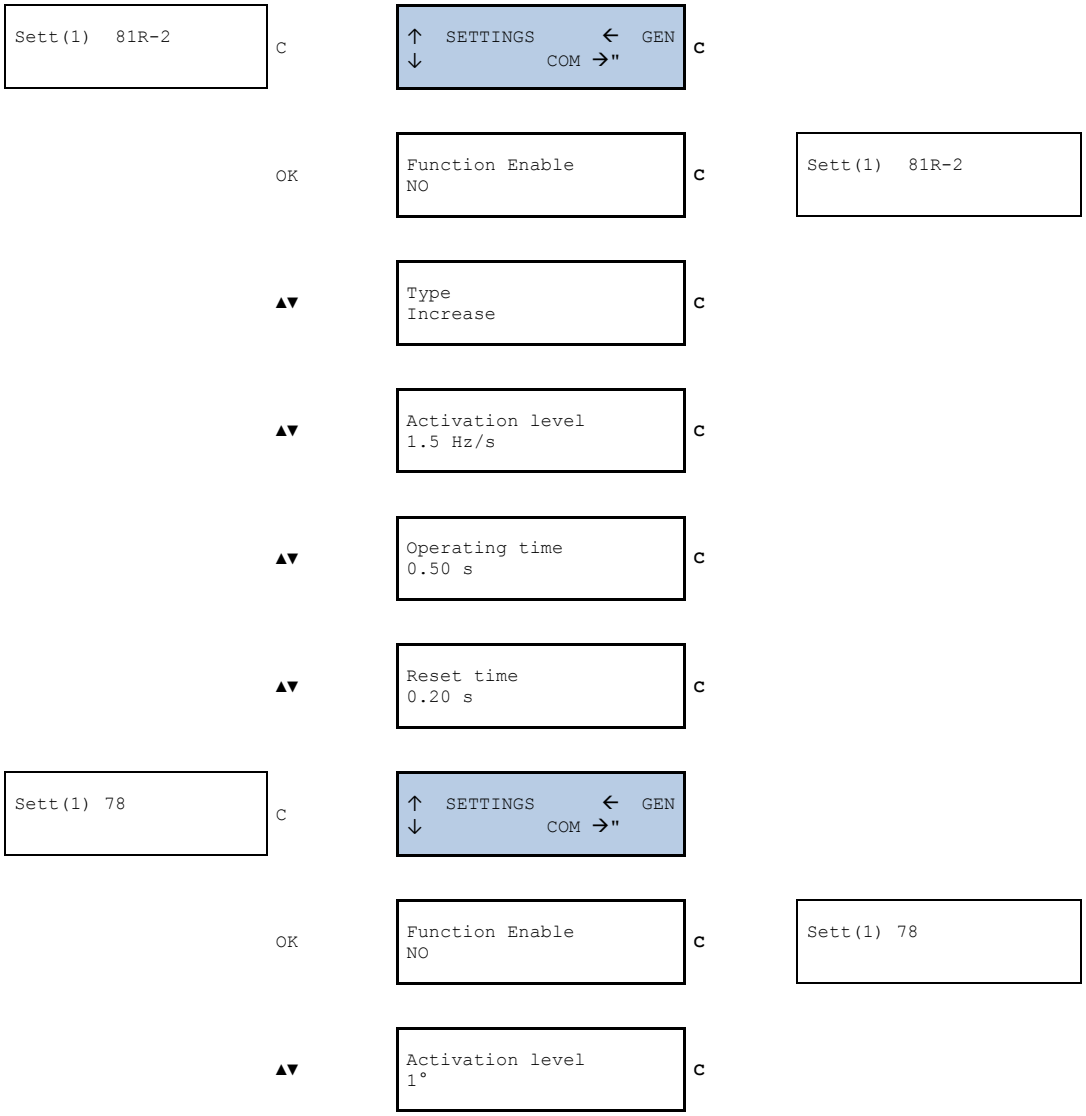

Sett(1) 59N-2
C
↑ SETTINGS ← GEN
↓ COM →"
OK
Function Enable
NO
C
Sett(1) 59N-2
▲▼
Tap
0.30 xIn
C
▲▼
Operating time
2.00 s
C
▲▼
Reset time
0.20 s
C
▲▼
Sett(1) 47
C
↑ SETTINGS ← GEN
↓ COM →"
OK
Function Enable
NO
C
Sett(1) 47
▲▼
Tap
0.30 xIn
C

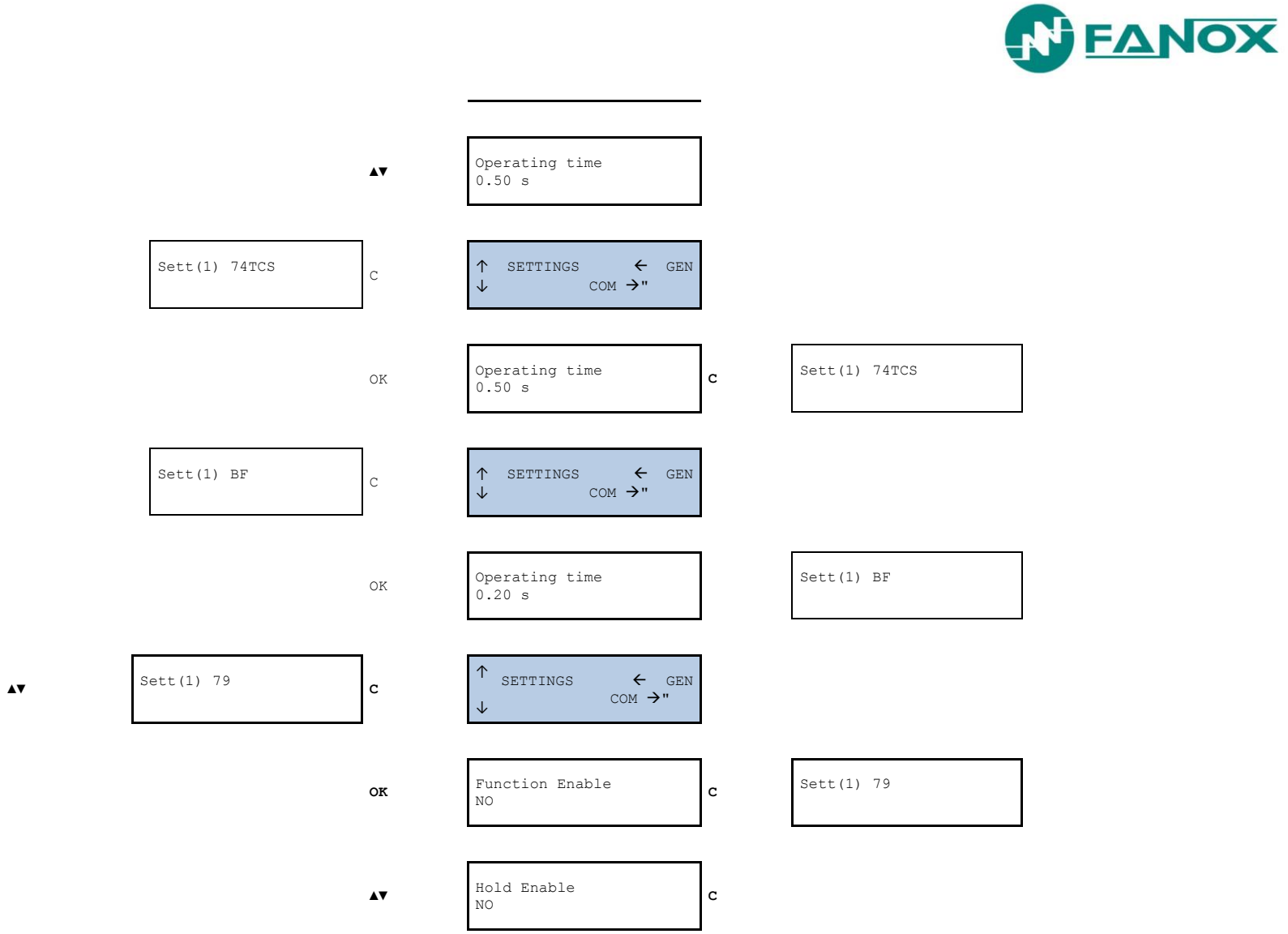

▲▼
Operating time
2.00 s
C
▲▼
Reset time
0.20 s
C
▲▼
Sett(1) 81-1
C
↑ SETTINGS ← GEN
COM →"
↓
OK
Function Enable
NO
C
Sett(1) 81-1
▲▼
Type
Overfrequency
C
▲▼
Activation level
50 Hz
C
▲▼
Operating time
0.50 s
C
▲▼
Reset time
0.20 s
C

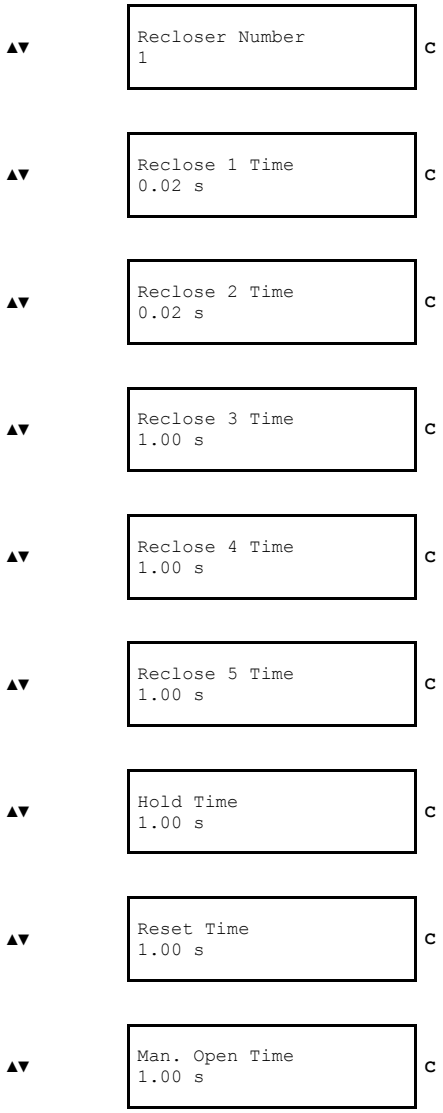

Sett(1) 81-2
C
↑ SETTINGS ← GEN
↓ COM →"
OK
Function Enable
NO
C
Sett(1) 81-2
▲▼
Type
Overfrequency
C
▲▼
Activation level
50 Hz
C
▲▼
Operating time
0.50 s
C
▲▼
Reset time
0.20 s
C
Sett(1) 81-3
C
↑ SETTINGS ← GEN
↓ COM →"
OK
Function Enable
NO
C
Sett(1) 81-3

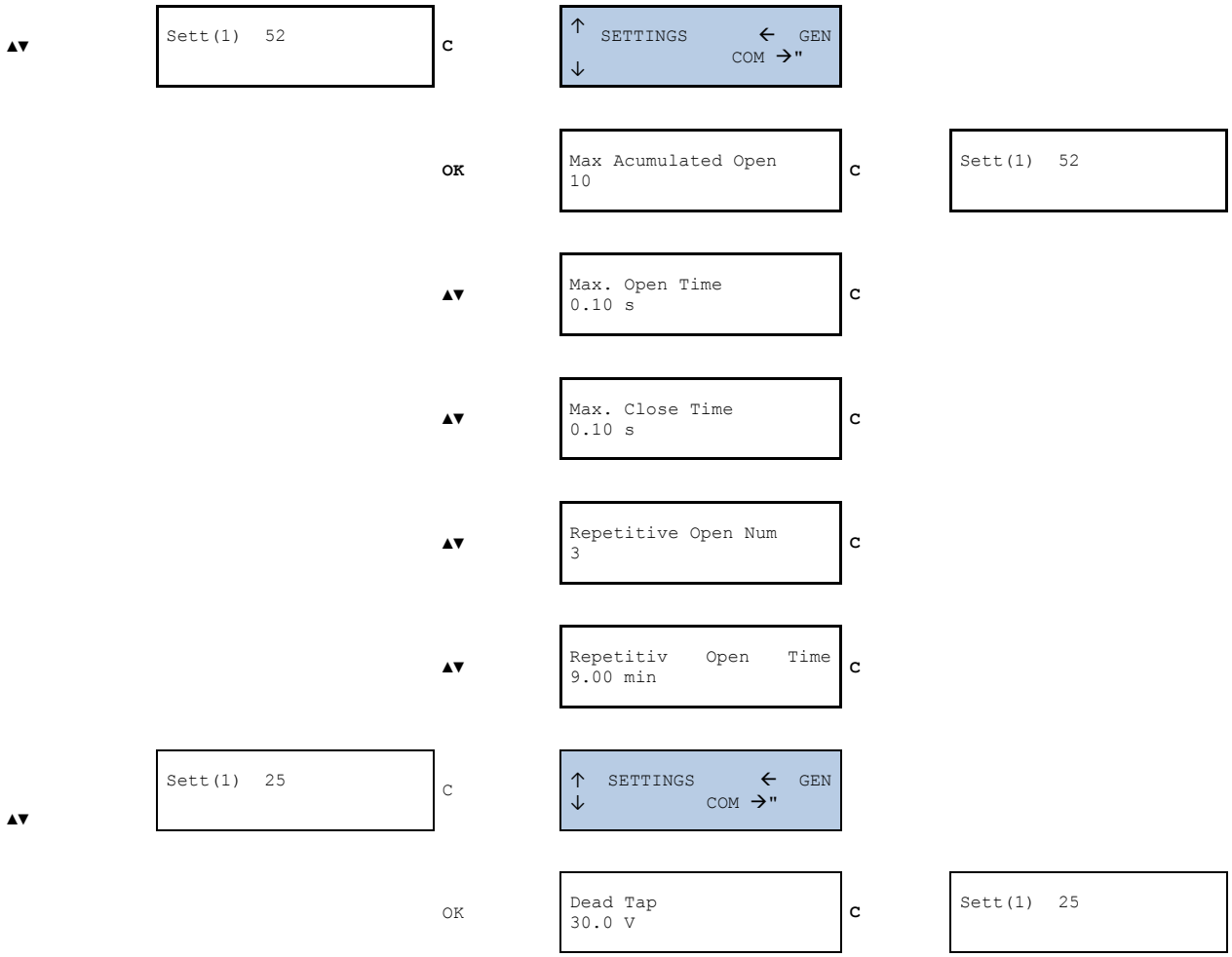

▲▼
Type
Overfrequency
C
▲▼
Activation level
50 Hz
C
▲▼
Operating time
0.50 s
C
▲▼
Reset time
0.20 s
C
Sett(1) 81-4
C
↑ SETTINGS ← GEN
↓ COM →"
OK
Function Enable
NO
C
Sett(1) 81-4
▲▼
Type
Overfrequency
C
▲▼
Activation level
50 Hz
C
▲▼
Operating time
0.50 s
C

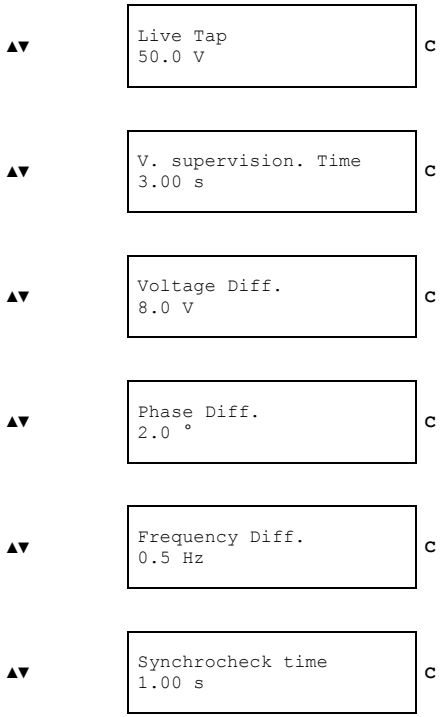

Sett(1) 81R-1
C
↑ SETTINGS ← GEN
↓ COM →"
▲▼
Reset time
0.20 s
C
OK
Function Enable
NO
C
▲▼
Type
Increase
C
▲▼
Activation level
1.5 Hz/s
C
▲▼
Operating time
0.50 s
C
▲▼
Reset time
0.20 s
C
Sett(1) 81R-1


Sett(1) 81R-2
C
↑ SETTINGS ← GEN
↓ COM →"
C
OK
Function Enable
NO
C
Sett(1) 81R-2
▲▼
Type
Increase
C
▲▼
Activation level
1.5 Hz/s
C
▲▼
Operating time
0.50 s
C
▲▼
Reset time
0.20 s
C
Sett(1) 78
C
↑ SETTINGS ← GEN
↓ COM →"
OK
Function Enable
NO
C
Sett(1) 78
▲▼
Activation level
1°
C


Operating time
0.50 s
▲▼
Sett(1) 74TCS
C
↑ SETTINGS ← GEN
↓ COM →"
OK
Operating time
0.50 s
C
Sett(1) 74TCS
Sett(1) BF
C
↑ SETTINGS ← GEN
↓ COM →"
OK
Operating time
0.20 s
Sett(1) BF
▲▼
Sett(1) 79
C
↑ SETTINGS ← GEN
↓ COM →"
OK
Function Enable
NO
C
Sett(1) 79
▲▼
Hold Enable
NO
C


▲▼
Recloser Number
1
C
▲▼
Reclose 1 Time
0.02 s
C
▲▼
Reclose 2 Time
0.02 s
C
▲▼
Reclose 3 Time
1.00 s
C
▲▼
Reclose 4 Time
1.00 s
C
▲▼
Reclose 5 Time
1.00 s
C
▲▼
Hold Time
1.00 s
C
▲▼
Reset Time
1.00 s
C
▲▼
Man. Open Time
1.00 s
C


▲▼
Sett(1) 52
C
↑ SETTINGS ← GEN
↓ COM →"
OK
Max Acumulated Open
10
C
Sett(1) 52
▲▼
Max. Open Time
0.10 s
C
▲▼
Max. Close Time
0.10 s
C
▲▼
Repetitive Open Num
3
C
▲▼
Repetitiv Open Time
9.00 min
C
▲▼
Sett(1) 25
C
↑ SETTINGS ← GEN
↓ COM →"
OK
Dead Tap
30.0 V
C
Sett(1) 25




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

The general setting "Equipment name" can be viewed and modified from the HMI and from SICom software.

The frequency can be 50 or 60 Hz.

Serial number is a read only setting.

Nominal voltage can be selected from 110 volts till 480 volts. Thanks to this range it is possible to work with VT or connecting the relay directly to the line

The VT configuration type will depend on the model:

**Using voltage transformers**

3 VT configuration (phase-neutral)

3 VT configuration (phase-neutral) + residual voltage

3VT configuration (phase-phase) + residual voltage

2VT configuration (phase-phase) + residual voltage

**Connecting the relay directly to Low Voltage line**

Phase to neutral configuration (250-480 V)

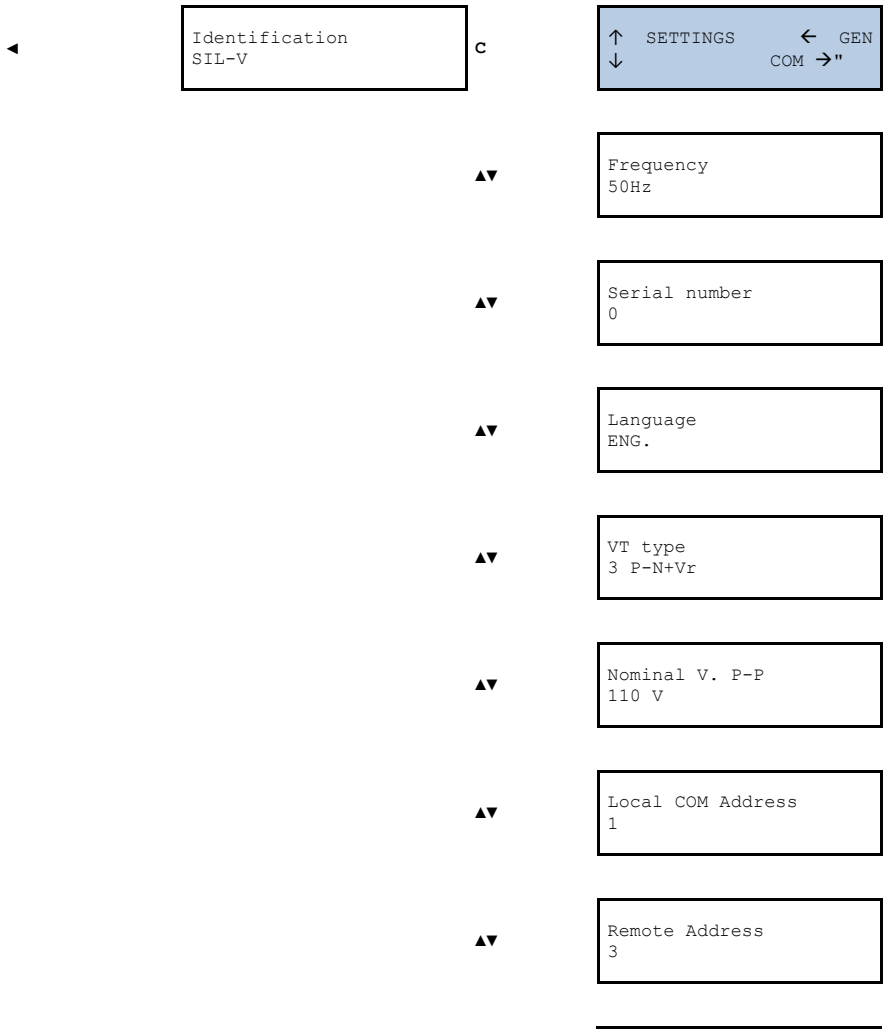
**SILVxxxx2xxxxx:**

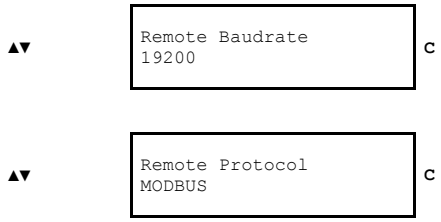
**Using voltage transformers**

3 VT configuration (phase-neutral) + busbar voltage

**Connecting the relay directly to Low Voltage line**

Phase to neutral configuration  + busbar voltage


Identification
SIL-V
C
↑ SETTINGS ← GEN
↓ COM →"
▲▼
Frequency
50Hz
C
▲▼
Serial number
0
C
▲▼
Language
ENG.
C
▲▼
VT type
3 P-N+Vr
C
▲▼
Nominal V. P-P
110 V
C
▲▼
Local COM Address
1
C
▲▼
Remote Address
3
C




Changing remote protocol through general settings is only available for **SILVxxxxxA(D,I)xxxx.** Remote protocol will depend on the model, this is:

**SILVxxxxxA(D,I)xxxx:**

It is possible to select remote protocol between MODBUS and IEC60870-5-103 though general settings.

**SILVxxxxxB(C,E,F,G,H)** remote protocol is impossed by the model and each model correspond to a concret protocol. These protocols can be: Modbus RTU (RS485) and IEC61850, DNP3.0 or IEC60870-5-104 (RJ45). In this case the protocol can not be changed from General settings.

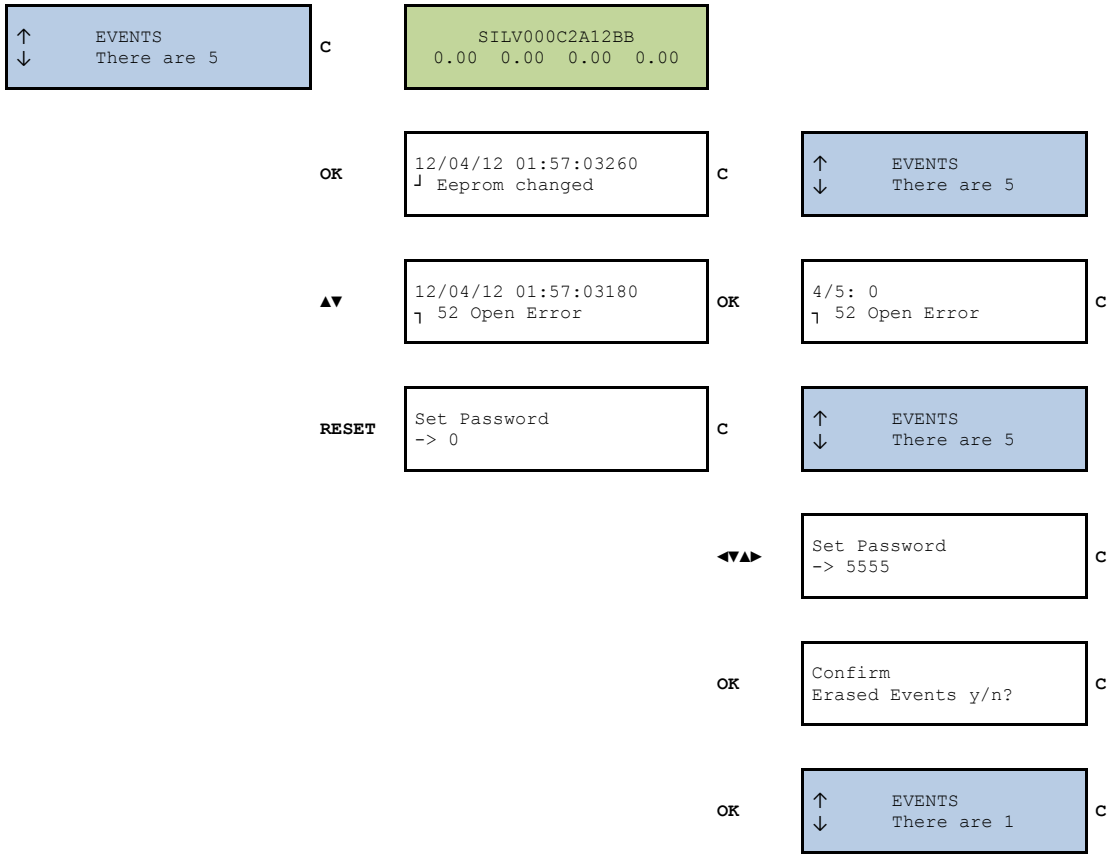
It is necessary to enter a password to change a setting for the first time. The settings can be changed after entering the password, until returning either manually or automatically to the standby mode screen. The system returns automatically to the standby mode screen if no key is pressed for five minutes.

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.

### 7.6.12. Events Menu

From the standby mode screen, press the “OK” key to access the first line of menus. Use the “▲” and “▼” keys to position the cursor over the “EVENTS” screen and the number of events in the buffer will be displayed. Press "OK" and use the “▲” and “▼” keys to position the cursor over the events.

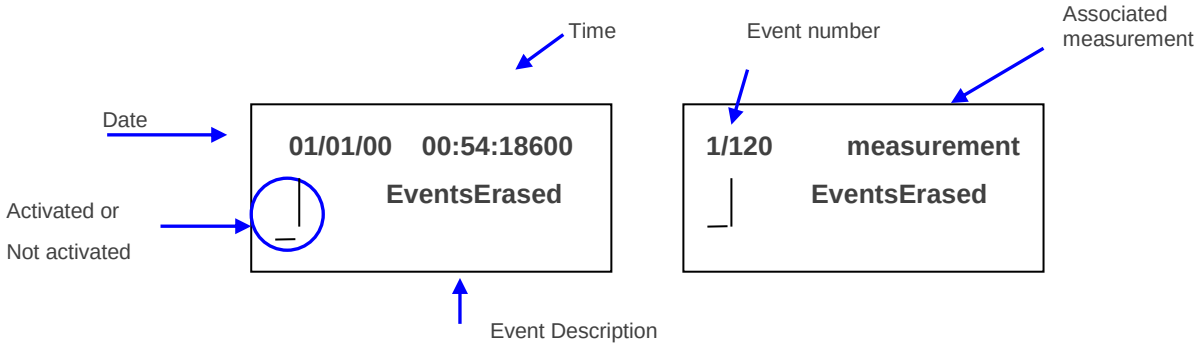


The “┘” and “┐” shows the event has been caused by the activation or reset of the associated status.

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 status activation or reset
- Associated measurement (if it has one)



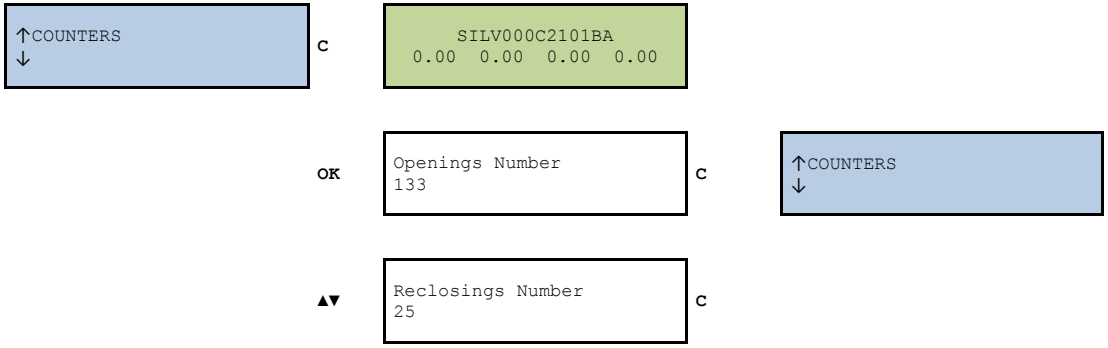
### 7.6.13. Counters Menu

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 counter name is its value.

The password must be entered before attempting to change a counter for the first time. Counter 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.

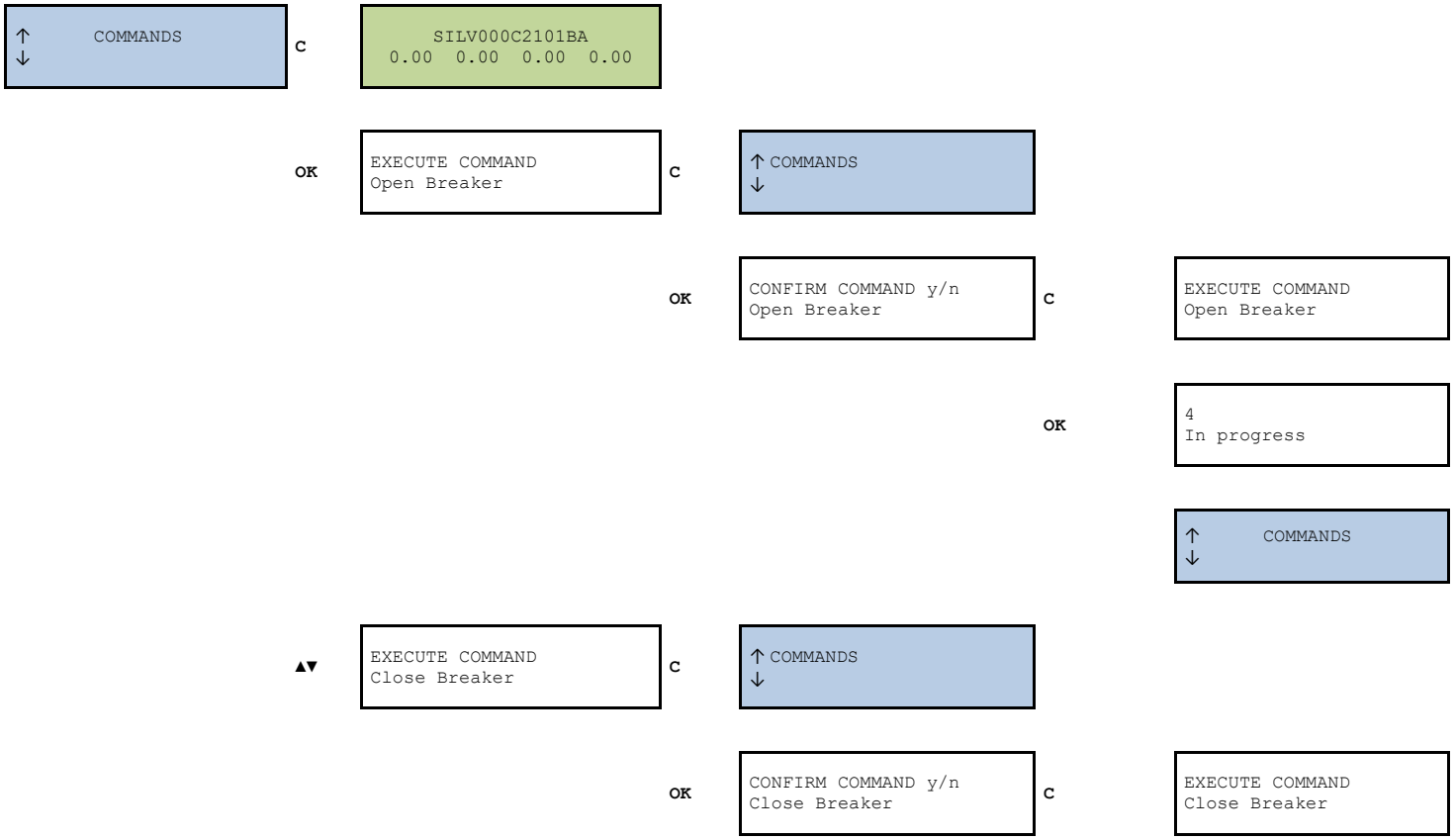
The factory setting password for the equipment is 5555. The password can be changed using the SICom program.

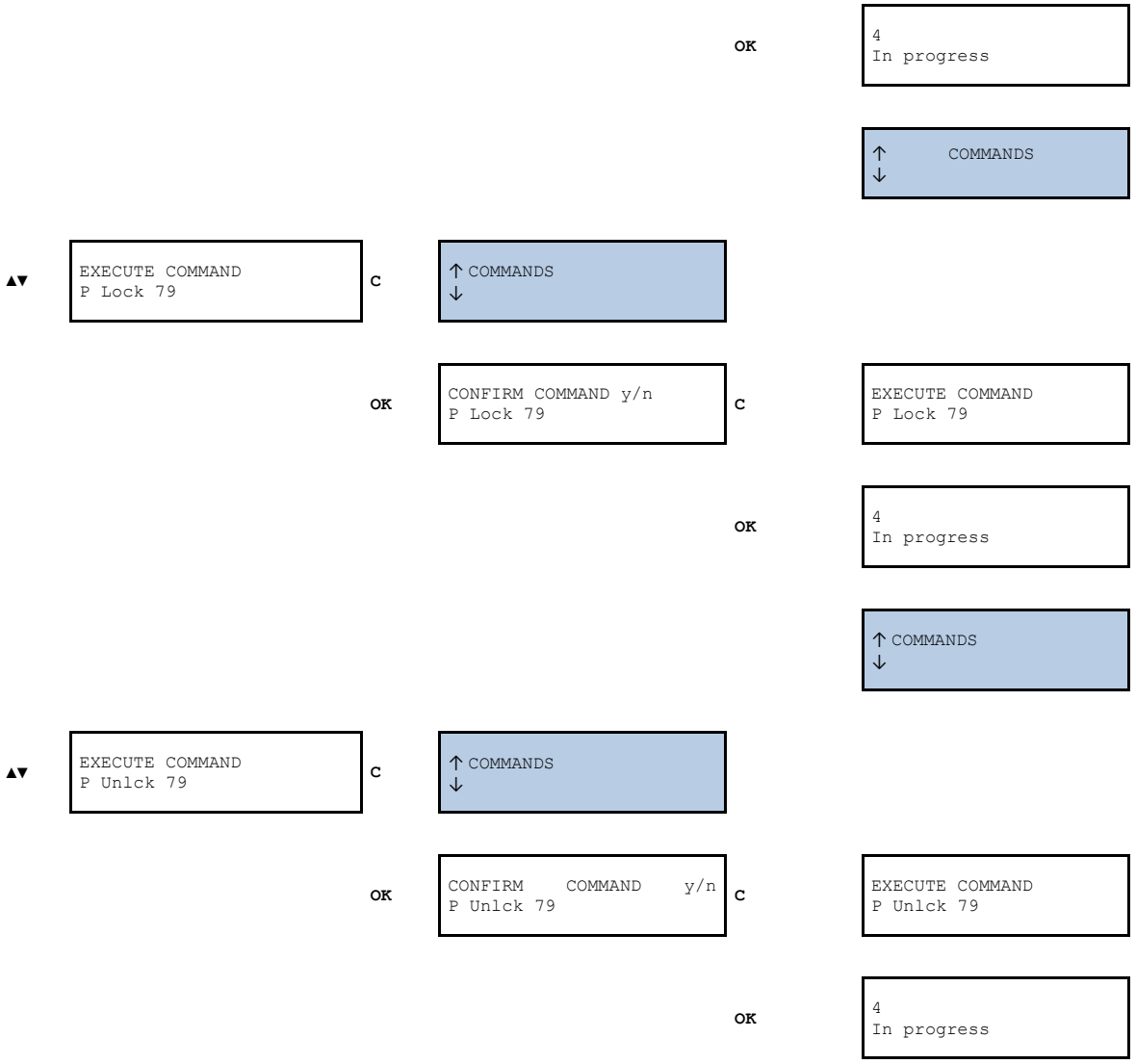
The keys ▲, ▼, ◄ and ► are used to enter the password. ▲ and ▼ are used to introduce a value or a character, and the ◄ and ► keys are used to move from one character to another. If it is necessary to change one of the password characters or numbers due to an error, press "C" to delete it. Press "OK”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

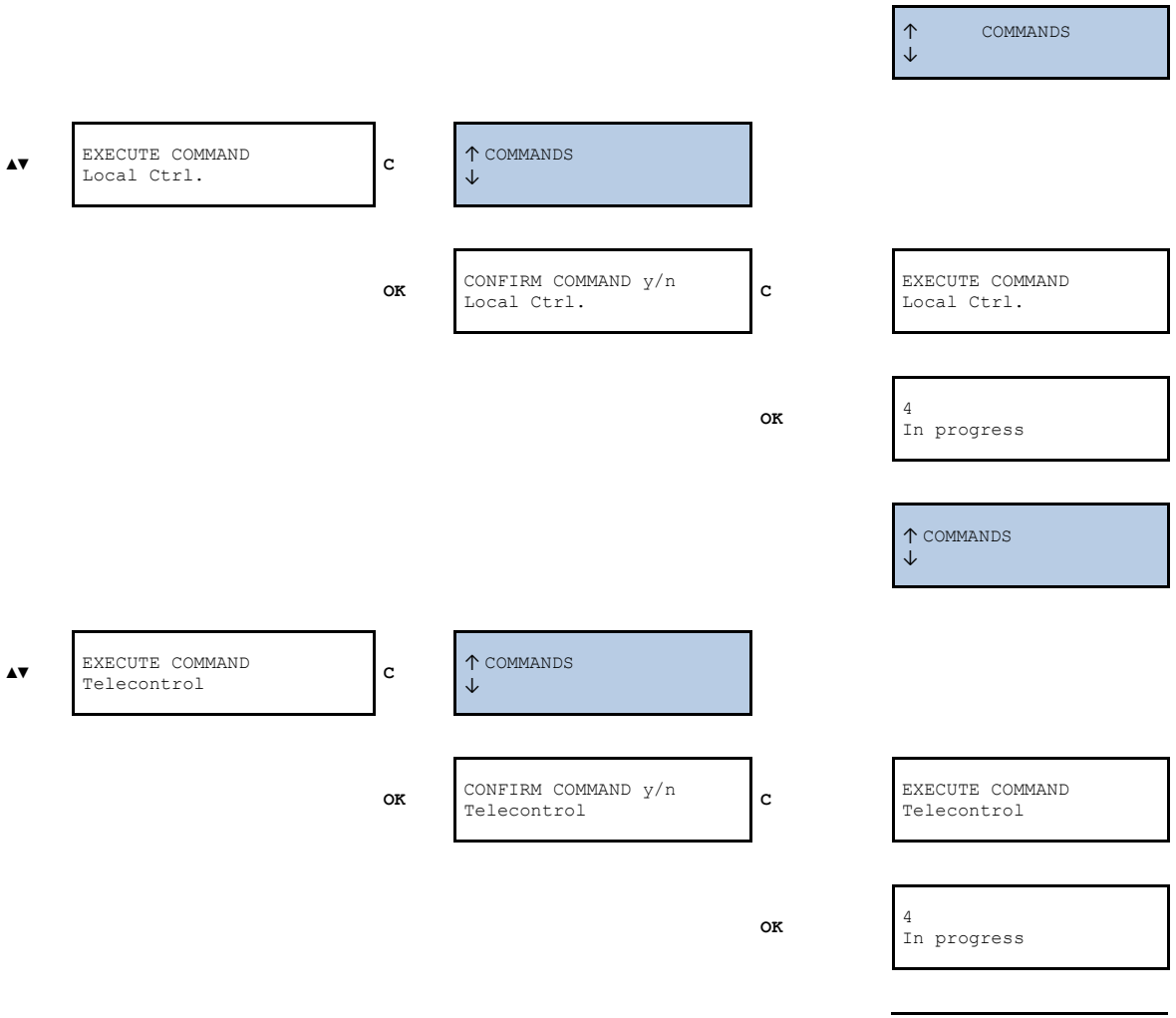


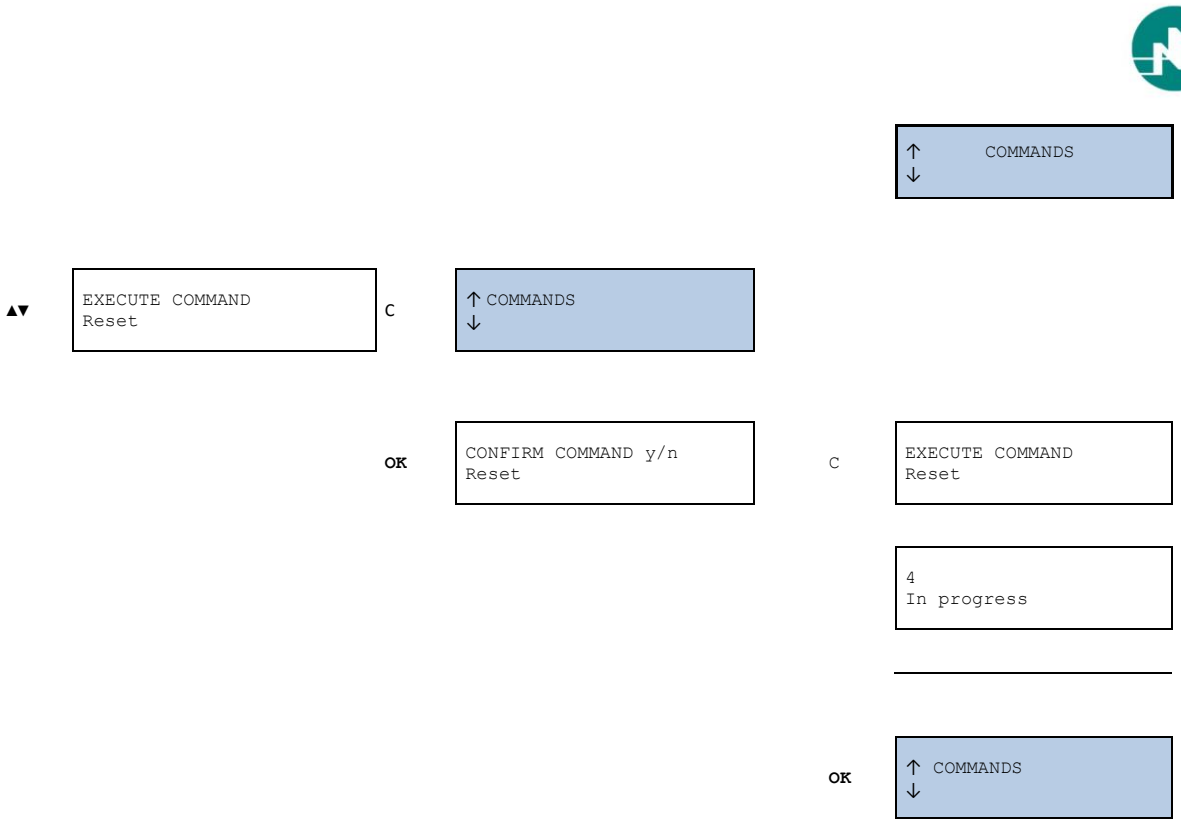
### 7.6.14. Commands Menu

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 operations. Press the "OK" key to perform an operation, and press the "OK" key again to confirm the operation.



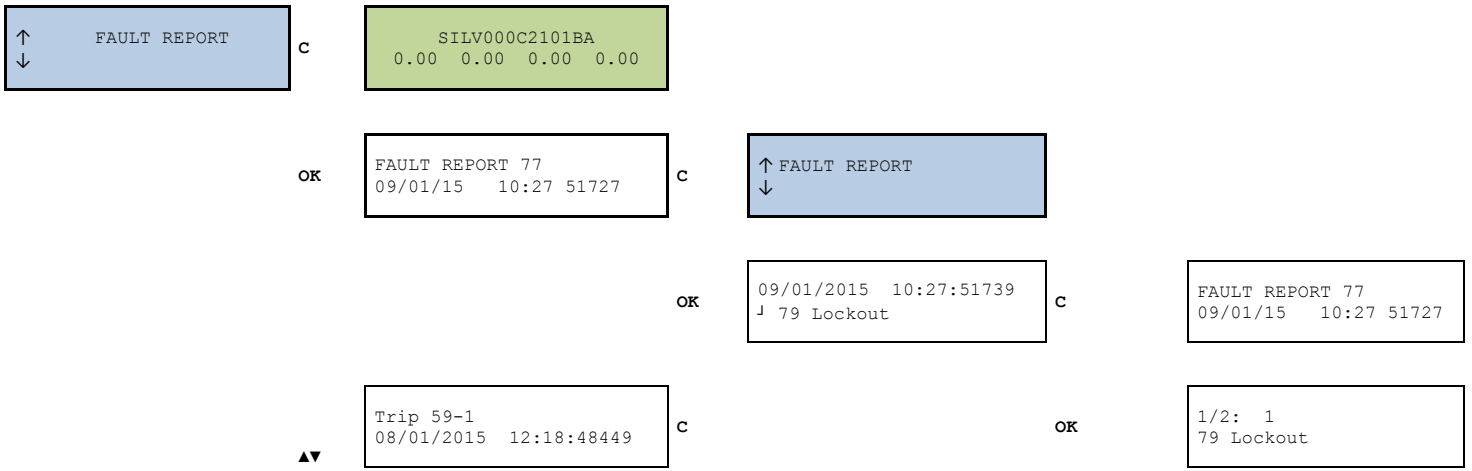

OK
4
In progress
↑ COMMANDS
↓
▲▼
EXECUTE COMMAND
P Lock 79
C
↑ COMMANDS
↓
OK
CONFIRM COMMAND y/n
P Lock 79
C
EXECUTE COMMAND
P Lock 79
OK
4
In progress
↑ COMMANDS
↓
▲▼
EXECUTE COMMAND
P Unlck 79
C
↑ COMMANDS
↓
OK
CONFIRM COMMAND y/n
P Unlck 79
C
EXECUTE COMMAND
P Unlck 79
OK
4
In progress


↑ COMMANDS
↓
▲▼
EXECUTE COMMAND
Local Ctrl.
C
↑ COMMANDS
↓
OK
CONFIRM COMMAND y/n
Local Ctrl.
C
EXECUTE COMMAND
Local Ctrl.
OK
4
In progress
↑ COMMANDS
↓
▲▼
EXECUTE COMMAND
Telecontrol
C
↑ COMMANDS
↓
OK
CONFIRM COMMAND y/n
Telecontrol
C
EXECUTE COMMAND
Telecontrol
OK
4
In progress


↑ COMMANDS
↓
▲▼
EXECUTE COMMAND
Reset
C
↑ COMMANDS
↓
OK
CONFIRM COMMAND y/n
Reset
C
EXECUTE COMMAND
Reset
4
In progress
OK
↑ COMMANDS
↓

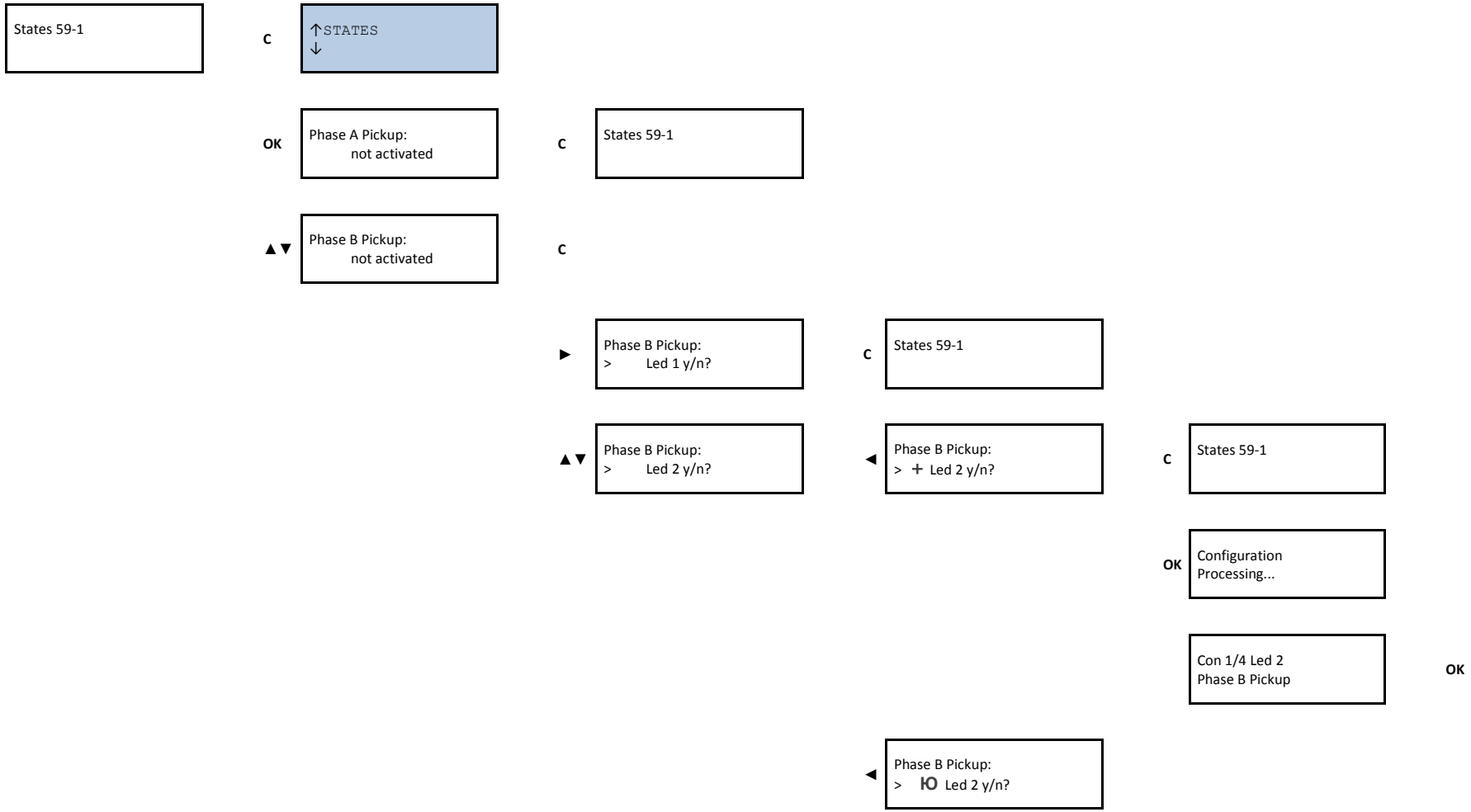
### 7.6.16. Fault report menu

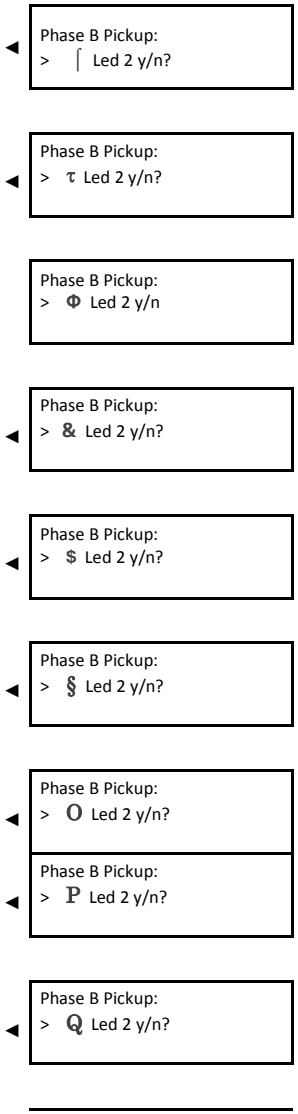
Dedicated fault report menu is available. Apart from this, it is possible to acces to faul reports by pressing ◄ key from dtandby screen.

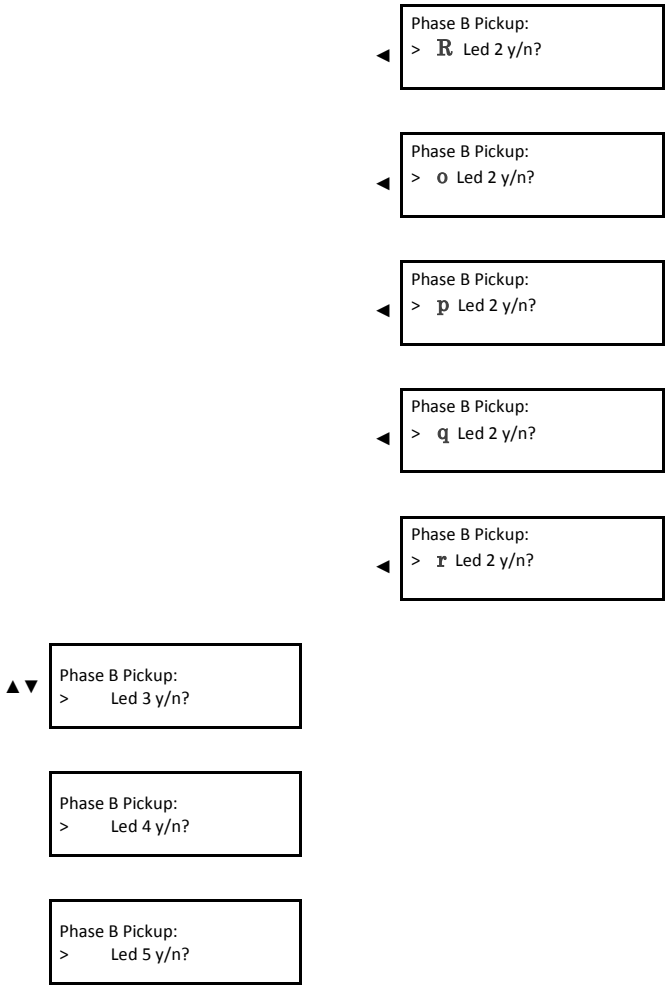



**NOTE**: if fault report is configured to a situation that does not cause trip screen then the fault report is identified with the number of report (example in the flowchart Fault report 77). If fault report is configured to a situation that originates a trip screen the the fault report is identified with the trip (example in the Trip 59-1)

### 7.6.17. Input, Leds, logical outputs and physical outputs configuration Menu.




Phase B Pickup:
> ⌠ Led 2 y/n?
Phase B Pickup:
> τ Led 2 y/n?
Phase B Pickup:
> Φ Led 2 y/n
Phase B Pickup:
> & Led 2 y/n?
Phase B Pickup:
> $ Led 2 y/n?
Phase B Pickup:
> § Led 2 y/n?
Phase B Pickup:
> O Led 2 y/n?
Phase B Pickup:
> P Led 2 y/n?
Phase B Pickup:
> Q Led 2 y/n?


Phase B Pickup:
> R Led 2 y/n?
Phase B Pickup:
> o Led 2 y/n?
Phase B Pickup:
> p Led 2 y/n?
Phase B Pickup:
> q Led 2 y/n?
Phase B Pickup:
> r Led 2 y/n?
Phase B Pickup:
> Led 3 y/n?
Phase B Pickup:
> Led 4 y/n?
Phase B Pickup:
> Led 5 y/n?

Phase B Pickup:
> Led 6 y/n?

Phase B Pickup:
> Led 7 y/n?

Phase B Pickup:
> Led-52 y/n?

Phase B Pickup:
> Led-79 y/n?

Phase B Pickup:
> Output 1 y/n?

Phase B Pickup:
> Output 2 y/n?

Phase B Pickup:
> Output 3 y/n?

Phase B Pickup:
> Output 4 y/n?

# 8. MODBUS RTU PROTOCOL

### 8.1.1. ModBus package 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:<br>15 ms at 2400 bps<br>2 ms at 19200 bps<br>...etc. |

### 8.1.2. Function codes

| HEX<br>DEC<br>CODE | MODBUS NAME | DEFINITION | COMMENT |
|---|---|---|---|
| 0x03<br>3 | Read Holding<br>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 are 60. |
| 0x10<br>16 | Preset Multiple<br>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. |

### 8.2.3. Exemptions an 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. |

### 8.2.4. 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.<br>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 auxiliar 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.<br>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 |
| **DWORD** | 2 | Integer with sign of 4 bytes |
| **FLOAT** | 2 | Number in floating decimal point “Float” of 4 bytes |
| **ASCIIxx** | xx/2 | String: In length variable character chain. Final of String marked with ‘\0’. |

| | | |
|---|---|---|
| | | E. g.: “ABC” 0x41x42x43x00.... |
| **MILIS** | 3 | Minutes(passed since 00:00 of 1/1/2000)(LONG).milliseconds(UINT) |
| **FH** | 5 | Year(UINT).month(UCHAR).day(UCHAR).hour(UCHAR).minutes(UCHAR).seconds (UCHAR).hundredth(UCHAR).thousandth(UINT) |
| **CONT** | 13 | Directory(UINT).Value(DWORD).Description(ASCII20) |
| **EVENT** | 9 | Criteria Directory(UINT).Event Identifier(UINT).Value(UINT).Associated Measure(UINT).Date and Time(FH) |
| **EVENTO** | 10 | Antiquity(UINT).Event(EVENT) |
| **CCRIT** | 6 | Criteria Number(UINT).Criteria Directory(UINT).Descriptive text(ASCII8) |
| **PEST** | 61 | Number of States(UINT).Protection State-1(BIT16). … Protection State-60(BIT16) |
| **PCRIT** | 61 | Number of Criteria(UINT).Index of Criteria-1(UINT). … Index of Criteria-60(UINT). |
| **CMED** | 8 | Number of Meassure(UINT).Descriptive text(ASCII7).Unit(ASCII3).Primary Unit(ASCII5).Number of decimals(UCHAR) |
| **GAJU** | 61 | Number of Groups(UINT).Index of the Criteria-1(UINT).Index of the first setting of the Criteria-1(UINT). … Index of the Criterion-30(UINT).Index of the first setting of the Criteria-30(UINT). |

When the data format takes up more than one BYTE, the most important BYTE is sent through the communications first, and the least important BYTE is sent last.

### 8.2.5. Memory map of SIL-V

| 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 | Access type | 162 | 2 | UCHAR4 | See Passwords and Access Levels |
| 16 | Session start | 168 | 2 | UCHAR4 | See Passwords and Access Levels |
| 03 and 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 and 16 | Counters | 202 | 2 | CONT | Number of openings |

| | | | | | |
|---|---|---|---|---|---|
| 03 and 16 | Counters | 212 | 2 | CONT | Number of reclosings |
| 03 | Serial number | 252 | 2 | LONG | |
| 03 | Equipment identifier | 254 | 44 | ASCII88 | |
| 03 | Primary measurement | 300 | 2 | FLOAT | MEASUREMENT_VA |
| 03 | Primary measurement | 302 | 2 | FLOAT | MEASUREMENT _VB |
| 03 | Primary measurement | 304 | 2 | FLOAT | MEASUREMENT _VC |
| 03 | Primary measurement | 306 | 2 | FLOAT | MEASUREMENT _VR or MEASUREMENT _VBB |
| 03 | Primary measurement | 308 | 2 | FLOAT | MEASUREMENT _3V-0 |
| 03 | Primary measurement | 310 | 2 | FLOAT | MEASUREMENT _V2 |
| 03 | Primary measurement | 312 | 2 | FLOAT | MEASUREMENT _V1 |
| 03 | Primary measurement | 314 | 2 | FLOAT | MEASUREMENT _VMIN |
| 03 | Primary measurement | 316 | 2 | FLOAT | MEASUREMENT _VMAX |
| 03 | Primary measurement | 318 | 2 | FLOAT | MEASUREMENT _ line freq. |
| 03 | Primary measurement | 320 | 2 | FLOAT | MEASUREMENT _ bar freq. |
| 03 | Primary measurement | 322 | 2 | FLOAT | MEASUREMENT _ freq. difference |
| 03 | Primary measurement | 324 | 2 | FLOAT | MEASUREMENT _ phase. difference |
| 03 | Primary measurement | 328 | 2 | FLOAT | MEASUREMENT _ dVA/dt |
| 03 | Primary measurement | 330 | 2 | FLOAT | MEASUREMENT _ dVB/dt |
| 03 | Primary measurement | 332 | 2 | FLOAT | MEASUREMENT _ dVC/dt |
| 03 | Primary measurement | 334 | 2 | FLOAT | MEASUREMENT _df/dt |
| 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 and 16 | Events number | 421 | 2 | | |
| 03 | State reading | 500 | 2 | BIT32 | General states in status and events section |
| 03 | State reading | 502 | 2 | BIT32 | Local communication in status and events section |
| 03 | State reading | 504 | 2 | BIT32 | Inputs in status and events section |

| | | | | | |
|---|---|---|---|---|---|
| 03 | State reading | 506 | 2 | BIT32 | Outputs in status and events section |
| 03 | State reading | 508 | 2 | BIT32 | Leds in status and events section |
| 03 | State reading | 510 | 2 | BIT32 | Logic in status and events section |
| 03 | State reading | 514 | 2 | BIT32 | Remote communication states map |
| 03 | State reading | 516 | 2 | BIT32 | IEC60870-5-103 in status and events section |
| 03 | State reading | 518 | 2 | BIT32 | BF in status and events section |
| 03 | State reading | 520 | 2 | BIT32 | 52 in status and events section |
| 03 | State reading | 522 | 2 | BIT32 | 79 in status and events section |
| 03 | State reading | 524 | 2 | BIT32 | 74TCS in status and events section |
| 03 | State reading | 526 | 2 | BIT32 | 27-1 in status and events section |
| 03 | State reading | 528 | 2 | BIT32 | 27-2 in status and events section |
| 03 | State reading | 530 | 2 | BIT32 | 59-1 in status and events section |
| 03 | State reading | 532 | 2 | BIT32 | 59-2 in status and events section |
| 03 | State reading | 534 | 2 | BIT32 | 59N-1 in status and events section |
| 03 | State reading | 536 | 2 | BIT32 | 59N-2 in status and events section |
| 03 | State reading | 538 | 2 | BIT32 | 81-1 in status and events section |
| 03 | State reading | 540 | 2 | BIT32 | 81-2 in status and events section |
| 03 | State reading | 542 | 2 | BIT32 | 81-3 in status and events section |
| 03 | State reading | 544 | 2 | BIT32 | 81-4 in status and events section |
| 03 | State reading | 546 | 2 | BIT32 | 81R-1 in status and events section |
| 03 | State reading | 548 | 2 | BIT32 | 81R-2 in status and events section |

| | | | | | |
|---|---|---|---|---|---|
| 03 | State reading | 550 | 2 | BIT32 | 27V1 in status and events section |
| 03 | State reading | 552 | 2 | BIT32 | 47 in status and events section |
| 03 | State reading | 554 | 2 | BIT32 | 78 in status and events section |
| 03 | State reading | 556 | 2 | BIT32 | 25 in status and events section |
| 03 | State reading | 558 | 2 | BIT32 | dV/dt in status and events section |
| 03 and 16 | Setting | 600 | 10 | ASCII20 | Equipment identifier |
| 03 and 16 | Setting | 610 | 2 | DENUM 5060Hz | Frequency |
| 03 and 16 | Setting | 612 | 2 | LONG | Serial number |
| 03 and 16 | Setting | 614 | 2 | DENUM LANGUAGE | Language |
| 03 and 16 | Setting | 616 | 2 | LONG | Active group |
| 03 and 16 | Setting | 618 | 2 | DENUM CURRENT | VT connection |
| 03 and 16 | Setting | 620 | 2 | DENUM CURRENT | Nominal voltage |
| 03 and 16 | Setting | 622 | 2 | FLOAT | VT Ratio |
| | | | | | |
| 03 and 16 | Setting | 626 | 2 | LONG | Local address |
| 03 and 16 | Setting | 628 | 2 | LONG | Remote address |
| 03 and 16 | Setting | 630 | 2 | DENUMBAUD | Remote baudrate |
| 03 and 16 | Setting | 632 | 2 | DENUM PROTOCOL | Protocol |
| 03 and 16 | Setting | 634 | 2 | DENUM NOSI | BF Permission |
| 03 and 16 | Setting | 636 | 2 | FLOAT | BF Operating time |
| 03 and 16 | Setting | 638 | 2 | LONG | F52 Max openings number |
| 03 and 16 | Setting | 640 | 2 | LONG | |
| 03 and 16 | Setting | 642 | 2 | FLOAT | 52 Max opening time |
| 03 and 16 | Setting | 644 | 2 | FLOAT | 52 Max closing time |
| 03 and 16 | Setting | 646 | 2 | LONG | 52 Excess openings number |
| 03 and 16 | Setting | 648 | 2 | FLOAT | 52 Excess openings time |
| 03 and 16 | Setting | 650 | 2 | DENUM NO SI | 79 Permission |

| | | | | | |
|---|---|---|---|---|---|
| 03 and 16 | Setting | 652 | 2 | DENUM NO SI | 79 Hold permission |
| 03 and 16 | Setting | 654 | 2 | FLOAT | 79 Number of reclosings |
| 03 and 16 | Setting | 656 | 2 | FLOAT | 79 Reclosing 1 time |
| 03 and 16 | Setting | 658 | 2 | FLOAT | 79 Reclosing 2 time |
| 03 and 16 | Setting | 660 | 2 | FLOAT | 79 Reclosing 3 time |
| 03 and 16 | Setting | 662 | 2 | FLOAT | 79 Reclosing 4 time |
| 03 and 16 | Setting | 664 | 2 | FLOAT | 79 Reclosing 5 time |
| 03 and 16 | Setting | 666 | 2 | FLOAT | 79 Hold time |
| 03 and 16 | Setting | 668 | 2 | FLOAT | 79 Reset time |
| 03 and 16 | Setting | 670 | 2 | FLOAT | 79 Definitive opening time |
| 03 and 16 | Setting | 672 | 2 | DENUM NO SI | 74TCS Permission |
| 03 and 16 | Setting | 674 | 2 | FLOAT | 74TCS Operating time |
| 03 and 16 | Setting | 676 | 2 | DENUM NO SI | 27-1 Permission |
| 03 and 16 | Setting | 678 | 2 | FLOAT | 27-1 Tap |
| 03 and 16 | Setting | 680 | 2 | FLOAT | 27-1 Operating time |
| 03 and 16 | Setting | 682 | 2 | FLOAT | 27-1 Reset time |
| 03 and 16 | Setting | 684 | 2 | DENUM NO SI | 27-2 Permission |
| 03 and 16 | Setting | 686 | 2 | FLOAT | 27-2 Tap |
| 03 and 16 | Setting | 688 | 2 | FLOAT | 27-2 Operating time |
| 03 and 16 | Setting | 690 | 2 | FLOAT | 27.-2 Reset time |
| 03 and 16 | Setting | 692 | 2 | DENUM NO SI | 59-1 Permission |
| 03 and 16 | Setting | 694 | 2 | FLOAT | 59.-1 Tap |
| 03 and 16 | Setting | 696 | 2 | FLOAT | 59-1 Operating time |
| 03 and 16 | Setting | 698 | 2 | FLOAT | 59-1 Reset time |
| 03 and 16 | Setting | 700 | 2 | DENUM NO SI | 59-2 Permission |
| 03 and 16 | Setting | 702 | 2 | FLOAT | 59-2 Tap |
| 03 and 16 | Setting | 704 | 2 | FLOAT | 59-2 Operating time |
| 03 and 16 | Setting | 706 | 2 | FLOAT | 59-2 Reset time |
| 03 and 16 | Setting | 708 | 2 | DENUM NO/YES | 81-1 Permission |
| 03 and 16 | Setting | 710 | 2 | DENUM UNDER/OVER | 81-1 Type |

| | | | | | |
|---|---|---|---|---|---|
| 03 and 16 | Setting | 712 | 2 | FLOAT | 81-1 Tap |
| 03 and 16 | Setting | 714 | 2 | FLOAT | 81-1 Operating time |
| 03 and 16 | Setting | 716 | 2 | FLOAT | 81-1 Reset time |
| 03 and 16 | Setting | 718 | 2 | DENUM NO/YES | 81-2 Permission |
| 03 and 16 | Setting | 720 | 2 | DENUM UNDER/OVER | 81-2 Type |
| 03 and 16 | Setting | 722 | 2 | FLOAT | 81-2 Tap |
| 03 and 16 | Setting | 724 | 2 | FLOAT | 81-2 Operating time |
| 03 and 16 | Setting | 726 | 2 | FLOAT | 81-2 Reset time |
| 03 and 16 | Setting | 728 | 2 | DENUM NO/YES | 81-3 Permission |
| 03 and 16 | Setting | 730 | 2 | DENUM UNDER/OVER | 81-3 Type |
| 03 and 16 | Setting | 732 | 2 | FLOAT | 81-3 Tap |
| 03 and 16 | Setting | 734 | 2 | FLOAT | 81-3 Operating time |
| 03 and 16 | Setting | 736 | 2 | FLOAT | 81-3 Reset time |
| 03 and 16 | Setting | 738 | 2 | DENUM NO/YES | 81-4 Permission |
| 03 and 16 | Setting | 740 | 2 | DENUM UNDER/OVER | 81-4 Type |
| 16 | Confirm setting | 1042 | 2 | FLOAT | 81-4 Tap |
| 16 | Confirm setting | 1044 | 2 | FLOAT | 81-4 Operating time |
| 16 | Confirm setting | 1046 | 2 | FLOAT | 81-4 Reset time |
| 16 | Confirm setting | 1048 | 2 | DENUM NO/YES | 81R-1 Permission |
| 16 | Confirm setting | 1050 | 2 | DENUM DEC/INC | 81R-1 Type |
| 16 | Confirm setting | 1052 | 2 | FLOAT | 81R-1 Tap |
| 16 | Confirm setting | 1054 | 2 | FLOAT | 81R-1 Operating time |
| 16 | Confirm setting | 1056 | 2 | FLOAT | 81R-1 Reset time |
| 16 | Confirm setting | 1058 | 2 | DENUM NO/YES | 81R-2 Permission |
| 16 | Confirm setting | 1060 | 2 | DENUM DEC/INC | 81R-2 Type |
| 16 | Confirm setting | 1062 | 2 | FLOAT | 81R-2 Tap |
| 16 | Confirm setting | 1064 | 22 | FLOAT | 81R-2 Operating time |
| 16 | Confirm setting | 1066 | 2 | FLOAT | 81R-2 Reset time |
| 16 | Confirm setting | 1068 | 2 | DENUM NO SI | 59N-1 Permission |

| | | | | | |
|---|---|---|---|---|---|
| 16 | Confirm setting | 1070 | 2 | FLOAT | 59N-1 Tap |
| 16 | Confirm setting | 1072 | 2 | FLOAT | 59N-1 Operating time |
| 16 | Confirm setting | 1074 | 2 | FLOAT | 59N-1 Reset time |
| 16 | Confirm setting | 1076 | 2 | DENUM NO SI | 59N-2 Permission |
| 16 | Confirm setting | 1078 | 2 | FLOAT | 59N-2 Tap |
| 16 | Confirm setting | 1080 | 2 | FLOAT | 59N-2 Operating time |
| 16 | Confirm setting | 1082 | 2 | FLOAT | 59N-2 Reset time |
| 16 | Confirm setting | 1084 | 2 | DENUM NO SI | 27V1 Permission |
| 16 | Confirm setting | 1086 | 2 | FLOAT | 27V1 Tap |
| 16 | Confirm setting | 1088 | 2 | FLOAT | 27V1 Operating time |
| 16 | Confirm setting | 1090 | 2 | FLOAT | 27V1 Reset time |
| 16 | Confirm setting | 1092 | 2 | DENUM NO SI | 47 Permission |
| 16 | Confirm setting | 1094 | 2 | FLOAT | 47 Tap |
| 16 | Confirm setting | 1096 | 2 | FLOAT | 47 Operating time |
| 16 | Confirm setting | 1098 | 2 | FLOAT | 47 Reset time |
| 16 | Confirm setting | 1100 | 2 | DENUM NO/YES | 78 Permission |
| 16 | Confirm setting | 1102 | 2 | FLOAT | 78 Tap |
| 16 | Confirm setting | 1104 | 2 | FLOAT | 78 Reset time |
| 16 | Confirm setting | 1106 | 2 | FLOAT | 25 Unde Voltage Tap |
| 16 | Confirm setting | 1108 | 2 | FLOAT | 25 Over Voltage Tap |
| 16 | Confirm setting | 1110 | 2 | FLOAT | 25 Voltage Supervision time |
| 16 | Confirm setting | 1112 | 2 | FLOAT | 25 Module Diference |
| 16 | Confirm setting | 1114 | 2 | FLOAT | 25 Phase Diference |
| 16 | Confirm setting | 1116 | 2 | FLOAT | 25 Frquency Diference |
| 16 | Confirm setting | 1118 | 2 | FLOAT | 25 Operacting time |
| 16 | Confirm setting | 1120 | 2 | DENUM NO/YES | dV/dt Permission |
| 16 | Confirm setting | 1122 | 2 | DENUM NO/YES | dV/dt Type |
| 16 | Confirm setting | 1124 | 2 | FLOAT | dV/dt Activation level |
| 16 | Confirm setting | 1126 | 2 | FLOAT | dV/dt Operating time |
| 16 | Confirm setting | 1128 | 2 | FLOAT | dV/dt Reset time |

### 8.2.6. Commands map

| | |
|---|---|
| **2** | Open Circuit breaker |
| **3** | Close circuit breaker |
| **4** | Pulse Lock 79 |
| **5** | Pulse Unlock 79 |
| **6** | Local control |
| **7** | Telecontrol |
| **8** | Reset |

### 8.2.7. Examples of Mosdbus frames

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

| address | function | H Pickup address | L Pickup address | Number of H registers | Number of L registers | Number of Bytes | Password | checksum H | checksum L |
|---|---|---|---|---|---|---|---|---|---|
| 01 | 10 | 00 | A8 | 00 | 02 | 04 | 35,35,35,35 | 30 | F4 |

And the SIL-V will reply OK:

| address | function | H Pickup address | L Pickup address | Number of H registers | Number of L registers | Number of Bytes | checksum H | checksum L |
|---|---|---|---|---|---|---|---|---|
| 01 | 10 | 00 | A8 | 00 | 02 | 04 | 29 | 93 |

Reading the 4 measurements from the primary winding of equipment no. 1

| address | function | H Pickup address | L Pickup address | Number of H registers | Number of L registers | checksum H | checksum L |
|---|---|---|---|---|---|---|---|
| 01 | 03 | 05 | 79 | 00 | 08 | 95 | 19 |

And the SIL-V will reply with the VA, VB, VC and V0 measurements in FLOAT format:

| address | function | Number of Bytes | Measurement VA | Measurement VB | Measurement VC | Measurement VN | checksum H | checksum L |
|---|---|---|---|---|---|---|---|---|
| 01 | 03 | 10 | 00,00,00,00 | 00,00,00,00 | 00,00,00,00 | 00,00,00,00 | E4 | 59 |

Reading the protection status of equipment no. 1

| address | function | H Pickup address | L Pickup address | Number of H registers | Number of L registers | checksum H | checksum L |
|---|---|---|---|---|---|---|---|
| 01 | 03 | 01 | F5 | 00 | 3D | 95 | D5 |

And the SIL-V will reply with:

| address | function | Number of Bytes | 50P Status | 51P Status | 50G Status | 51G Status | General Status | Inputs Status | Outputs Status | COM Status |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | 03 | 7A | 00,09 | 00,00 | 00,00 | 00,00 | 00,00,00,D2 | 80,21 | 00,00 | 00,03 |

| RESERVED | checksum H | checksum L |
|---|---|---|
| 00,00,00,01,00,00,00,00,……,7C,B1,0A,AF,DD | 3B | 1D |

# 9. IEC 60870-5-103 PROTOCOL

This section describes the protocol IEC 60870-5-103 implementation in the unit.

## 9.1. Physical layer

Electrical interface

| | |
|---|---|
| **X** | RS-485 |
| **32** | Number of loads for one protection equipment |

Transmission speed

| | |
|---|---|
| **X** | 4800 bits/s |
| **X** | 9600 bits/s |
| **X** | 19200 bits/s |
| **X** | 38400 bits/s |

Transmission parameters

| | |
|---|---|
| **Data size** | 8 bit |
| **parity** | EVEN |
| **Stop bits** | 1 |

## 9.2. Application layer

Transmission mode for application data

Mode 1 (least significant octet first), as defined in 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

The following functions are supported:

- Initialization
- General Interrogation
- Synchronization
- Commands transmission

Information in monitor direction:

<1>:= time-tagged message
<2>:= time-tagged message with relative time
<3>:= measurands I
<5>:= identification
<6>:= time synchronization
<8>:= general interrogation termination

Information in control direction:

<6>:= time synchronization
<7>:= general interrogation
<20>:= general command

Common address of ASDU

| | |
|---|---|
| **X** | One COMMON ADDRESS OF ASDU (identical with station address) |
| | More than one COMMON ADDRESS OF ASDU |
| **255** | GLOBAL ADDRESS |

Selection of standard information numbers in monitor direction

| SIL-V | FUN | INF | Description | TYP | COT |
|---|---|---|---|---|---|
| **System functions in monitor direction** | | | | | |
| X | 160 | <0> | End of general interrogation | 8 | End of GI |
| X | 160 | <0> | Time synchronization | 6 | TS |
| X | 160 | <2> | Reset FCB | 5 | Reset FCB |
| X | 160 | <3> | Reset CU | 5 | Reset CU |
| X | 160 | <4> | Start/restart | 5 | Start/restart |
| | | <5> | Power on | | |
| **Status indications in monitor direction** | | | | | |
| X | 160 | <16> | Auto-recloser active | 1 | SE,GI |
| X | 160 | <17> | Teleprotection active | 1 | SE,GI |
| X | 160 | <18> | Protection active | 1 | SE,GI |
| X | 160 | <19> | LED reset | 1 | SE,GI |
| | | <20> | Monitor direction locked | | |
| | | <21> | Test mode | | |
| X | 160 | <22> | Local parameter setting | 1 | SE,GI |
| | | <23> | Characteristic 1 | | |
| | | <24> | Characteristic 2 | | |
| | | <25> | Characteristic 3 | | |
| | | <26> | Characteristic 4 | | |
| X | 160 | <27> | Auxiliary input 1 | 1 | SE,GI |

| | | | | | |
|---|---|---|---|---|---|
| X | 160 | <28> | Auxiliary input 2 | 1 | SE,GI |
| X | 160 | <29> | Auxiliary input 3 | 1 | SE,GI |
| X | 160 | <30> | Auxiliary input 4 | 1 | SE,GI |
| **Supervision indications in monitor direction** | | | | | |
| | | <32> | Measurment supervision I | | |
| | | <33> | Measurement supervision V | | |
| | | <35> | Phase sequence supervision | | |
| | | <36> | Trip circuit supervision | | |
| | | <37> | I>> back-up operation | | |
| | | <38> | VT fuse failure | | |
| | | <39> | Teleprotection disturbed | | |
| | | <46> | Group warning | | |
| | | <47> | Group alarm | | |
| **Earth fault indications in monitor direction** | | | | | |
| | | <48> | Earth fault L1 | | |
| | | <49> | Earth fault L2 | | |
| | | <50> | Earth fault L3 | | |
| | | <51> | Earth fault forward, i.e. line | | |
| | | <52> | Earth fault reverse, i.e. busbar | | |
| **Fault indications in monitor direction** | | | | | |
| X | 160 | <64> | Pickup L1 | 2 | SE |
| X | 160 | <65> | Pickup L2 | 2 | SE |
| X | 160 | <66> | Pickup L3 | 2 | SE |
| X | 160 | <67> | Pickup N | 2 | SE |
| X | 160 | <68> | General trip | 2 | SE |
| X | 160 | <69> | Trip L1 | 2 | SE |
| X | 160 | <70> | Trip L2 | 2 | SE |
| X | 160 | <71> | Trip L3 | 2 | SE |
| | | <72> | Trip I>> (back-up operation) | | |

| | | | | | |
|---|---|---|---|---|---|
| | | <73> | Fault location X in ohms | | |
| | | <74> | Fault forward / line | | |
| | | <75> | Fault forward / busbar | | |
| | | <76> | Teleprotection signal transmitted | | |
| | | <77> | Teleprotection signal received | | |
| | | <78> | Zone 1 | | |
| | | <79> | Zone 2 | | |
| | | <80> | Zone 3 | | |
| | | <81> | Zone 4 | | |
| | | <82> | Zone 5 | | |
| | | <83> | Zone 6 | | |
| X | 160 | <84> | General Pickup | 2 | SE |
| X | 160 | <85> | Breaker failure | 1 | SE,GI |
| | | <86> | Trip measuring system L1 | | |
| | | <87> | Trip measuring system L2 | | |
| | | <88> | Trip measuring system L3 | | |
| | | <89> | Trip measuring system E | | |
| | | <90> | Trip I> | | |
| | | <91> | Trip I>> | | |
| | | <92> | Trip IN> | | |
| | | <93> | Trip IN>> | | |
| **Auto-reclosure indications in monitor direction** | | | | | |
| X | 160 | <128> | CB 'on' by AR | 2 | SE |
| | | <129> | CB 'on' by long-time AR | | |
| X | 160 | <130> | AR blocked | 1 | SE,GI |
| **Measurements in monitor direction** | | | | | |
| | | <144> | Measurement I | | |
| | | <145> | Measurement I, V | | |

| | | | | | |
|---|---|---|---|---|---|
| | | <146> | Measurements I, V, P, Q | | |
| | | <147> | Measurements In, Vn | | |
| X | 160 | <148> | Measurements IL123, VL123, P, Q, f (**) | 9 | CYC |
| **Generic functions in monitor direction** | | | | | |
| X | 200 | <1> | CB close / open | 1 | SE,GI |
| X | 200 | <4> | 52 Status Open Time | 2 | SE |
| X | 200 | <5> | 52 Status Open Failure | 2 | SE |
| X | 200 | <6> | 52 Status Close Failure | 2 | SE |
| X | 200 | <7> | 52 Status excessive openings | 1 | SE,GI |
| X | 200 | <9> | 52 Status excessive openings per minute | 1 | SE,GI |
| X | 200 | <16> | 79 Status Reclose Time | 2 | SE |
| X | 200 | <17> | 79 Status Open | 2 | SE |
| X | 200 | <18> | 79 Status Wait Time | 2 | SE |
| X | 200 | <19> | 79 Status Reset Time | 2 | SE |
| X | 200 | <20> | 79 Status Security Time | 2 | SE |
| X | 200 | <21> | 79 Status final open Time | 2 | SE |
| X | 200 | <24> | GEN 50Hz | 1 | SE,GI |
| X | 200 | <26> | GEN Measurement Error | 1 | SE,GI |
| X | 200 | <28> | GEN synchronism | 2 | SE |
| X | 200 | <29> | GEN Eeprom with default values | 1 | SE,GI |
| X | 200 | <30> | GEN eeprom Error | 1 | SE,GI |
| X | 200 | <31> | GEN Eeprom values changed | 1 | SE,GI |
| X | 200 | <48> | 52 a Input | 1 | SE, GI |

| | | | | | |
|---|---|---|---|---|---|
| X | 200 | <49> | 52 b Input | 1 | SE, GI |
| X | 200 | <52> | External trip input | 1 | SE, GI |
| X | 200 | <53> | Fault init input | 1 | SE, GI |
| X | 200 | <54> | 79 init input | 1 | SE, GI |
| X | 200 | <55> | 79 Enable input | 1 | SE, GI |
| X | 200 | <56> | 79 Level lockout input | 1 | SE, GI |
| X | 200 | <57> | 1 Setting group input | 1 | SE, GI |
| X | 200 | <58> | 2 Setting group input | 1 | SE, GI |
| X | 200 | <59> | 79 pulse lockout input | 1 | SE, GI |
| X | 200 | <60> | 79 pulse unlock input | 1 | SE, GI |
| X | 200 | <61> | 50BF init input | 1 | SE, GI |
| X | 200 | <63> | Continuity A | 1 | SE, GI |
| X | 200 | <64> | Continuity B | 1 | SE, GI |
| X | 200 | <76> | Auxiliary Input 5 | 1 | SE, GI |
| X | 200 | <77> | Auxiliary Input 6 | 1 | SE, GI |
| X | 200 | <92> | Auxiliary output 1 | 1 | SE, GI |
| X | 200 | <93> | Auxiliary output 2 | 1 | SE, GI |
| X | 200 | <94> | Auxiliary output 3 | 1 | SE, GI |
| X | 200 | <95> | Auxiliary output 4 | 1 | SE, GI |
| X | 200 | <120> | 52 Close enabled | 1 | SE, GI |
| X | 200 | <133> | CB Open | 2 | SE |
| X | 200 | <134> | CB Close | 2 | SE |
| X | 200 | <135> | 79 Lockout | 2 | SE |

| | | | | | |
|---|---|---|---|---|---|
| X | 200 | <136> | 79 Unlock | 2 | SE |
| X | 200 | <137> | Remote control into Local | 2 | SE |
| X | 200 | <138> | Telecontrol into Remote | 2 | SE |
| X | 200 | <141> | Open CB | 2 | SE |
| X | 200 | <142> | Close CB | 2 | SE |
| X | 200 | <143> | Lockout 79 | 2 | SE |
| X | 200 | <144> | Unlock 79 | 2 | SE |
| X | 200 | <149> | Open CB | 2 | SE |
| X | 200 | <150> | Close CB | 2 | SE |
| X | 200 | <151> | Lockout 79 | 2 | SE |
| X | 200 | <152> | Unlock 79 | 2 | SE |
| X | 201 | <40> | 50BF Start | 2 | SE |
| X | 201 | <41> | 50BF Activation | 2 | SE |
| X | 202 | <1> | Live Line, Live Bus | 2 | SE |
| X | 202 | <2> | Live Line, Dead Bus | 2 | SE |
| X | 202 | <3> | Dead Line, Live Bus | 2 | SE |
| X | 202 | <4> | Dead Line, Dead Bus | 2 | SE |
| X | 202 | <5> | Synchronism Permmision | 2 | SE |
| X | 202 | <15> | 27 Trip P_1 | 2 | SE |
| X | 202 | <23> | 27 Trip P_2 | 2 | SE |
| X | 202 | <24> | 59 Start N_1 | 2 | SE |
| X | 202 | <25> | 59 Trip N_1 | 2 | SE |
| X | 202 | <26> | 59 Start N_2 | 2 | SE |

| | | | | | |
|---|---|---|---|---|---|
| X | 202 | <27> | 59 Trip N_2 | 2 | SE |
| X | 202 | <31> | 59 Start P_1 | 2 | SE |
| X | 202 | <35> | 59 Trip P_1 | 2 | SE |
| X | 202 | <39> | 59 Start P_2 | 2 | SE |
| X | 202 | <43> | 59 Trip P_2 | 2 | SE |
| X | 202 | <48> | 81 Start_1 | 2 | SE |
| X | 202 | <49> | 81 Trip_1 | 2 | SE |
| X | 202 | <50> | 81 General Lockout | 1 | SE,GI |
| X | 202 | <51> | 81 Start_2 | 2 | SE |
| X | 202 | <52> | 81 Trip_2 | 2 | SE |
| X | 202 | <54> | 81 Start_3 | 2 | SE |
| X | 202 | <55> | 81 Trip_3 | 2 | SE |
| X | 202 | <57> | 81 Start_4 | 2 | SE |
| X | 202 | <58> | 81 Trip_4 | 2 | SE |
| X | 202 | <60> | 81R Start_1 | 2 | SE |
| X | 202 | <61> | 81R Trip_1 | 2 | SE |
| X | 202 | <62> | 81R Start_2 | 2 | SE |
| X | 202 | <63> | 81R Trip_2 | 2 | SE |
| X | 202 | <72> | 78 Trip | 2 | SE |
| X | 203 | <3> | 74TC Trip | 1 | SE,GI |
| X | 203 | <4> | 74TC Start | 2 | SE |
| X | 203 | <6> | 27V1 Start | 2 | SE |
| X | 203 | <7> | 27V1 Trip | 2 | SE |

| | | | | | |
|---|---|---|---|---|---|
| X | 203 | <8> | 47 Start | 2 | SE |
| X | 203 | <9> | 47 Trip | 2 | SE |
| X | 203 | <10> | 100% DV/DT | 2 | SE |
| X | 203 | <11> | 25 Voltage Difference | 2 | SE |
| X | 203 | <12> | 25 Frequency Difference | 2 | SE |
| X | 203 | <13> | 25 Phase Difference | 2 | SE |
| X | 203 | <14> | Manual Close | 1 | SE,GI |

(**) Type Identification 9 : Measurands II (Measurements IL123, VL123, P, Q, f)

SIL-V relay uses this type to send the value of theVL1, VL2 and VL3, the other measures remain with value 0.

Each value is in the range 0 – 4095 where 4095 corresponds to 1,2*Vn

e.g. a received value of 323 with a nominal value Vn=63.5A corresponds to 6V

Selection of standard information numbers in control direction

| SIL-V | FUN | INF | Description | TYP | COT |
|---|---|---|---|---|---|
| **System functions in control direction** | | | | | |
| X | 160 | <0> | Initiation of general interrogation | 7 | Init of GI |
| X | 160 | <0> | Time synchronization | 6 | TS |
| **General commands in control direction** | | | | | |
| X | 160 | <16> | Auto-recloser on (1) / off (0) | 20 | ACK,NACK |
| | | <17> | Teleprotection on / off | | |
| | | <18> | Protection on / off | | |
| X | 160 | <19> | LED reset (0) | 20 | ACK,NACK |
| | | <23> | Activate characteristic 1 | | |
| | | <24> | Activate characteristic 2 | | |
| | | <25> | Activate characteristic 3 | | |
| | | <26> | Activate characteristic 4 | | |
| **Generic functions in control direction** | | | | | |
| | | <240> | Read headings of all defined groups | | |
| | | <241> | Read values or attributes of all entries of one group | | |
| | | <243> | Read directory of a single entry | | |
| | | <244> | Read value or attribute of a single entry | | |
| | | <245> | End of general interrogation of generic data | | |
| | | <248> | Write entry | | |
| | | <249> | Write entry with confirmation | | |
| | | <250> | Write entry with execution | | |
| | | <251> | Write entry aborted | | |
| **Particular commands in control direction** | | | | | |
| X | 200 | <1> | CB close (1) / open (0) | 20 | ACK,NACK |

# 10. IEC 61850 PROTOCOL

This section describes the implementation of IEC 61850 protocol.

IEC 61850 protocol defines a way of structuring the available information in each device, that is reflected in the Data Model and a way of managing and sending this information through communications using specific Services.

SILG device will be known as a Server IED (Intelligent Electronic Device), which services will be available using the Ethernet through its default IP (192.168.0.121)

MMS will be the used Ethernet protocol for the Client-Server communication and 102 will be the used port.

GOOSE fast messages is not a Client-Server communication like TCP/IP but a Multicast communication that sends messages directly to the Link Layer using MAC directions as destination directions for publishing the GOOSE.

## 10.1. Data model

Server IEDs have all the information of all their events, measures, parameters and services, organized in a hierachical structure with device's functional units as main ones.

The main level of the structure is the name of the IED, by default TEMPLATE, with its instance LD1

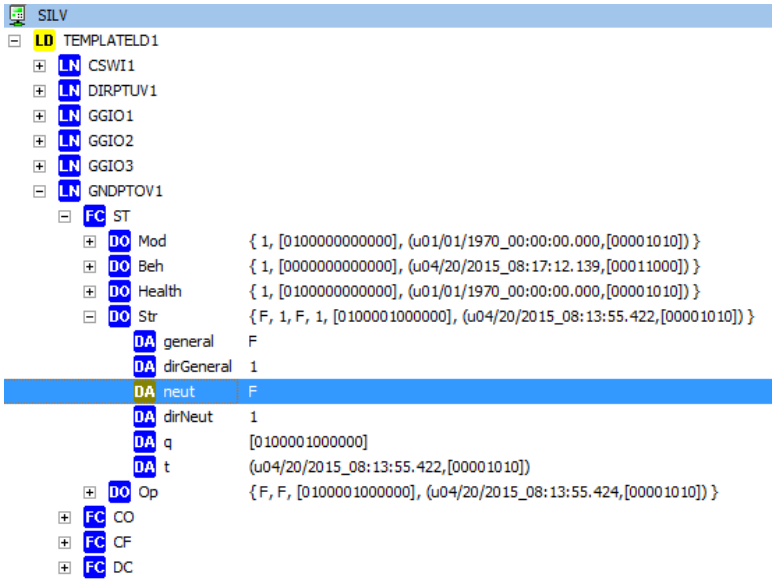
Down the IED there are Logical Nodes that represent the functional units of the IED (Protection, Control and measure units, status of external elements like circuit breaker, etc.)

Inside Logical Nodes there are Data objects that compose a functional unit, and inside each Data object, there are Data attributes that give complete information about this Data object.

As example, the ground overvoltage protection unit is represented in SIL-V according IEC 61850 as the logical node PTOV, with the prefix GND and the instance 1: GNDPTOV1

In the Logical Node, the starting of the unit is represented by its Data Object, *Str*, with a list of Data Attributes that give information about the starting:

Attribute *neut* indicates the status of the starting, *t* attribute indicates the time stamp when the starting has changed, etc.




The Data model of SIL-V according IEC 61850 is represented in the following tables:

**Protection:**

| Function | Logical Node | Data Object | Data Attribute |
|---|---|---|---|
| General Start / Pick up | PTRC1 | Str | general |
| Start / pick up L1 | PTRC1 | Str | phsA |
| Start / pick up L2 | PTRC1 | Str | phsB |
| Start / pick up L3 | PTRC1 | Str | phsC |
| Start / pick up N | PTRC1 | Str | neut |
| General Trip | PTRC1 | Tr | general |
| Trip L1 | PTRC1 | Op | phsA |
| Trip L2 | PTRC1 | Op | phsB |
| Trip L3 | PTRC1 | Op | phsC |
| 37P_2 Trip C | PTUC2 | Op | phsC |
| 37P_2 Trip P | PTUC2 | Op | general |
| 50BF Start | RBRF1 | Str | general |
| Break Failure | RBRF1 | OpEx | general |
| 50BF Activation | RBRF1 | OpIn | general |
| Synchronism Permmision | RSYN1 | Rel | stVal |
| 27P_1 Start P | (PHS)PTUV1 | Str | general |

| | | | |
|---|---|---|---|
| 27P_1 Trip P | (PHS)PTUV1 | Op | general |
| 27P_2 Start P | (PHS)PTUV2 | Str | general |
| 27P_2 Trip P | (PHS)PTUV2 | Op | general |
| 59N_1 Start | (GND)PTOV1 | Str | general |
| 59N_1 Trip | (GND)PTOV1 | Op | general |
| 59N_2 Start | (GND)PTOV2 | Str | general |
| 59N_2 Trip | (GND)PTOV2 | Op | general |
| 59P_1 Start P | (PHS)PTOV1 | Str | general |
| 59P_1 Trip P | (PHS)PTOV1 | Op | general |
| 59P_2 Start P | (PHS)PTOV2 | Str | general |
| 59P_2 Trip P | (PHS)PTOV2 | Op | general |
| 81_1 Start | PTUF1 | Str | general |
| 81_1 Trip | PTUF1 | Op | general |
| 81_2 Start | PTUF2 | Str | general |
| 81_2 Trip | PTUF2 | Op | general |
| 81_3 Start | PTOF1 | Str | general |
| 81_3 Trip | PTOF1 | Op | general |
| 81_4 Start | PTOF2 | Str | general |
| 81_4 Trip | PTOF2 | Op | general |
| 81R_1 Start | PFRC1 | Str | general |
| 81R_1 Trip | PFRC1 | Op | general |
| 81R_2 Start | PFRC2 | Str | general |
| 81R_2 Trip | PFRC2 | Op | general |
| 81R_4 Trip | PFRC4 | Op | general |
| 81R_4 Lockout | PFRC4 | Blk | stVal |
| 78_1 Start | PPAM1 | Str | general |
| 81 Lockout | GGIO3 | Ind24 | stVal |

### Measures:

| Function | Logical Node | Data Object | Data Attribute |
|---|---|---|---|
| Voltage Phase A | MMXU1 | PhV.phsA | cVal.mag.i |
| Voltage Phase B | MMXU1 | PhV.phsB | cVal.mag.i |
| Voltage Phase C | MMXU1 | PhV.phsC | cVal.mag.i |

### System Functions:

| Function | Logical Node | Data Object | Attribute |
|---|---|---|---|
| Teleprotection active | LLN0 | LocKey | stVal |
| Protection active | LPHD1 | PwrUp | stVal |
| Auxiliary Input 1 | GGIO1 | Ind1 | stVal |
| Auxiliary Input 2 | GGIO1 | Ind2 | stVal |
| Auxiliary Input 3 | GGIO1 | Ind3 | stVal |
| Auxiliary Input 4 | GGIO1 | Ind4 | stVal |
| Auxiliary Input 5 | GGIO1 | Ind5 | stVal |
| Auxiliary Input 6 | GGIO1 | Ind6 | stVal |
| Auxiliary Output 1 | GGIO1 | Ind9 | stVal |
| Auxiliary Output 2 | GGIO1 | Ind10 | stVal |
| Auxiliary Output 3 | GGIO1 | Ind11 | stVal |
| Auxiliary Output 4 | GGIO1 | Ind12 | stVal |
| 79 Enabled | GGIO2 | Ind1 | stVal |
| Local Parameter Setting | GGIO2 | Ind2 | stVal |
| Trip Circuit Supervision | GGIO2 | Ind3 | stVal |
| Trip I> | GGIO2 | Ind4 | stVal |
| Trip IN> | GGIO2 | Ind5 | stVal |
| CB on by AR | GGIO2 | Ind6 | stVal |
| 52 Status Open Failure | GGIO2 | Ind7 | stVal |
| 52 Status Close Failure | GGIO2 | Ind8 | stVal |
| 52 Status excessive openinigs | GGIO2 | Ind9 | stVal |
| 52 Status excessive sum of | GGIO2 | Ind10 | stVal |

| | | | |
|---|---|---|---|
| switched amperes | | | |
| 52 Status excessive openings per minute | GGIO2 | Ind11 | stVal |
| 52-A Status | GGIO2 | Ind12 | stVal |
| 52-B Status | GGIO2 | Ind13 | stVal |
| 52 Status Error | GGIO2 | Ind14 | stVal |
| 79 Status Reclose Time | GGIO2 | Ind15 | stVal |
| 79 Status Open | GGIO2 | Ind16 | stVal |
| 79 Status Wait Time | GGIO2 | Ind17 | stVal |
| 79 Status Reclaim Time | GGIO2 | Ind18 | stVal |
| 79 Status Security Time | GGIO2 | Ind19 | stVal |
| 79 Status Final opne Time | GGIO2 | Ind20 | stVal |
| GEN 50Hz | GGIO2 | Ind21 | stVal |
| Magnetic module Error | GGIO2 | Ind22 | stVal |
| GEN Measurand Error | GGIO2 | Ind23 | stVal |
| GEN Synchronism | GGIO2 | Ind24 | stVal |
| GEN Eeprom with default values | GGIO2 | Ind25 | stVal |
| GEN eeprom Error | GGIO2 | Ind26 | stVal |
| GEN Eeprom values changed | GGIO2 | Ind27 | stVal |
| GEN Events Error | GGIO2 | Ind28 | stVal |
| GEN New Oscillograph register | GGIO2 | Ind29 | stVal |
| 52 a Input | GGIO2 | Ind30 | stVal |
| 52 b Input | GGIO2 | Ind31 | stVal |
| Phase lockout input | GGIO2 | Ind32 | stVal |
| Ground lockout input | GGIO3 | Ind1 | stVal |
| External trip input | GGIO3 | Ind2 | stVal |
| Fault init input | GGIO3 | Ind3 | stVal |
| 79 Init input | GGIO3 | Ind4 | stVal |
| 79 Enable input | GGIO3 | Ind5 | stVal |
| 79 Level lockout input | GGIO3 | Ind6 | stVal |

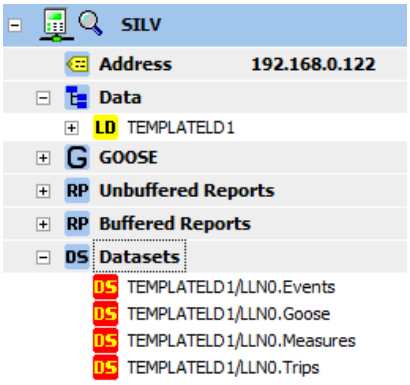
| | | | |
|---|---|---|---|
| 1 Setting group input | GGIO3 | Ind7 | stVal |
| 2 Setting group input | GGIO3 | Ind8 | stVal |
| 79 pulse lockout input | GGIO3 | Ind9 | stVal |
| 79 pulse unlock input | GGIO3 | Ind10 | stVal |
| 50BF init input | GGIO3 | Ind11 | stVal |
| Voltage command | GGIO3 | Ind12 | stVal |
| Continuity A | GGIO3 | Ind13 | stVal |
| Continuity B | GGIO3 | Ind14 | stVal |
| Live Line, Live Bus | GGIO3 | Ind15 | stVal |
| Live Line, Dead Bus | GGIO3 | Ind16 | stVal |
| Dead Line, Live Bus | GGIO3 | Ind17 | stVal |
| Dead Line, Dead Bus | GGIO3 | Ind18 | stVal |
| Start | SCBC1 | ColFail | stVal |
| Trip Circuit Supervision | SCBC1 | Mod | stVal |
| Fault init | RDRE1 | RcdStr | stVal |
| 52 Status | XCBR1 | Pos | stVal |
| 52 Status Open Time | CSWI1 | OpOpn | stVal |
| 52 Status Close Time | CSWI1 | OpCls | stVal |
| 52 Open | CSWI1 | Pos | Oper$ctlVal |
| 52 Close | CSWI1 | Pos | Oper$ctlVal |

## 10.2. Services

SIL-V disposes of the following services according IEC 61850:

**DATASETS**

A Dataset is a grouping of information from the data model of the IED:
These groupings can be used by other services for the sending of information (GOOSE, RCB, BRC).
The definition of Datasets has to be made in a IEC61850's file with extension .ICD (IED Capability Description) that is provided with the device.
By default there are 4 Datasets, grouped according the functionality (Trips, Measures, Events and Goose):




Trips, with the name of **Trips** and the following data objects:

| Member |
|---|
| TEMPLATELD1/PTRC1$ST$Op |
| TEMPLATELD1/PTRC1$ST$Str |
| TEMPLATELD1/PHSPTUV1$ST$Op |
| TEMPLATELD1/PHSPTUV1$ST$Str |
| TEMPLATELD1/PHSPTUV2$ST$Op |
| TEMPLATELD1/PHSPTUV2$ST$Str |
| TEMPLATELD1/PHSPTOV1$ST$Op |
| TEMPLATELD1/PHSPTOV1$ST$Str |
| TEMPLATELD1/PHSPTOV2$ST$Op |
| TEMPLATELD1/PHSPTOV2$ST$Str |
| TEMPLATELD1/GNDPTOV1$ST$Op |
| TEMPLATELD1/GNDPTOV1$ST$Str |
| TEMPLATELD1/GNDPTOV2$ST$Op |
| TEMPLATELD1/GNDPTOV2$ST$Str |
| TEMPLATELD1/SECPTUV1$ST$Op |
| TEMPLATELD1/SECPTUV1$ST$Str |
| TEMPLATELD1/DIRPTUV1$ST$Op |
| TEMPLATELD1/DIRPTUV1$ST$Str |

| |
|---|
| TEMPLATELD1/PTUF1$ST$Op |
| TEMPLATELD1/PTUF1$ST$Str |
| TEMPLATELD1/PTUF2$ST$Op |
| TEMPLATELD1/PTUF2$ST$Str |
| TEMPLATELD1/PTOF1$ST$Op |
| TEMPLATELD1/PTOF1$ST$Str |
| TEMPLATELD1/PTOF2$ST$Op |
| TEMPLATELD1/PTOF2$ST$Str |
| TEMPLATELD1/PFRC1$ST$Op |
| TEMPLATELD1/PFRC1$ST$Str |
| TEMPLATELD1/PFRC2$ST$Op |

Measures, with the name of **Measures** and the following data objects:

| Member |
|---|
| TEMPLATELD1/MMXU1$MX$PhV |

Events, with the name of **Events** and the following data objects:

| Member |
| --- |
| TEMPLATELD1/LLN0$CF$RemCtlBlk |
| TEMPLATELD1/LPHD1$ST$PwrUp |
| TEMPLATELD1/GGIO1$ST$Ind1 |
| TEMPLATELD1/GGIO1$ST$Ind2 |
| TEMPLATELD1/GGIO1$ST$Ind3 |
| TEMPLATELD1/GGIO1$ST$Ind4 |
| TEMPLATELD1/GGIO1$ST$Ind5 |
| TEMPLATELD1/GGIO1$ST$Ind6 |
| TEMPLATELD1/GGIO1$ST$Ind9 |
| TEMPLATELD1/GGIO1$ST$Ind10 |
| TEMPLATELD1/GGIO1$ST$Ind11 |
| TEMPLATELD1/GGIO1$ST$Ind12 |
| TEMPLATELD1/GGIO2$ST$Ind1 |
| TEMPLATELD1/GGIO2$ST$Ind2 |
| TEMPLATELD1/GGIO2$ST$Ind3 |
| TEMPLATELD1/GGIO2$ST$Ind6 |
| TEMPLATELD1/GGIO2$ST$Ind7 |
| TEMPLATELD1/GGIO2$ST$Ind8 |
| TEMPLATELD1/GGIO2$ST$Ind9 |
| TEMPLATELD1/GGIO2$ST$Ind10 |
| TEMPLATELD1/GGIO2$ST$Ind11 |
| TEMPLATELD1/GGIO2$ST$Ind12 |

| |
| --- |
| TEMPLATELD1/GGIO2$ST$Ind13 |
| TEMPLATELD1/GGIO2$ST$Ind15 |
| TEMPLATELD1/GGIO2$ST$Ind16 |
| TEMPLATELD1/GGIO2$ST$Ind17 |
| TEMPLATELD1/GGIO2$ST$Ind18 |
| TEMPLATELD1/GGIO2$ST$Ind19 |
| TEMPLATELD1/GGIO2$ST$Ind20 |
| TEMPLATELD1/GGIO2$ST$Ind21 |
| TEMPLATELD1/GGIO2$ST$Ind23 |
| TEMPLATELD1/GGIO2$ST$Ind24 |
| TEMPLATELD1/GGIO2$ST$Ind25 |
| TEMPLATELD1/GGIO2$ST$Ind26 |
| TEMPLATELD1/GGIO2$ST$Ind27 |
| TEMPLATELD1/GGIO2$ST$Ind30 |
| TEMPLATELD1/GGIO2$ST$Ind31 |
| TEMPLATELD1/GGIO3$ST$Ind2 |
| TEMPLATELD1/GGIO3$ST$Ind3 |
| TEMPLATELD1/GGIO3$ST$Ind4 |
| TEMPLATELD1/GGIO3$ST$Ind5 |
| TEMPLATELD1/GGIO3$ST$Ind6 |
| TEMPLATELD1/GGIO3$ST$Ind7 |
| TEMPLATELD1/GGIO3$ST$Ind8 |
| TEMPLATELD1/GGIO3$ST$Ind9 |
| TEMPLATELD1/GGIO3$ST$Ind10 |

| |
| --- |
| TEMPLATELD1/GGIO3$ST$Ind11 |
| TEMPLATELD1/GGIO3$ST$Ind13 |
| TEMPLATELD1/GGIO3$ST$Ind14 |
| TEMPLATELD1/GGIO3$ST$Ind15 |
| TEMPLATELD1/GGIO3$ST$Ind16 |
| TEMPLATELD1/GGIO3$ST$Ind17 |
| TEMPLATELD1/GGIO3$ST$Ind18 |
| TEMPLATELD1/GGIO3$ST$Ind23 |
| TEMPLATELD1/GGIO3$ST$Ind24 |
| TEMPLATELD1/GGIO3$ST$Ind25 |
| TEMPLATELD1/GGIO3$ST$Ind26 |
| TEMPLATELD1/GGIO3$ST$Ind27 |
| TEMPLATELD1/GGIO3$ST$Ind28 |
| TEMPLATELD1/RREC1$ST$Op |
| TEMPLATELD1/RBRF1$ST$Str |
| TEMPLATELD1/RBRF1$ST$OpIn |
| TEMPLATELD1/RDRE1$ST$RcdMade |
| TEMPLATELD1/SCBC1$ST$ColFail |
| TEMPLATELD1/XCBR1$ST$Pos |

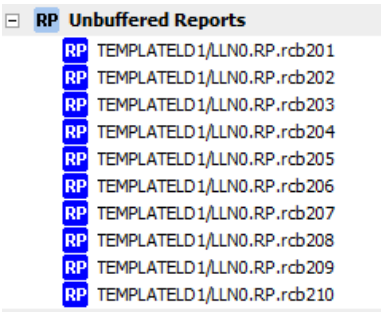
Goose, with the name of **Goose** and the following data attributes:

| Member |
| --- |
| TEMPLATELD1/PTRC1$ST$Op$general |
| TEMPLATELD1/PTRC1$ST$Op$q |
| TEMPLATELD1/PTRC1$ST$Tr$general |
| TEMPLATELD1/PTRC1$ST$Tr$q |

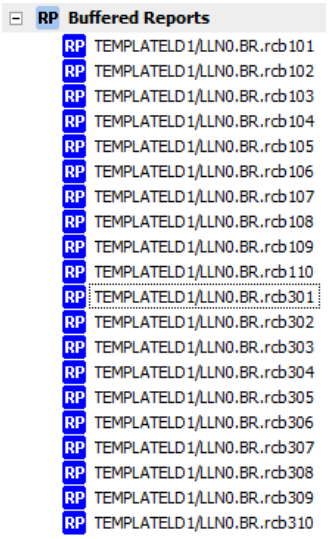
### REPORTS

The Report service is used for the sending of values from elements of a Dataset to a communication client that enables the report service (Central unit of Substation, remote unit o software application).
The use of Reports optimizes the communication when the information of the associated Dataset is only sent when there is a change of value, when is requested or time integrity is enabled.
There are 2 kind of Reports, BRCB and URCB.
BRCB have a time buffer to store reports in the case a client has disconnected or the information had lost.
It is usually used for reporting events, alarms and trips.
URCB have not this time buffer and it is not possible recovering lost or past reports. They are usually used for reporting of measures.

SIL-G device is pre configured with 10 URCB associated to the Measures Dataset:




10 BRCB associated to Events Dataset and another 10 to Trips Dataset:




This way, up to 10 different clients can dispose of the whole information of events and measures.

**GOOSE**

Goose service allows the Multicast sending (to multiple devices) of the existing information in a Dataset.

Goose message is an Ethernet message that is continuously cast to the Ethernet and every device can analyze it.

SIL-G disposes by default a Goose message associated to the Goose Dataset:


This message is sent to the Ethernet with a latency time of 30 seconds till one of the values of the element of the Dataset changes, then the message is sent immediately in a repeating way in a short time, increasing till reaching the latency time.

## 10.3. Operation

SIL-V is pre configured with a sample configuration to be integrated in an IEC 61850 system.

It disposes all the Data model with all the functionallity available via MMS (using a software application like IEDScout) or via Reports (with their Event, measure or Trip Datasets) in case a client needs to receive information from the device.

To retrieve the data model from the device to a PC with an IEC 61850 tool, it is only required the IP of the device (by default 192.168.0.121).The tool has to be able of asking the data model automatically.

The name of the IED is by default TEMPLATELD1 and below it there is the data model with its logical nodes, data objects and data attributes according IEC 61850.

The common way to integrate a new IED in a SCADA is using reports and the ICD files from SIL-V provided for this purpose.

From the ICD file of SIL-V, the client device has to select a Report with the associated Dataset. This way, client will have a list of signals that will use to configure its own database. Once client device is configured, the communication between server could be initiated by the client by enabling the report and receving the existing information from the report.

Each client has different ways of configuring, so it will be necessary referring to IEC61850's configuration chapter from the client's manual.

Goose message is activated by default and is published with the information from the Goose dataset (General Trips and Starts) into the net.

One IED that requires the information from a Goose has to be configured using the ICD file from SIL-G. In this file appears the default parameters of the Goose message.

# 11. DNP 3.0 PROCOCOL

## 11.1. Device profile document

# DNP V3.00

**DEVICE PROFILE DOCUMENT**

This document must be accompanied by : **Implementation Table** and **Point List**.

Vendor Name: **FANOX Electronic, S.L.**

Device Name: **SIL-V**

| Highest DNP Level Supported: | Device Function: |
|---|---|
| For Requests **2**<br>For Responses **2** | ☐ Master ☒ **Slave** |

Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table):

**For static (non-change-event) object requests, request qualifier codes 07 and 08 (limited quantity), and 17 and 28 (index) are supported. Static object requests sent with qualifiers 07, or 08, will be responded with qualifiers 00 or 01.**

**16-bit, 32-bit and Floating Point Analog Change Events with Time may be requested.**

| Maximum Data Link Frame Size (octets): | Maximum Application Fragment Size (octets): |
|---|---|
| Transmitted **292**<br>Received **292** | Transmitted **2048**<br>Received **2048** |

| Maximum Data Link Re-tries: | Maximum Application Layer Re-tries: |
|---|---|
| ☐ None<br>☐ Fixed at _____<br>☒ **Configurable, from 0 to 255**<br>**Default, 3** | ☒ **None**<br>☐ Configurable |

Requires Data Link Layer Confirmation:

☐ Never
☐ Always
☐ Sometimes. If 'Sometimes', when? _____
☒ **Configurable as Never, Only for multi-frame messages, or Always. Default Never**

Requires Application Layer Confirmation:

☐ Never
☐ Always (not recommended)
☐ When reporting Event Data (Slave devices only)
☐ When sending multi-fragment responses (Slave devices only)

☐ Sometimes. If 'Sometimes', when?
☒ **Configurable as: "Only when reporting event data", or "<u>When reporting event data or multi-fragment messages</u>."**

Timeouts while waiting for:

| | | | | |
|---|---|---|---|---|
| Data Link Confirm | ☐ None | ☐ Default at 5000ms | ☐ Variable | ☒ **Configurable** |
| Complete Appl. Fragment | ☒ **None** | ☐ Fixed at ____ | ☐ Variable | ☐ Configurable |
| Application Confirm | ☐ None | ☐ Default at 5000ms | ☐ Variable | ☒ **Configurable** |
| Complete Appl. Response | ☒ **None** | ☐ Fixed at ____ | ☐ Variable | ☐ Configurable |

Others **Need Time Interval, configurable, default Enable**
**Need Restart IIN, configurable, default Disable**
**Unsolicited Response Retry Delay, configurable, default 2000ms**
**Unsolicited Offline Interval, configurable, default 3000ms**

Sends/Executes Control Operations:

| | | | | |
|---|---|---|---|---|
| WRITE Binary Outputs | ☒ **Never** | ☐ Always | ☐ Sometimes | ☐ Configurable |
| SELECT (3) / OPERATE (4) | ☒ **Never** | ☐ Always | ☐ Sometimes | ☐ Configurable |
| DIRECT OPERATE (5) | ☐ Never | ☒ **Always** | ☐ Sometimes | ☐ Configurable |
| DIRECT OPERATE - NO ACK (6) | ☐ Never | ☒**Always** | ☐ Sometimes | ☐ Configurable |
| Count > 1 | ☒ **Never** | ☐ Always | ☐ Sometimes | ☐ Configurable |
| Pulse On | ☐ Never | ☒**Always** | ☐ Sometimes | ☐ Configurable |
| Pulse Off | ☐ Never | ☒**Always** | ☐ Sometimes | ☐ Configurable |
| Latch On | ☐ Never | ☒**Always** | ☐ Sometimes | ☐ Configurable |
| Latch Off | ☐ Never | ☒**Always** | ☐ Sometimes | ☐ Configurable |
| Queue | ☒ **Never** | ☐ Always | ☐ Sometimes | ☐ Configurable |
| Clear Queue | ☒ **Never** | ☐ Always | ☐ Sometimes | ☐ Configurable |

---

Attach explanation:

**All points support the same Function Codes :Direct Operate and Direct Operate-No ACK**
**All points support the same Control Codes : Pulse ON, Latch ON, Latch OFF, Pulse OFF and Trip-Pulse ON.**

**FILL OUT THE FOLLOWING ITEMS FOR SLAVE DEVICES ONLY:**

Reports Binary Input Change Events when no specific variation requested:

- ☐ Never
- ☐ Only time-tagged
- ☒ **Only non-time-tagged**
- ☐ Configurable to send both, one or the other (attach explanation)

Reports time-tagged Binary Input Change Events when no specific variation requested:

- ☐ Never
- ☐ Binary Input Change With Time
- ☒ **Binary Input Change With Relative Time**
- ☐ Configurable (attach explanation)

Sends Unsolicited Responses:

- ☐ Never
- ☐ Configurable
- ☒ **Only certain objects (Class 1)**
- ☐ Sometimes (attach explanation)

☒ **ENABLE/DISABLE UNSOLICITED Function codes supported**

Sends Static Data in Unsolicited Responses:

- ☒ **Never**
- ☐ When Device Restarts
- ☐ When Status Flags Change

No other options are permitted.

Default Counter Object/Variation:

- ☒ **No Counters Reported**
- ☐ Configurable (attach explanation)
- ☐ Default Object _____
  Default Variation _____
- ☐ Point-by-point list attached

Counters Roll Over at:

- ☒ **No Counters Reported**
- ☐ Configurable (attach explanation)
- ☐ 16 Bits
- ☐ 32 Bits
- ☐ Other Value _____
- ☐ Point-by-point list attached

Sends Multi-Fragment Responses: ☒ Yes ☐ No

**QUICK REFERENCE FOR DNP3.0 LEVEL 2 FUNCTION CODES & QUALIFIERS**

**Function Codes**

```
 1   Read
 2   Write
 3   Select
 4   Operate
 5   Direct Operate
 6     Direct Operate-No ACK
 13  Cold Start
 14  Warm Start
 20      Enable   Unsol. Messages
 21      Disable  Unsol. Messages
 23  Delay Measurement
129  Response
130  Unsolicited Message
```

| | Index Size | Qualifier Code |
|---|---|---|

**Index Size**

```
0-   No   Index, Packed
1- 1 byte Index
2- 2 byte Index
3- 4 byte Index
4- 1 byte Object Size
5- 2 byte Object Size
6- 4 byte Object Size
```

**Qualifier Code**

```
0- 8-Bit Start and Stop Indices
1-  16-Bit  Start  and  Stop Indices
2-  32-Bit  Start  and  Stop Indices
3-  8-Bit  Absolute  address Ident.
4-  16-Bit  Absolute  address Ident.
5-  32-Bit  Absolute  address Ident.
6- No Range Field (all)
7- 8-Bit Quantity
8- 16-Bit Quantity
9- 32-Bit Quantity
11-(0xB) Variable array
```

## 11.2. Implementation table

| OBJECT | | | REQUEST (BCD will parse) | | RESPONSE (BCD will respond) | | |
|---|---|---|---|---|---|---|---|
| **Obj** | **Var** | **Description** | **Func Codes (dec)** | **Qual Codes (hex)** | **Func Codes (dec)** | **Qual Codes (hex)** | **Notes** |
| 1 | 0 | Binary Input – All variations | 1 | 6 | | | |
| 1 | 1 | Binary Input | | | 129 | 1 | Assigned to Class 0. |
| 2 | 0 | Binary Input Change – All variations | 1 | 6,7,8 | | | |
| 2 | 1 | Binary Input Change without Time | 1 | 6,7,8 | 129 | | |
| 2 | 2 | Binary Input Change with Time | 1 | 6,7,8 | 129,130 | 28 | Assigned to Class 1. |
| 2 | 3 | Binary Input Change with Relative Time | 1 | 6,7,8 | 129 | | |
| 10 | 0 | Binary Outputs – All variations | 1 | 6 | 129 | | |
| 12 | 1 | Control Relay Output Block | 4,5,6 | 17,28 | 129 | 17,28 | |
| 30 | 0 | Analog Input – All variations | 1 | 6 | | | |
| 30 | 2 | 16-Bit Analog Input | | | 129 | 1 | Assigned to Class 0. |
| 32 | 0 | Analog Change Event – All variations | 1 | 6,7,8 | | | |
| 32 | 4 | 16-Bit Analog Change Event with Time | | | 129,130 | 28 | Assigned to Class 2. |
| 50 | 1 | Time and Date | 2 | 7 count=1 | 129 | | |
| 52 | 2 | Operating time Fine | 23 | | 129 | 7 count=1 | |
| 60 | 1 | Class 0 Data | 1 | 6 | | | |
| 60 | 2 | Class 1 Data | 1 | 6,7,8 | | | |
| | | | 20,21 | 6 | | | |
| 60 | 3 | Class 2 Data | 1 | 6,7,8 | | | |
| | | | 20,21 | 6 | | | |
| 60 | | Class 3 Data | 1 | 6,7,8 | | | |
| | | | 20,21 | 6 | | | |
| 80 | | Internal Indications | 2 | 0 index=7 | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| - - | | No Object (Cold Start) | 13 | | | | |
| - - | | No Object (Warm Start) | 14 | | | | |
| - - | | No Object (Delay Measurement) | 23 | | | | |

## 11.3. Point list

| BINARY INPUT (OBJECT 1) -> Assigned to Class 0.<br>BINARY INPUT CHANGE (OBJECT 2) -> Assigned to Class 1. | | |
|---|---|---|
| **Index** | **Description** | |
| 0 | Protection active | |
| 1 | Auxiliary input 1 | |
| 2 | Auxiliary input 2 | |
| 3 | Auxiliary input 3 | |
| 4 | Auxiliary input 4 | |
| 5 | Auxiliary input 5 | |
| 6 | Auxiliary input 6 | |
| 7 | Auxiliary output 1 | |
| 8 | Auxiliary output 2 | |
| 9 | Auxiliary output 3 | |
| 10 | Auxiliary output 4 | |
| 11 | Auto-recloser active | |
| 12 | Teleprotection active | |
| 13 | Local parameter setting | |
| 14 | Start / pick-up L1 | |
| 15 | Start / pick-up L2 | |
| 16 | Start / pick-up L3 | |
| 17 | Start / pick-up N | |
| 18 | General trip | |
| 19 | Trip L1 | |
| 20 | Trip L2 | |
| 21 | Trip L3 | |
| 22 | General start / pick-up | |
| 23 | Breaker failure | |
| 24 | CB 'on' by AR | |
| 25 | AR blocked | |
| 26 | CB close / open | |
| 27 | 52 Status Open Time | |
| 28 | 52 Status Open Failure | |
| 29 | 52 Status Close Failure | |
| 30 | 52 Status excessive openings | |
| 31 | 52 Status excessive sum of switched amperes | |
| 32 | 52 Status excessive openings per minute | |
| 33 | 52-A Status | |
| 34 | 52-B Status | |
| 35 | 79 Status Reclose Time | |
| 36 | 79 Status Open | |
| 37 | 79 Status Wait Time | |
| 38 | 79 Status Reclaim Time | |
| 39 | 79 Status Security Time | |
| 40 | 79 Status final open Time | |
| 41 | GEN 50Hz | |

| | | |
|---|---|---|
| 42 | Measurment Error | |
| 43 | synchronism | |
| 44 | Eeprom with default values | |

**BINARY INPUT (OBJECT 1) -> Assigned to Class 0.**
**BINARY INPUT CHANGE (OBJECT 2) -> Assigned to Class 1.**

| Index | Description | |
|---|---|---|
| 45 | Eeprom Error | |
| 46 | Eeprom values changed | |
| 47 | 52 a Input | |
| 48 | 52 b Input | |
| 49 | External trip input | |
| 50 | Fault init input | |
| 51 | 79 init input | |
| 52 | 79 Enable input | |
| 53 | 79 Level lockout input | |
| 54 | 1 Setting group input | |
| 55 | 2 Setting group input | |
| 56 | 79 pulse lockout input | |
| 57 | 79 pulse unlock input | |
| 58 | 50BF init input | |
| 59 | Continuity A | |
| 60 | Continuity B | |
| 61 | 52 Close enabled | |
| 62 | Manual Close Init | |
| 63 | CB Open (local) | |
| 64 | CB Close (local) | |
| 65 | 79 Lockout (local) | |
| 66 | 79 Unlock (local) | |
| 67 | Remote control into Local | |
| 68 | Telecontrol into Remote | |
| 69 | Open CB (Modbus remote) | |
| 70 | Close CB (Modbus remote) | |
| 71 | Lockout 79 (Modbus remote) | |
| 72 | Unlock 79 (Modbus remote) | |
| 73 | Open CB (remote) | |
| 74 | Close CB (remote) | |
| 75 | Lockout 79 (remote) | |
| 76 | Unlock 79 (remote) | |
| 77 | 50BF Start | |
| 78 | 50BF Activation | |
| 79 | Live Line, Live Bus | |
| 80 | Live Line, Dead Bus | |
| 81 | Dead Line, Live Bus | |
| 82 | Dead Line, Dead Bus | |
| 83 | 74TCS Activation | |
| 84 | 74TCS Start | |
| 85 | 25 Synhronism | |
| 86 | 27V1 Start | |
| 87 | 27V1 Trip | |
| 88 | 47 Start | |
| 89 | 47 Trip | |
| 90 | 100% DV/DT | |
| 91 | 27_1 Start P | |
| 92 | 27_1 Trip P | |
| 93 | 27_2 Start P | |
| 94 | 27_2 Trip P | |

| | | |
|---|---|---|
| 95 | 25 Voltage Diff. | |
| 96 | 25 Frequency Diff. | |
| 97 | 25 Phase Diff. | |
| **BINARY INPUT (OBJECT 1) -> Assigned to Class 0.<br>BINARY INPUT CHANGE (OBJECT 2) -> Assigned to Class 1.** | | |
| **Index** | **Description** | |
| 98 | 59_1 Start N | |
| 99 | 59_1 Trip N | |
| 100 | 59_2 Start N | |
| 101 | 59_2 Trip N | |
| 102 | 59_1 Start P | |
| 103 | 59_1 Trip P | |
| 104 | 59_2 Start P | |
| 105 | 59_2 Trip P | |
| 106 | 50BF Start | |
| 107 | 50BF Activation | |
| 108 | 81_1 Start | |
| 109 | 81_1 Trip | |
| 110 | 81_2 Start | |
| 111 | 81_2 Trip | |
| 112 | 81_3 Start | |
| 113 | 81_3 Trip | |
| 114 | 81_4 Start | |
| 115 | 81_4 Trip | |
| 116 | 81 General Lockout | |
| 117 | 81R_1 Start | |
| 118 | 81R_1 Trip | |
| 119 | 81R_2 Start | |
| 120 | 81R_2 Trip | |
| 121 | 78 Trip | |
| **CONTROL RELAY OUTPUT BLOCK (OBJECT 12)** | | |
| **Index** | **Description** | |
| 0 | Lock/Unlock 79 | |
| 1 | 52 open/close | |
| 3 | Reset | |

| | | | |
|---|---|---|---|
| **ANALOG INPUT (OBJECT 30) -> Assigned to Class 0.<br>ANALOG INPUT CHANGE (OBJECT 32) -> Assigned to Class 2.** | | | |
| **Index** | **Description** | **Full Scale Range** | |
| 0 | Phase A voltage | 0 to 1.2*Vnominal Volts | (0 to 4095). |
| 1 | Phase B voltage | 0 to 1.2*Vnominal Volts | (0 to 4095). |
| 2 | Phase C voltage | 0 to 1.2*Vnominal Volts | (0 to 4095). |

## 11.4. DNP3 protocol settings

| Setting Name | Type | Minimum Value | Maximum Value | Default Value | Step | Voltage Value |
|---|---|---|---|---|---|---|
| RTU Address | Integer | 0 | 65535 | 1 | 1 | |
| Validate Source | Boolean | 0 (No) | 1 (Yes) | 0 | 1 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Address | | | | | | |
| Application Confirm Timeout | Integer | 0 | 4294967295 | 5000 | 1 | msec. |
| Enable Unsol. Report | Boolean | 0 (No) | 1 (Yes) | 1 (Yes) | 1 | |
| Source Address | Integer | 0 | 65534 | 4 | 1 | |
| Unsol. Retry Delay | Integer | 0 | 4294967295 | 2000 | 1 | msec. |
| Unsol. Max Retries | Integer | 0 | 65535 | 3 | 1 | |
| Unsol. Offline Retry Delay | Integer | 0 | 4294967295 | 3000 | 1 | msec. |

**RTU Address :** Remote Terminal Unit Address.
**Validate Source Address:** Slave respond only if the source address in received requests matches configured source.

**Application Confirm Timeout:** Specifies how long the slave DNP device will wait for an application layer confirmation from the master.

**Enable Unsolicited Reporting:** Enables or disables Unsolicited responses.

**Source Address:** Destination address of the Master device to which the unsolicited responses are to be sent.

**Unsolicited Retry Delay:** Specifies the time to delay after an unsolicited confirm timeout before retrying the unsolicited response.

**Unsolicited Max. Retries:** How many times should this slave resend Unsols before declaring the station offline

**Unsolicited Offline Retry Delay:** How often to retry unsolicited responses after maxRetries attempts

# 12. APPENDIX

## 12.1. Identification

Date: ……

Official: ……

Substation: ……..

Circuit: ……

Model: ……..

Serial no.: ……..……

Software Versions: ……

## 12.2. Checks

Cabling check: ❒

Box earth: ❒

Vaux value: ❒

## 12.3. Test menu

| | | | |
|---|---|---|---|
| Led -1: | ❒ | Output 1: | ❒ |
| Led -2: | ❒ | Output 2: | ❒ |
| Led -3: | ❒ | Output 3: | ❒ |
| Led -4: | ❒ | Output 4: | ❒ |
| Led -5: | ❒ | | |
| Led -6: | ❒ | | |
| Led -79: | ❒ | | |
| Led -52: | ❒ | | |

## 12.4. Register of commissioning settings

Password:……

Identification: ……

Nominal voltage:……

VT configuration type:……

**27_1**

Permission ❒ Permitted ❒ Prohibited

Tap .....xIn

Operating time .....s

Reset Time .....s

**27_2**

Permission ❒ Permitted ❒ Prohibited

Tap .....xIn

Operating time .....s

Reset Time .....s

**27V1**

Permission ❒ Permitted ❒ Prohibited

Tap .....xIn

Operating time .....s

Reset Time .....s

**59_1**

Permission ❒ Permitted ❒ Prohibited

Tap .....xIn

Operating time .....s

Reset Time .....s

**59_2**

Permission ❒ Permitted ❒ Prohibited

Tap .....xIn

Operating time .....s

Reset Time .....s

**59N_1**

Permission ❒ Permitted ❒ Prohibited

Tap .....xIn

Operating time .....s

Reset Time .....s

**59N_2**

Permission ❒ Permitted ❒ Prohibited

Tap .....xIn

Operating time .....s

Reset Time .....s

**47**

Permission ❒ Permitted ❒ Prohibited

Tap .....xIn

Operating time .....s

Reset Time .....s

**81_1**

Permission ❒ Permitted ❒ Prohibited

Type ❒ Underfrequency ❒ Overfrequency

Activation level ..... Hz

Operating time ..... s

Reset time ..... s

**81_2**

Permission ❒ Permitted ❒ Prohibited

Type ❒ Underfrequency ❒ Overfrequency

Activation level ..... Hz

Operating time ..... s

Reset time ..... s

**81_3**

Permission ❒ Permitted ❒ Prohibited

Type ❒ Underfrequency ❒ Overfrequency

Activation level ..... Hz

Operating time ..... s

Reset time ..... s

**81_4**

Permission ❒ Permitted ❒ Prohibited

Type ❒ Underfrequency ❒ Overfrequency

Activation level ..... Hz/s

Operating time ..... s

Reset time ..... s

**81R_1**

Permission ❒ Permitted ❒ Prohibited
Type ❒ Decement ❒ Increment
Activation level ..... Hz/s
Operating time ..... s
Reset time ..... s

**81R_2**

Permission ❒ Permitted ❒ Prohibited
Type ❒ Decrement ❒ Increment
Activation level ..... Hz/s
Operating time ..... s
Reset time ..... s

**78**

Permission ❒ Permitted ❒ Prohibited
Activation level ..... deg
Reset time ..... s

**BF**

Permission ❒ Permitted ❒ Prohibited
Operating time ..... s

**79**

Permission ❒ Permitted ❒ Prohibited
Wait permission ❒ Permitted ❒ Prohibited
Number of reclosings .....
1st reclosure time ..... s
2nd reclosure time ..... s
3rd reclosure time ..... s
4th reclosure time ..... s
5th reclosure time ..... s
Wait time ..... s
Reset time ..... s
Definitive opening time .....s

**25**

Live voltage level ……..V

Dead voltage level ……..V

Voltage supervisión temporisation ……..s

Line-bar voltage difference …… V

Line-bar phase difference ……º

Line-bar frequency difference …… mHz

Synchrocheck time …… s

**52**

Maximum number of openings …….

Maximum opening time ……..

Maximum closure time ……

Number of openings……

Number openings/time:……

Time period ……min

**74TCS**

Permission ❒ Permitted ❒ Prohibited

Operating time ……..… s

## 12.5. Inputs

| | | | |
|---|---|---|---|
| Input -1: | ❒ | Input -5: | ❒ |
| Input -2: | ❒ | Input -6: | ❒ |
| Input -3: | ❒ | | |
| Input -4: | ❒ | | |

## 12.6. Logical signals

| Logical inputs | In1 | In2 | In3 | In4 | In5 | In6 |
|---|---|---|---|---|---|---|
| 52 a | | | | | | |
| 52 b | | | | | | |
| External trip | | | | | | |
| BF Init | | | | | | |
| Fault init | | | | | | |
| Close Init | | | | | | |
| Close Enable | | | | | | |
| Reset | | | | | | |
| Setting group 1 | | | | | | |
| Setting group 2 | | | | | | |
| 79 Init | | | | | | |
| 79 Permission | | | | | | |
| Level 79 Lock | | | | | | |
| Pulse 79 Lock | | | | | | |
| Pulse 79 unlock | | | | | | |
| Continuity A | | | | | | |
| Continuity B | | | | | | |
| Logical signal 1 | | | | | | |
| Logical signal 2 | | | | | | |

## 12.7. Outputs configuration

| Outputs | | | | |
|---|---|---|---|---|
| Output 1 | | | | |
| | | | | |
| | | | | |
| | | | | |
| Output 2 | | | | |
| | | | | |
| | | | | |
| | | | | |
| Output 3 | | | | |
| | | | | |
| | | | | |
| | | | | |
| Output 4 | | | | |
| | | | | |
| | | | | |
| | | | | |

## 12.8. Leds configuration

| Leds | Flashing | Latch | Inverted |
|---|---|---|---|
| Led 1 | | | |
| Led 2 | | | |
| Led 3 | | | |
| Led 4 | | | |
| Led 5 | | | |
| Led 6 | | | |
| Led 52 | | | |
| Led 79 | | | |

### 12.8.1. Leds configuration Template

| |
|---|
| ON |
| PICKUP |
| CLOSE |
| TRIP |
| 74TCS |
| BF |

## 12.9. Comments

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……

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

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

NOTES:

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