FEEDER MANAGER
with
AUTORECLOSING
RELAY

TYPE

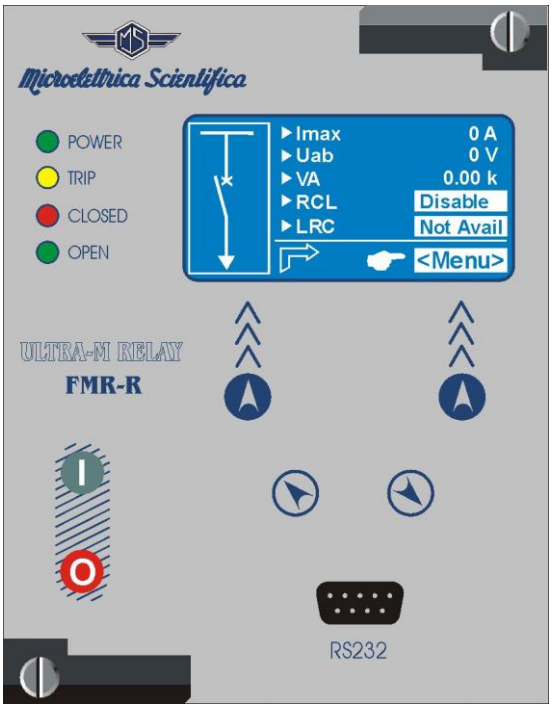
# FMR-R

**(IEC61850)**

(Multiple I/O Boards)

# ULTRA Line

# OPERATION MANUAL




CE

# 1. General Utilization and Commissioning Directions

Always make reference to the specific description of the product and to the Manufacturer's instruction. Carefully observe the following warnings.

## *1.1 - Storage and Transportation*

Must comply with the environmental conditions stated in the product's specification or by the applicable IEC standards.

## *1.2 - Installation*

Must be properly made and in compliance with the operational ambient conditions stated by the Manufacturer.

## *1.3 - Electrical Connection*

Must be made strictly according to the wiring diagram supplied with the Product, to its electrical characteristics and in compliance with the applicable standards particularly with reference to human safety.

## *1.4 - Measuring Inputs and Power Supply*

Carefully check that the value of input quantities and power supply voltage are proper and within the permissible variation limits.

## *1.5 - Outputs Loading*

Must be compatible with their declared performance.

## *1.6 - Protection Earthing*

When earthing is required, carefully check its effectiveness.

## *1.7 - Setting and Calibration*

Carefully check the proper setting of the different functions according to the configuration of the protected system, the safety regulations and the co-ordination with other equipment.

## *1.8 - Safety Protection*

Carefully check that all safety means are correctly mounted, apply proper seals where required and periodically check their integrity.

## *1.9 - Handling*

Notwithstanding the highest practicable protection means used in designing M.S. electronic circuits, the electronic components and semiconductor devices mounted on the modules can be seriously damaged by electrostatic voltage discharge which can be experienced when handling the modules.
The damage caused by electrostatic discharge may not be immediately apparent but the design reliability and the long life of the product will have been reduced. The electronic circuits produced by M.S. are completely safe from electrostatic discharge (8 kV IEC 255.22.2) when housed in their case; withdrawing the modules without proper cautions expose them to the risk of damage.

## *1.10 - Maintenance*

Make reference to the instruction manual of the Manufacturer; maintenance must be carried-out by specially trained people and in strict conformity with the safety regulations.

### *1.11 - Fault Detection and Repair*

Internal calibrations and components should not be altered or replaced.
For repair please ask the Manufacturer or its authorized Dealers.

Misapplication of the above warnings and instruction relieves the Manufacturer of any liability.

## 2. General

Input currents are supplied to 4 current transformers: - three measuring phase current - one measuring the earth fault zero-sequence current.
Current input can be selected 1A or 5A by movable jumpers available on relay cards.
Input voltage are supplied to 4 Potential Transformers: three measuring phase-to-neutral voltage and one measuring the zero sequence voltage supplied by the secondary of three system P.Ts. Y/Open Delta connected.
***The Measuring Ranges of the different inputs respectively are:***

| | | | | | |
|---|---|---|---|---|---|
| Phase Currents | : | (0.1-40)In | Phase Voltage | : | (0.01-2)Un |
| Neutral Current | : | (0.01-10)On | Neutral Voltage | : | (0.01-2)Un |

Make electric connection in conformity with the diagram reported on relay's enclosure.
Check that input currents and voltages are same as reported on the diagram and on the test certificate.
The auxiliary power is supplied by a built-in interchangeable module fully isolated an self protected.

### *2.1 - Power Supply*

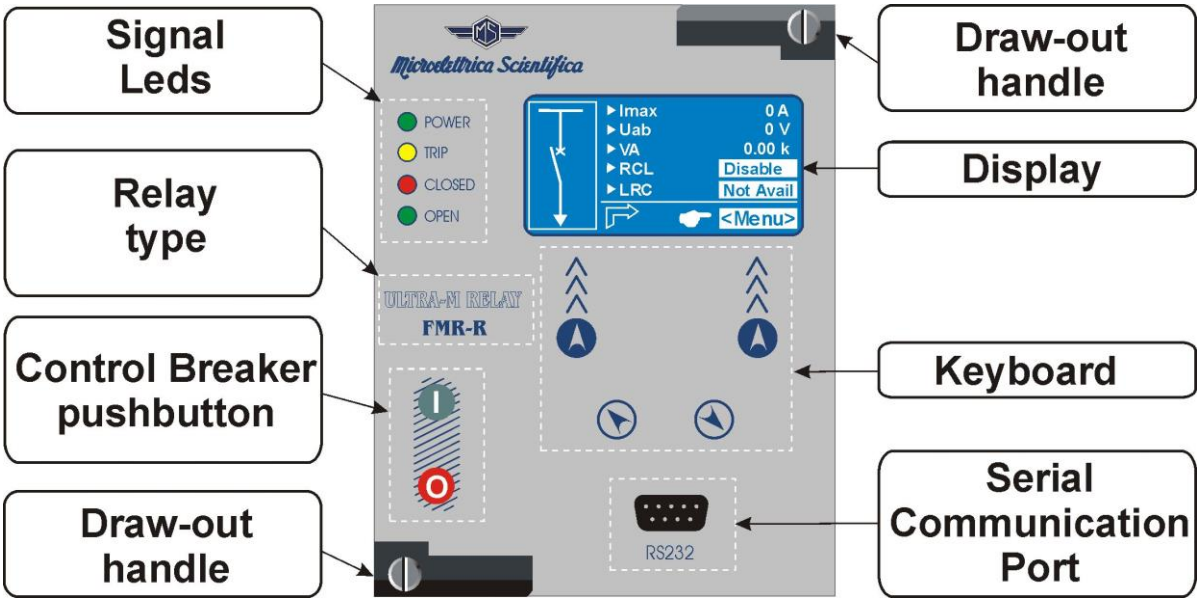
The relay can be fitted with two different types of **power supply**:

**Type 1) - { 24V(-20%) / 110V(+15%) a.c. ; 24V(-20%) / 125V(+20%) d.c.**

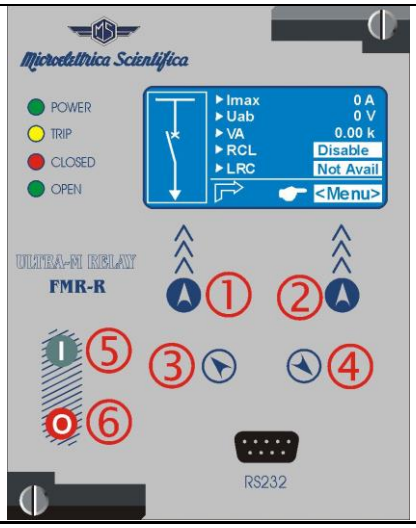
**Type 2) - { 80V(-20%) / 220V(+15%) a.c. ; 90V(-20%) / 250V(+20%) d.c.**

Before energizing the unit check that supply voltage is within the allowed limits.

## 3. Front Panel



## 4. Keyboard and Display

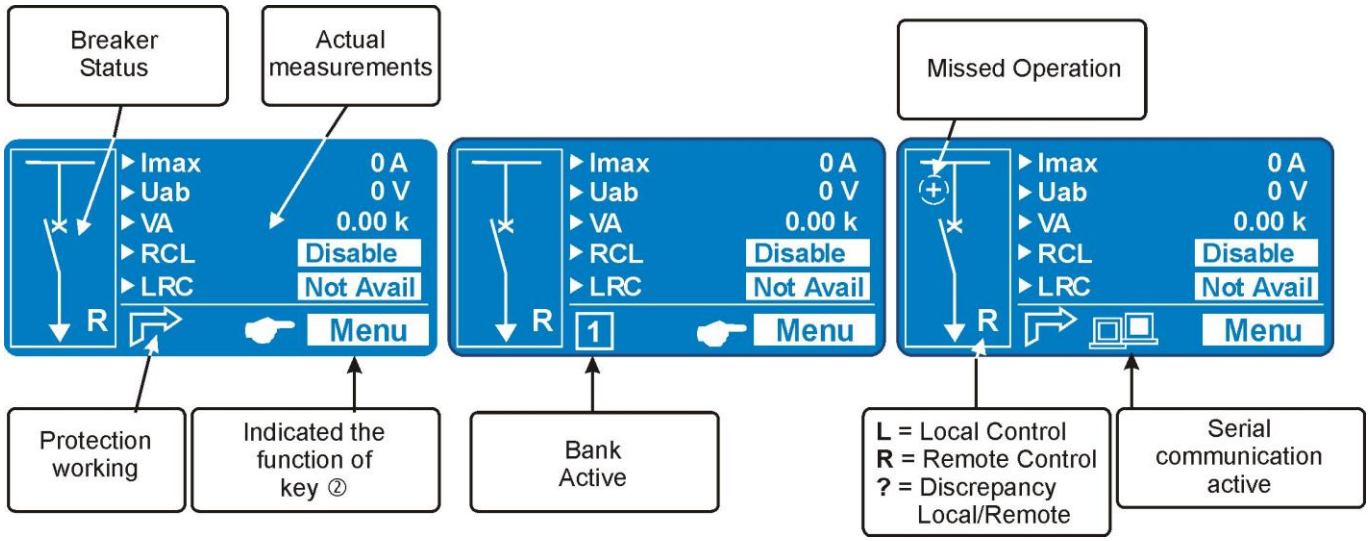



| | |
|---|---|
| **Navigation menu** | By these buttons the options showed in correspondence on the display are selected. |
| **Increase** | These buttons are used to scroll the items of the different menus (Local Control, Measurements, Energy metering etc). |
| **Decrease** | |
| **Open** | these buttons (when enabled) operate Circuit Breaker Open/Close control (see § C/B manage) |
| **Close** | |

- By the key ② select the windows showing the ICONS of the available menus.
- By the key ③, ④ select the desired icon and enter by key ①
- The different elements can be selected by the key ③ and ④.
  *The details of the individual menus are given in the following paragraphs.*

### *4.1 - Display*

The 128x64 pixel LCD display the available information (menu, etc.).

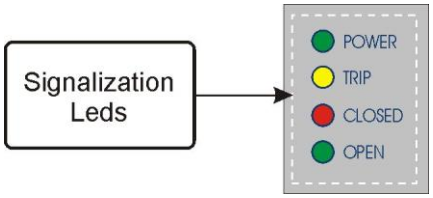


## 5. Icons of Display

| | | |
|---|---|---|
|  | **LocalCmd** | LOCAL COMMANDS |
|  | **Measure** | ACTUAL MEASUREMENTS |
|  | **Energy** | ENERGY MEASUREMANTS |
|  | **TripRec.** | TRIP RECORDING |
|  | **Counter** | PARTIAL COUNTERS (RESETTABLE COUNTER) |
|  | **Events** | EVENT RECORDING |
|  | **Setting** | FUNCTION SETTINGS |
|  | **System** | SYSTEM SETTINGS |
|  | **Inp-Out** | INPUT - OUTPUT |
|  | **TimeDate** | TIME AND DATE |
|  | **Healthy** | DIAGNOSTIC INFORMATION |
|  | **Dev.Info** | RELAY VERSION |

## 6. Signalization

Four signal leds are provided:




| | | | |
|---|---|---|---|
| Green Led | POWER | ❑ Illuminated<br>❑ Flashing | - Relay working properly.<br>- Internal Relay Fault |
| Yellow Led | TRIP | ❑ Off<br>❑ Illuminated<br>❑ Flashing | - No Trip<br>- Trip occurred<br>- Function Timing |
| | | Reset from Illuminated status is manual (see § 6.1) | |
| Red Led | CLOSED | ❑ Off<br>❑ Illuminated | - C/B Open<br>- C/B Close |
| Green Led | OPEN | ❑ Off<br>❑ Illuminated | - C/B Close<br>- C/B Open |

Both Flashing

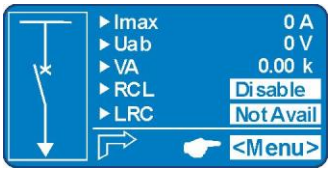
Operation of Trip Circuit Supervision element.

❑ In case of auxiliary power supply failure the status of the leds is recorded and reproduced when power supply is restored.

### *6.1 - Leds Manual Reset*

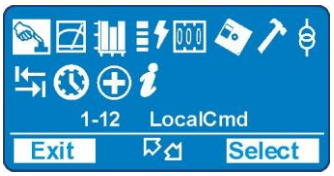
For Leds' manual reset operate as follows:

**1**



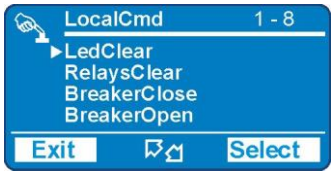

- Press "***Menu***" for access to the main menu with icons.

**2**




- Select icon "***LocalCmd***" .
- Press "***Select***",

**3**




- Select "***LedClear***"
- Press "***Select***" to execute the command. (See § Password).

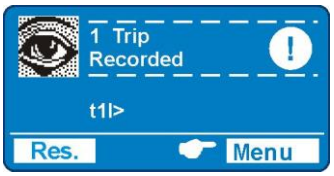
**4**


- When command has been executed the display shows "***! Command Done***";

### *6.2 – Display of the last trip*

Beside the signalization of the yellow led "Trip", indicating a generic function trip, the display shows a window indicating the last function that was tripped and the number of events that are stored in the memory. The display will show this window until the reset button or external reset are operated.

**1**




- Press "***Menu***" to access to the main menu with icons.
  Press "***Res.***" to erase visualization.
  Ex. "t1I>" (flashing) is the last trip.

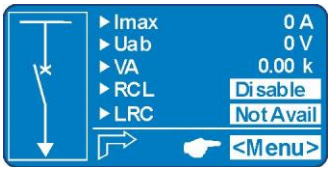
# 7. Local Commands

"***LOCAL COMMANDS***" allow to operate from relay front face controls like Thermal Memory reset, Leds reset, etc.

| Menu | | Description | Password |
|---|---|---|---|
| → **Led** | **Clear** | Reset of signal Leds | *No* |
| → **Relays** | **Clear** | Manual reset of output relays | *No* |
| → **Breaker** | **Close** | Manual C/B closing (conditioned by Password) | Yes |
| → **Breaker** | **Open** | Manual C/B opening (conditioned by Password) | Yes |
| → **Event** | **Clear** | Reset of all Events recorded | Yes |
| → **HistFail** | **Clear** | Reset of Internal Failure Historic records | Yes |
| → **Reset** | **Term** | Reset to zero of the accumulations relevant to Thermal Image and Interruption Energy. | Yes |
| → **Leds** | **Test** | Signal Leds test | *No* |

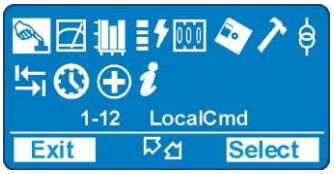
To operate one command by the Front Face Keyboard, proceed as follows (Led Reset in the present example).

**1**



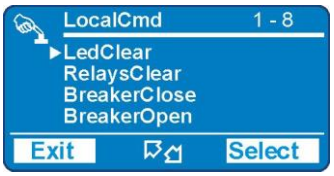

- Press "***Menu***" for access to the main menu with icons.

**2**




- Select "***LocalCmd***" *icon with pushbutton* "***Increase***" or "***Decrease***".
- Press "***Select***" for access.

**3**




- Select *with pushbutton* "***Increase***" or "***Decrease***" the menu "***LedClear***".
- Press "***Select***" to execute the command.
  (if Password is request, see § Password).

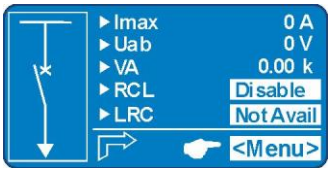
**4**


- When command has been executed the display shows "***! Command Done***"; go to "*3*".

# 8. Measure

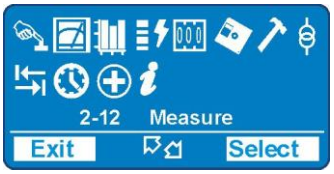
Real time values as measured during the normal operation.

**1**




- Press "***Menu***" for access to the main menu with icons.

**2**




- Select "***Measure***" *icon with pushbutton* "***Increase***" or "***Decrease***".
- Press "***Select***" for access.

**3**


- Scroll the menu "***Measure***" *with pushbutton* "***Increase***" or "***Decrease***" to display the measurement.
- Press "***Exit***" to go to the main menu.

| | Name | Range | Unit | *IEC 61850 protocol* | Description | Unit description |
|---|---|---|---|---|---|---|
| → | **Imax** | (0 ÷ 9999) | **A** | | Largest phase current (Ia,Ib,Ic) | |
| → | **Ia** | (0 ÷ 9999) | **A** | *MMXU-MX-A-phsA* | Phase A current | (R.M.S. ampere) |
| → | **Ib** | (0 ÷ 9999) | **A** | *MMXU-MX-A-phsB* | Phase B current | (R.M.S. ampere) |
| → | **Ic** | (0 ÷ 9999) | **A** | *MMXU-MX-A-phsC* | Phase C current | (R.M.S. ampere) |
| → | **Io** | (0 ÷ 9999) | **A** | *MMXU-MX-A-neut* | Zero Sequence Current | (fundamental frequency value 3Io) |
| → | **I1** | (0.00 ÷ 99.99) | **In** | *MSQI-MX-SeqA-C1* | Positive sequence current | |
| → | **I2** | (0.00 ÷ 99.99) | **In** | *MSQI-MX-SeqA-C2* | Negative sequence current | |
| → | **Frq** | (0.00 ÷ 99.99) | **Hz** | *MMXU-MX-Hz* | Frequency | |
| → | **Uan** | (0 ÷ 999999) | **V** | *MMXU-MX-PhV-phsA* | Phase Voltage "A-N" | (R.M.S. value) |
| → | **Ubn** | (0 ÷ 999999) | **V** | *MMXU-MX-PhV-phsB* | Phase Voltage "B-N" | (R.M.S. value) |
| → | **Ucn** | (0 ÷ 999999) | **V** | *MMXU-MX-PhV-phsC* | Phase Voltage "C-N" | (R.M.S. value) |
| → | **Uab** | (0 ÷ 999999) | **V** | *MMXU-MX-PPV-phsAB* | Phase-to-phase Voltage "A-B" | (R.M.S. value) |
| → | **Ubc** | (0 ÷ 999999) | **V** | *MMXU-MX-PPV-phsBC* | Phase-to-phase Voltage "B-C" | (R.M.S. value) |
| → | **Uca** | (0 ÷ 999999) | **V** | *MMXU-MX-PPV-phsCA* | Phase-to-phase Voltage "C-A" | (R.M.S. value) |
| → | **Uo** | (0 ÷ 999999) | **V** | *MMXU-MX-PhV-neut* | Zero Sequence Voltage | (fundamental frequency value 3Vo) |
| → | **V1** | (0.00 ÷ 99.99) | **Vn** | *MSQI-MX-SeqV-C1* | Positive Sequence Voltage | |
| → | **V2** | (0.00 ÷ 99.99) | **Vn** | *MSQI-MX-SeqV-C2* | Negative Sequence Voltage | |
| → | **PhA** | (0 ÷ 359) | **°** | | Phase angle "Ia ^ Uan" | |
| → | **PhB** | (0 ÷ 359) | **°** | | Phase angle "Ib ^ Ubn" | |
| → | **PhC** | (0 ÷ 359) | **°** | | Phase angle "Ic ^ Ucn" | |
| → | **Ph0** | (0 ÷ 359) | **°** | | Phase angle "Io ^ Uo" | |
| → | **W** | (0 ÷ 9999999) | **k** | *MMXU-MX-TotW* | Three Phase Active Power | (kW) |
| → | **VAr** | (0 ÷ 9999999) | **k** | *MMXU-MX-TotVAr* | Three Phase Reactive Power | (kVAr) |
| → | **VA** | (0 ÷ 9999999) | **k** | *MMXU-MX-TotVA* | Three Phase Apparent Power | (kVA) |
| → | **Cos** | (0.000 ÷ 1.000) | **-** | *MMXU-MX-TotPF* | Power Factor | |
| → | **Tem** | (0 ÷ 9999) | **%T** | | Thermal status as % of the full load continuous operation temperature Tn | |
| → | **Wir** | (100 ÷ 0) | **%W** | | Amount still remaining of permissible interruption energy before Circuit Breaker maintenance is requested. | |

# 9. Energy

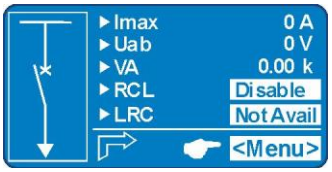
Real time energy measurements

| | | | | |
|---|---|---|---|---|
| ***Display*** | → | **+ kWh** | (0 – 9999999) | Exported Active Energy |
| | → | **- kWh** | (0 – 9999999) | Imported Active Energy |
| | → | **+ kRh** | (0 – 9999999) | Exported Reactive Energy |
| | → | **- kRh** | (0 – 9999999) | Imported Reactive Energy |

| | | |
|---|---|---|
| ***Erase*** | → | All Energy counters are cleared |

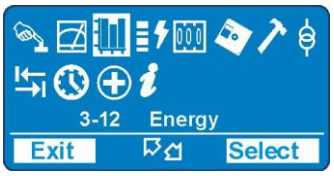
When the measurement exceed "9999999" the counters restart from "0".

**1**



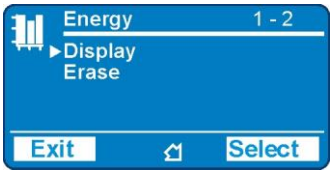

- Press "***Menu***" for access to the main menu with icons.

**2**



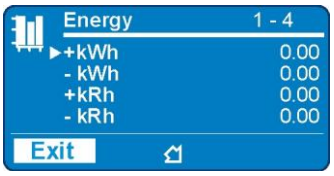

- Select "***Energy***" *icon with pushbutton* "***Increase***" or "***Decrease***".
- Press "***Select***" for access.

**3**



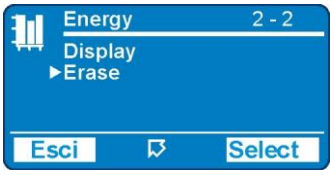

- Select "***Display***" *with pushbutton* "***Increase***" or "***Decrease***".
- Press "***Select***" for access.

**4**




- Display of Real time Energy measurements.
- Press "***Exit***" to go back to the level "*3*".

**5**




- Select "***Erase***" with pushbutton "***Decrease***" to clear all reading.
- Press "***Select***". (if Password is request, see § Password).

**6**


- When command has been execute the display shows "***! Command Done***"; to go to the level "*5*".
- Press "***Exit***" to go back to the main menu.

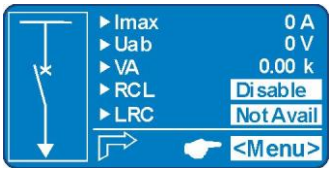
## 10. Trip Recording

Display of the function which caused the tripping of the relay plus values of the measurement at the moment of tripping. The last 10 events are recorded.
The memory buffer is refreshed at each new relay tripping (FIFO logic).

| | | |
|---|---|---|
| ***Display*** | → | Reading of recorded Trips. |

| | | |
|---|---|---|
| ***Erase*** | → | Clear all Trip recorded. |

**1**




- Press "***Menu***" for access to the main menu with icons.

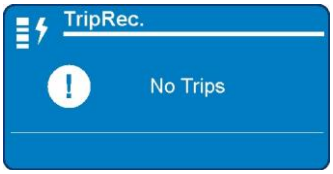
**2**


- Select "***TripRec.***" *icon with pushbutton* "***Increase***" or "***Decrease***".
- Press "***Select***" for access.

**3**

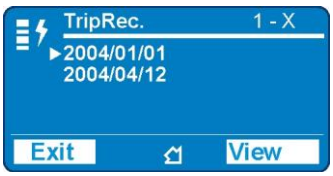

- Select "***Display***" *with pushbutton* "***Increase***" or "***Decrease***".
- Press "***Select***" for access.
- For "***Erase***" go to "8"

**4**



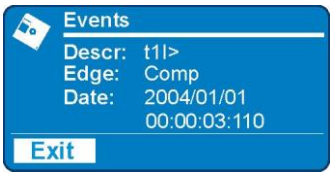

- If no trip is recorded the display shows "***! No Trips***".

**5**



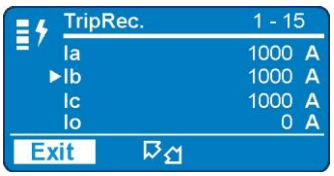

- If any trip was recorded, select "***View***" to display the chronological list of the records.
- By the keys "***Increase***" or "***Decrease***" select the date of the record to be checked.

**6**




- Will be shown:
  "***Descr***" the function that caused the event (Example: t1I> = Trip)
  "***Edge***" if the function was tripped (Rise) or reset (Fall)
  "***Date***", date of trip, year/month/day, hour:minutes:seconds:milliseconds
- Press "***Value***", for reading the value of input quantities on tripping.

**7**




- Scroll with pushbuttons "***Increase***" or "***Decrease***" the available measurements.
- Select "***Exit***" to go back to "5" for another selection, or "2" go back to the main menu.

**8**


- Select "***Erase***" with button "***Decrease***".
- Press "***Select***" to execute the commands; **All** Trips recorded are erased. (if Password is request, see § Password).

**9**

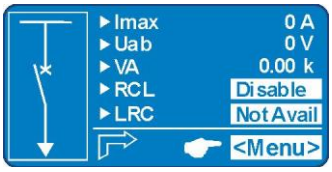

- When command has been executed the display shows "***! Command Done***";
- Press "***Exit***" to go back to the main menu.

## 11. Counters

Counters of the number of operations for each of the relay functions.
By the interface program “MSCom 2” it is possible to individually reset the counters and set an initial starting number.

| Display | | | | |
|---|---|---|---|---|
| → T> | 0 | Operations counters | Thermal Image |
| → 1I> | 0 | Operations counters | First overcurrent element |
| → 2I> | 0 | Operations counters | Second overcurrent element |
| → 3I> | 0 | Operations counters | Third overcurrent element |
| → 1Io> | 0 | Operations counters | First Earth Fault element |
| → 2Io> | 0 | Operations counters | Second Earth Fault element |
| → 3Io> | 0 | Operations counters | Third Earth Fault element |
| → 1Is> | 0 | Operations counters | First Negative Sequence element |
| → 2Is> | 0 | Operations counters | Second Negative Sequence element |
| → 1U> | 0 | Operations counters | First Overvoltage element |
| → 2U> | 0 | Operations counters | Second Overvoltage element |
| → 1U< | 0 | Operations counters | First Undervoltage element |
| → 2U< | 0 | Operations counters | Second Undervoltage element |
| → 1f> | 0 | Operations counters | First Overfrequency element |
| → 2f> | 0 | Operations counters | Second Overfrequency element |
| → 1f< | 0 | Operations counters | First Underfrequency element |
| → 2f< | 0 | Operations counters | Second Underfrequency element |
| → 1Uo> | 0 | Operations counters | First Zero Sequence overvoltage element |
| → 2Uo> | 0 | Operations counters | Second Zero Sequence overvoltage element |
| → IRF | 0 | Operations counters | Internal Relay Fault |
| → U2> | 0 | Operations counters | Negative Sequence overvoltage element |
| → U1< | 0 | Operations counters | Positive Sequence undervoltage element |
| → TCS | 0 | Operations counters | Trip Circuit Supervision |
| → BrkF | 0 | Operations counters | Breaker failure to open |
| → Wi | 0 | Operations counters | Circuit Breaker maintenance alarm |
| → RT | 0 | Operations counters | Remote Trip |
| → RCL f | 0 | Operations counters | Autoreclosure Failed |
| → TwRCL | 0 | Operations counters | Trip not enabled for initiating Automatic Reclosure |
| → RCL ok | 0 | Operations counters | Autoreclosure successful |
| → MCL ok | 0 | Operations counters | Manual Reclosure successful |
| → RCL BL | 0 | Operations counters | Autoreclosure blocked (Lock-Out) |
| → Aut Op | 0 | Operations counters | Automatic C/B Openings |
| → Aut CL | 0 | Operations counters | Automatic C/B Closings |
| → Man Op | 0 | Operations counters | Manual C/B Openings |
| → Man CL | 0 | Operations counters | Manual C/B Closings |
| → OvrOp | 0 | Operations counters | Overall C/B Openings total (Man+Aut) |
| → OvrCL | 0 | Operations counters | Overall C/B Closings total (Man+Aut) |

**1**




- Press "***Menu***" for access to the main menu with icons.

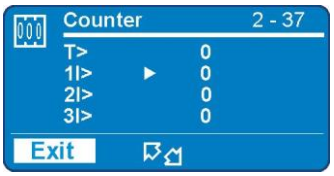
**2**


- Press "***Counter***" for access.

**3**


- Press "***Display***" for access.

**4**



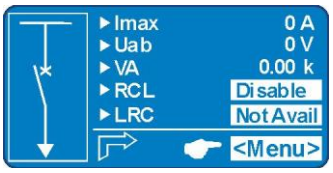

- Display of the number of operations of each individual function.
- With pushbuttons "***Increase***" or "***Decrease***" scroll the parameters
- Press "***Exit***" go back to "*3*".

## 12. Events

Display of the function which caused any of the following events: - *Status change of digital Inputs/Outputs. - Start of protection functions – Trip of protection function – Function reset.*
The last 100 events are recorded.
The memory buffer is updated at each new event.

| | | |
|---|---|---|
| ***Display*** | → | Reading events recorded. |
| ***Erase*** | → | Clear all events recorded. |

**1**




- Press "***Menu***" for access to the main menu with icons.

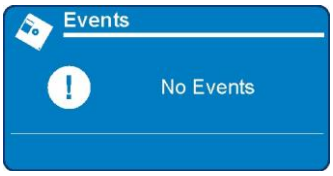
**2**


- Select "***Events***" *icon with pushbutton* "***Increase***" or "***Decrease***".
- Press "***Select***" for access.

**3**


- Select "***Display***" *with pushbutton* "***Increase***" or "***Decrease***".
- Press "***Select***" for access.
- For "***Erase***" go to "7"

**4**

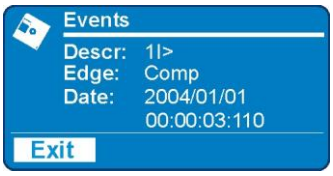



- If no event is recorded the display shows message "***! No Events***".

**5**


- If any event was recorded, select "***View***" to display the chronological list of the records.
- By the keys "***Increase***" or "***Decrease***" select the date of the record to be checked.

**6**




- Will be shown:
  "***Descr***" the function that caused the event
  (Example: 1I> = Start, t1I> = Trip)
  "***Edge***" if the function was tripped (Rise) or reset (Fall)
  "***Date***", date of trip, year/month/day, hour:minutes:seconds:milliseconds

**7**


- Select "***Erase***" with button "***Decrease***".
- Press "***Select***" to execute the commands; **All** Events recorded are erased.
  (if Password is request, see § Password).

**8**


- When command has been execute the display shows "***! Command Done***";
- Press "***Exit***" to go back to the main menu.

## *12.1 – Events on display*

| Functions | Events Displayed | Events Description MScom2 | Status | |
|---|---|---|---|---|
| T> | Tal | *Tal (Alarm – Thermal Image T>)* | Rise | |
| | T> | *T> (Trip – Thermal Image T>)* | Rise | Fall |
| 1I> | 1I> | *1I> (Start - First overcurrent element F50-51)* | Rise | |
| | t1I> | *t1I> (Trip - First overcurrent element F50-51)* | Rise | Fall |
| 2I> | 2I> | *2I> (Start – Second overcurrent element F50-51)* | Rise | |
| | t2I> | *t2I> (Trip – Second overcurrent element F50-51)* | Rise | Fall |
| 3I> | 3I> | *3I> (Start – Third overcurrent element F50-51)* | Rise | |
| | t3I> | *t3I> (Trip - Third overcurrent element F50-51)* | Rise | Fall |
| 1Io> | 1Io> | *1Io> (Start - First earth fault element F50N-51N)* | Rise | |
| | t1Io> | *t1Io> (Trip - First earth fault element F50N-51N)* | Rise | Fall |
| 2Io> | 2Io> | *2Io> (Start - Second earth fault element F50N-51N)* | Rise | |
| | t2Io> | *t2Io> (Trip - Second earth fault element F50N-51N)* | Rise | Fall |
| 3Io> | 3Io> | *3Io> (Start - Third earth fault element F50N-51N)* | Rise | |
| | t3Io> | *t3Io> (Trip - Third earth fault element F50N-51N)* | Rise | Fall |
| 1Is> | 1Is> | *1Is> (Start - First negative sequence current element F46)* | Rise | |
| | t1Is> | *t1Is> (Trip - First negative sequence current element F46)* | Rise | Fall |
| 2Is> | 2Is> | *2Is> (Start – Second negative sequence current element F46)* | Rise | |
| | t2Is> | *t2Is> (Trip – Second negative sequence current element F46)* | Rise | Fall |
| 1U> | 1U> | *1U> (Start - First overvoltage element F59)* | Rise | |
| | t1U> | *t1U> (Trip - First overvoltage element F59)* | Rise | Fall |
| 2U> | 2U> | *2U> (Start – Second overvoltage element F59)* | Rise | |
| | t2U> | *t2U> (Trip – Second overvoltage element F59)* | Rise | Fall |
| 1U< | 1U< | *1U< (Start - First undervoltage element F27)* | Rise | |
| | t1U< | *t1U< (Trip - First undervoltage element F27)* | Rise | Fall |
| 2U< | 2U< | *2U< (Start – Second undervoltage element F27)* | Rise | |
| | t2U< | *t2U< (Trip – Second undervoltage element F27)* | Rise | Fall |
| 1f> | 1f> | *1f> (Start - First overfrequency element F81)* | Rise | |
| | t1f> | *t1f> (Trip - First overfrequency element F81)* | Rise | Fall |
| 2f> | 2f> | *2f> (Start – Second overfrequency element F81)* | Rise | |
| | t2f> | *t2f> (Trip – Second overfrequency element F81)* | Rise | Fall |
| 1f< | 1f< | *1f< (Start - First underfrequency element F81)* | Rise | |
| | t1f< | *t1f< (Trip - First underfrequency element F81)* | Rise | Fall |
| 2f< | 2f< | *2f< (Start – Second underfrequency element F81)* | Rise | |
| | t2f< | *t2f< (Trip – Second underfrequency element F81)* | Rise | Fall |
| 1Uo> | 1Uo> | *1Uo> (Start - First zero sequence voltage element F59Uo)* | Rise | |
| | t1Uo> | *t1Uo> (Trip - First zero sequence voltage element F59Uo)* | Rise | Fall |
| 2Uo> | 2Uo> | *2Uo> (Start – Second zero sequence voltage element F59Uo)* | Rise | |
| | t2Uo> | *t2Uo> (Trip – Second zero sequence voltage element F59Uo)* | Rise | Fall |
| U1< | U1< | *U1< (Start - Positive sequence undervoltage element F27U1)* | Rise | |
| | tU1< | *tU1< (Trip – Positive sequence undervoltage element F27U1)* | Rise | Fall |
| U2> | U2> | *U2> (Start – Negative sequence overvoltage element F59U2)* | Rise | |
| | tU2> | *tU2> (Trip – Negative sequence overvoltage element F59U2)* | Rise | Fall |
| Wi | tWi> | *tWi> (Circuit breaker maintenance level)* | Rise | |
| TCS | TCS | *TCS (Start - trip coil supervision)* | Rise | |
| | tTCS | *tTCS (trip coil supervision)* | Rise | Fall |
| IRF | IRF | *IRF (Start - Internal Relay Failure)* | Rise | |
| | tIRF | *tIRF (Trip - Internal Relay Failure)* | Rise | |
| RT | Start RT | *RT (Start - Element Remote Trip)* | Rise | |
| | RemTrip | *tRT (Trip - Element Remote Trip)* | Rise | |
| Anom.Int | tBF | *tBF (Trip – Breaker Failure)* | Rise | |

| Functions | Events Displayed | Events Description MScom2 | Status | |
|---|---|---|---|---|
| | 79X | *Reclosure command* | Rise | |
| | FR | *Reclosure failure* | Rise | |
| | CRC | *Recloser cycle in progress* | Rise | |
| | TWR | *Trip without reclosure* | Rise | |
| | ReclDone | *Reclosure succesfull* | Rise | |
| | StartTnExt | *Start reclaim time [TrExt] on external lockout* | Rise | |
| | StopTrExt | *Stop reclaim time [TrExt] on external lockout* | Rise | |
| | RCLInterr. | *Reclosure interrupted by setup cause* | Rise | |
| | CH-Riusc. | *Manual close succesfull* | Rise | |
| | BiRCL | *Presence reclosure external lockout cause (input/CB Failure)* | Rise | |
| | StartR1 | *Start first reclosure* | Rise | |
| | StartR2 | *Start second reclosure* | Rise | |
| | StartR3 | *Start third reclosure* | Rise | |
| | StartR4 | *Start fourth reclosure* | Rise | |
| | StartTr-d1 | *Start Reclaim and Discrimination time on first closure* | Rise | |
| | StartTr-d2 | *Start Reclaim and Discrimination time on second closure* | Rise | |
| | StartTr-d3 | *Start Reclaim and Discrimination time on third closure* | Rise | |
| | StartTr-d4 | *Start Reclaim and Discrimination time on fourth closure* | Rise | |
| | CRIntScDis | *Cycle blocked by not reclosing trip* | Rise | |
| | CRIntApInt | *Cycle blocked by intentional C/B open* | Rise | |
| | CRIntBinp | *Cycle interupted by external cause* | Rise | |
| | CRCInChCB | *Cycle blocked by intentional C/B close* | Rise | |
| | StartRChM | *Start manual reclosure cycle* | Rise | |
| | FrLTr | *Trip in last reclaim time available* | Rise | |
| | Gr1-Gr2 | *Switch to setup Bank 2* | Rise | Fall |
| | RCLInterr | *Reclosure interrupt by persistent fault* | Rise | |
| | SeqC | *Sequence coordination (Start mew/next RCL cycle)* | Rise | |
| | L/Rdisc. | *Local/Remote signal Discrepancy* | Rise | |
| | manOpKey | *Circuit Breaker intentional open by Key* | Rise | |
| | manOpLocC | *Circuit Breaker intentional open by local command* | Rise | |
| | manOpRemC | *Circuit Breaker intentional open by remote command* | Rise | |
| | manOpExtIn | *Circuit Breaker intentional open by external input* | Rise | |
| | ExterManOp | *Circuit Breaker intentional external open* | Rise | |
| | manClKey | *Circuit Breaker intentional close by Key* | Rise | |
| | manClLocC | *Circuit Breaker intentional close by local command* | Rise | |
| | manClRemC | *Circuit Breaker intentional close by remote command* | Rise | |
| | manClExtIn | *Circuit Breaker intentional close by external input* | Rise | |
| | ExterManCh | *Circuit Breaker intentional external close* | Rise | |
| | CB-Fail | *Circuit Breaker failure* | Rise | Fall |
| | 0.D0<br>----<br>0.D4 | *Digital Input* | Rise | Fall |
| | 1.D1<br>----<br>1.D15 | *Digital input* | Rise | Fall |
| | 2.D1<br>----<br>2.D15 | *Digital input* | Rise | Fall |
| | 0.R1<br>----<br>0.R6 | *Output relay* | Rise | Fall |
| | 1.R1<br>----<br>1.R14 | *Output relay* | Rise | Fall |
| | 2.R1<br>----<br>2.R14 | *Output relay* | Rise | Fall |
| | UpDateMon | *Update Monitor* | Rise | Fall |
| | IPU boot | *IPU boot* | Rise | |

## 13. System (System parameters)

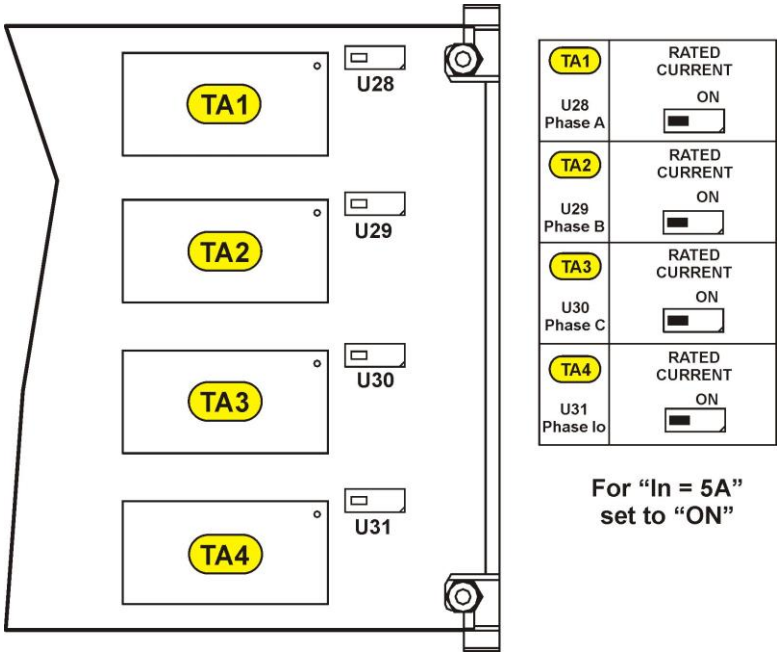
Setting of system parameters.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **CT&PTs** | Phase CT | **Prim.** | → | 1000 | A | (1 ÷9999) | step | 1 | A | |
| | | **Sec.** | → | 1 | A | (1 / 5) | | | | (1) |
| | PT (Ph-Ph) | **Prim.** | → | 10.00 | kV | (0.10 ÷500.00) | step | 0.01 | kV | |
| | | **Sec.** | → | 100 | V | (50 ÷150) | step | 1 | V | (2)(3) |
| | Neut. CT | **Prim.** | → | 1000 | A | (1÷9999) | | 1 | A | |
| | | **Sec.** | → | 1 | A | (1 / 5) | | | | (1) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sys.Ratings** | → | **fn** | 50 | Hz | (50 / 60) | | | |
| (System Rated Values) | → | **In** | 500 | A | (1÷9999) | | 1 | A |
| | → | **Un** | 10.00 | kV | (0.10 ÷500.00) | | 0.01 | kV |

| | | | | | |
|---|---|---|---|---|---|
| **Setup Group** | → | **Group** | 1 | | (1 / 2) |

(1) Move the switch in the corresponding founding to the required input current as herebelow shorted.

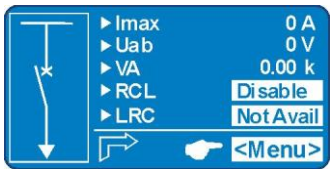



(2) Set the value of the phase-to-phase PT voltage.

$$\text{Example: Example : TV} \quad \frac{10000 : \sqrt{3}}{100 : \sqrt{3}} \rightarrow \text{set} \quad \frac{\text{Prim.} = 10000}{\text{Sec.} = 100}$$

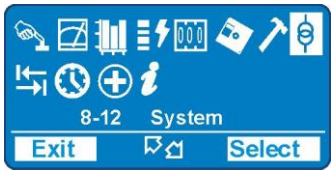
(3) Zero sequence voltage input is to be supplied by three system P.Ts. Y/Open Delta connected; the open delta connected secondary are rated 1/3 of the phase-to-phase secondary voltage (Example: 10000 / 100:√3 / 100:3).

**1**




- Press "***Menu***" for access to the main menu with icons.

**2**

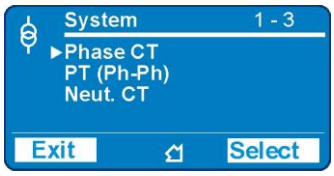



- Select "***System***" *icon with pushbuttons* "***Increase***" or "***Decrease***".
- Press "***Select***" for access.

**3**

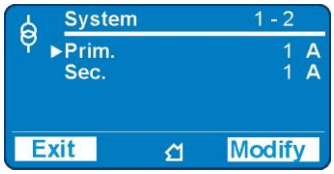

- Select "***CT&PTs***".
- Press "***Select***" *for access.*

**4**



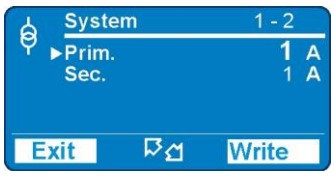

- Select "***Phase CT***".
- Press "***Select***" for access.

**5**



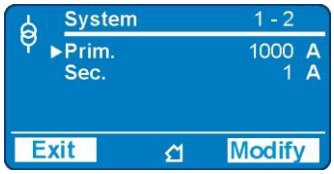

- Select "***Prim.***" to modify the primary value of Phase CT, or press "***Decrease***" and select "***Sec.***" to modify the secondary value of Phase CT.
- Press "***Modify***" to modify the parameter.
  (if Password is request, see § Password).

**6**



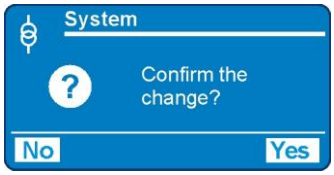

- The value appear as bold figure.
- Use pushbuttons "***Increase***" or "***Decrease***" to set the value.
- Press "***Write***" to confirm the value

**7**




- The value is now set.
- To set a new value return to the point "5".
- Press "***Exit***".

**8**

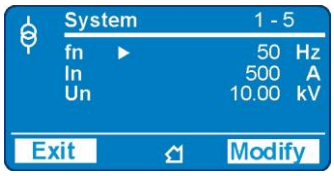



- The display show "***Confirm the change?***".
- Choose "***Yes*** " to convalidate the changes.
- Choose "***No*** " to **not** confirm the changes.
- After set confirmation (or non confirmation) the display goes back to point "4".

**9**


- To modify the input quantities, select with pushbutton "***Decrease***", "***Sys.Ratings***".
- Press "***Select***" for access.

**10**




- To set the input quantities see points "5-6-7-8" .

**11**


- To select the Active Bank of setting press "***SetUp Group***".

**12**


- Select with pushbuttons "***Increase***" or "***Decrease***", the Bank to be Active.

## 14. Settings

Two complete banks of settings of the programmable variables are available in the "***SETTING***" menu. Both "Bank #1" and "Bank #2" include the hereunder listed variables.

**1**


Indicates the Setting Bank that is actually being modified.

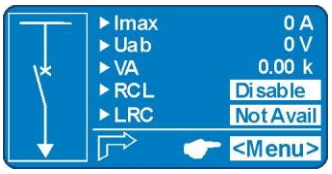
This symbol indicates that the function is enabled; symbol missing indicates that the function is disabled.

| | Function name | IEC 61850 | Description |
|---|---|---|---|
| → | **Comunic.** | | Serial communication parameters |
| → | **Customize** | | Visualization parameters |
| → | **T>** | *PTTR1* | Thermal Image |
| → | **1I>** | *PTOC1* | First overcurrent Element |
| → | **2I>** | *PIOC1* | Second overcurrent Element |
| → | **3I>** | *PTOC2* | Third overcurrent Element |
| → | **1Io>** | *PTOC3* | First Earth Fault Element |
| → | **2Io>** | *PTOC4* | Second Earth Fault Element |
| → | **3Io>** | *PTOC5* | Third Earth Fault Element |
| → | **1Is>** | *PTOC6* | First Negative Sequence Current Element |
| → | **2Is>** | *PTOC7* | Second Negative Sequence Current Element |
| → | **1U>** | *PTOV1* | First Overvoltage Element |
| → | **2U>** | *PTOV2* | Second Overvoltage Element |
| → | **1U<** | *PTUV1* | First Undervoltage Element |
| → | **2U<** | *PTUV2* | Second Undervoltage Element |
| → | **1f>** | *PTOF1* | First Overfrequency Element |
| → | **2f>** | *PTOF2* | Second Overfrequency Element |
| → | **1f<** | *PTUF1* | First Underfrequency Element |
| → | **2f<** | *PTUF2* | Second Underfrequency Element |
| → | **1Uo>** | *PTOV3* | First Zero Sequence Voltage Element |
| → | **2Uo>** | *PTOV4* | Second Zero Sequence Voltage Element |
| → | **U1<** | *PTUV3* | Positive Sequence Undervoltage Element F27U1 |
| → | **U2>** | *PTOV5* | Negative sequence Overvoltage Element F59U2 or F47 |
| → | **Wi** | | Amount of Energy to reach the C/B maintenance level |
| → | **TCS** | *TCS_CALH1* | Setting variables for Trip Circuit Supervision |
| → | **IRF** | | Internal Relay Fault |
| → | **RT** | *RT_CALH2* | Remote Trip |
| → | **TripTimeRd** | | Trip time Reduction |
| → | **AutomRecl.** | *RREC1* | Automatic Reclosure |
| → | **CB Manage** | | C/B command Local / Remote setting |
| → | **Oscillo** | | Setting variables for Oscillographic recording |
| → | **BreakerFail** | *RBRF1* | Setting variables for Breaker Failure detection |
| → | **ExtResCfg** | | Configuration for external reset input |

## *14.1. Modifying the setting of variables*

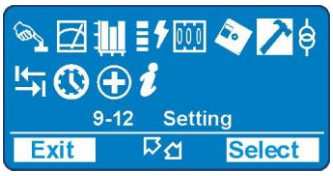
To modify any variable setting by the keyboard proceed as follows:
(example: change setting of element "***1I>***", from "**Is *4.000* In**" to "**Is *3.500* In**")

**1**




- Press "***Menu***" for access to the main menu with icons.

**2**




- Select icon "***Setting***" by pushbuttons "***Increase***" or "***Decrease***".
- Press "***Select***".

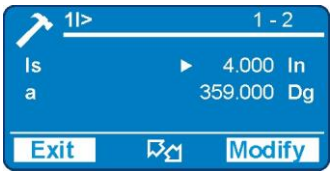
**3**


- Select by pushbuttons "***Increase***" or "***Decrease***" the parameter "***1I>***".
- Press "***Select***".

**4**


- Select by buttons "***Increase***" or "***Decrease***" the menu "***Oper.Levels***".
- Press "***Select***".

**5**

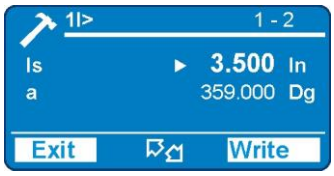



- The arrow aside "***Is***" shows the parameter selected for changing
- Press "***Modify***".
- If Password is request, see § Password

**6**

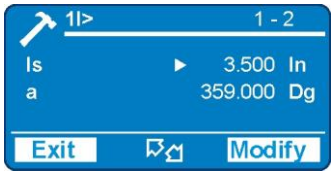

- The value appear as bold figure.

**7**




- Set new values pushbuttons "***Increase***" or "***Decrease***" buttons
- Press "***Write***".

**8**




- If the change of parameters is completed, press "***Exit***".

**9**


- "***Yes***" confirm all changes.
- "***No***" voids all the changes.

**10**


- The relay returns to point "**4**".

## *14.2. Password*

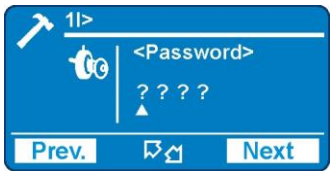
The password is requested any time the user wishes to modify any password protected parameter (example “1I>” menu “Setting”).

The factory default password is “ 1111 “.

The password is only modifiable with “MSCom 2” software (see Manual “MSCom 2”).

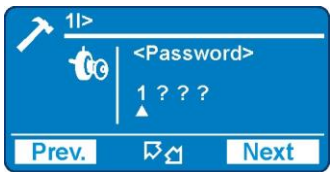
When password is requested, proceed as follows:

**1**



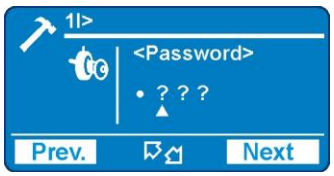

- Use the key “***Increase***” and “***Decrease***” and set the first digit of password.

**2**



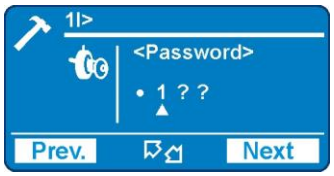

- Press “***Next***” to validate and go to the next digit.

**3**



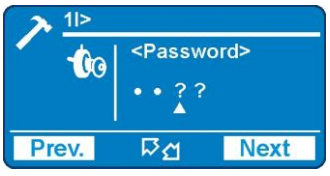

- Use the key “***Increase***” or “***Decrease***” to set second digit.

**4**



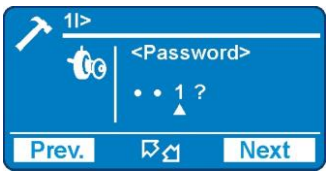

- Press “***Next***” to validate and go to the next digit.

**5**



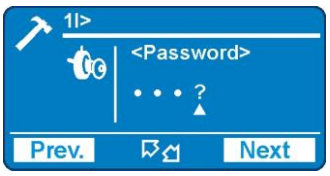

- Use the key “***Increase***” or “***Decrease***” to set the third digit.

**6**



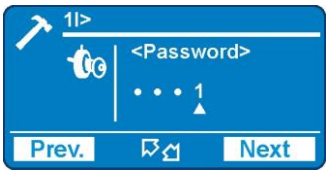

- Press “***Next***” to validate and go to the next digit.

**7**




- Use the key “***Increase***” or “***Decrease***” to set the fourth digit.

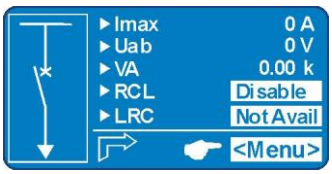
**8**




- Press “***Next***” to validate and go to modify the next parameter.

By key “***Prev***” go back to previous digit.

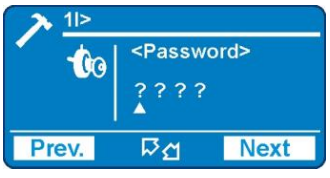
The password validity expires 60 sec after the last setting modification or as soon as you go back to the main menu




**1**


- If set the incorrect password the display shows “***! Wrong code***”.

**2**




- The display will repeat the initial interrogation

## *14.3 – Menu:* ***Communic. (Communication)***

| | | | | |
|---|---|---|---|---|
| ***Options*** | → | **BRLoc** | 38400 | [9600 / 19200 / 38400 / 57600] |
| | → | **BRRem** | 38400 | [9600 / 19200 / 38400 / 57600]<br>Fixed for 61850 protocol |
| **Node Address** | → | **Indir.** | 1 | [1 ÷ 255]<br>Fixed for 61850 protocol |

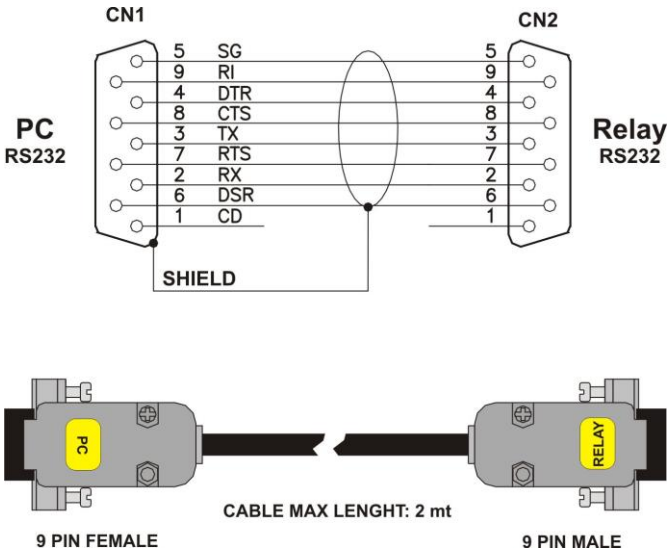
### *14.3.1 – Description of variables*

- **BRLoc** : RS232 local (Front Panel) serial communication speed
- **BRRem** : Remote serial, serial communication dedicated to 61850 protocol
- **Indir.** : Identification number for the connection on serial communication bus

### *14.3.2 – Front Panel serial communication port (RS232)*

A D-Sub, -pin female socket is available on Relay's front face for connection to the local RS232 serial communication line. Through this port - and by the interface program available from Microelettrica Scientifica S.p.A. (MSCom 2 for Windows 98/ME/2000/XP) – it is possible to connect a Personal Computer to download all available information, operate any control and program the relay; the protocol used is " Modbus RTU".

### *14.3.3 – Cable for direct connection of Relay to Personal Computer*




### *14.3.4 – Rear communication port (Ethernet with IEC 61850 protocol)*

Relay's back Ethernet connection is available for communication with a IEC 61850 Client program, the Ethernet connector is a standard RJ45 and can be connected to a PC with a Ethernet "Crossover" cable, or it can be connected to a switch with a Ethernet "Patch" cable.
The communication IP address is **192.168.0.121**, but it can be changed in the purchase order.
The time synchronization is available via SNTP protocol, the request is done to a SNTP server to IP address **192.168.0.20**, but it can be changed in the purchase order.

## *14.4 - Menu:* ***Customize***

| | | | |
|---|---|---|---|
| ***Options*** | → **Lang** | English | [English / Loc.Lang] |
| | → **Light** | On | [Autom. / On] |

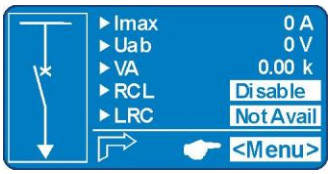
### *14.4.1 – Description of variables*

| | | |
|---|---|---|
| ❑ **Lang** | : | Set Language |
| ❑ **Light** | : | Set Display backlight |

This menu allows to customize the Language and the Display's backlight.
The standard languages are English and Italian. On request, other languages can be loaded (French, German, etc..).
The Display backlight can be programmed always on "ON" or switched-on "Automatically" for a few second at any operation of the keyboard "Auto".

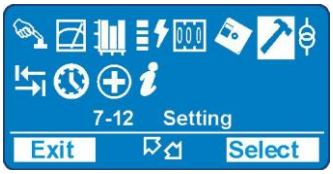
*Example: set Local Language.*

**1**




- Press "***Menu***" for access to the main menu with icons.

**2**




- Select icon "***Setting***" by pushbuttons "***Increase***" or "***Decrease***".
- Press "***Select***".

**3**


- Select "***Bank 1***" or "***Bank 2***"
- Select "***Customize***"
- Select "***Options***".
- Press "***Select***".

**4**


- Select "***Lang***"
- Press "***Modify***".

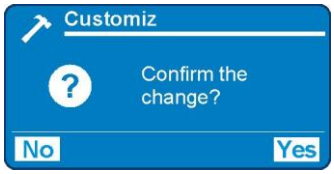
**5**


- Select "***Loc.Lang***".
- Press "***Write***"
- If Password is requested, see § Password

**6**


- Press "***Exit***"

**7**




- "***Yes***" confirms all changes.
- "***No***" void all changes.

**8**


- After set confirmation the display shows "***Please Wait***"

## 14.5 - Function: **T>** (Thermal Image F49)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***Status*** | → | **Enab.** | No | | [No / Yes] | | | |
| ***Options*** | → | **OPMOD** | I1 I2 | | [I1 I2 – Imax] | | | |
| | → | **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | |
| ***Oper.Levels*** | → | **Tal** | 10.000 | **%Tn** | [10 ÷ 100] | step | 1.000 | %Tn |
| | → | **Is** | 0.500 | | [0.5 ÷ 1.5] | step | 0.010 | |
| | → | **Kt** | 1.000 | **min** | [1 ÷ 600] | step | 0.010 | min |

### 14.5.1 - Description of variables

- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **OPMOD** : Operation Mode
- **TrOsc** : Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the "T>" function.
- **Tal** : Temperature prealarm level
- **Is** : Continuous admissible current
- **Kt** : Warming-up Time Constant of the load

### 14.5.2 - Trip and Alarm

The algorithm compares the amount of heat accumulated "T" (≡ $i^2 \bullet t$) to the steady state amount of heat "Tn" corresponding to continuous operation of the rated current "In".
When the ratio "T/Tn" reaches the level set for Thermal Alarm "Tal" or the max allowed heating, the relay trips accordingly

#### 14.5.2.1 – Operation mode "Imax"

With this option, the largest of the three phase currents measured is used to compute the Thermal Image:

$$I = MAX(Ia, Ib, Ic)$$

#### 14.5.2.2 – Operation mode "I1-I2"

With this option, a composition of Positive and Negative Sequence components of the current measured is used to compute the Thermal Image:

$$I = \sqrt{(I_1)^2 + 3(I_2)^2}$$

*14.5.2.3 – Trip time of the Thermal Image Element*

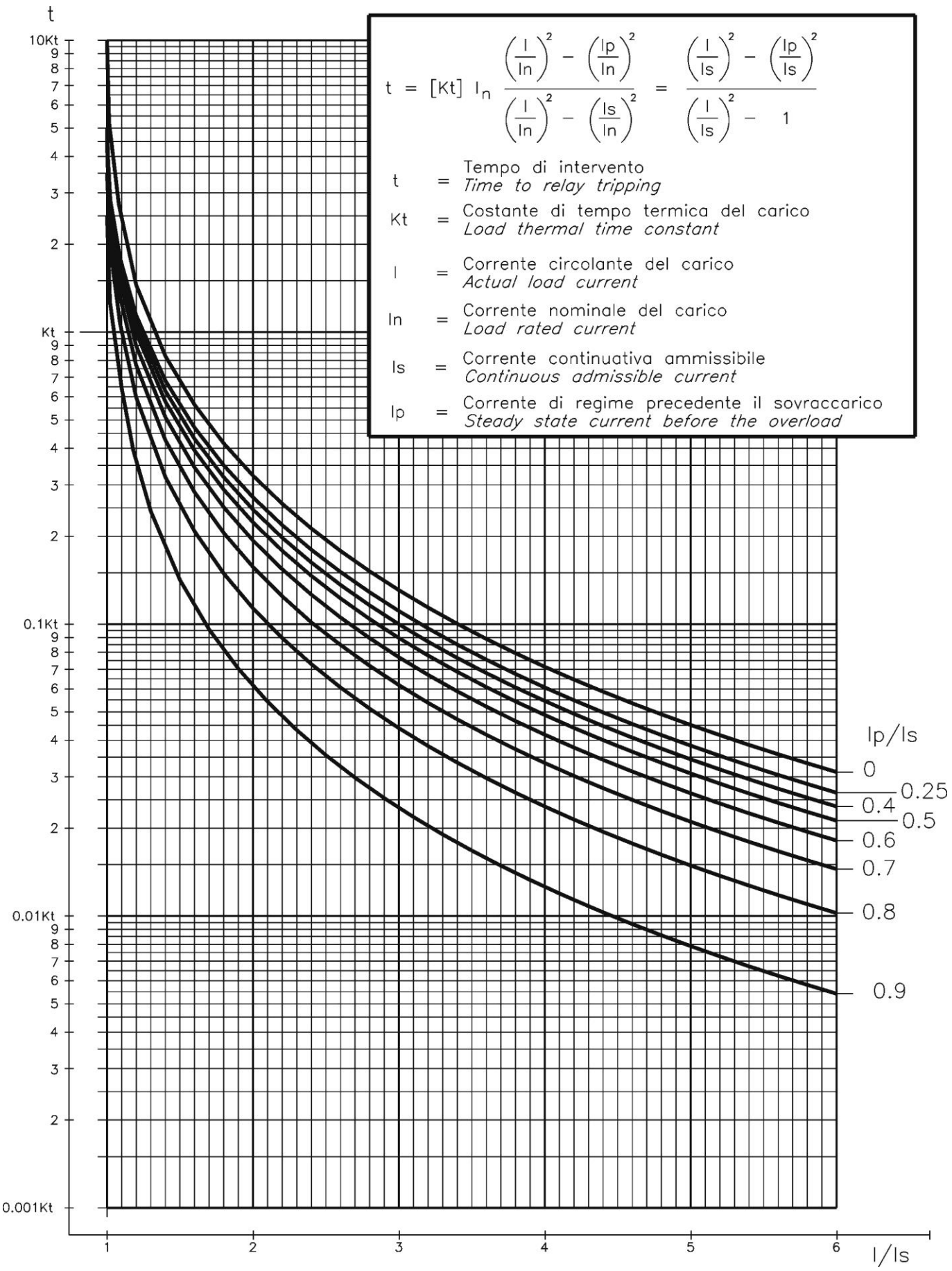
The trip time of the Thermal Image Element is a function of the current "I" flowing into the load and depends on its warming-up Time Constant "Kt", on the previous thermal status "Ip" and on the maximum admissible continuous current "Is" according to the equation:

$$t = Kt \cdot \ell_n \frac{\left(\frac{I}{In}\right)^2 - \left(\frac{Ip}{In}\right)^2}{\left(\frac{I}{In}\right)^2 - \left(\frac{Is}{In}\right)^2}$$

| | | |
|---|---|---|
| **t** | = | Time to relay tripping |
| **Kt** | = | Load thermal time constant |
| **I** | = | Actual load current |
| **In** | = | Load rated current |
| **Is** | = | Continuous admissible current |
| **Ip** | = | Steady state current before the overload |
| $\ell$ **n** | = | Natural Logarithm |

When the heating exceeds the set alarm level "Tal" or the max. allowed level ("I" > "Is" for the time "t") the output relays programmed for these function will be operated. Reset will take place when the heating will drop below 99% of the trip level.

*14.5.2.4 – Thermal Image Curves (TU1024 Rev.1)*



## 14.6 - Function: **1I>** (First Overcurrent Element F50/51)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Status** | → | **Enab.** | No | | [No / Yes] | | | | |
| **Options** | → | **f(t)** | Type - D | | [D / A / B / C / I / VI / EI / MI / SI] | | | | |
| | → | **tBI** | Off | | [Off / 2tBO] | | | | (1) |
| | → | **f(a)** | Disable | | [Disable / Sup / Dir] | | | | |
| | → | **f(U)** | Disable | | [Disable / Enable] | | | | |
| | → | **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | | |
| **Oper. Levels** | → | **Is** | 4.000 | **In** | (0.100÷4) | step | 0.010 | In | |
| | → | **a** | 359.000 | **°** | (0.000÷359) | step | 1.000 | ° | |
| **Timers** | → | **ts** | 100.00 | **s** | (0.02÷100) | step | 0.01 | s | |
| | → | **tBO** | 0.75 | **s** | (0.05÷0.75) | step | 0.01 | s | (1) |

### 14.6.1 - Description of variables

- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **f(t)** : Operation characteristic (Time/Current curve):
  - (D) = Independent definite time
  - (A) = IEC Inverse Curve type A
  - (B) = IEC Very Inverse Curve type B
  - (C) = IEC Extremely Inverse Curve type C
  - (I) = IEEE Inverse Curve
  - (VI) = IEEE Very Inverse Curve
  - (EI) = IEEE Extremely Inverse Curve
  - (MI) = IEEE Moderate Inverse Curve
  - (SI) = IEEE Short Inverse Curve
- **tBI** : Blocking input reset time
  - Off = Permanent block
  - *2tBO* = Set 2xtBO.
- **f(a)** : Operation mode:
  - *Disable* = Non Directional
  - *Sup.* = Directional Supervision
  - *Dir.* = Total Directional
- **f(U)** : Voltage restraint
- **TrOsc** : Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the function.
- **Is** : Minimum operation level
- **a** : Reference phase current displacement angle for Directional operation
- **ts** : Trip time delay
- **tBO** : Time to reset of the Blocking Output after expiring of the Trip time delay. “tBO” is also the trip time delay of the Breaker Failure function.

*14.6.2 - Algorithm of the time current curves*

The Time Current Curves are generally calculated with the following equation

**(1)** $t(I)\left[\frac{A}{\left(\frac{I}{Is}\right)^{a}-1}+B\right]\cdot K\cdot T_S\cdot+T_r$ where

t(I) = Actual trip time delay when the input current equals "I"

Is = Set minimum pick-up level

$K = \left(\frac{A}{10^{a}-1}+B\right)^{-1}$

$T_s$ = Set time delay: $t(I) = T_s$ when $\frac{I}{I_s}=10$

tr = Operation time of the output relay on pick-up.

The parameters A, B and a have different values for the different Time Current Curves.

| Curve Name | Curve Identifier | A | B | a |
|---|---|---|---|---|
| IEC A Inverse | A | 0.14 | 0 | 0.02 |
| IEC B Very Inverse | B | 13.5 | 0 | 1 |
| IEC C Extremely Inverse | C | 80 | 0 | 2 |
| IEEE Moderate Inverse | MI | 0.0104 | 0.0226 | 0.02 |
| IEEE Short Inverse | SI | 0.00342 | 0.00262 | 0.02 |
| IEEE Very Inverse | VI | 3.88 | 0.0963 | 2 |
| IEEE Inverse | I | 5.95 | 0.18 | 2 |
| IEEE Extremely Inverse | EI | 5.67 | 0.0352 | 2 |

For the IEC curves, being B = 0, the Time/Current equation (1), becomes:

$(1')\quad t(I) = \frac{\left(10^{a}-1\right)Ts}{\left(\frac{I}{Is}\right)^{a}-1} + tr = \frac{Kt}{\left(\frac{I}{Is}\right)^{a}-1} + tr$

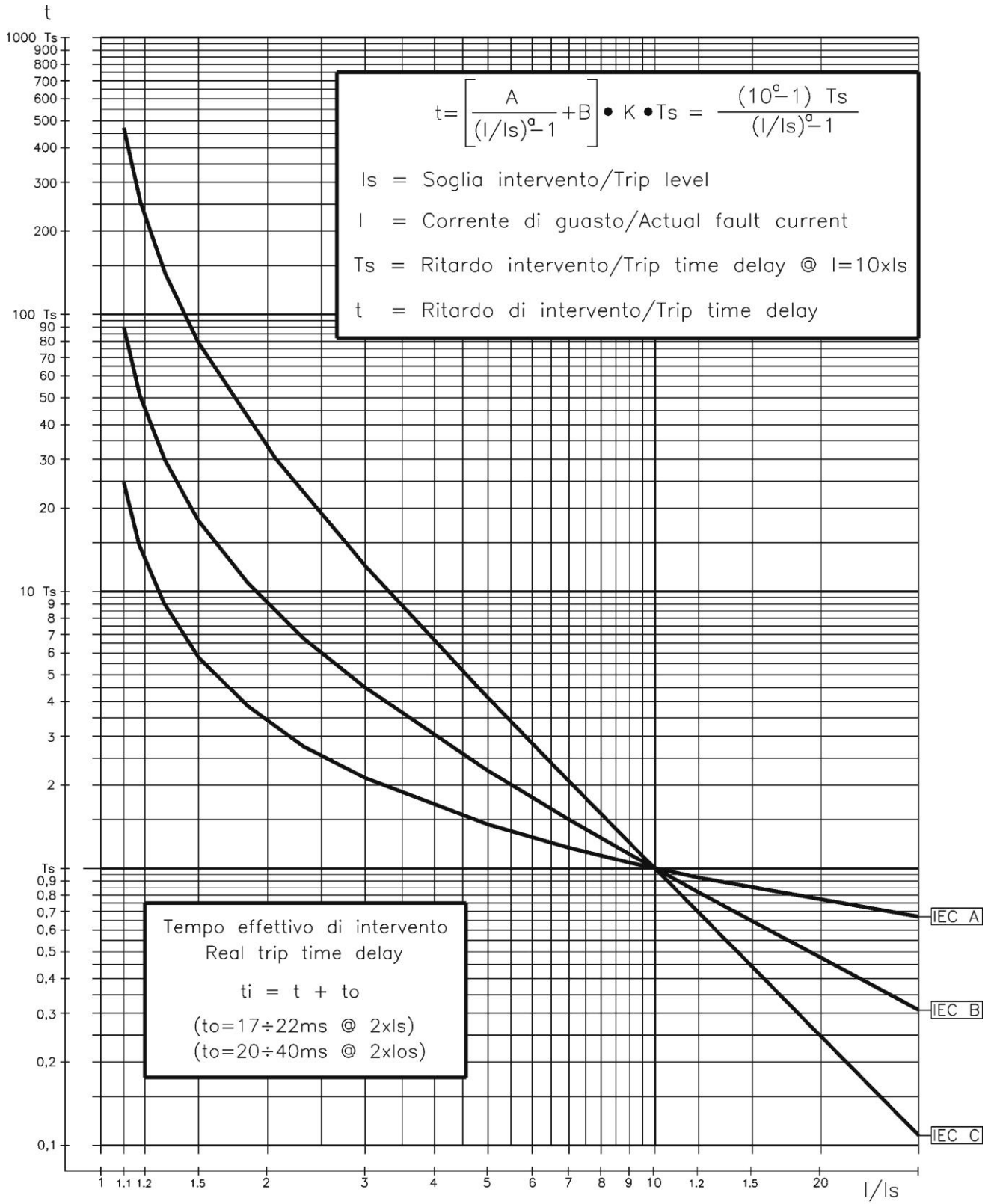
Where $Kt = (10^{a}-1)Ts$ is the time multiplier

When "f(t) = D" is programmed, the trip time delay is Definite and independent from the current: excess "t = ts".

***The maximum measuring current is "40xIn" for phase elements and "10xOn" for the neutral elements.***

Trip takes place when the current measured exceeds (no matter how much) the set level "Is" for the set time "ts".

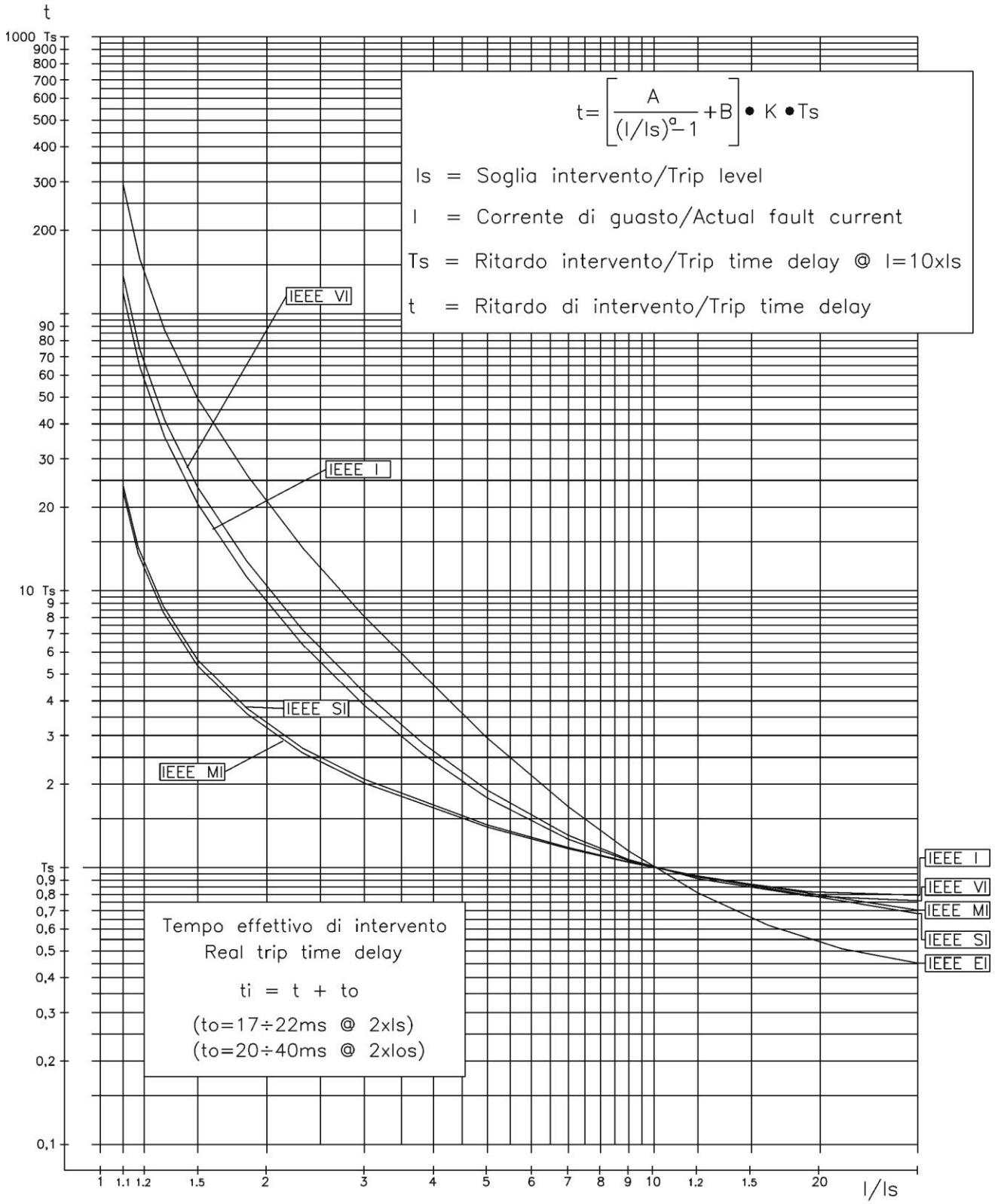
## *14.6.3 - IEC Curves*




| Curve Type | A | B | K | a |
|---|---|---|---|---|
| IEC A | 0.14 | 0 | 0.336632 | 0.02 |
| IEC B | 13.5 | 0 | 0.666667 | 1 |
| IEC C | 80 | 0 | 1.2375 | 2 |

Max. "I" Phase = 40xIn
Max. "I" Neutral = 10xOn

## *14.6.4 – IEEE Curves*




| Curve Type | A | B | K | a |
|---|---|---|---|---|
| MI= IEEE Moderate Inv. | 0.0104 | 0.0226 | 4.110608 | 0.02 |
| SI= IEEE Short Inv. | 0.00342 | 0.00262 | 13.30009 | 0.02 |
| VI= IEEE Very Inv. | 3.88 | 0.0963 | 7.380514 | 2 |
| I= IEEE Inverse | 5.95 | 0.18 | 4.164914 | 2 |
| EI= IEEE Extremely Inv. | 5.67 | 0.0352 | 10.814 | 2 |

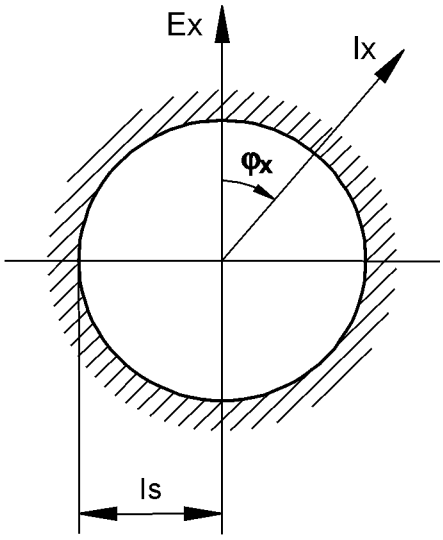
Max. "I" Phase = 40xIn
Max. "I" Neutral = 10xOn

*14.6.5 – Operation of the phase Overcurrent Elements in function of variable "f(a)"*

On each phase the relay measures the current "Ix" and its displacement "$\varphi_x$" from the relevant phase-to-neutral voltage "Ex".
Different operation modes are possible according to the programming of the variable "f(a)".

- Is = Minimum operation current level.
- a = Operation reference angle (phase x; x = A, B, C).
- Ix = Measured input current (largest among the three phase currents IA, IB, IC).
- $\varphi_x$ = Phase displacement of current "Ix" from phase-to-neutral "Ex" (X = A, B, C).
- Idx = Component of "Ix" on the direction "a".

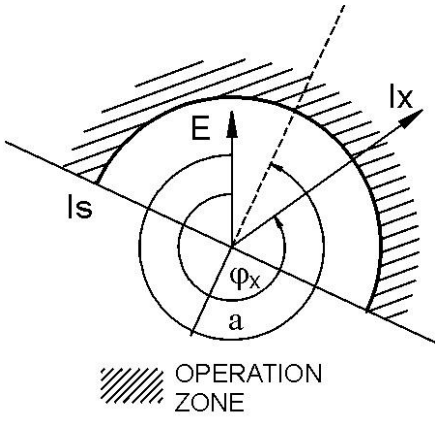
A) Set f(a) = Disab.




Ix>[Is]

The overcurrent element operates independently from the current direction.

B) Set f(a) = Sup.



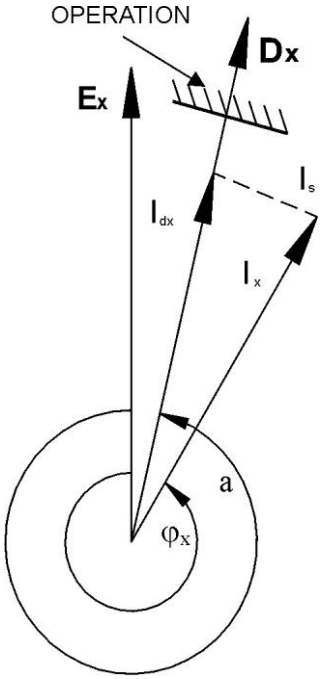

The Overcurrent element only supervises the direction of the current:

the operation conditions are:

- Input voltage above 1-2% of the rated input value.
- Input current above the set level: Ix > [Is]
- Phase displacement "$\varphi_x$" within ±90° from the reference direction "a".

$$(a - 90°) < \varphi_x < (a + 90°)$$

C) Set f(a) = Dir.




The overcurrent element operates in a real directional mode measuring the component "Idx" of the input current in the reference direction "a" (x = A, B, C).

$I_{dA}=I_A \cos(\varphi_A-a)$ $I_{dB}=I_B \cos(\varphi_B-a)$ $I_{dC}=I_C \cos(\varphi_C-a)$

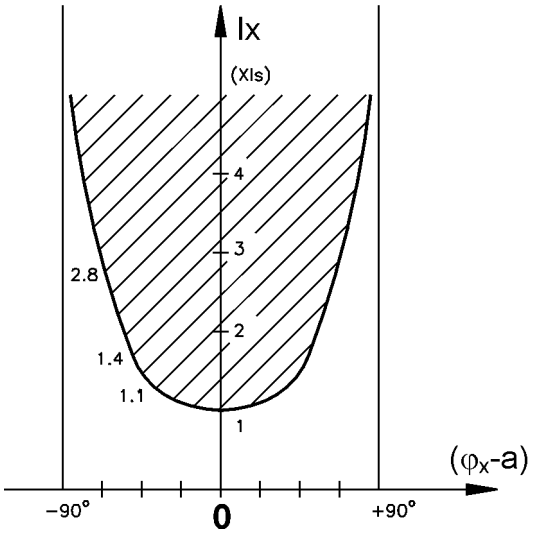
The overcurrent starts to operate when the component "Idx" of the input current in the direction "Dx" (versor displaced of "a°" from the phase-to-neutral voltage "Ex") exceeds the set level "Is".

$I_{dx} = Ix \cos(\varphi_x-a) \geq Is$

In details:

- When $\varphi_x = a$ : $I_{dx}= I_x \rightarrow$ operation if $I_x>Is$
- When $(\varphi_x-a) = 90°$ : $I_{dx}= 0 \rightarrow$ no operation
- When $(\varphi_x-a) > 90°$ : $I_{dx}$ opposite to Dx $\rightarrow$ no operation

The operation is practically independent from the voltage as low as 1-2% of rated value.

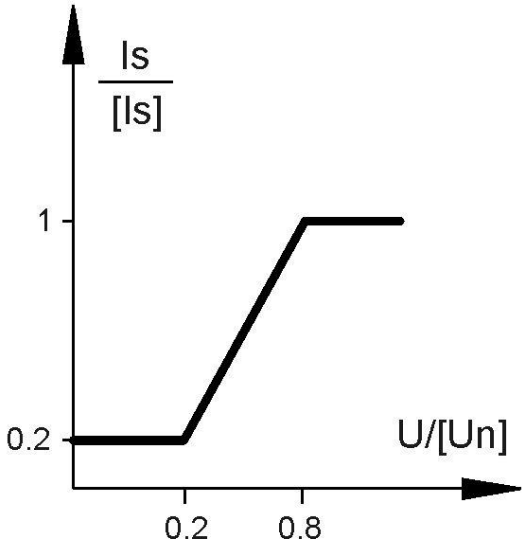



Recommended Reference angles for different applications:

- Measurement of resistive component of current (active power) :
  Direct : a = 0° - Reverse : a = 180°
- Directional phase fault detection:
  Direct : a = 300°(60° lag) – Reverse : a = 120°
- Measurement of inductive reactive component:
  Direct : a = 270°(90° lag) - Reverse : a = 90°
- Measurement of capacitive reactive component:
  Direct : a = 90°(90° lead) - Reverse: a = 270°

*14.6.6 – Operation of the Overcurrent Element with Voltage Control f(U)*

When the “Voltage Restraint” function is enabled (F(U)=Enable), the set minimum pick-up level “Is” of the overcurrent elements, changes proportionally to the smallest of the input phase-to-phase voltages: Is = F(U).




$$\frac{Is}{[Is]} = \frac{\text{Actual pick - up level}}{\text{[Set pick - up level]}}$$

$$\frac{U}{[Uns]} = \frac{\text{Actual input voltage}}{\text{[Set rated input voltage]}}$$

the algorithm uses the smallest among the ratios $\frac{Ex \cdot \sqrt{3}}{[Uns]} (x = A, B, C)$

Practically, between 0.2 Uns and 0.8 Uns, the trip level of the Overcurrent element variates according to the equation:

$$\frac{Is}{[Is]} = \frac{0.8}{0.6} \cdot \left( \frac{U}{[Uns]} - 0.8 \right) + 1$$

Below 0.2 [Un] $\frac{Is}{[Is]} = 0.2$

Above 0.8 [Un] $\frac{Is}{[Is]} = 1$

### *14.6.7 – Blocking Logic (BO-BI)*

For each Protection Function it is possible to activate a Blocking Logic allowing for inhibiting their operation by external signals supplied to the Digital Input.

#### *14.6.7.1 – Output Blocking signal "BO"*

All the protection functions that can be programmed to operate in the blocking logic mode, element, have an instantaneous element (beside the time delayed) which is operated as soon as the controlled quantity exceeds the set trip level (I > [Is] for current, etc..) and is instantaneously reset when the input quantity drops below the reset level (normally 0.95Is).
The instantaneous element can control one of the user programmable output relays that, by its contacts, makes the signal available for blocking an external element (BO = Blocking Output).
In case, "tBO" sec after the set trip time "ts" has expired, the Protection function is still in operation (current above trip level), the Blocking Output relay (instantaneous element) is anyhow reset to eventually remove the Blocking signal from a back-up protection.

#### *14.6.7.2 – Blocking Input "BI"*

For all the functions controllable by the Blocking Logic, it is possible to inhibit the time delayed tripping by an external signal that activates a Digital Input programmed for this functionality.
The programmed Digital Input gets activated by an external cold contact closing across its terminals.
With the variable "tBI" set to "OFF" (tBI=OFF), the tripping of the delayed function is blocked as long as the Blocking Input signal is present at the terminals of the Digital Input.
With the variable "tBI" set to "2xtBI" (tBI=2xtBI), 2xtBI seconds after the set trip time delay of the function has expired the blocking input is anyhow ignored and the function enabled to trip.

### *14.6.8 - Automatic doubling of Overcurrent thresholds on current inrush*

For some of the phase Overcurrent functions it is possible to have the set trip level [Is] automatically doubled when strong inrush current is detected.
If at circuit Breaker switch-on (i.e. when the input current rises from zero to a minimum measurable value) the current increases from 0 to 1.5 times the rated value [In] in less than 60ms, the set minimum pick-up level [Is] is dynamically doubled ([Is]→[2Is]) and keeps this value until the input current drops below 1.25xIn or the set time [t2xI] has elapsed.
This functionality is very useful to avoid spurious tripping of the instantaneous, or short-time delayed Overcurrent elements, that could be experienced at switch-on of reactive loads like Transformer or Capacitors.

## *14.7 – Function: **2I>** (Second Overcurrent Element F50/51)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Stats** | → | **Enab.** | No | | [No / Yes] | | | |
| **Options** | → | **tBI** | Off | | [Off / 2tBO] | | | |
| | → | **f(a)** | Disable | | [Disable / Sup / Dir] | | | |
| | → | **2xI** | Disable | | [Disable / Enable] | | | |
| | → | **f(U)** | Disable | | [Disable / Enable] | | | |
| | → | **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | |
| **Oper. Levels** | → | **Is** | 40.000 | **In** | (0.100÷40) | step | 0.010 | In |
| | → | **a** | 359.000 | ° | (0.000÷359) | step | 1.000 | ° |
| **Timers** | → | **ts** | 100.00 | **s** | (0.02÷100) | step | 0.01 | s |
| | → | **tBO** | 0.75 | **s** | (0.05÷0.75) | step | 0.01 | s |
| | → | **t2xI** | 100.00 | **s** | (0.02÷100) | step | 0.01 | s |
| | → | **td2xI** | 0.06 | **s** | fixed | | | |

### *14.7.1 – Description of variables*

- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **tBI** : Blocking input reset time
  Off = Permanent block
  *2tBO* = Set 2xtBO.
- **f(a)** : Operation mode:
  *Disable* = Non Directional
  *Sup.* = Directional Supervision
  *Dir.* = Total Directional
- **2xI** : Automatic doubling of trip level on inrush
- **f(U)** : Voltage restraint
- **TrOsc** : Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the function.
- **Is** : Minimum operation level
- **a** : Reference phase current displacement angle for Directional operation
- **ts** : Trip time delay
- **tBO** : Time to reset of the Blocking Output after expiring of the Trip time delay. “tBO” is also the trip time delay of the Breaker Failure function.
- **t2xI** : Maximum time of automatic threshold doubling on inrush
- **td2xI** : Time for calculation of current rate of rise.

## 14.8 - Function: **3I>** (Third Overcurrent Element F50/51)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Status** | → | **Enab.** | No | | [No / Yes] | | | |
| **Options** | → | **tBl** | Off | | [Off / 2tBO] | | | |
| | → | **f(a)** | Disable | | [Disable / Sup / Dir] | | | |
| | → | **2xI** | Disable | | [Disable / Enable] | | | |
| | → | **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | |
| **Oper. Levels** | → | **Is** | 40.000 | **In** | (0.100÷40) | step | 0.010 | In |
| | → | **a** | 359.000 | ° | (0.000÷359) | step | 1.000 | ° |
| **Timers** | → | **ts** | 100.00 | **s** | (0.02÷100) | step | 0.01 | s |
| | → | **tBO** | 0.75 | **s** | (0.05÷0.75) | step | 0.01 | s |
| | → | **t2xI** | 100.00 | **s** | (0.02÷100) | step | 0.01 | s |
| | → | **td2xI** | 0.06 | **s** | fixed | | | |

### 14.8.1 - Description of variables

- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **tBl** : Blocking input reset time
  Off = Permanent block
  *2tBO* = Set 2xtBO.
- **f(a)** : Operation mode:
  *Disable* = Non Directional
  *Sup.* = Directional Supervision
  *Dir.* = Total Directional
- **2xI** : Automatic doubling of trip level on inrush
- **TrOsc** : Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the function.
- **Is** : Minimum operation level.
- **a** : Reference phase current displacement angle for Directional operation
- **ts** : Trip time delay
- **tBO** : Time to reset of the Blocking Output after expiring of the Trip time delay. “tBO” is also the trip time delay of the Breaker Failure function.
- **t2xI** : Maximum time of automatic threshold doubling on inrush
- **td2xI** : Time for calculation of current rate of rise

## 14.9 - Function: **1Io>** (First Earth Fault Element 50N/51N)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Status** | → **Enab.** | No | | [No / Yes] | | | | |
| **Options** | → **f(t)** | Type - D | | [D / A / B / C / I / VI / EI / MI / SI] | | | | |
| | → **tBI** | Off | | [Off / 2tBO] | | | | |
| | → **f($a_o$)** | Disable | | [Disable / Dir] | | | | |
| | → **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | | |
| **Oper. Levels** | → **Is** | 0.010 | **On** | (0.01÷4.00) | step | 0.01 | On | |
| | → **Vo** | 0.000 | **%Un** | (0.000÷20) | step | 0.100 | %Un | |
| | → **$a_o$** | 0.000 | ° | (0.000÷359) | step | 1.000 | ° | |
| | → **$a_z$** | 0.000 | ° | (0.000÷359) | step | 1.000 | ° | |
| **Timers** | → **ts** | 100.00 | **s** | (0.02÷100) | step | 0.01 | s | |
| | → **tBO** | 0.75 | **s** | (0.05÷0.75) | step | 0.01 | s | |

On = Rated primary current of CTs or of the current Tore CT.

### 14.9.1 - Description of variables

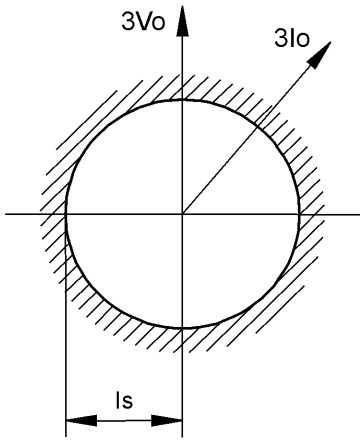
- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **f(t)** : Operation characteristic (Time/Current curve):
  - (D) = Independent definite time
  - (A) = IEC Inverse Curve type A
  - (B) = IEC Very Inverse Curve type B
  - (C) = IEC Extremely Inverse Curve type C
  - (I) = IEEE Inverse Curve
  - (VI) = IEEE Very Inverse Curve
  - (EI) = IEEE Extremely Inverse Curve
  - (MI) = IEEE Moderate Inverse Curve
  - (SI) = IEEE Short Inverse Curve
- **tBI** : Blocking Input reset time
  - *Off* = Permanent block
  - *2tBO* = Set 2xtBO.
- **f($a_o$)** : Operation mode:
  - *Disable* = Non Directional
  - *Dir.* = Total Directional
- **TrOsc** : Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the function.
- **Is** : Minimum operation level
- **Vo** : Minimum residual voltage level for enabling the directional operation
- **$a_o$** : Reference Zero Sequence current displacement angle for Directional operation
- **$a_z$** : Trip sector amplitude
- **ts** : Trip time delay
- **tBO** : Time to reset of the Blocking Output after expiring of the Trip time delay. “tBO” is also the trip time delay of the Breaker Failure function.

*14.9.2 – Operation mode of the Earth Fault elements programming the variable "f($a_o$)"*

The relay measures the current "3Io" and the input voltage "3Vo" of the Earth Fault input and the displacement "$\varphi_o$" of the current from the voltage. Different operation modes are programmable by the variable "f($a_o$)".

- **Is** = Set minimum pick-up residual current "3Io".
- **Vo** = Set minimum residual voltage (3Vo) to enable operation.
- **$a_o$** = Set displacement of the reference current direction.
- **3Io** = Earth Fault current.
- **3Vo** = Earth Fault voltage.
- **$\varphi_o$** = Io/Vo phase displacement.
- **$a_z$** = Angle defining the directional operation area around the reference direction.

The Directional Earth Fault element can operate in two different modes:




**f($a_o$) = Dis** (Disable)

Operation is Non Directional without any influence by the Zero Sequence Voltage "Vo" and the displacement "$\varphi_o$".

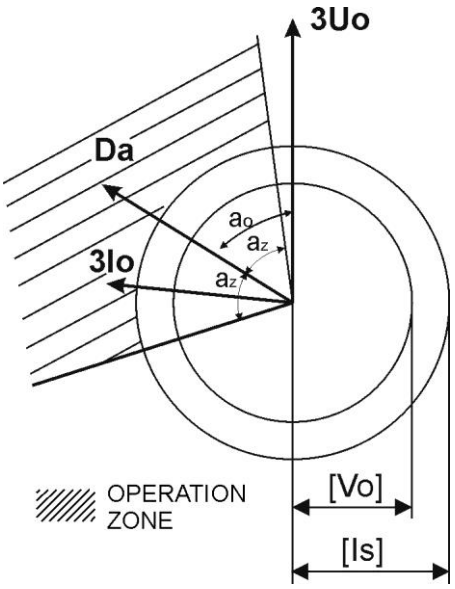
- Operation starts when : 3Io $\geq$ [Is]

**f($a_o$) = Dir** (Directional).

Operation starts when the following 3 conditions are present:

- The Residual Voltage "3Vo" exceeds the set level "Vo" : 3Vo $\geq$ [Vo]
- The Residual Current "3Io" exceeds the set level "Is" : 3Io $\geq$ [Is]
- The angle "$\varphi_o$" is within "$\pm a_z$" from "a"

$$(a_o - a_z) \leq \varphi_o \leq (a_o + a_z)$$




- 3Uo > [Vo]
- 3Io > [Is]
- $(a_o - a_z) \leq \varphi_o \leq (a_o + a_z)$

## 14.10 - Function: **2Io>** (Second Earth Fault Element 50N/51N)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Status** | → **Enab.** | No | | [No / Yes] | | | | |
| **Options** | → **tBI** | Off | | [Off / 2tBO] | | | | |
| | → **f($a_o$)** | Disable | | [Disable / Dir] | | | | |
| | → **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | | |
| **Oper. Levels** | → **Is** | 0.010 | **On** | (0.01÷9.99) | step | 0.01 | On | |
| | → **Vo** | 0.000 | **%Un** | (0.000÷20) | step | 0.100 | %Un | |
| | → **$a_o$** | 0.000 | ° | (0.000÷359) | step | 1.000 | ° | |
| | → **$a_z$** | 0.000 | ° | (0.000÷359) | step | 1.000 | ° | |
| **Timers** | → **ts** | 100.00 | **s** | (0.02÷100) | step | 0.01 | s | |
| | → **tBO** | 0.75 | **s** | (0.05÷0.75) | step | 0.01 | s | |

On = Rated primary current of CTs or of the current Tore CT.

### 14.10.1 - Description of variables

- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **tBI** : Blocking Input reset time
  *Off* = Permanent block
  *2tBO* = Set 2xtBO.
- **f($a_o$)** : Operation mode:
  *Disable* = Non Directional
  *Dir.* = Total Directional
- **TrOsc** : Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the function.
- **Is** : Minimum operation level
- **Vo** : Minimum residual voltage level for enabling the directional operation
- **$a_o$** : Reference Zero Sequence current displacement angle for Directional operation
- **$a_z$** : Trip sector amplitude
- **ts** : Trip time delay
- **tBO** : Time to reset of the Blocking Output after expiring of the Trip time delay. “tBO” is also the trip time delay of the Breaker Failure function.

## 14.11 - Function: **3Io>** (Second Earth Fault Element 50N/51N)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Status** | → | **Enab.** | No | | [No / Yes] | | | |
| **Options** | → | **tBI** | Off | | [Off / 2tBO] | | | |
| | → | **f($a_o$)** | Disable | | [Disable / Dir] | | | |
| | → | **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | |
| **Oper. Levels** | → | **Is** | 0.010 | **On** | (0.01÷9.99) | step | 0.01 | On |
| | → | **Vo** | 0.000 | **%Un** | (0.000÷20) | step | 0.100 | %Un |
| | → | **$a_o$** | 0.000 | ° | (0.000÷359) | step | 1.000 | ° |
| | → | **$a_z$** | 0.000 | ° | (0.000÷359) | step | 1.000 | ° |
| **Timers** | → | **ts** | 100.00 | **s** | (0.02÷100) | step | 0.01 | s |
| | → | **tBO** | 0.75 | **s** | (0.05÷0.75) | step | 0.01 | s |

On = Rated primary current of CTs or of the current Tore CT.

### 14.11.1 - Description parameters

- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **tBI** : Blocking Input reset time
  *Off* = Permanent block
  *2tBO* = Set 2xtBO.
- **f($a_o$)** : Operation mode:
  *Disable* = Non Directional
  *Dir.* = Total Directional
- **TrOsc** : Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the function.
- **Is** : Minimum operation level
- **Vo** : Minimum residual voltage level for enabling the directional operation
- **$a_o$** : Reference Zero Sequence current displacement angle for Directional operation
- **$a_z$** : Trip sector amplitude
- **ts** : Trip time delay
- **tBO** : Time to reset of the Blocking Output after expiring of the Trip time delay. “tBO” is also the trip time delay of the Breaker Failure function.

## 14.12 - Function: **1Is>** (First Negative Sequence Element F46)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Status** | → | **Enab.** | No | | [No / Yes] | | | |
| **Options** | → | **t(t)** | Type-D | | [D / A / B / C / I / VI / EI / MI / SI / ] | | | |
| | → | **tBI** | Off | | [Off / 2tBO] | | | |
| | → | **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | |
| **Oper. Levels** | → | **Is** | 4.000 | **In** | (0.1÷4) | step | 0.01 | In |
| **Timers** | → | **ts** | 100.00 | **s** | (0.02÷100) | step | 0.01 | s |
| | → | **tBO** | 0.75 | **s** | (0.05÷0.75) | step | 0.01 | s |

### 14.12.1 - Description of variables

- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **f(t)** : Operation characteristic (Time/Current curve):
  - (D) = Independent definite time
  - (A) = IEC Inverse Curve type A
  - (B) = IEC Very Inverse Curve type B
  - (C) = IEC Extremely Inverse Curve type C
  - (I) = IEEE Inverse Curve
  - (VI) = IEEE Very Inverse Curve
  - (EI) = IEEE Extremely Inverse Curve
  - (MI) = IEEE Moderate Inverse Curve
  - (SI) = IEEE Short Inverse Curve
- **tBI** : Blocking Input reset time
  - Off = Permanent block
  - *2tBO* = Set 2xtBO.
- **TrOsc** : Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the function.
- **Is** : Minimum operation level
- **ts** : Trip time delay
- **tBO** : Time to reset of the Blocking Output after expiring of the Trip time delay. "tBO" is also the trip time delay of the Breaker Failure function.

### 14.12.2 – Time/Current operation of the first Current Unbalance element "f(t)"

the relay measures the Negative Sequence component "$I_2$" of the input current.
The Time/Current curves can be selected by programming the variable "f(t)":

- f(t) = D Independent definite time operation.
- f(t) = I, VI, EI, MI, SI, A, B, C Dependent Inverse time operation

## *14.13 - Function: **2Is>** (Second Negative Sequence Element F46)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Status** | → **Enab.** | No | | [No / Si] | | | | |
| **Options** | → **tBI** | Off | | [Off / 2tBO] | | | | |
| | → **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | | |
| **Oper. Levels** | → **Is** | 4.000 | **In** | (0.1÷4) | step | 0.01 | In | |
| **Timers** | → **ts** | 100.00 | **s** | (0.02÷100) | step | 0.01 | s | |
| | → **tBO** | 0.75 | **s** | (0.05÷0.75) | step | 0.01 | s | |

### *14.13.1 - Description of variables*

- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **tBI** : Blocking Input reset time
  Off = Permanent block
  *2tBO* = Set 2tBO.
- **TrOsc** : Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the function.
- **Is** : Minimum operation level
- **ts** : Trip time delay
- **tBO** : Time to reset of the Blocking Output after expiring of the Trip time delay. “tBO” is also the trip time delay of the Breaker Failure function.

## *14.14 - Function: **1U>** (First Overvoltage Element F59)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Status** | → **Enab.** | No | | [No / Yes] | | | | |
| **Options** | → **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | | |
| **Oper. Levels** | → **Us** | 90.000 | **%Un** | (10÷190) | step | 1 | %Un | |
| **Timers** | → **ts** | 100.00 | **s** | (0.02÷100) | step | 0.01 | s | |

### *14.14.1 - Description of variables*

| | | | |
|---|---|---|---|
| ❑ | **Enab.** | : | Function enabling (No = Disable / Yes = Enable) |
| ❑ | **TrOsc** | : | Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the function. |
| ❑ | **Us** | : | Minimum operation level |
| ❑ | **ts** | : | Trip time delay |

## *14.15 - Function: **2U>** (Second Overvoltage Element F59)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Status** | → **Enab.** | No | | [No / Yes] | | | | |
| **Options** | → **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | | |
| **Oper. Levels** | → **Us** | 90.000 | **%Un** | (10÷190) | step | 1 | %Un | |
| **Timers** | → **ts** | 100.00 | **s** | (0.02÷100) | step | 0.01 | s | |

### *14.15.1 - Description of variables*

| | | | |
|---|---|---|---|
| ❑ | **Enab.** | : | Function enabling (No = Disable / Yes = Enable) |
| ❑ | **TrOsc** | : | Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the function. |
| ❑ | **Us** | : | Minimum operation level |
| ❑ | **ts** | : | Trip time delay |

## 14.16 - Function: **1U<** *(First Undervoltage Element F27)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Status** | → **Enab.** | No | | [No / Yes] | | | | |
| **Options** | → **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | | |
| **Oper. Levels** | → **Us** | 90.000 | **%Un** | (10÷190) | step | 1 | % | |
| **Timers** | → **ts** | 100.00 | **s** | (0.02÷100) | step | 0.01 | s | |

### 14.16.1 - Description of variables

| | | | |
|---|---|---|---|
| ❑ | **Enab.** | : | Function enabling (No = Disable / Yes = Enable) |
| ❑ | **TrOsc** | : | Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the function. |
| ❑ | **Us** | : | Minimum operation level |
| ❑ | **ts** | : | Trip time delay |

## 14.17 - Function: **2U<** *(Second Undervoltage Element F27)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Status** | → **Enab.** | No | | [No / Yes] | | | | |
| **Options** | → **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | | |
| **Oper. Levels** | → **Us** | 90.000 | **%** | (10÷190) | step | 1 | % | |
| **Timers** | → **ts** | 100.00 | **s** | (0.02÷100) | step | 0.01 | s | |

### 14.17.1 - Description of variables

| | | | |
|---|---|---|---|
| ❑ | **Enab.** | : | Function enabling (No = Disable / Yes = Enable) |
| ❑ | **TrOsc** | : | Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the function. |
| ❑ | **Us** | : | Minimum operation level |
| ❑ | **ts** | : | Trip time delay |

### *14.18 - Function: **1f>** (First Overfrequency Element F81>)*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Status** | → **Enab.** | No | | [No / Yes] | | | |
| **Options** | → **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | |
| **Oper. Levels** | → **fs** | 40.000 | **Hz** | (40÷70) | step | 0.01 | Hz |
| **Timers** | → **ts** | 10.00 | **s** | (0.02÷1000) | step | 0.01 | s |

#### *14.18.1 - Description of variables*

- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **TrOsc** : Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the function.
- **fs** : Minimum operation level
- **ts** : Trip time delay

### *14.19 - Function: **2f>** (Second Overfrequency Element F81>)*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Status** | → **Enab.** | No | | [No / Yes] | | | |
| **Options** | → **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | |
| **Oper. Levels** | → **fs** | 40.000 | **Hz** | (40÷70) | step | 0.01 | Hz |
| **Timers** | → **ts** | 10.00 | **s** | (0.02÷1000) | step | 0.01 | s |

#### *14.19.1 - Description of variables*

- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **TrOsc** : Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the function.
- **fs** : Minimum operation level
- **ts** : Trip time delay

### *14.20 – Function: **1f<** (First Underfrequency Element F81<)*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Status** | → **Enab.** | No | | [No / Yes] | | | |
| **Options** | → **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | |
| **Oper. Levels** | → **fs** | 40.000 | **Hz** | (40÷70) | step | 0.01 | Hz |
| **Timers** | → **ts** | 10.00 | **s** | (0.02÷1000) | step | 0.01 | s |

#### *14.20.1 - Description of variables*

- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **TrOsc** : Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the function.
- **fs** : Minimum operation level
- **ts** : Trip time delay

### *14.21 - Function: **2f<** (Second Underfrequency Element F81<)*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Status** | → **Enab.** | No | | [No / Yes] | | | |
| **Options** | → **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | |
| **Oper. Levels** | → **fs** | 40.000 | **Hz** | (40÷70) | step | 0.01 | Hz |
| **Timers** | → **ts** | 10.00 | **s** | (0.02÷1000) | step | 0.01 | s |

#### *14.21.1 - Description of variables*

- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **TrOsc** : Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the function.
- **fs** : Minimum operation level
- **ts** : Trip time delay

## *14.22 - Function: **1Uo>** (First Zero Sequence Overvoltage Element F59Uo)*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Status*** | → **Enab.** | No | | [No / Yes] | | | |
| ***Options*** | → **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | |
| ***Oper. Levels*** | → **Us** | 1.000 | **%Un** | (1÷100) | step | 1 | %Un |
| ***Timers*** | → **ts** | 100.00 | **s** | (0.02÷100) | step | 0.01 | s |

### *14.22.1 - Description of variables*

| | | |
|---|---|---|
| ❑ **Enab.** | : | Function enabling (No = Disable / Yes = Enable) |
| ❑ **TrOsc** | : | Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the function. |
| ❑ **Us** | : | Minimum operation level |
| ❑ **ts** | : | Trip time delay |

## *14.23 - Function: **2Uo>** (Second Zero Sequence Overvoltage Element F59Uo)*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Status*** | → **Enab.** | No | | [No / Yes] | | | |
| ***Options*** | → **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | |
| ***Oper. Levels*** | → **Us** | 1.000 | **%Un** | (1÷100) | step | 1 | %Un |
| ***Timers*** | → **ts** | 100.00 | **s** | (0.02÷100) | step | 0.01 | s |

### *14.23.1 - Description of variables*

| | | |
|---|---|---|
| ❑ **Enab.** | : | Function enabling (No = Disable / Yes = Enable) |
| ❑ **TrOsc** | : | Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the function. |
| ❑ **Us** | : | Minimum operation level |
| ❑ **ts** | : | Trip time delay |

## 14.24 - Function: **U1<** (Positive Sequence Undervoltage Element F27U1)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Status** | → **Enab.** | No | | [No / Yes] | | | | |
| **Options** | → **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | | |
| **Oper. Levels** | → **Us** | 90.000 | **%Un** | (10÷190) | step | 1 | %Un | |
| **Timers** | → **ts** | 100.00 | **s** | (0.02÷100) | step | 0.01 | s | |

### 14.24.1 - Description of variables

- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **TrOsc** : Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the function.
- **Us** : Minimum operation level
- **ts** : Trip time delay

## 14.25 - Function: **U2>** (Negative sequence Overvoltage Element F59U2 or F47)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Status** | → **Enab.** | No | | [No / Yes] | | | | |
| **Options** | → **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | | |
| **Oper. Levels** | → **Us** | 90.000 | **%Un** | (10÷190) | step | 1 | %Un | |
| **Timers** | → **ts** | 100.00 | **s** | (0.02÷100) | step | 0.01 | s | |

### 14.25.1 - Description of variables

- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **TrOsc** : Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the function.
- **Us** : Minimum operation level
- **ts** : Trip time delay

## 14.26 - Function: **Wi** (Circuit Breaker maintenance level)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Status** | → **Enab.** | No | | [No / Yes] | | | |
| **Options** | → **TrOsc** | TrigDisab | | [TrigDisab – TrigEnab] | | | |
| **Oper. Levels** | → **Ii** | 1.000 | **In** | (0.1÷99) | step | 0.1 | In |
| | → **Wi** | 1.000 | | (1÷9999) | step | 1 | |

### 14.26.1 - Description of variables

- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **TrOsc** : Oscillographic Recording triggered (TrigEnab) or not triggered (TrigDisab) on tripping of the function.
- **Ii** : Circuit Breaker Rated Current in multiples of the Relay rated input current In
- **Wi** : Maximum allowed amount of accumulated interruption energy before maintenance as stated by the C/B Manufactured.

### 14.26.2 - Operation (Accumulation of the interruption Energy)

The relay computes the Arc Energy developed during each interruption of the Circuit Breaker and accumulates these values.
When the amount of the accumulated energy exceeds a settable level the relay gives out an alarm to signalize that maintenance inspection of the Circuit Breaker is needed.
The operation of this function is based on the following parameters:

**Ii** = Ii = (0.1-99)In

**Wi** = Wi =(1 - 9999)

“Wi" is set as a multiple of the conventional interruption energy unit.
Any time the Circuit Breaker opens (change of status from closed to open of the digital input connected to the normally open contact 52a of the C/B) the relay decreases the amount of energy corresponding to a number of conventional units:

$$nW_C = \frac{W}{Wc} = \frac{I^2 \cdot t_X}{Ii^2 \cdot t_i}$$

where:

**W** = $I^2 \bullet t_X$ Interruption Energy during the interruption time “tx” with interruption current “I”.

**Wc** = $Ii^2 \bullet t_i$ Conventional unit of interruption energy corresponding to C/B rated current and rated interruption time “$t_i$”.

When the set Energy level before maintenance is decreased to zero a user programmable output relay is operated.

Reset to Zero of the Energy accumulation is available in the menu “***Local Cmd***” (Reset Term).

## 14.27 - Function: **TCS** (Trip Circuit Supervision)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Status** | → **Enab.** | No | | [No / Yes] | | | |
| **Timers** | → **ts** | 0.10 | **s** | (0.1÷100) | step | 0.01 | s |

### 14.27.1 - Description of variables

- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **ts** : Trip time delay

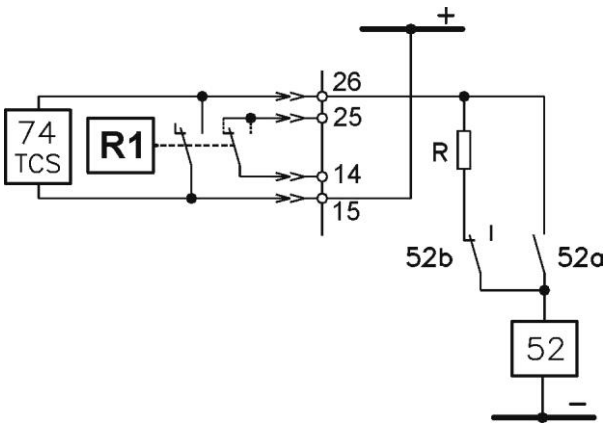
### 14.27.2 - Operation

The relay includes a complete Circuit Breaker Trip Circuit Supervision unit that is associated to the Contact “15-26” of the “R1” Output Relay.
The contact of “R1” is used to trip the C/B as reported in the drawing here below.
The supervision works when the C/B is closed and recognizes the Trip Circuit as sound as far as the current flowing exceeds “1mA”.
In case of Trip Circuit Fault detection, the diagnostic relay is operated and the Led starts flashing (see § Signalization).
To have Supervision also with the C/B open one N/C contact (52b) from the C/B and an external resistor “R” are needed.

$$R[k\Omega] \le \frac{V}{1mA} - R_{52}$$ where **$R_{52}$**= Trip Coil internal resistance [kΩ]

**V** = Trip Circuit Voltage

$$P_R \ge 2 \cdot \frac{V^2}{R}[W]$$ Designe power of external resistance “R”




***Circuit Breaker Trip is controlled by output relay “R1” whereas tripping of the “TCS” function operates another user programmable output relay.***

## 14.28 - Function: **IRF** (Internal Relay Fault)

In this menu it is possible to configurate the operation of the Relay Internal Fault detection element

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Status** | → **Enab.** | No | | [No / Yes] | | | |
| **Timers** | → **tIRF** | 5.00 | **s** | (5÷200) | step | 0.01 | s |

### 14.28.1 - Description of variables

- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **tIRF** : Trip time delay

### 14.28.2 - Operation

Tripping of the function operates a user programmable output relay.

## 14.29 - Function: **RT** (Remote Trip)

In this menu it is possible to configurate the operation of Remote Trip via the relevant Digital Input.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Status** | → **Enab.** | No | | [No / Yes] | | | |
| **Options** | → **RTon** | FallEdge | | [RiseEdge – FallEdge] | | | |
| **Timers** | → **ts** | 5.00 | **s** | (0.00÷10.00) | step | 0.01 | s |

### 14.29.1 - Description of variables

- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **RTon** : Remote trip Edge selector
- **ts** : Remote Trip time delay

### 14.29.2 - Operation

This function operate when the Digital Input "RT" is activated.
It can also be used to receive an external command from another protection. (Temperature sensor, RTD, etc.)

## 14.30 - Function: **TripTimeRd.** (Trip Time Reduction)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Status** | → | **Enab.** | No | | [No / Yes] | | | |
| **Timers** | → | **tHold** | 0.00 | **s** | (0.00÷180) | step | 1 | s |
| | → | **tC1 I** | 0.02 | **s** | (0.02÷100) | step | 0.01 | s |
| | → | **tC2 I** | 0.02 | **s** | (0.02÷100) | step | 0.01 | s |
| | → | **tC3 I** | 0.02 | **s** | (0.02÷100) | step | 0.01 | s |
| | → | **tC1 Io** | 0.02 | **s** | (0.02÷100) | step | 0.01 | s |
| | → | **tC2 Io** | 0.02 | **s** | (0.02÷100) | step | 0.01 | s |
| | → | **tC3 Io** | 0.02 | **s** | (0.02÷100) | step | 0.01 | s |
| | → | **tC1 Uo** | 0.02 | **s** | (0.02÷100) | step | 0.01 | s |
| | → | **tC2 Uo** | 0.02 | **s** | (0.02÷100) | step | 0.01 | s |
| | → | **tCRT** | 0.00 | **s** | (0.00÷10) | step | 0.1 | s |

### 14.30.1 - Description of variables

- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **tHold** : Duration of the trip time reduction; is set to 0,00 the reduction function does not operate.
- **tC1 I** : Reduced trip time for 1I>
- **tC2 I** : Reduced trip time for 2I>
- **tC3 I** : Reduced trip time for 3I>
- **tC1 Io** : Reduced trip time for 1Io>
- **tC2 Io** : Reduced trip time for 2Io>
- **tC3 Io** : Reduced trip time for 3Io>
- **tC1 Uo** : Reduced trip time for 1Uo>
- **tC2 Uo** : Reduced trip time for 2Uo>
- **tCRT** : Reduced trip time for RT

### 14.30.2 - Operation

When this function is enabled, after a manual or automatic reclosure, the trip time delay of the protection functions is reduced from the original set value to the new time delay “tc” untill “tHold” is expired.
Anyhow when the ongoing reclose cycle is over and the relay is ready for new reclose cycle, the original trip time delay is restored.
Functions originally programmed for a inverse time operation, during “tHold” operate as independent time function with definite time delay “tc”.

## 14.31 - Function: **AutomRecl** (Automatic Reclosure RCL)

### 14.31.1 – Definitions

- ***Shot Number (ShNum = 0, 1, 2, 3, 4):***
  Number of autoreclosure commands that can be issued in a Reclosure cycle before lock-out.
- Selection of the reclose shot of a cycle (R1, R2, ....) that can be initiated by the tripping of selectable protection elements (1I<, 2I>, ....).
- ***Set Group Change-over (GR1-2):***
  Determines the reclosure shot in a cycle after switch the relay automatically switches from setting group 1 to setting group 2.
  At the end of the reclaim time “Tr” the setting group 1 is automatically restored.
- ***Sequence Coordination (SeqC), (tSeqC):***
  When “SeqC” is set to “enable”, it allows the reclose element to count any downstream recloser operation, taking place within the sequence coordination time “tSeqC”, as its own, thereby preventing unnecessary operations of the back-up device for a fault beyond the downstream device. This is particularly useful when the back-up breaker feeds several branch reclosers, only one of which is experiencing a fault.
- ***Reclosure time (t1, t2, t3, t4):***
  It is the reclose dead time before a reclosure command (R1, R2, R3, R4) is issued after C/B opening.
- ***Reclaim time (Tr1, Tr2, Tr3, Tr4):***
  It is the reclaim time started after any automatic reclosure command.
  Any initiation signal (trip of enabled protection or seqC function) detected during “Trx” starts the next autoreclosure shot of the cycle.
  Any initiation signal detected during “Trx” after the last shot of the reclose cycle, produces the lock-out status.
- ***Discrimination time (Td1, Td2, Td3):***
  Any new trip detected after a automatic reclosure shot, during the time “Tdx” (Td<Tr) produces the “lock-out” status with display information “Failed Reclosure”.
- ***Reclaim time after manual closure (TrCL):***
  It is the reclaim time started after a manual closure of the C/B.
  Tripping of any protection element detected during “TrCL”, produces the lock-out status.
  Tripping of an “enabled” protection, shows the display “Failed” Reclosure.
- ***Holding time of the external lock-out signal (ThExt):***
  The digital input programmed to detected an external reclosure lock-out signal, remains activated for the time the signal is present plus the holding time “ThExt” from the external signals removal.

*14.31.2 - Description of variables*

| | | | |
|---|---|---|---|
| ❑ | **Enab.** | : | Function enabling (No = Disable / Yes = Enable) |
| ❑ | **ShNum** | : | Number of Shots available in one AutoReclosure Cycle |
| ❑ | **R1I>** | : | Allows to select one or more of the Shots of a Cycle to be initiated by tripping of the function.....: 1I> |
| ❑ | **R2I>** | : | Same as above.....: 2I> |
| ❑ | **R3I>** | : | Same as above.....: 3I> |
| ❑ | **R1Io>** | : | Same as above.....: 1Io> |
| ❑ | **R2Io>** | : | Same as above.....: 2Io> |
| ❑ | **R3Io>** | : | Same as above.....: 3Io> |
| ❑ | **R1Uo>** | : | Same as above.....: 1Uo> |
| ❑ | **R2Uo>** | : | Same as above.....: 2Uo> |
| ❑ | **RRT** | : | Same as above.....: RT |
| ❑ | **GR1-2** | : | Change-over SetGroup 1 to SetGroup 2 |
| ❑ | **SeqC** | : | Sequence coordination |
| ❑ | **tSeqC** | : | Sequence coordination time |
| ❑ | **t1** | : | Reclosure time of 1st AR shot |
| ❑ | **Tr1** | : | Reclaim time of 1st AR shot |
| ❑ | **Td1** | : | Discrimination of 1st AR shot |
| ❑ | **t2** | : | Reclosure time of 2nd AR shot |
| ❑ | **Tr2** | : | Reclaim time of 2nd AR shot |
| ❑ | **Td2** | : | Discrimination of 2nd AR shot |
| ❑ | **t3** | : | Reclosure time of 3rd AR shot |
| ❑ | **Tr3** | : | Reclaim time of 3rd AR shot |
| ❑ | **Td3** | : | Discrimination of 3rd AR shot |
| ❑ | **t4** | : | Reclosure time of 4th AR shot |
| ❑ | **Tr4** | : | Reclaim time of 4th AR shot |
| ❑ | **TrCL** | : | Reclaim time on manual closure |
| ❑ | **ThExt** | : | Hold of lock-out signal after removal of external lock-out |

*14.31.3 – Setting*

| | | | | |
|---|---|---|---|---|
| **Status** | → **Enab.** | No | | [No / Yes] |

| | | | | |
|---|---|---|---|---|
| **Options** | → **ShNum** | 1 | | [0 - 1 - 2 - 3 - 4] |
| | → **R 1I>** | Recl. Dis. | → | Recl. Dis = Automatic Reclosure (AR) disable<br>1 = AR Enable on shot 1<br>2 = AR Enable on shot 2<br>1+2 = AR Enable on shot 1+2<br>3 = AR Enable on shot 3<br>1+3 = AR Enable on shot 1+3<br>2+3 = AR Enable on shot 2+3<br>1+2+3 = AR Enable on shot 1+2+3<br>4 = AR Enable on shot 4<br>1+4 = AR Enable on shot 1+4<br>2+4 = AR Enable on shot 2+4<br>1+2+4 = AR Enable on shot 1+2+4<br>3+4 = AR Enable on shot 3+4<br>1+3+4 = AR Enable on shot 1+3+4<br>2+3+4 = AR Enable on shot 2+3+4<br>1+2+3+4 = AR Enable on shot 1+2+3+4<br>(*) see example |
| | → **R 2I>** | Recl. Dis. | | Same as above |
| | → **R 3I>** | Recl. Dis. | | Same as above |
| | → **R 1Io>** | Recl. Dis. | | Same as above |
| | → **R 2Io>** | Recl. Dis. | | Same as above |
| | → **R 3Io>** | Recl. Dis. | | Same as above |
| | → **R 1Uo>** | Recl. Dis. | | Same as above |
| | → **R 2Uo>** | Recl. Dis. | | Same as above |
| | → **R RT** | Recl. Dis. | | Same as above |
| | → **GR1-2** | Disable | | [Disable / Shot1 / Shot2 / Shot3 / Shot4] |
| | → **SeqC** | Disable | | [Disable / Enable] |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Timers** | → **tSeqC** | 0.00 | **s** | (0.00 ÷ 5.00) | step | 0.01 | s |
| | → **t1** | 0.30 | **s** | (0.10 ÷ 200) | step | 0.1 | s |
| | → **Tr1** | 5.00 | **s** | (5.00 ÷ 200) | step | 1 | s |
| | → **Td1** | 0.00 | **s** | (0.00 - 5.00) | step | 0 / 5 | s |
| | → **t2** | 1.00 | **s** | (0.10 ÷ 1000) | step | 0.1 | s |
| | → **Tr2** | 5.00 | **s** | (5.00 ÷ 200) | step | 1 | s |
| | → **Td2** | 0.00 | **s** | (0.00 - 5.00) | step | 0 / 5 | s |
| | → **t3** | 3.00 | **s** | (0.10 ÷ 1000) | step | 0.1 | s |
| | → **Tr3** | 5.00 | **s** | (5.00 ÷ 200) | step | 1 | s |
| | → **Td3** | 0.00 | **s** | (0.00 - 5.00) | step | 0 / 5 | s |
| | → **t4** | 10.00 | **s** | (0.10 ÷ 1000) | step | 0.1 | s |
| | → **Tr4** | 5.00 | **s** | (5.00 ÷ 200) | step | 1 | s |
| | → **TrCL** | 5.00 | **s** | (5.00 ÷ 200) | step | 1 | s |
| | → **ThExt** | 5.00 | **s** | (5.00 ÷ 200) | step | 1 | s |

*14.31.3.1 - Example*

example: programming of the Reclose Shots initiated by tripping of the protection function 1I>.

| | | | | |
|---|---|---|---|---|
| **R 1I>** | = | Recl.Dis. | : | no shot is initiated on tripping of the function 1I>. |
| **R 1I>** | = | 1 | : | only the shot n°1 of the AR cycle is initiated on tripping of the function 1I>. |
| **R 1I>** | = | 1+2 | : | only the shots n°1 and 2 of the AR cycle are initiated on tripping of the function 1I>. |
| **R 1I>** | = | 1+2+3 | : | only the shots n°1 and 2 and 3 of the AR cycle are initiated on tripping of the function 1I>. |
| **R 1I>** | = | 1+2+3+4 | : | all the shots n°1 and 2 and 3 and 4 of the AR cycle are initiated on tripping of the function 1I>. |

| | | | | |
|---|---|---|---|---|
| **R RT** | = | Recl.Dis. | : | no shot is initiated on Remote Trip signal (RT). |
| **R RT** | = | 1 | : | only the shot n°1 of the AR cycle is initiated on Remote Trip signal (RT). |
| **R RT** | = | 1+2 | : | only the shots n°1 and 2 of the AR cycle are initiated on Remote Trip signal (RT). |
| **R RT** | = | 1+2+3 | : | only the shots n°1 and 2 and 3 of the AR cycle are initiated on Remote Trip signal (RT). |
| **R RT** | = | 1+2+3+4 | : | all the shots n°1 and 2 and 3 and 4 of the AR cycle are initiated on Remote Trip signal (RT). |

Similarly for the other variables (R 2I>, R 3I>, R 1Io>, R 2Io>, R 3Io>, R 1Uo>, R 2Uo>).

*14.31.4 - Operation*

The Autoreclose function is based on the setting of the variables described in the § Setting and involves the following operational status (§ Definition and Description variable).

| | | |
|---|---|---|
| **E/D** | Enable/Disable | Autoreclosing function Enabled/Disabled. |
| **S0** | "Wait C/B cl" | Waiting for C/B's manual closure |
| **Sx=S1** | "Ready" | Ready to start a AR Cycle after manual C/B closure |
| **Sx=Sh** | "Progress" | Ready to operate the next AR shot of the Cycle. |
| **L.O.** | "Lock-out" | Function blocked due to external blocking signal present at the relevant Digital Input, or due to the detection of a failure of the Circuit Breaker operation. |

The status of the Circuit Breaker (C/B) is indicated by one normally open contact of the C/B itself and it is detected by the digital input "C/B" of the relay that has been programmed for monitoring C/B status (see § Pysical Input).

A reclose shot is started after a C/B's opening operated by one of the relay's protection elements programmed to initiate this reclose shot; C/B's opening operated by one element not programmed to initiate the next reclosure shot, interrupts the Reclose cycle and activates the status "TwRCL" (Trip without Reclosure) of the relay. C/B's opening operated manually interrupts the Reclose cycle: the display of the relay shows "WaitC/Bcl" (Wait for C/B manual closure).

- Any time the Circuit Breaker (C/B) is manually closed the Reclaim time "TrCL" is started.
- Any time the C/B is reclosed by one AR shot (Sh1, 2, 3, 4) the relevant reclaim time (Tr1, Tr2, Tr3, Tr4) and the discrimination time (Td1, Td2, Td3) are started.
- After a manual closure of the C/B, tripping of any of the relay protection elements during "TrCL" makes the relay enter into the Lock-Out status (L.O.). In the L.O. status the relay, after breaker opening, does not produce any command for automatic reclose ; in this situation the "RCL" display indicates "Failed" Reclosure; if programmed the output relay (RCLf) is operated.
- Reset from the L.O. status take place when C/B manually closed or when the digital input "ExtReset" (if programmed) is activated.
- If none of the relay protection elements trips during "TrCL" after a manual closure of the C/B, the relay is ready to start the Automatic Reclose Sequence;
  the display indications are : RCL = Ready, LRC = Manual Close.
- The tripping of any element programmed for the operation of the next reclosure during the reclaim time "Trx" makes the relay proceed with the reclosing cycle.
- After "Trx" is expired the relay is ready for a new AR Cycle.

***N.B.***
***For operation of the Autoreclose Function C/B trip must be controlled by output relay "R1", and C/B close must be controlled by relay "R2".***

### *14.31.5 - Reclose Command*

As soon as the C/B is opened due to tripping of one of the relay's elements programmed to initiate the next automatic reclose the relevant reclose, the relevant time delay (t1, t2, t3, t4) is started and at the end of this time the reclose command is issued by the relay.

The C/B is then automatically reclosed, the reclaim time "Trx" and the discrimination time "TDx" are started.

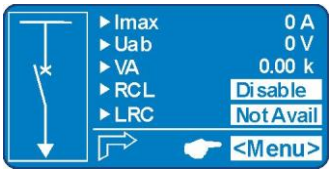
If during Tdx the C/B is again opened by any relay's protection element the relay goes in to L.O. status.

If during Trx the C/B is again opened by tripping of a protection element programmed to initiate the next AR shot, the C/B is reclosed after the relevant delay time "tx".

When the last shot of the AR Cycle sequence has been done, any further tripping during tr produces the relay's lock-out status.

If after any reclose shot no tripping takes peace during "Tr", the relay gets ready for a new AR Cycle.

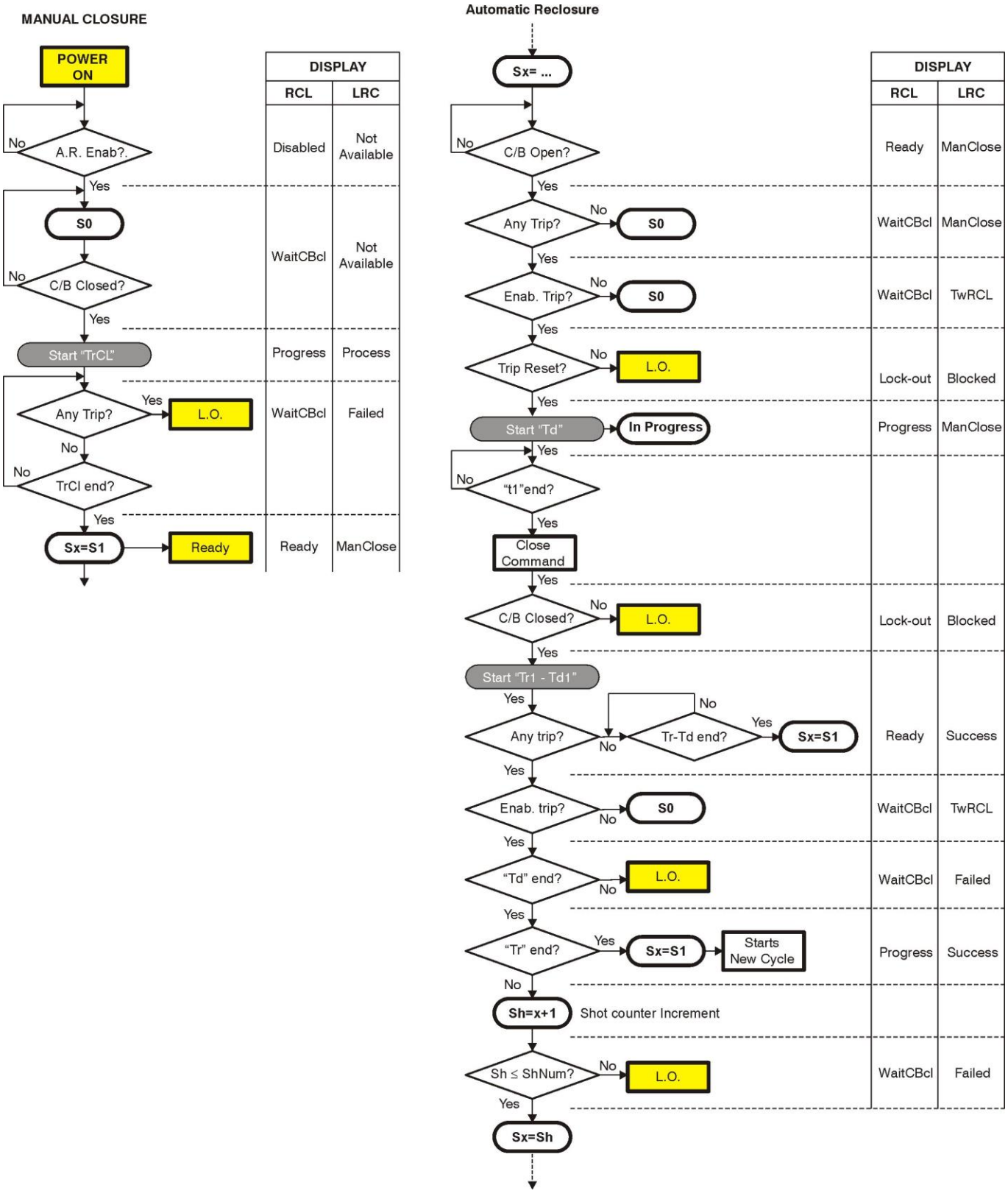
### *14.31.6 - Display Message*




| | | | | |
|---|---|---|---|---|
| **RCL** | Status of the current Autoreclosure. | | | |
| | **Disable** | : | Disabled | |
| | **WaitC/Bcl** | : | Wait for C/B manual closure | |
| | **Ready** | : | Ready | |
| | **Progress** | : | In Progress | |
| | **LockOut** | : | LockOut | |

| | | | | |
|---|---|---|---|---|
| **LRC** | Last Autoreclosure | | | |
| | **ManClose** | : | Manual Closure | |
| | **Success** | : | Successful Automatic Reclosure | |
| | **Failed** | : | Reclosure Failed | |
| | **TwRCL** | : | Trip without Automatic Reclosure | |
| | **Blocked** | : | Blocked by external cause | |
| | **NotAvail** | : | Information not Available | |

## *14.31.7 - Flow chart - Automatic Reclosure RCL*



## *14.32 - Function: **CB Manage** (Control C/B)*

This menu allows to configurate the command for C/B operation.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***Options*** | → | **L/R** | Ignored | | [Ignored – Active] | | | |
| | → | **Key** | Enable | | [Disable – Enable] | | | |
| ***Timers*** | → | **tL/R** | 0.05 | **s** | (0.05 ÷ 1.00) | step | 0.05 | s |
| | → | **tC/Bs** | 0.50 | **s** | (0.05 ÷ 1.00) | step | 0.05 | s |

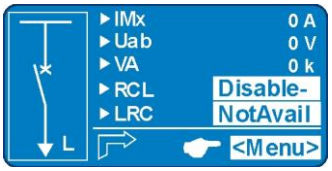
### *14.32.1 - Description of variables*

- **L/R** : Selection of Local/Remote C/B operation mode Ignored or Active
- **Key** : Disable = The pushbuttons on Front Panel are disabled;
  the operation of the C/B can be controlled by;
  1 - serial bus commands
  2 - commands available in the menu "***Local Cmd***"
  (Password protected).
  3 - Digital Inputs.
  Enable = The C/B can be controlled also by the pushbuttons available on Relay's Front Face.

- **tL/R** : Admissible time before detection of the Local/Remote discrepancy alarm.
- **tC/Bs** : Maximum admissible delay for detection of status signal after C/B operation.

*14.32.2 - Display Message*

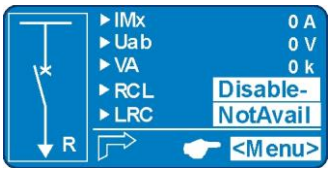
**1**




- L

- "***L***" the control of C/B is in "Local" mode

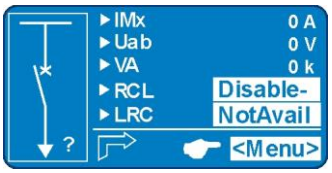
**2**




- R

- "***R***" the control of C/B is in "Remote" mode

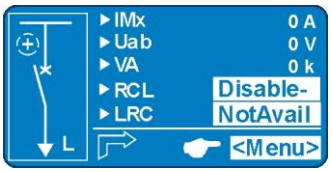
**3**




- ?

If the symbol "**?**" show up the relay is in discrepancy Local/Remote.
The commands can be send from "Local" or "Remote".

**4**




- ⊕

This symbol indicates the CB breaker failure (example: C/B closing failure)

## *14.33 - Function: **Oscillo** (Oscillographic Recording)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***Status*** | → | **Enab.** | No | | [No / Yes] | | | |
| ***Options*** | → | **Trig** | Disable | | [Disable / Start / Trip / ExtInp] | | | |
| ***Timers*** | → | **tPre** | 0.50 | **s** | (0.01÷0.50) | step | 0.01 | s |
| | → | **tPost** | 0.50 | **s** | (0.01÷1.50) | step | 0.01 | s |

### *16.33.1 - Description of variables*

- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **Trig** : Selection of the Trigger command source (start recording):
  - *Disable* = Function Disable (no recording)
  - *Start* = Trigger on time start of protection functions
  - *Trip* = Trigger on trip (time delay end) of protection functions
  - *ExtInp* = External Trigger from Digital Input
- **tPre** : Recording time before Trigger
- **tPost** : Recording time after Trigger

### *14.33.2 - Operation*

In the options: “Trig = Start” and “Trig = Trip”, the oscillographic recording starts respectively when any protection function starts operating or trip (provided the function was programmed “TrigEnab”).

| | | | | | |
|---|---|---|---|---|---|
| **T>** | **1Io>** | **2Is>** | **2U<** | **2f<** | **U1<** |
| **1I>** | **2Io>** | **1U>** | **1f>** | **1Uo>** | **U2>** |
| **2I>** | **3Io>** | **2U>** | **2f>** | **2Uo>** | **Wi** |
| **3I>** | **1Is>** | **1U<** | **1f<** | | |

In the option “ExtInp”, the oscillographic record starts when the Digital Input is activated (terminals shorted)

The “Osc” Function includes the wave Form Capture of the input quantities (IA, IB, IC, Io, EA, EB, EC, Eo) and can totally store a record of 3 seconds.
The number of events recorded depends on the duration of each individual recording (tPre + tPost).
In any case the number of event stored can not exceed ten (10 x 0.3 sec).
Any new event beyond the 3 sec capacity of the memory, cancels and overwrites the former records (FIFO Memory).

## 14.34 - Function: **BreakerFail** (Breaker Failure)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Status** | → **Enab.** | No | | [No / Yes] | | | |
| **Timers** | → **tBF** | 0.75 | **s** | (0.05÷0.75) | step | 0.01 | s |

### 14.34.1 - Description of variables

- **Enab.** : Function enabling (No = Disable / Yes = Enable)
- **tBF** : Trip time delay

### 14.34.2 - Operation

The Breaker Failure detection is started by the operation of the output relay “R1” (programmed to be controlled by the Protection Functions that trip the C/B).
If after [tBF] seconds from operation of the relay “R1”, any input current flow is still detected (>10% In) , the function “BF” trips and operate one user programmable output relay,

## *14.35 - Function: **ExtResCfg** (External Reset Configuration)*

This menu allows to configurate the edge polarity of the digital input associated to the trip reset function.

| ***Options*** | → **ActOn** | RiseEdge | [RiseEdge / FallEdge] |
|---|---|---|---|

### *14.35.1 - Description of variables*

- **ActOn** : RiseEdge Active on Rise Edge (Digital Input close).
  FallEdge Active on Fall Edge (Digital Input open).

# 15. Input - Output

The firmware can manage up to 32 digital inputs and 34 output relays; among these, 4 digital inputs and 6 output relays are available on the relay module, the remaining are available on additional expansion modules controlled via the CAN-Bus communication channel:
14DI Module = 14 Digital Imputs
14DO Module = 14 Outputs Relay
10-4 Module = 10 Digital Inputs and 4 Outputs Relay.
1 or 2 additional modules in any combination can be controlled.
***N.B. Circuit Breaker trip must be controlled by relay "R1"; For closing it is recommended to use relay "R2".***

## *15.1 - Operation*

Each Protection Element operates by means of "Inputs" and "Outputs":

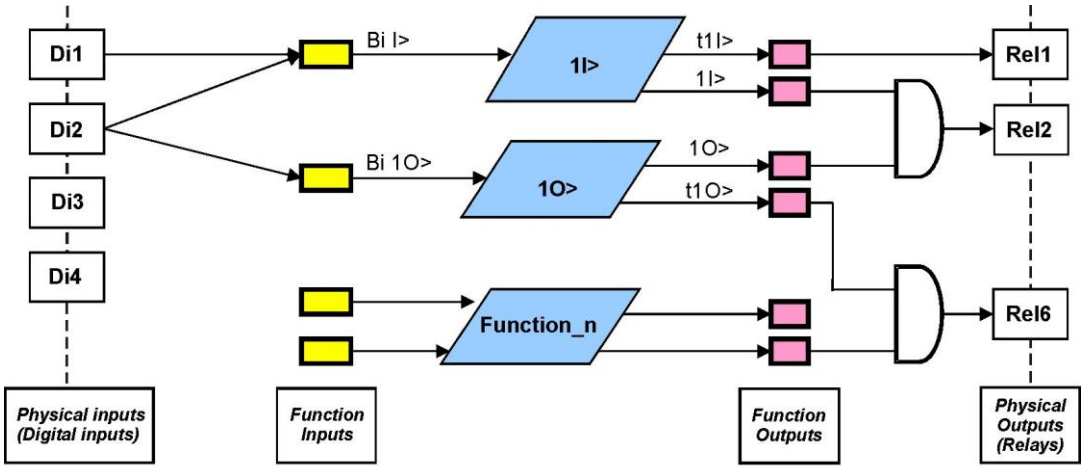
- Analogue Inputs : The measured input quantities
- Functional Inputs : The blocking input
- Physical Inputs : The Digital Inputs
- Functional Outputs : The functional elements
- Physical Outputs : The Output Relays

Any Physical Input can be assigned to the Functional Inputs of one or more elements: in the example the Digital Input "0.D1" controls the Functional Inputs of both the elements "1I>" and "1Io>"

Similarly any Physical Output can be controlled by the Functional Outputs of one or more of the FMR elements (see list of elements at § Physical Outputs): in the example "0.R2" is controlled by both "1I>" and "1Io>".

In case more than one Functional Output are programmed to control the same output relay, the setting menu requires to select between two different logic operation modes: "OR" or "AND" and "XOR":

- "OR" : Means that the relay is operated if at least one of the associated Functional Outputs is activated.
- "AND" : Means that the relay is operated only if all the associated Functional Output are activated.
- "XOR" : Means that the relay is operated only if one and only one of the associated Functional Output are activated.



The interfacing software “MSCom 2” also allows to program the operation of the output relays (Physical Output), the available operation are:

*Output Configuration: “**N.D.**” or “**N.E.**”:*

- “**N.D.**” : *Normally Deenergized* — The output relay is deenergized in normal conditions and gets energized on activation of the controlling Functional Output; reset means deenergizing.
- “**N.E.**” : *Normally Energized* — The output relay is energized in normal conditions and gets deenergized on activation of the controlling Functional Output; reset means energizing.

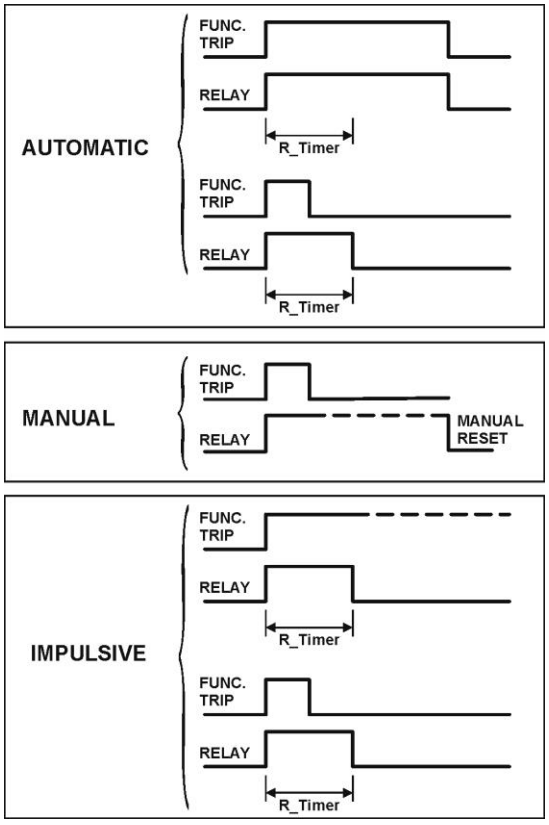
*Operation Time: R_Timer:*

This timer controls the duration of the activation of the output relay.

- “**R_Timer** : 0 (0-10)s, step 0.01s

*Operation Mode: **Automatic** / **Manual** / **Impulse** (see figure):*

- ***Automatic*** : In this mode the output relay is “operated” (energized if “N.D.”, deenergized if “N.E.”) when the controlling Functional Output is activated and it is reset to the “non operated” condition when the Functional Output gets disactivated but, anyhow, not before the time “R_Timer” has elapsed (minimum duration of the operation time)
- ***Manual*** : In this mode the output relay is “operated” when the controlling Functional Output is activated and remains in the operated condition until a manual reset command is issued by the FMR keyboard (local commands menu) or via the serial communication. In this mode the timer ”R_Timer” has no effect.
- ***Impulsive*** : In this mode the output relay is “operated” when the controlling Functional Output is activated and it remains in the “operated” condition (energized if “N.D.”, deenergized if “N.E.”) for the set time “R_Timer” independently from the status of the controlling Functional Output.



*15.2 - Physical Input*

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Input*** | → **0.D1** | **OFF**(1) | **+**(2) | Available in the FMR relay | | |
| | → **0.D2** | **OFF**(1) | **+**(2) | | | |
| | → **0.D3** | **OFF**(1) | **+**(2) | | | |
| | → **0.D4** | **OFF**(1) | **+**(2) | | | |
| | → **1.D1** | **OFF**(1) | **+**(2) | Available in the first additional expansion module | Inputs "D8", "D16" not available | By the interface program "MSCom 2" it is possible to Activate/Deactivate the modules. |
| | → **1.D--** | **OFF**(1) | **+**(2) | | | |
| | → **1.D15** | **OFF**(1) | **+**(2) | | | |
| | → **2.D1** | **OFF**(1) | **+**(2) | Available in the second additional expansion module | | |
| | → **2.D--** | **OFF**(1) | **+**(2) | | | |
| | → **2.D15** | **OFF**(1) | **+**(2) | | | |

**(1)** "ON", "OFF" **:** Actual status of the Input.

**(2)** + , ⊢ **:** + Indicates that this Input is not yet associated to any function.

⊢ Indicates that this Input is already associated to one or more functions.

0.D1 **:** "0" = Main Board, "1" = First Board Expansion, "2" = Second Board Expansion

Four Digital Input are available on FMR relay:

| | | | | |
|---|---|---|---|---|
| ❑ | **D1** (0.D1) | (terminals 38 - 28) | : | Programmable |
| ❑ | **D2** (0.D2) | (terminals 38 - 18) | : | Programmable |
| ❑ | **D3** (0.D3) | (terminals 38 - 29) | : | Programmable |
| ❑ | **D4** (0.D4) | (terminals 38 - 19) | : | Programmable (PTC) |

Three of them (0.D1, 0.D2, 0.D3) are disactivated, when the relevant terminals are open and get activated when the relevant terminals are shorted by an external cold contact.

The operation of the Input "0.D4" is dependent on the value "R" of resistance of the external circuit connected to its terminals (38-19):

- Activated if "R < 50Ω" or "R > 3000Ω". - Disactivated if "50Ω ≤ R ≤ 3000Ω".

Therefore, if the terminals "38-19" are open-circuited, the input "0.D4" is activated; for using "0.D4" as a normal Digital Input simply controlled by an external cold contact, it is necessary to permanently connect across the terminal's "38-19" (in parallel to the external contact) a load resistor of value between 50 and 3000Ω (example 1000Ω - 0.5W).

The additional inputs "1.D1....1.D15" are available when the first expansion module is present.

The additional inputs "2.D1....2.D15" are available when the second expansion module is present.

Any digital input of the expansion modules is active when the relevant terminals (see wiring diagram) are shorted.

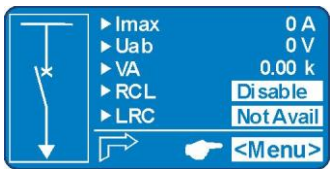
Any of the Digital Inputs can be programmed to control one or more of the following functions.

| | | |
|---|---|---|
| **Bi1I>** | Blocking input to the | 1I> |
| **Bi2I>** | Blocking input to the | 2I> |
| **Bi3I>** | Blocking input to the | 3I> |
| **Bi1Io>** | Blocking input to the | 1Io> |
| **Bi2Io>** | Blocking input to the | 2Io> |
| **Bi3Io>** | Blocking input to the | 3Io> |
| **Bi1Is>** | Blocking input to the | 1Is> |
| **Bi2Is>** | Blocking input to the | 2Is> |
| **Bi1U>** | Blocking input to the | 1U> |
| **Bi2U>** | Blocking input to the | 2U> |
| **Bi1U<** | Blocking input to the | 1U< |
| **Bi2U<** | Blocking input to the | 2U< |
| **B1Uo>** | Blocking input to the | 1Uo> |
| **B2Uo>** | Blocking input to the | 2Uo> |
| **BiU1<** | Blocking input to the | U1< |
| **BiU2>** | Blocking input to the | U2> |
| **C/B** | Indication of the Open/Close status of the C/B | |
| **RT** | Remote Trip (External Trip) | |
| **FastTrip** | Digital input for reduction of the trip time delay | |
| **BiRCL** | Blocking of the reclosing function | |
| **Local** | Local mode operation | |
| **Remote** | Remote mode operation | |
| **OpenCB** | C/B open command | |
| **CloseCB** | C/B close command | |
| **ExtTrgOsc** | External Trigger of the Oscillographic Recording. | |
| **ExtReset** | External Reset | |
| **Bank 1-2** | Selection of the setting Bank 1 or 2. | |

Moreover, any Digital Input can be programmed to control one or more output relays in “AND” or “OR” or “XOR” logic (see § Digital Input)

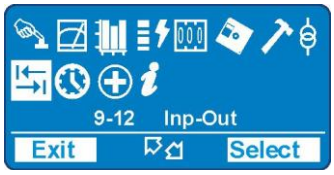
*15.2.1 – Example*

**1**



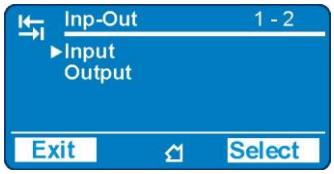

- Press "***Menu***" for access to the main menu with icons.

**2**



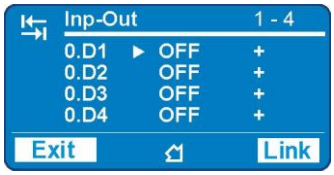

- Select icon "***Inp-Out***" by pushbuttons "***Increase***" or "***Decrease***".
- Press "***Select***".

**3**




- Select "***Input***".
- Press "***Select***".

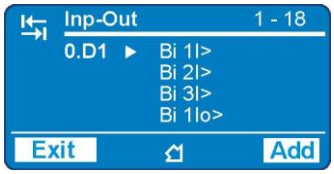
**4**




- Select "***0.D1***".
- Press "***Link***" for access to input "**1**".

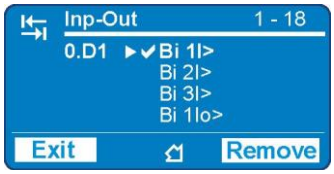
"***0.D1***" corresponding to physical digital input "***0.***D1".
"***0.D1***" corresponding to physical digital input "***0.***D2".
"***0.D1***" corresponding to physical digital input "***0.***D3".
"***0.D1***" corresponding to physical digital input "***0.***D4".
"***1.D--***" corresponding to physical digital input "***1.D--***". (additional first module)
"***2.D--***" corresponding to physical digital input "***2.D--***". (additional second module)

**5**



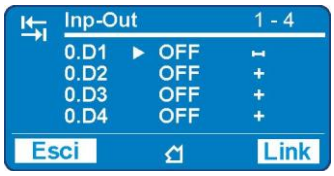

- Press "***Add***" to select and associate the function.
  (Digital Input 1 terminals 38-28).

**6**




- When one or more Blocking Input is associated this symbol shows
- To remove selection one function:
  Select function by pushbuttons "***Increase***" or "***Decrease***" and press "***Remove***"
- Press "***Exit***".

**7**




- Press "***Exit***" to go back to the previous menu.

**8**


- The display show "***Confirm the change?***".
- Choose "***Yes*** " to convalidate the changes.
- Choose "***No*** " to **not** confirm the changes.

## *15.3 – Physical Outputs*

The output relay are fully user programmable and controlled by any protection functions and by any digital inputs.

| | | | | | |
|---|---|---|---|---|---|
| ***Output*** | → **0.R1** | **OFF**(1) | **+**(2) | Available in the FMR relay | |
| | → **0.R2** | **OFF**(1) | **+**(2) | | |
| | → **0.R3** | **OFF**(1) | **+**(2) | | |
| | → **0.R4** | **OFF**(1) | **+**(2) | | |
| | → **0.R5** | **OFF**(1) | **+**(2) | | |
| | → **0.R6** | **OFF**(1) | **+**(2) | | |
| | → **1.R1** | **OFF**(1) | **+**(2) | Available in the first additional expansion module | By the interface program "MSCom II" it is possible to Activate/Deactivate the modules. |
| | → **1.R--** | **OFF**(1) | **+**(2) | | |
| | → **1.R14** | **OFF**(1) | **+**(2) | | |
| | → **2.R1** | **OFF**(1) | **+**(2) | Available in the second additional expansion module | |
| | → **2.R--** | **OFF**(1) | **+**(2) | | |
| | → **2.R14** | **OFF**(1) | **+**(2) | | |

**(1)** "ON", "OFF" **:** Actual status of the Output Relay

**(2)** + , ⊢ **:** + Indicates that this Relay is not yet associated to any function.

⊢ Indicates that this Relay is already associated to one or more functions.

**0.R1** **:** "0" = Main Board, "1" = First Board Expansion, "2" = Second Board Expansion

The relays "Rel1...Rel6" are always present on FMR module.
The additional relays "1.R1.....1.R14" are available when the first expansion module is present.
The additional relays "2.R1.....2.R14" " are available when the second expansion module is present.

Any Output Relay can be programmed to be controlled (energized) by one or more of the following functions or Digital Inputs:

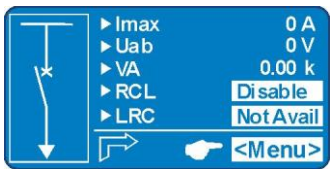
| | | |
|---|---|---|
| **Tal** | Thermal alarm | |
| **T>** | Thermal trip | |
| **1I>** | First instantaneous overcurrent element | (Start) |
| **t1I>** | First time delayed overcurrent element | (Trip) |
| **2I>** | Second instantaneous overcurrent element | (Start) |
| **t2I>** | Second time delayed overcurrent element | (Trip) |
| **3I>** | Third instantaneous overcurrent element | (Start) |
| **t3I>** | Third time delayed overcurrent element | (Trip) |
| **1Io>** | First instantaneous earth fault element | (Start) |
| **t1Io>** | First time delayed earth fault element | (Trip) |
| **2Io>** | Second instantaneous earth fault element | (Start) |
| **t2Io>** | Second time delayed earth fault element | (Trip) |
| **3Io>** | Third instantaneous earth fault element | (Start) |
| **t3Io>** | Third time delayed earth fault element | (Trip) |
| **1Is>** | First instantaneous Negative Sequence element | (Start) |
| **t1Is>** | First time delayed Negative Sequence element | (Trip) |
| **2Is>** | Second instantaneous Negative Sequence element | (Start) |
| **t2Is>** | Second time delayed Negative Sequence element | (Trip) |
| **1U>** | First instantaneous overvoltage element | (Start) |
| **t1U>** | First time delayed overvoltage element | (Trip) |
| **2U>** | Second instantaneous overvoltage element | (Start) |
| **t2U>** | Second time delayed overvoltage element | (Trip) |
| **1U<** | First instantaneous undervoltage element | (Start) |
| **t1U<** | First time delayed undervoltage element | (Trip) |
| **2U<** | Second instantaneous undervoltage element | (Start) |
| **t2U<** | Second time delayed undervoltage element | (Trip) |

| | | |
|---|---|---|
| **1f>** | First instantaneous overfrequency element | (Start) |
| **t1f>** | First time delayed overfrequency element | (Trip) |
| **2f>** | Second instantaneous overfrequency element | (Start) |
| **t2f>** | Second time delayed overfrequency element | (Trip) |
| **1f<** | First instantaneous underfrequency element | (Start) |
| **t1f<** | First time delayed underfrequency element | (Trip) |
| **2f<** | Second instantaneous underfrequency element | (Start) |
| **t2f<** | Second time delayed underfrequency element | (Trip) |
| **1Uo>** | First instantaneous zero sequence overvoltage element | (Start) |
| **t1Uo>** | First time delayed zero sequence overvoltage element | (Trip) |
| **2Uo>** | Second instantaneous zero sequence overvoltage element | (Start) |
| **t2Uo>** | Second time delayed zero sequence overvoltage element | (Trip) |
| **U1<** | Instantaneous positive sequence undervoltage element | (Start) |
| **tU1<** | Time delayed positive sequence undervoltage element | (Trip) |
| **U2>** | Instantaneous negative sequence overvoltage element | (Start) |
| **tU2>** | Time delayed negative sequence overvoltage element | (Trip) |
| **tWi>** | Circuit breaker maintenance level | |
| **tTCS** | Time delayed Trip Circuit Supervision | (Trip) |
| **IRF** | Time delayed Internal relay Fault | (Start) |
| **tIRF** | Instantaneous Internal relay Fault | (Trip) |
| **RT** | Remote trip | |
| **tRT** | Time delayed remote trip | |
| **TripTimeR** | Trip time reduction active | |
| **RCLf** | Autoreclosure failed | |
| **RCLrun** | Autoreclosure in progress | |
| **TwRCL** | Trip not enabled for Automatic Reclosure | |
| **RCL-OK** | Successful Automatic Reclosure | |
| **ManCL-OK** | Manual Closure | |
| **BiRCL** | Autoreclosure Blocked by external cause | |
| **Gr1to2** | Change over Group 1 to Group 2 | |
| **manOpCmd** | Manual opening command | |
| **CL-Cmd** | Closing command | |
| **C/BFail** | C/B Failure | |
| **L/Rdisc** | Local/Remote Discrepancy | |
| **BF** | Breaker Failure | |
| **Gen.Start** | General Start (pick-up of a protection function) | |
| **Gen.Trip** | General Trip (trip of a protection function) | |

| | | | | | |
|---|---|---|---|---|---|
| **0.D1** | Digital Input “0.D1” | activated | Available in the Main relay | | |
| **0.D1 (not)** | Digital Input “0.D1” | deactivated | | | |
| **0.D2** | Digital Input “0.D2” | activated | | | |
| **0.D2 (not)** | Digital Input “0.D2” | deactivated | | | |
| **0.D3** | Digital Input “0.D3” | activated | | | |
| **0.D3 (not)** | Digital Input “0.D3” | deactivated | | | |
| **0.D4** | Digital Input “0.D4” | activated | | | |
| **0.D4 (not)** | Digital Input “0.D4” | deactivated | | | |
| **1.D1** | Digital Input “1.D1” | activated | Available in the first additional expansion module | Inputs "D8", "D16" not available | By the interface program “MSCom 2” it is possible to Activate/Deactivate the modules. |
| **1.D1 (not)** | Digital Input “1.D1” | deactivated | | | |
| **1.D --** | Digital Input “1.D--” | activated | | | |
| **1.D -- (not)** | Digital Input “1.D--” | deactivated | | | |
| **1.D15** | Digital Input “1.D15” | activated | | | |
| **1.D15 (not)** | Digital Input “1.D15” | deactivated | | | |
| **2.D1** | Digital Input “2.D1” | activated | Available in the second additional expansion module | | |
| **2.D1 (not)** | Digital Input “2.D1” | deactivated | | | |
| **2.D --** | Digital Input “2.D--” | activated | | | |
| **2.D -- (not)** | Digital Input “2.D--” | deactivated | | | |
| **2.D15** | Digital Input “2.D15” | activated | | | |
| **2.D15 (not)** | Digital Input “2.D15” | deactivated | | | |

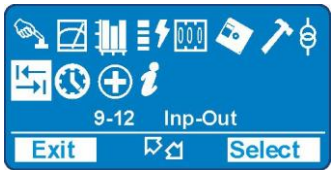
*15.3.1 – Example*

**1**



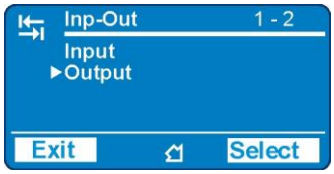

- Press "***Menu***" for access to the main menu with icons.

**2**



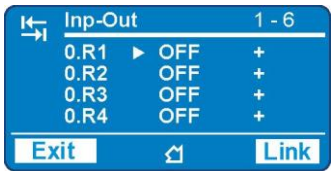

- Select icon "***Inp-Out***" by pushbuttons "***Increase***" or "***Decrease***".
- Press "***Select***".

**3**




- Select "***Output***".
- Press "***Select***".

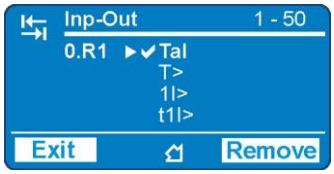
**4**




- Select "***0.R1***".
- Press "***Link***" for access to relay "**1**".

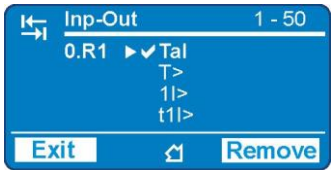
"***0.R1***" - "***0.Rx***" corresponding to physical output relay "**1**" - "**x**"
(**x** =available in the additional expansion modules)

**5**



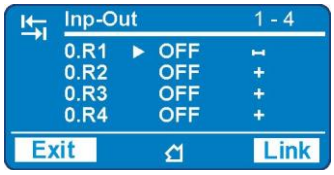

- Press "***Add***" to select and associate the function.

**6**



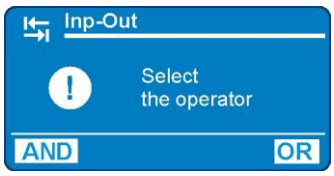

- When one or more function is associated this symbol shows
- To remove selection one function:
  Select function by pushbuttons "***Increase***" or "***Decrease***" and press "***Remove***"
- Press "***Exit***".

**7**



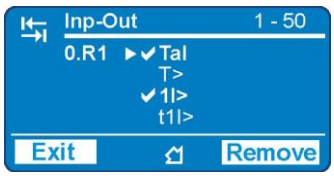

- Press "***Exit***"

**8**




- If more than one function or digital input are associated to one output relay, it is necessary to select the logic operator "AND" or "OR" "**!Select the operator**" (see § Operation).

**9**




- Press "***Exit***" to go back to the previous menu.

**10**

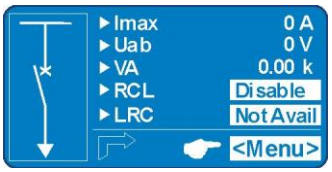

- The display show "***Confirm the change?***".
- Choose "***Yes*** " to convalidate the changes.
- Choose "***No*** " to **not** confirm the changes.

## 16. Date and Time

In this menu it is possible to configurate the Date and Time

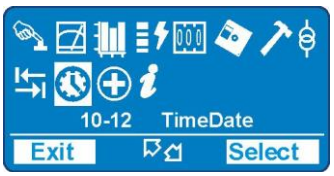
| | | | | | | |
|---|---|---|---|---|---|---|
| **Date:** | 20YY | / | MM | / | DD | (2000/01/01 ÷ 2099/12/31)<br>YY = Year / MM = Month / DD = Day |
| **Time:** | HH | : | MM | : | 00 | HH = hour / MM = Minutes / 00 |
| **DofW:** | Day | | | | | Es: Wednesday |

**1**




- Press "***Menu***" for access to the main menu with icons.

**2**




- Select icon "***TimeDate***" by pushbuttons "***Increase***" or "***Decrease***".
- Press "***Select***".

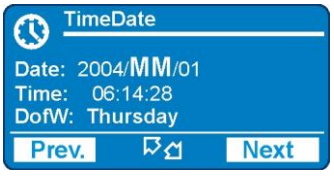
**3**


- Press "***Modify***".

**4**

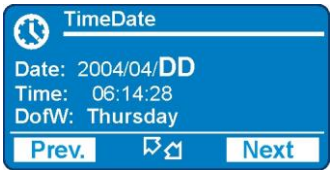

- The last two figures of the Year will appear in bold character; by pushbuttons "***Increase***" or "***Decrease***" set the new figures.
- Press "***Next***" to go to the next setting.

**5**



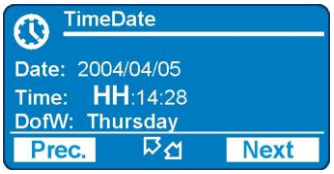

- As above for changing the "Month"
- Press "***Next***" to go to the next setting.

**6**



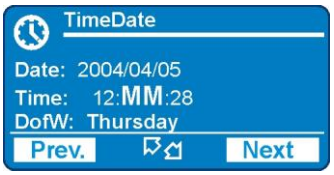

- As above for changing the "Day"
- Press "***Next***" to go to the next setting.

**7**



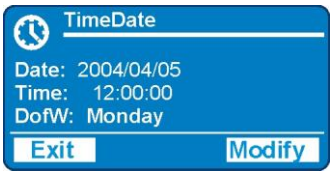

- As above for changing the "Hours"
- Press "***Next***" to go to the next setting.

**8**




- As above for changing the "Minutes"
- Press "***Next***" to go to the next setting.

**9**




- The **D**ay **of** the **W**eek is calculated and displayed automatically.
- Press "***Exit***" to go back to the main menu.
- Press "***Modify***" to go back to the step "3"

Press the button "***Next***" to go back to the previous display.

## *16.1 – Clock synchronization*

The internal clock has 1ms resolution and a stability of ±35ppm in the operational temperature range.

It can be synchronized with an external time reference in the following ways:

- Using the SNTP protocol by the rear Ethernet port.

*Note*: On power supply failure an internal battery supports the internal clock for over two years.

## 17. Healthy (Diagnostic Information)

The relay operates a continuous checking of the vital functionalities and in case an internal failure is detected, the I.R.F. function (see § I.R.F.) is activated and the Power/IRF led is set to flashing.

| | | | | |
|---|---|---|---|---|
| ***Device*** | → | **No Fail** | → | No Fail |
| | | **Fail** | → | Fail present |
| | | **MinorFail** | → | Minor Fail |
| | | **HisoricalFail** | → | Cleared Fail |
| | | **FW not comp.** | → | Firmware not compatible |

If an internal self-clearing (transient) fault is detected, it is recorded into an historical file without any other action.

## 18. Dev.Info (Relay Version)

In this menu it is possible to read the information relevant to relay unit.

| | | | | |
|---|---|---|---|---|
| ***SW Version*** | **AcqUnit-I/O** | → | ####.##.##.# | Firmware version of acquisition unit |
| | **ProtectUnit** | → | ####.##.##.# | Firmware version of CPU unit |
| ***Protect.Model*** | | → | FeederManager | Protection Type |
| ***Serial Number*** | | → | ###I##I##I#### | Relay Serial Number |
| ***User Tag*** | | → | FMR | Relay identification label. |
| ***Build*** | | → | ############ | Build identification label. |
| ***Line*** | | → | ############ | Line identification label. |

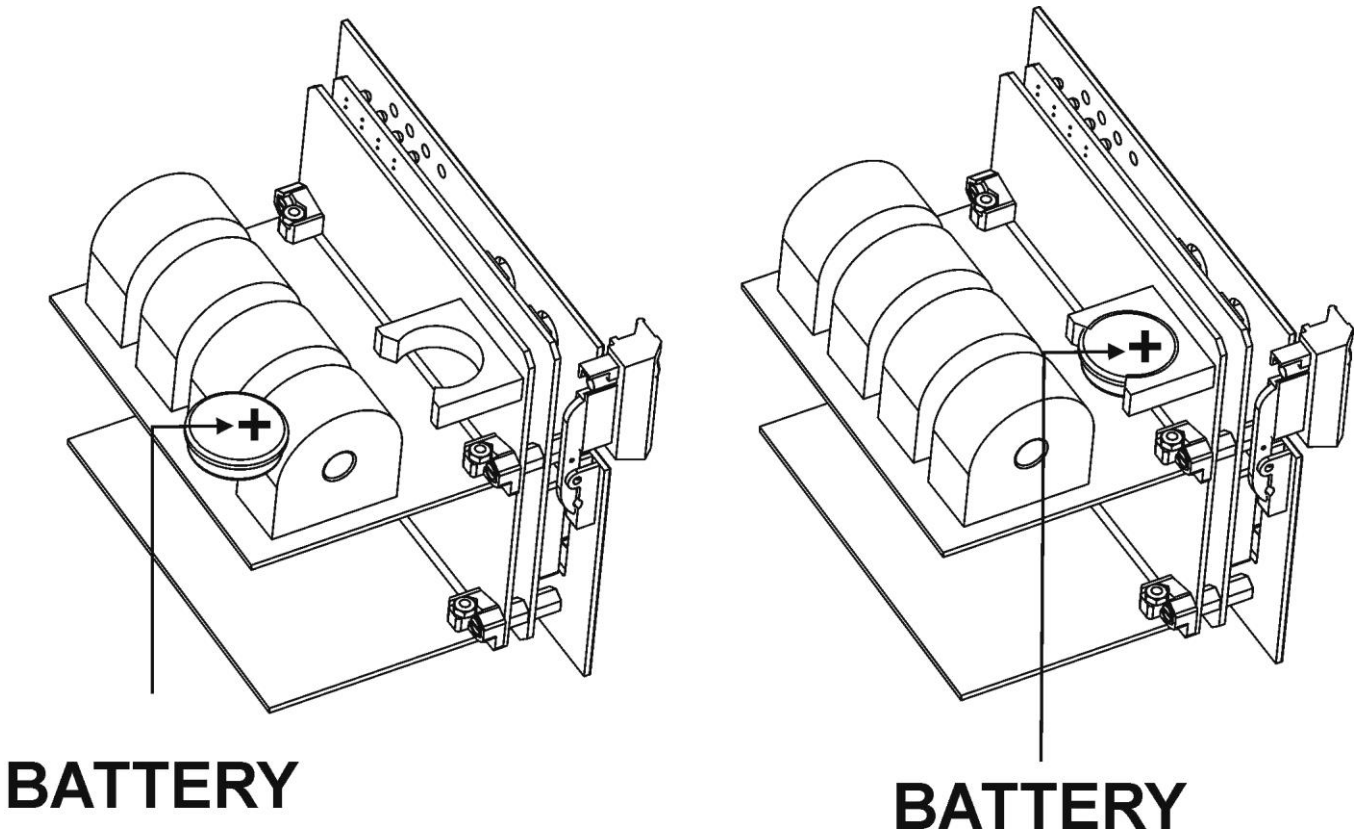
This information can only be modified by the interface program "MSCom II" and allows the user to give to the relay any suitable denomination.

## 19. Battery

The relay is equipped with a lithium battery type “CR2477N 3V”, to support the internal clock and the oscillographic recording memory in case of programmed lack of power.
The expected minimum duration without power exceed 2 years.

**Attention!!** Use only battery specified.

Instruction for replacement the battery:



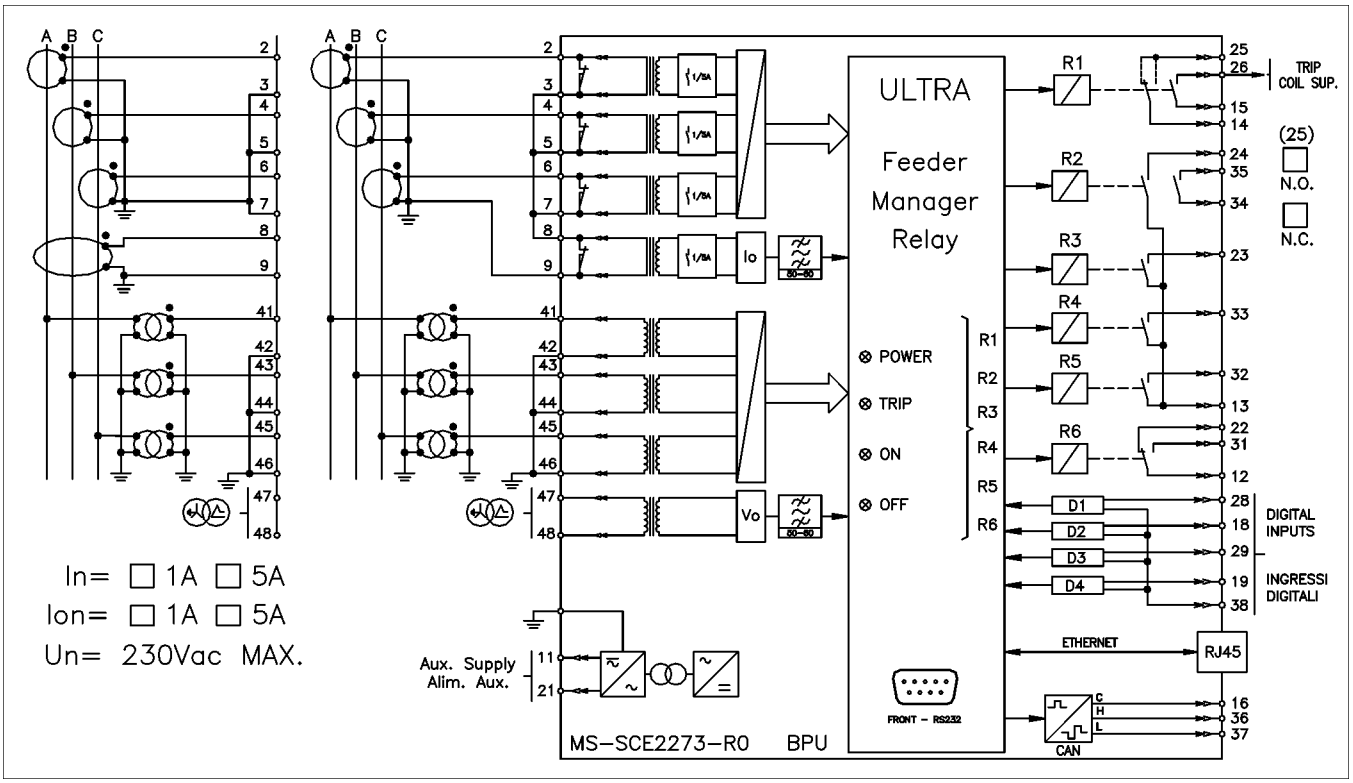

## 20. Maintenance

No maintenance is required. In case of malfunctioning please contact Microelettrica Scientifica Service or the local Authorized Dealer mentioning the relay's Serial No reported in the label on relays enclosure.

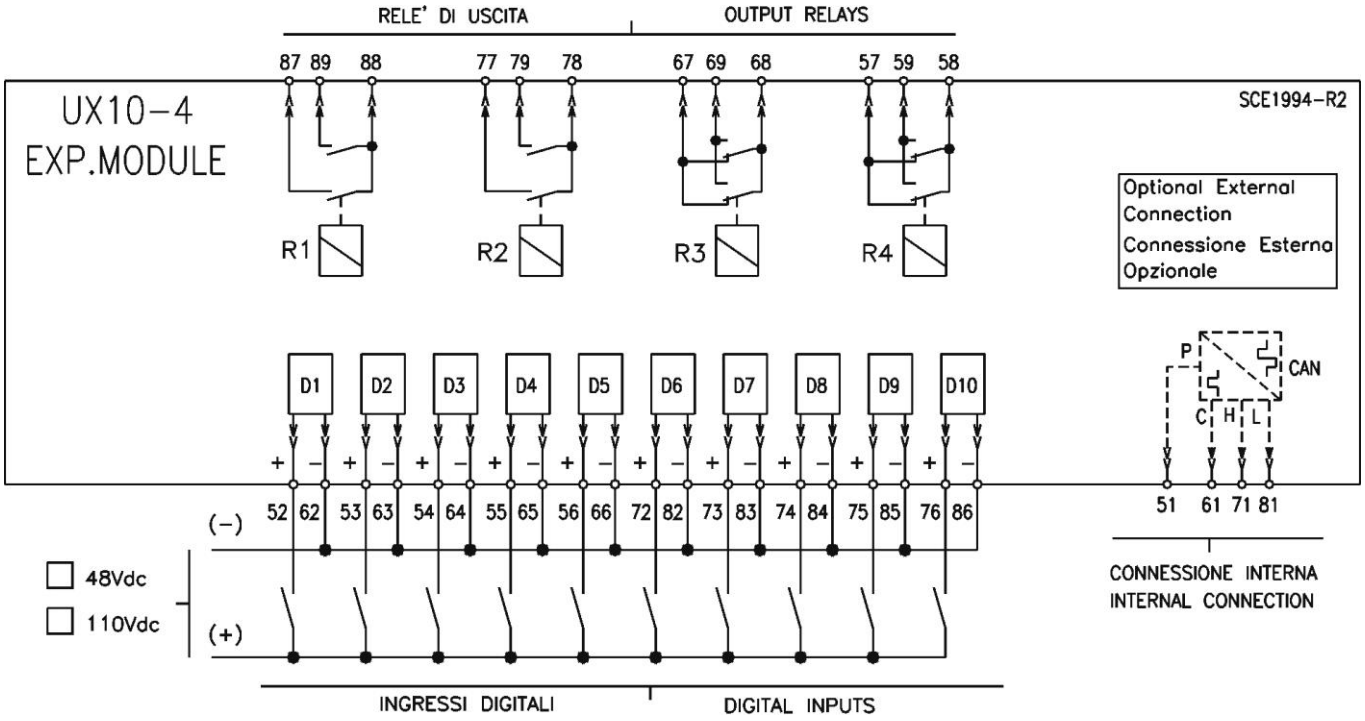
## 21. Power Frequency Insulation Test

Every relay individually undergoes a factory insulation test according to IEC255-5 standard at 2 kV, 50 Hz 1min. Insulation test should not be repeated as it unusefully stresses the dielectrics.
When doing the insulation test, the terminals relevant to serial output, digital inputs and RTD input must always be short circuited to ground. When relays are mounted in switchboards or relay boards that have to undergo the insulation tests, the relay should be isolated. This is extremely important as discharges eventually tacking place in other parts or components of the board can severely damage the relays or cause damages not immediately evident to the electronic components.

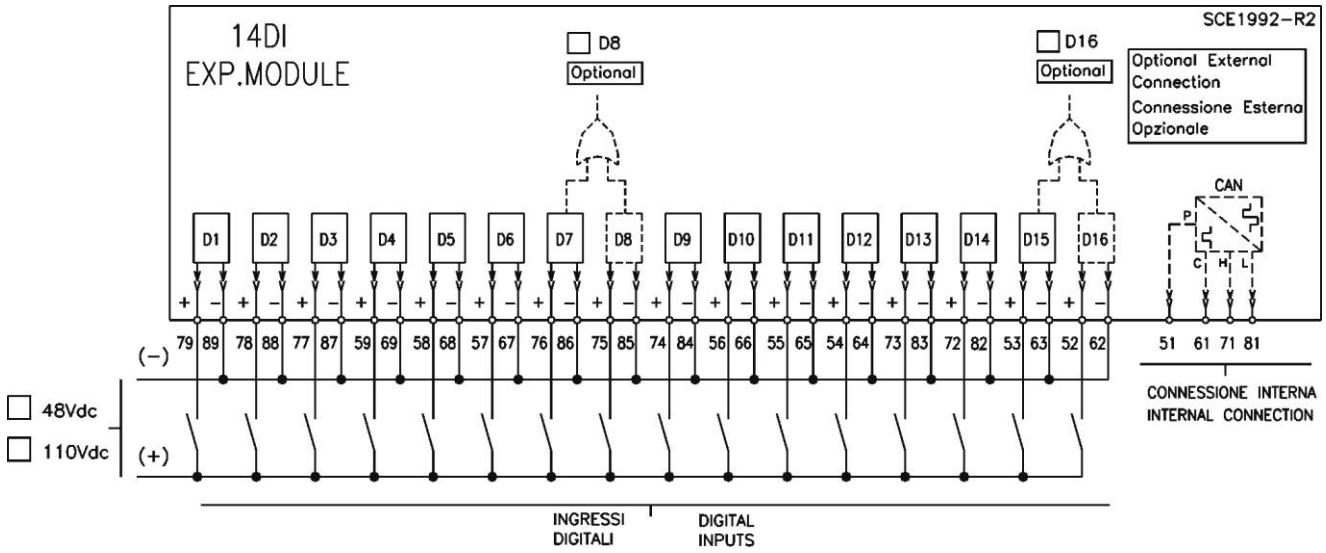
## 22. Basic Relay - Wiring Diagram



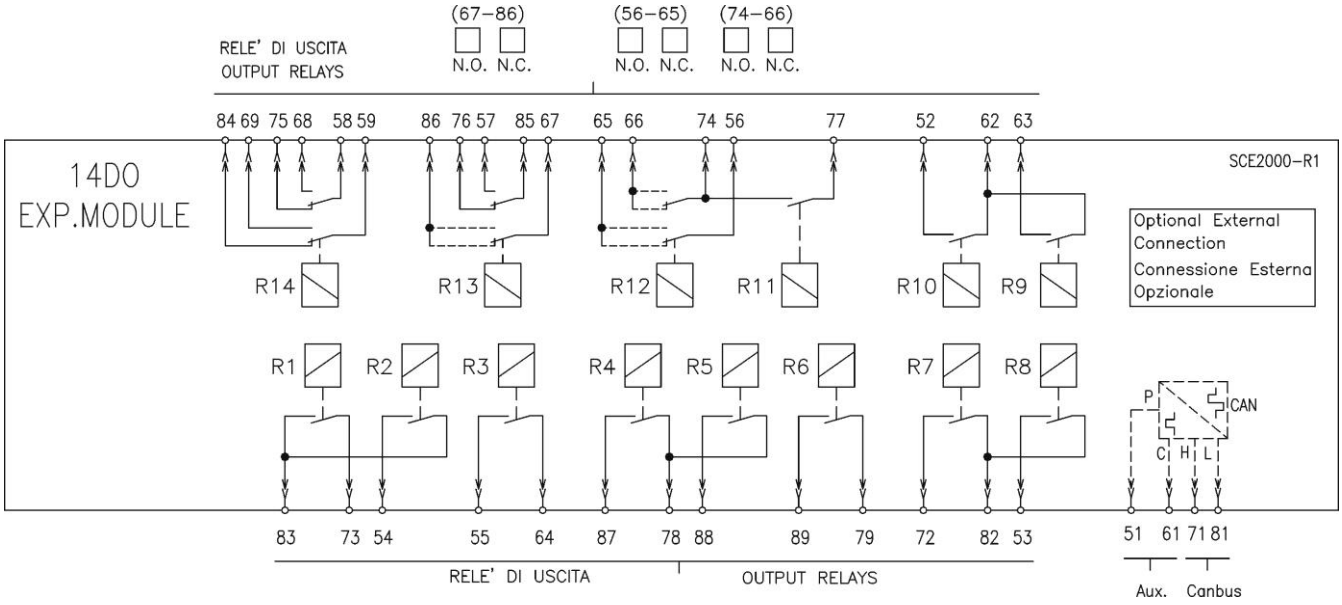

### *22.1 – **UX10-4** - Expansion Module - Wiring Diagram (10 Digital Inputs + 4 Output Relays)*



## *22.2 – **14DI** - Expansion Module - Wiring Diagram (14 Digital Inputs)*

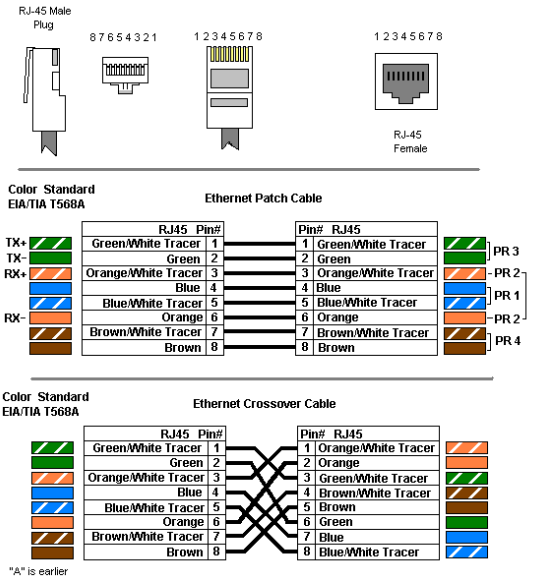



## *22.3 – **14DO** - Expansion Module - Wiring Diagram (14 Output Relays)*




## *22.4 – **PSU** – Power Supply for Expansion Module - Wiring Diagram*

## 23. Wiring the Ethernet Communication




The back Ethernet connector is a standard RJ45 connector and can be wired with a normal Ethernet UTP cable in class 5 minimum.
The relay can be connected directly to a PC with a Ethernet “Crossover” cable, or it can be connected to a switch with a Ethernet “Patch” cable.

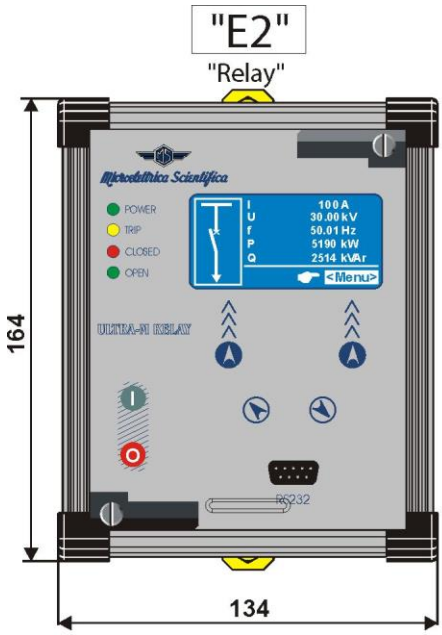
## 24. Basic Relay - Overall Dimensions

Flush mounting protection degree: IP44 (54 on request).

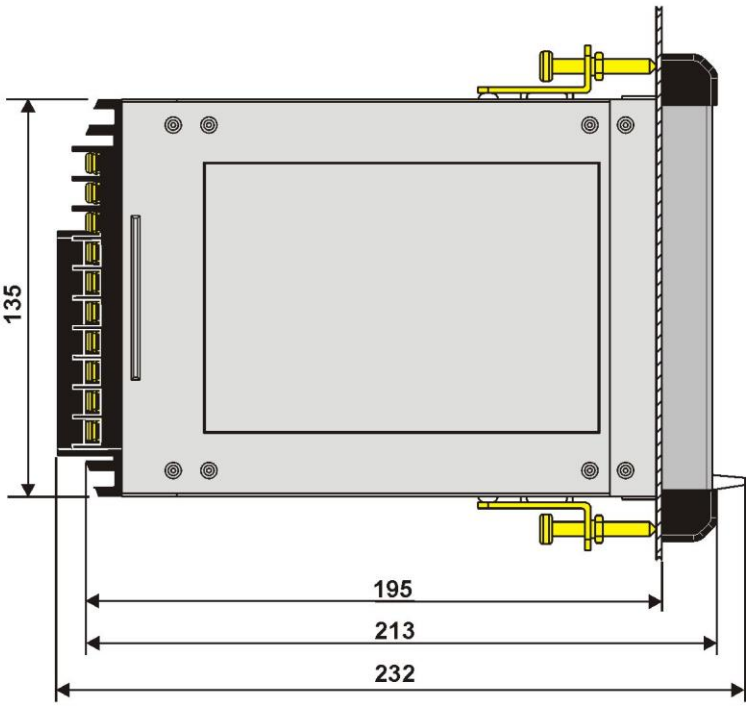
### *24.1 - Configuration box*

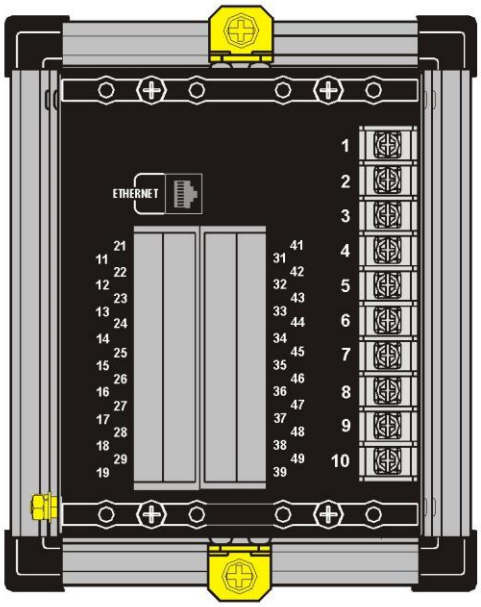
| Relay | Expansions | | | | | | | Box |
|---|---|---|---|---|---|---|---|---|
| | 1st | | | 2nd | | | Aux.Supply | |
| | UX10-4 | 14DI | 14DO | UX10-4 | 14DI | 14DO | PSU | |
| ☒ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | E2 |
| ☒ | ☒ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | E3 |
| ☒ | ☐ | ☒ | ☐ | ☐ | ☐ | ☐ | ☐ | E3 |
| ☒ | ☐ | ☐ | ☒ | ☐ | ☐ | ☐ | ☒ | E4 |
| ☒ | ☒ | ☐ | ☐ | ☒ | ☐ | ☐ | ☒ | E5 |
| ☒ | ☒ | ☐ | ☐ | ☐ | ☒ | ☐ | ☐ | E4 |
| ☒ | ☒ | ☐ | ☐ | ☐ | ☐ | ☒ | ☒ | E5 |
| ☒ | ☐ | ☒ | ☐ | ☒ | ☐ | ☐ | ☐ | E4 |
| ☒ | ☐ | ☒ | ☐ | ☐ | ☐ | ☒ | ☒ | E5 |
| ☒ | ☐ | ☒ | ☐ | ☐ | ☒ | ☐ | ☐ | E4 |
| ☒ | ☐ | ☐ | ☒ | ☒ | ☐ | ☐ | ☒ | E5 |
| ☒ | ☐ | ☐ | ☒ | ☐ | ☒ | ☐ | ☒ | E5 |
| ☒ | ☐ | ☐ | ☒ | ☐ | ☐ | ☒ | ☒ | E5 |

## *24.2 – Box "E2"*




**PANEL CUT-OUT**
**115x137 (LxH)**



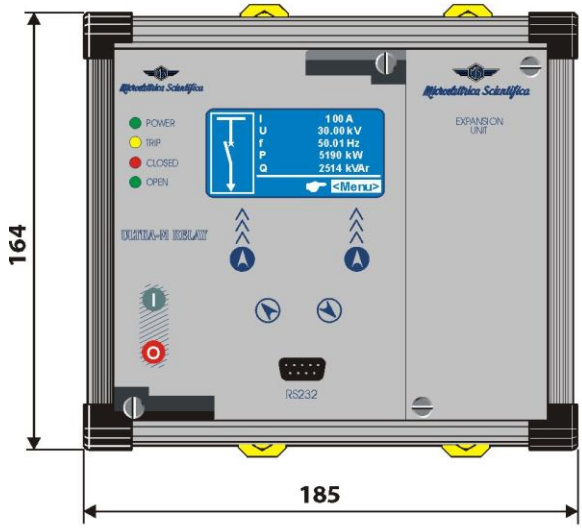




**TERMINAL CONNECTION**

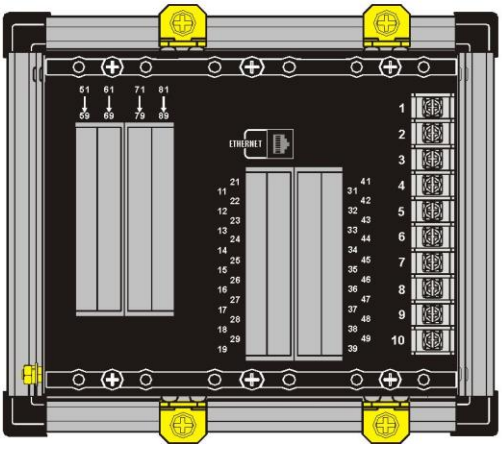
## *24.3 – Box "E3" & Box "E4"*

"E3"

"Relay" "1st"

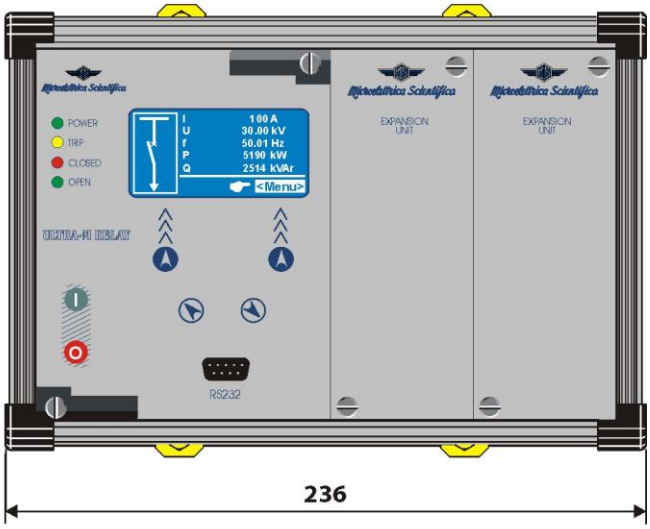



**PANEL CUT-OUT 165x137 (LxH)**

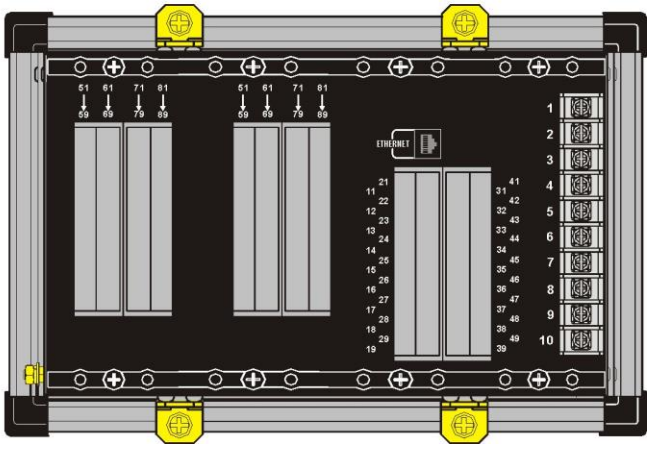



"E4"

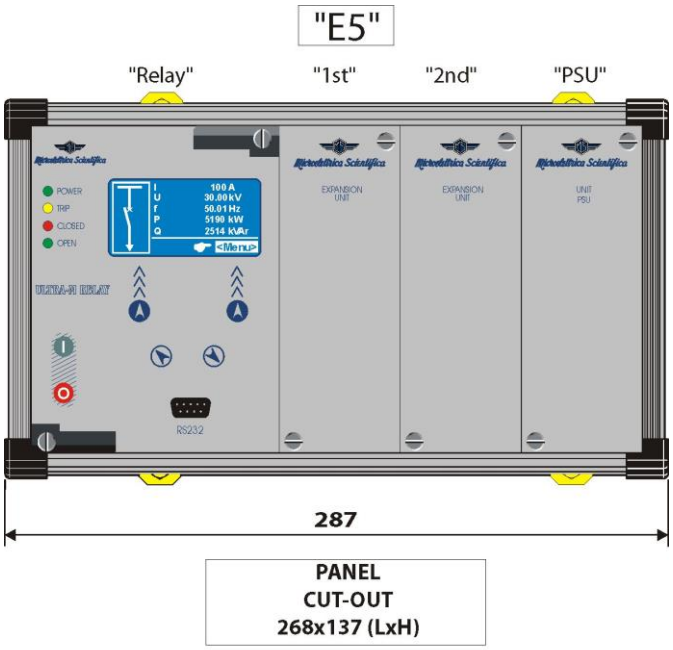
"Relay" "1st" "2nd"or "PSU"

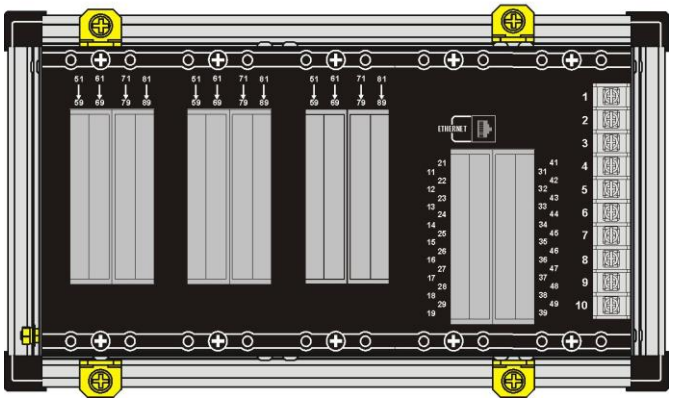



**PANEL CUT-OUT 217x137 (LxH)**

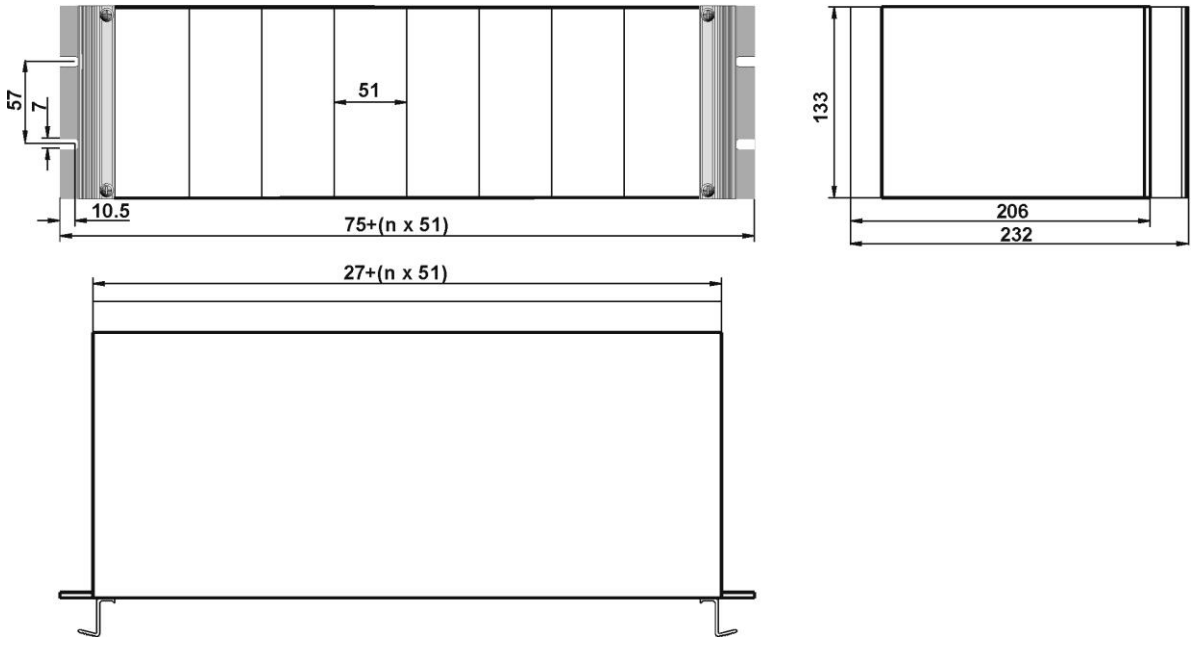


## *24.4 – Box "E5"*



## *24.5 – Rack 3U*



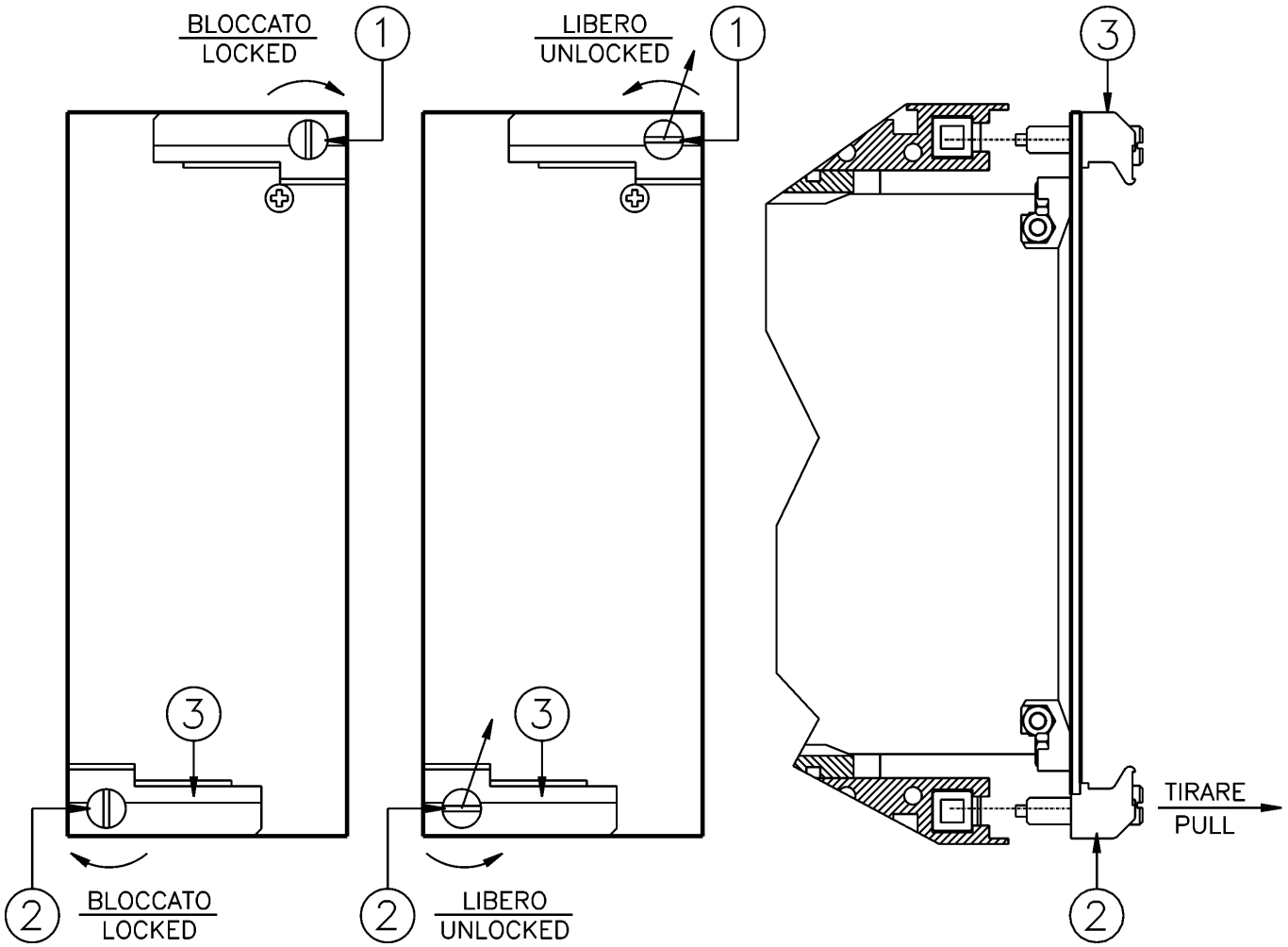
## 25. Direction for Pcb's Draw-Out and Plug-In

### *25.1 - Draw-out*

Rotate clockwise the screws ① and ② in the horizontal position of the screw-driver mark.
Draw-out the PCB by pulling on the handles ③

### *25.2 – Plug-in*

Rotate clockwise the screws ① and ②in the horizontal position of the screw-driver mark.
Slide-in the card on the rails provided inside the enclosure.
Plug-in the card completely and press the handle to the closed position.
Rotate anticlockwise the screws ① and ② with the mark in the vertical position (locked).



## 26. Electrical Characteristics

**APPROVAL: CE**
**REFERENCE STANDARDS IEC 60255 - CE Directive - EN/IEC61000 - IEEE C37**

| | | | | | |
|---|---|---|---|---|---|
| ❑ | Dielectric test voltage | | IEC 60255-5 | 2kV, 50/60Hz, 1 min. | |
| ❑ | Impulse test voltage | | IEC 60255-5 | 5kV (c.m.), 2kV (d.m.) – 1,2/50μs | |
| ❑ | Insulation resistance | | > 100MΩ | | |
| **Environmental Std. Ref. (IEC 60068)** | | | | | |
| ❑ | Operation ambient temperature | | -10°C / +55°C | | |
| ❑ | Storage temperature | | -25°C / +70°C | | |
| ❑ | Environmental testing | (Cold) | IEC60068-2-1 | | |
| | | (Dry heat) | IEC60068-2-2 | | |
| | | (Change of temperature) | IEC60068-2-14 | | |
| | | (Damp heat, steady state) | IEC60068-2-78 | RH 93% Without Condensing AT 40°C | |
| **CE EMC Compatibility (EN61000-6-2 - EN61000-6-4 - EN50263)** | | | | | |
| ❑ | Electromagnetic emission | | EN55011 | industrial environment | |
| ❑ | Radiated electromagnetic field immunity test | | IEC61000-4-3<br>ENV50204 | level 3 | 80-2000MHz 10V/m<br>900MHz/200Hz 10V/m |
| ❑ | Conducted disturbances immunity test | | IEC61000-4-6 | level 3 | 0.15-80MHz 10V |
| ❑ | Electrostatic discharge test | | IEC61000-4-2 | level 3 | 6kV contact / 8kV air |
| ❑ | Power frequency magnetic test | | IEC61000-4-8 | | 1000A/m 50/60Hz |
| ❑ | Pulse magnetic field | | IEC61000-4-9 | | 1000A/m, 8/20μs |
| ❑ | Damped oscillatory magnetic field | | IEC61000-4-10 | | 100A/m, 0.1-1MHz |
| ❑ | Immunity to conducted common mode disturbance 0Hz-150KHz | | IEC61000-4-16 | level 4 | |
| ❑ | Electrical fast transient/burst | | IEC61000-4-4 | level 3 | 2kV, 5kHz |
| ❑ | HF disturbance test with damped oscillatory wave (1MHz burst test) | | IEC60255-22-1 | class 3 | 400pps, 2,5kV (m.c.), 1kV (d.m.) |
| ❑ | Oscillatory waves (Ring waves) | | IEC61000-4-12 | level 4 | 4kV(c.m.), 2kV(d.m.) |
| ❑ | Surge immunity test | | IEC61000-4-5 | level 4 | 2kV(c.m.), 1kV(d.m.) |
| ❑ | Voltage interruptions | | IEC60255-4-11 | | |
| ❑ | Resistance to vibration and shocks | | IEC60255-21-1 - IEC60255-21-2 10-500Hz 1g | | |

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| | | | |
|---|---|---|---|
| ❑ | Accuracy at reference value of influencing factors | 1% In – 0.1%On<br>2% + to (to=20÷30ms @ 2xIs) | for measure<br>for times |
| ❑ | Rated Current | In = 1 or 5A - On = 1 or 5A | |
| ❑ | Current overload | 80 In for 1 sec; 4 In continuous | |
| ❑ | Burden on current inputs | Phase : 0.01VA at In = 1A; 0.2VA at In = 5A<br>Neutral : 0.01VA at In = 1A ; 0.2VA at In = 5A | |
| ❑ | Rated Voltage | Un = (100 ÷125)Vac | |
| ❑ | Voltage Overload | 2Un permanent | |
| ❑ | Burden on voltage inputs | 0,1VA at Un | |
| ❑ | Average power supply consumption | < 10 VA | |
| ❑ | Output relays | rating 5 A; Vn = 380 V<br>A.C. resistive switching = 1100W (380V max)<br>make = 30 A (peak) 0,5 sec.<br>break = 0.3 A, 110 Vcc,<br>L/R = 40 ms (100.000 op.) | |

**COMMUNICATION PARAMETER**

| | | |
|---|---|---|
| ❑ | Rear Ethernet communication port | IP Address :<br>Device : 192.168.0.121 default, modifiable at the purchase order,<br>Time synchronization server : 192.168.0.20 default, modifiable at the purchase order, |
| ❑ | Front serial port | RS232 – 9600 to 57600 bps – 8,n,1 – Modbus RTU |

## 27. Software & Firmware Version

- **Firmware for version**

| | |
|---|---|
| **IAU** (Intelligent Acquisition Unit) | DSP_FMR-X_014.02.x |
| **IPU** (Processor Unit) | 0580.20.01.X |

- **Application Software**

| | |
|---|---|
| **MSCom 2** | 1.03.36 or later |

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