FEEDER MANAGER
with
AUTORECLOSING
RELAY

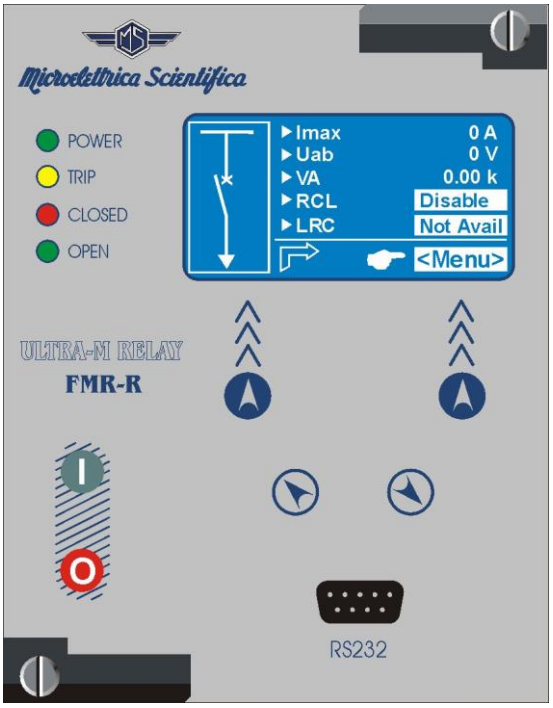
TYPE

FMR-R

(Multiple I/O Boards)

ULTRA Line

OPERATION MANUAL



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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

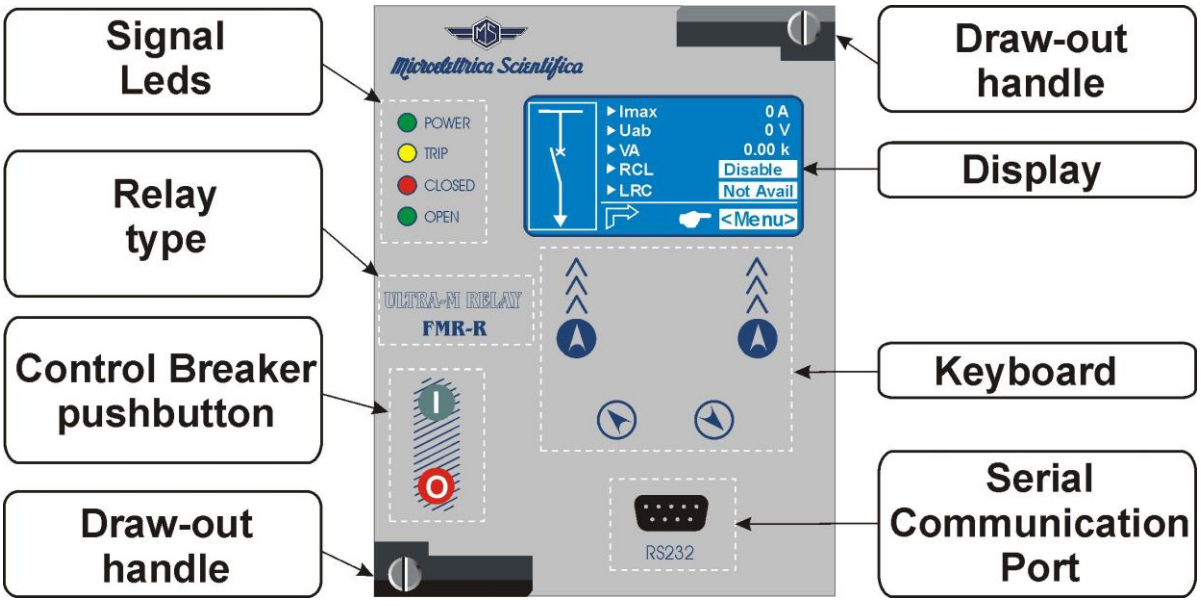
The relay can be fitted with two different types of **power supply**:

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

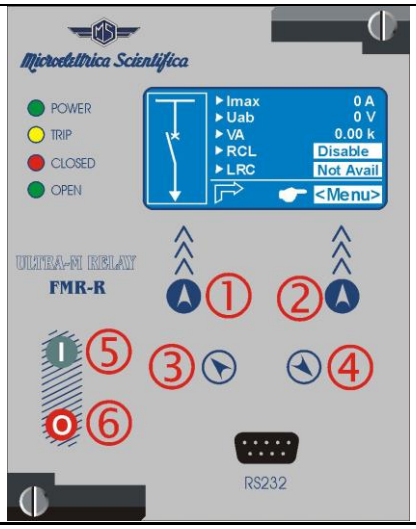
Type 2) - { 80V(-20%) / 220V(+15%) a.c. ; 90V(-20%) / 250V(+20%) d.c.

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

3. FRONT PANEL



4. KEYBOARD AND DISPLAY

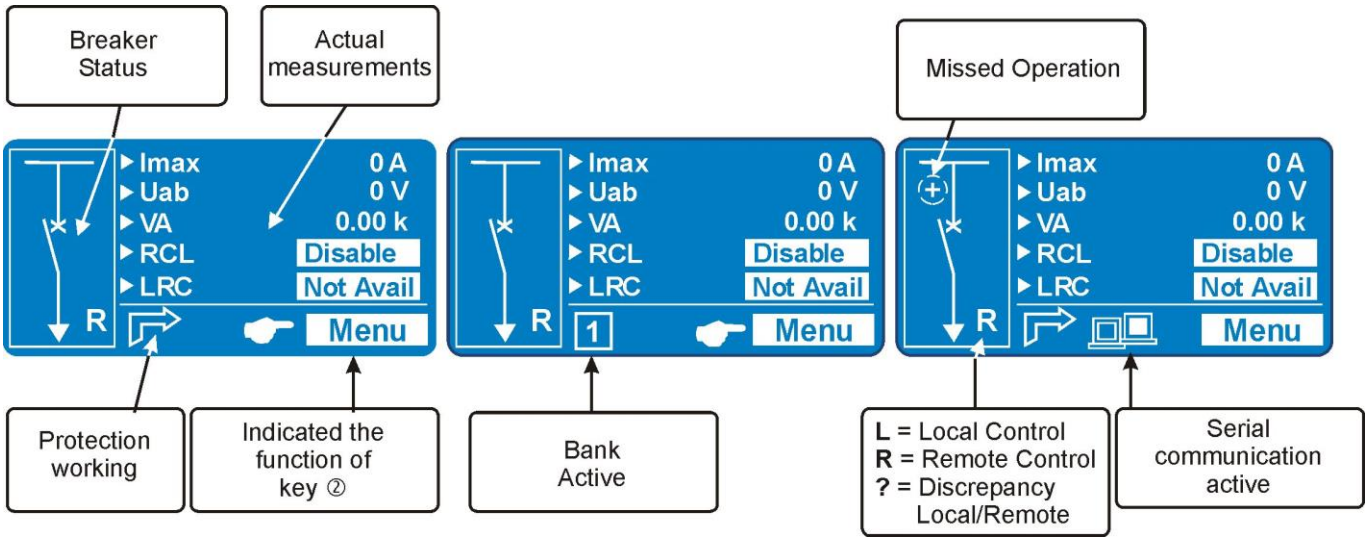


Navigation menu	By these buttons the options showed in correspondence on the display are selected.
Increase	These buttons are used to scroll the items of the different menus (Local Control, Measurements, Energy metering etc).
Decrease	
Open	these buttons (when enabled) operate Circuit Breaker Open/Close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

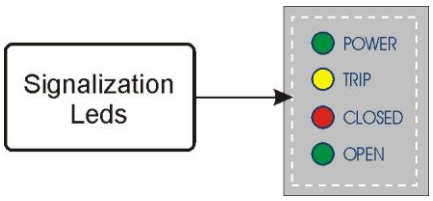


5. ICONS OF DISPLAY

	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:



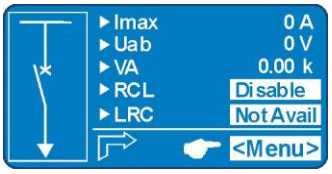
Green Led	POWER	❑ Illuminated ❑ Flashing	- Relay working properly. - Internal Relay Fault	
Yellow Led	TRIP	❑ Off ❑ Illuminated ❑ Flashing	- No Trip - Trip occurred - Function Timing	
		Reset from Illuminated status is manual (see § 6.1)		
Red Led	CLOSED	❑ Off ❑ Illuminated	- C/B Open - C/B Close	Both Flashing Operation of Trip Circuit Supervision element.
Green Led	OPEN	❑ Off ❑ Illuminated	- C/B Close - C/B Open	

❑ 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

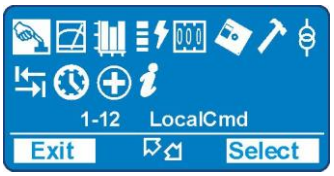
For Leds' manual reset operate as follows:

1



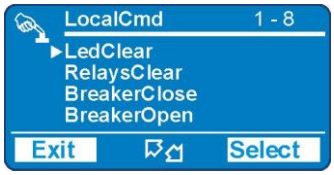
- Press "***Menu***" for access to the main menu with icons.

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.

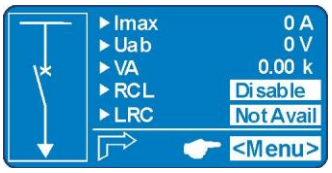
7. LOCAL COMMANDS

"***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*

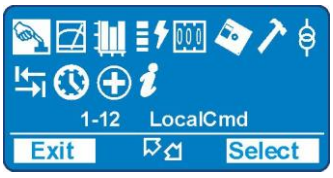
To operate one command by the Front Face Keyboard, proceed as follows (Led Reset in the present example).

1



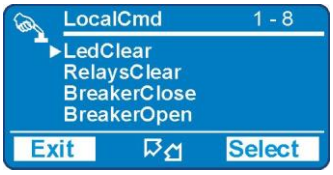
- Press "***Menu***" for access to the main menu with icons.

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).

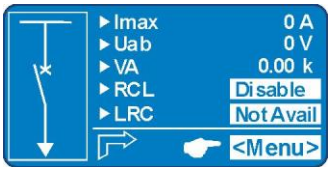
4

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

8. MEASURE

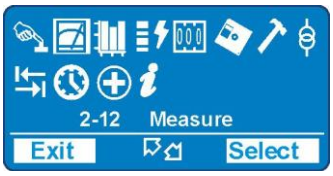
Real time values as measured during the normal operation.

1



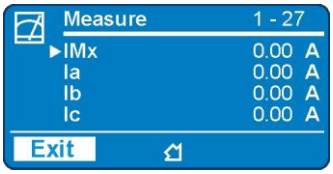
- Press "***Menu***" for access to the main menu with icons.

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.

→	**Imax**	(0 ÷ 9999)	**A**	Largest phase current (Ia, Ib, Ic).
→	**Ia**	(0 ÷ 9999)	**A**	Phase A current (R.M.S. ampere)
→	**Ib**	(0 ÷ 9999)	**A**	Phase B current (R.M.S. ampere)
→	**Ic**	(0 ÷ 9999)	**A**	Phase C current (R.M.S. ampere)
→	**Io**	(0 ÷ 9999)	**A**	Zero Sequence Current (fundamental frequency value 3Io)
→	**I1**	(0.00 ÷ 99.99)	**In**	Positive sequence current
→	**I2**	(0.00 ÷ 99.99)	**In**	Negative sequence current
→	**Frq**	(0.00 ÷ 99.99)	**Hz**	Frequency
→	**Uan**	(0 ÷ 999999)	**V**	Phase Voltage "A-N" (R.M.S. value)
→	**Ubn**	(0 ÷ 999999)	**V**	Phase Voltage "B-N" (R.M.S. value)
→	**Ucn**	(0 ÷ 999999)	**V**	Phase Voltage "C-N" (R.M.S. value)
→	**Uab**	(0 ÷ 999999)	**V**	Phase-to-phase Voltage "A-B" (R.M.S. value)
→	**Ubc**	(0 ÷ 999999)	**V**	Phase-to-phase Voltage "B-C" (R.M.S. value)
→	**Uca**	(0 ÷ 999999)	**V**	Phase-to-phase Voltage "C-A" (R.M.S. value)
→	**Uo**	(0 ÷ 999999)	**V**	Zero Sequence Voltage (fundamental frequency value 3Vo)
→	**V1**	(0.00 ÷ 99.99)	**Vn**	Positive Sequence Voltage
→	**V2**	(0.00 ÷ 99.99)	**Vn**	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**	(0.00 ÷ 99.99 ÷ 999.9 ÷ 9999999)	**k**	Three Phase Active Power (kW)
→	**VAr**	(0.00 ÷ 99.99 ÷ 999.9 ÷ 9999999)	**k**	Three Phase Reactive Power (kVAr)
→	**VA**	(0.00 ÷ 99.99 ÷ 999.9 ÷ 9999999)	**k**	Three Phase Apparent Power (kVA)
→	**Cos**	(0.000 ÷ 1.000)	**-**	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

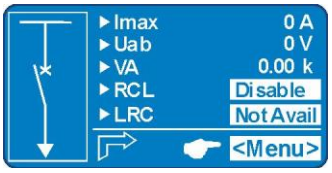
Real time energy measurements

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

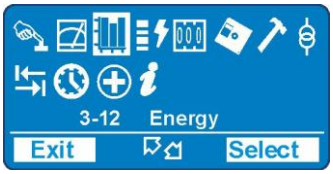
When the measurement exceed "9999999" the counters restart from "0".

1



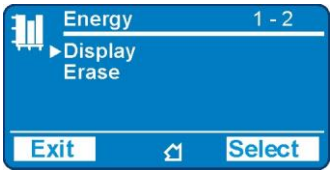
- Press "***Menu***" for access to the main menu with icons.

2



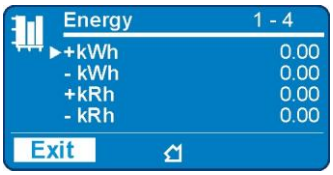
- Select "***Energy***" *icon with pushbutton* "***Increase***" or "***Decrease***".
- Press "***Select***" for access.

3



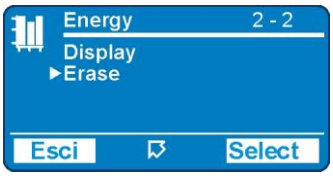
- Select "***Display***" *with pushbutton* "***Increase***" or "***Decrease***".
- Press "***Select***" for access.

4



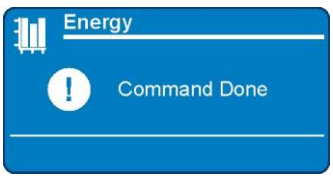
- Display of Real time Energy measurements.
- Press "***Exit***" to go back to the level "*3*".

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.

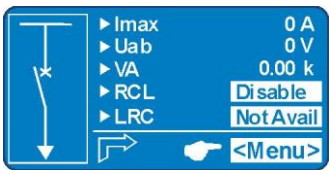
10. TRIP RECORDING

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.

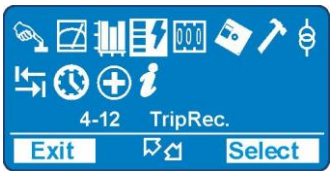
Erase	→	Clear all Trip recorded.

1



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

2

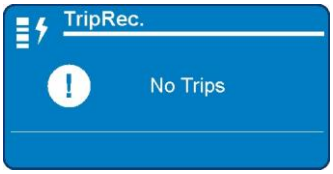


- Select "***TripRec.***" *icon with pushbutton* "***Increase***" or "***Decrease***".
- Press "***Select***" for access.

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***".

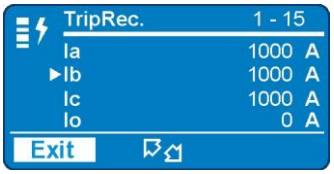
5

- 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)

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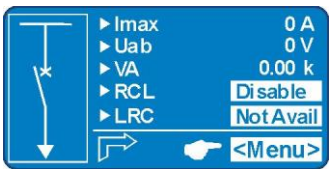
1



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

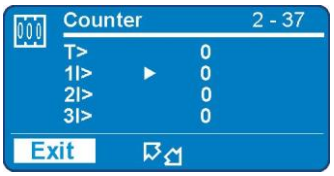
2

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

3

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

4



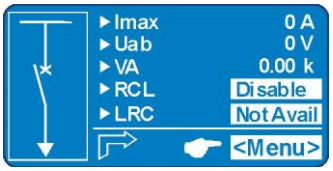
- Display of the number of operations of each individual function.
- With pushbuttons "***Increase***" or "***Decrease***" scroll the parameters
- Press "***Exit***" go back to "*3*".

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.

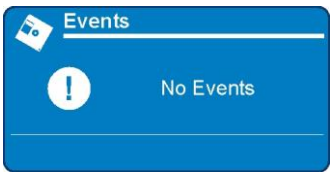
2

- 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

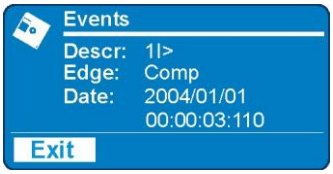


- If no event is recorded the display shows message "***! No Events***".

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 ---- 0.D4	*Digital Input*	Rise	Fall
	1.D1 ---- 1.D15	*Digital input*	Rise	Fall
	2.D1 ---- 2.D15	*Digital input*	Rise	Fall
	0.R1 ---- 0.R6	*Output relay*	Rise	Fall
	1.R1 ---- 1.R14	*Output relay*	Rise	Fall
	2.R1 ---- 2.R14	*Output relay*	Rise	Fall
	UpDateMon	*Update Monitor*	Rise	Fall
	IPU boot	*IPU boot*	Rise	

13. SYSTEM (System parameters)

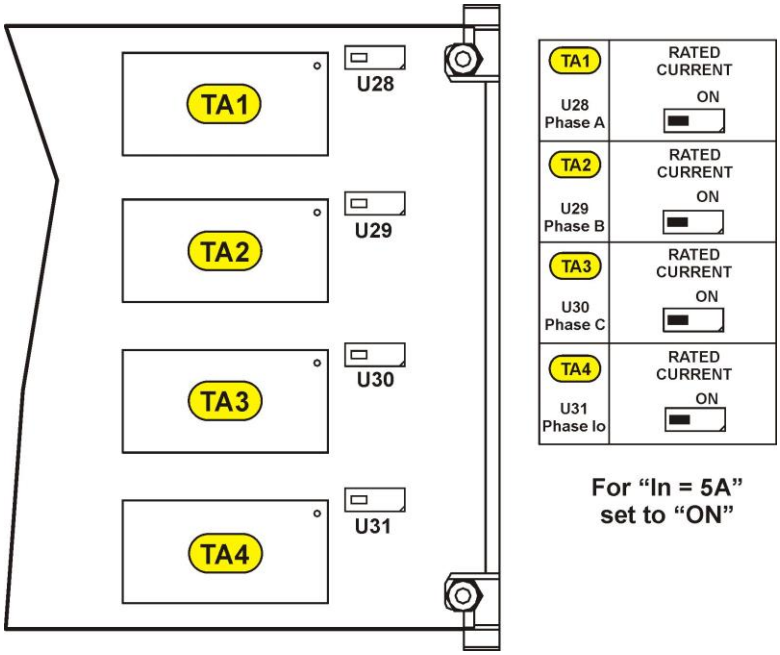
Setting of system parameters.

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.

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

(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).

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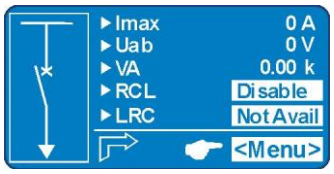
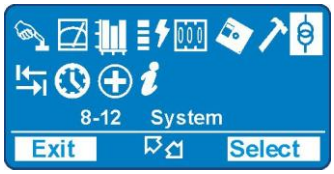
1



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

2

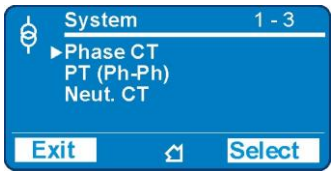


- Select "***System***" *icon with pushbuttons* "***Increase***" or "***Decrease***".
- Press "***Select***" for access.

3

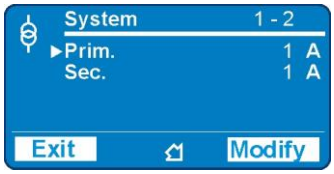
- Select "***CT&PTs***".
- Press "***Select***" *for access.*

4



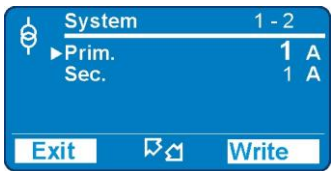
- Select "***Phase CT***".
- Press "***Select***" for access.

5



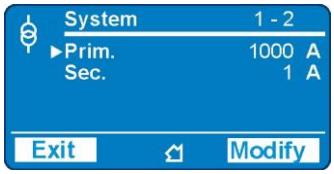
- Select "***Prim.***" to modify the primary value of Phase CT, or press "***Decrease***" and select "***Sec.***" to modify the secondary value of Phase CT.
- Press "***Modify***" to modify the parameter.
  (if Password is request, see § Password).

6



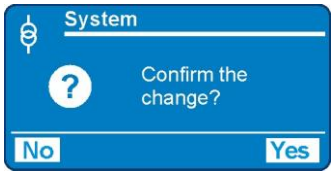
- The value appear as bold figure.
- Use pushbuttons "***Increase***" or "***Decrease***" to set the value.
- Press "***Write***" to confirm the value

7



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

8

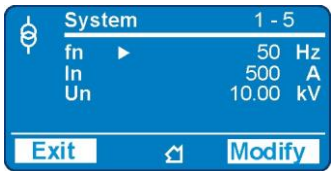


- The display show "***Confirm the change?***".
- Choose "***Yes*** " to convalidate the changes.
- Choose "***No*** " to **not** confirm the changes.
- After set confirmation (or non confirmation) the display goes back to point "4".

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.

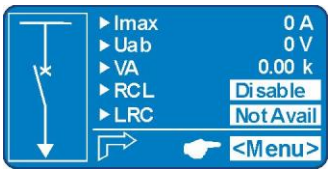
This symbol indicates that the function is enabled; symbol missing indicates that the function is disabled.

→ **Comunic.**	Serial communication parameters	
→ **Customize**	Visualization parameters	
→ **T>**	Thermal Image	
→ **1I>**	First	overcurrent Element
→ **2I>**	Second	overcurrent Element
→ **3I>**	Third	overcurrent Element
→ **1Io>**	First	Earth Fault Element
→ **2Io>**	Second	Earth Fault Element
→ **3Io>**	Third	Earth Fault Element
→ **1Is>**	First	Negative Sequence Current Element
→ **2Is>**	Second	Negative Sequence Current Element
→ **1U>**	First	Overvoltage Element
→ **2U>**	Second	Overvoltage Element
→ **1U<**	First	Undervoltage Element
→ **2U<**	Second	Undervoltage Element
→ **1f>**	First	Overfrequency Element
→ **2f>**	Second	Overfrequency Element
→ **1f<**	First	Underfrequency Element
→ **2f<**	Second	Underfrequency Element
→ **1Uo>**	First	Zero Sequence Voltage Element
→ **2Uo>**	Second	Zero Sequence Voltage Element
→ **U1<**	Positive Sequence Undervoltage Element F27U1	
→ **U2>**	Negative sequence Overvoltage Element F59U2 or F47	
→ **Wi**	Amount of Energy to reach the C/B maintenance level	
→ **TCS**	Setting variables for Trip Circuit Supervision	
→ **IRF**	Internal Relay Fault	
→ **RT**	Remote Trip	
→ **TripTimeRd**	Trip time Reduction	
→ **AutomRecl.**	Automatic Reclosure	
→ **CB Manage**	C/B command Local / Remote setting	
→ **Oscillo**	Setting variables for Oscillographic recording	
→ **BreakerFail**	Setting variables for Breaker Failure detection	
→ **ExtResCfg**	Configuration for external reset input	

14.1. Modifying the setting of variables

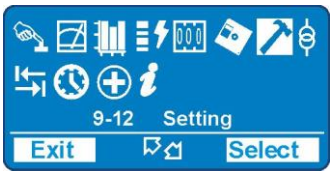
To modify any variable setting by the keyboard proceed as follows:
(example: change setting of element "***1I>***", from "**Is *4.000* In**" to "**Is *3.500* In**")

1



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

2



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

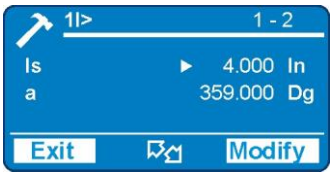
3

- 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

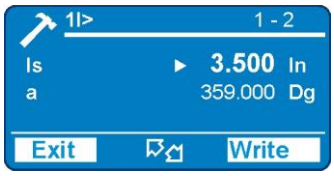


- The arrow aside "***Is***" shows the parameter selected for changing
- Press "***Modify***".
- If Password is request, see § Password

6

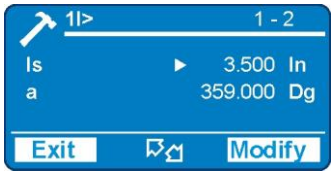
- The value appear as bold figure.

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

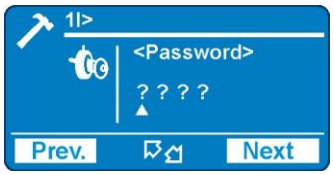
The password is requested any time the user wishes to modify any password protected parameter (example “1I>” menu “Setting”).

The factory default password is “ 1111 “.

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

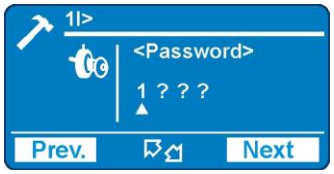
When password is requested, proceed as follows:

1



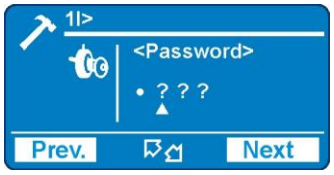
- Use the key “***Increase***” and “***Decrease***” and set the first digit of password.

2



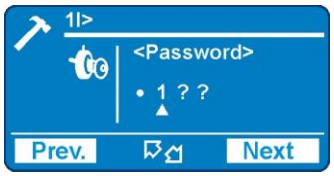
- Press “***Next***” to validate and go to the next digit.

3



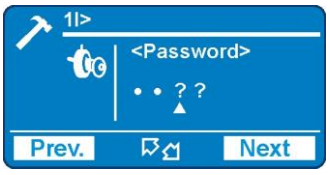
- Use the key “***Increase***” or “***Decrease***” to set second digit.

4



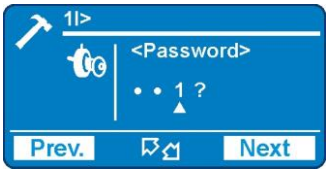
- Press “***Next***” to validate and go to the next digit.

5



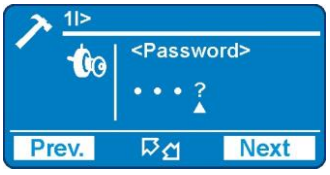
- Use the key “***Increase***” or “***Decrease***” to set the third digit.

6



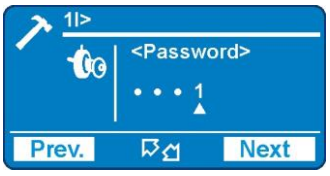
- Press “***Next***” to validate and go to the next digit.

7



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

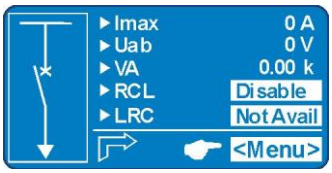
8



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

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

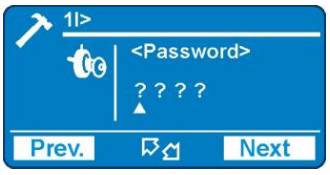
The password validity expires 60 sec after the last setting modification or as soon as you go back to the main menu



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**	19200	[9600 / 19200 / 38400]
	→ **PRRem**	Modbus	[Modbus / IEC103]
Node Address	→ **Indir.**	1	[1 ÷ 255]

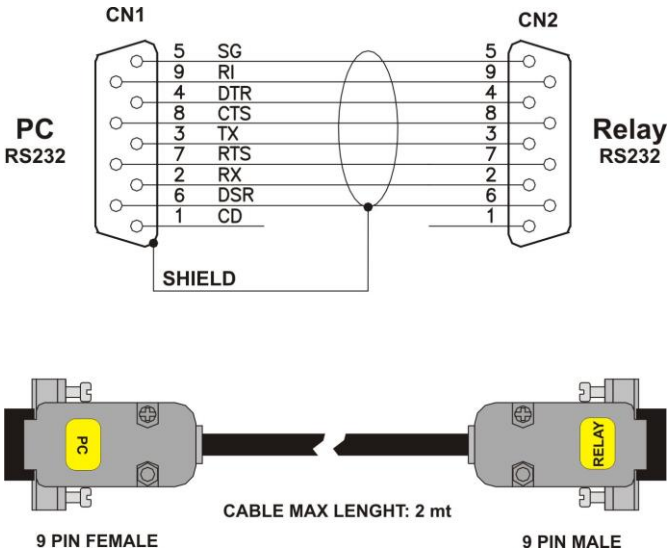
14.3.1 – Description of variables

- **BRLoc** : RS232 local (Front Panel) serial communication speed
- **BRRem** : RS485 remote (Rear terminal block) serial communication speed
- **PRRem** : Protocol for remote (Rear terminal block) serial communication RS485
- **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 – Main serial communication port (RS485)

From the Relay's back terminal board, a RS485 ports is available for communication with SCADA system with Protocol Modbus RTU or IEC60870-5-103 (selectable).
The communication interface allows to program all settings, operate all commands and download all information and records.
The physical connection can be via a normal pair of wires (RS485) or, on request, via fiber optic.

14.4 - Menu: **Customize**

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

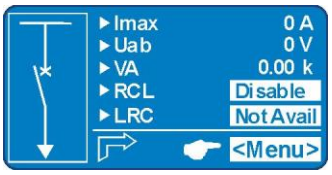
14.4.1 – Description of variables

❑ **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".

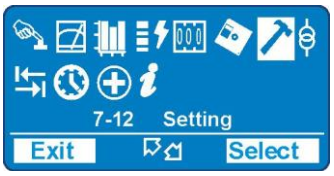
Example: set Local Language.

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***".

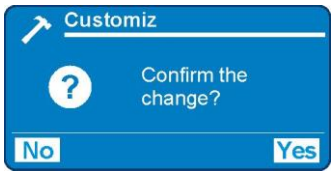
5

- 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

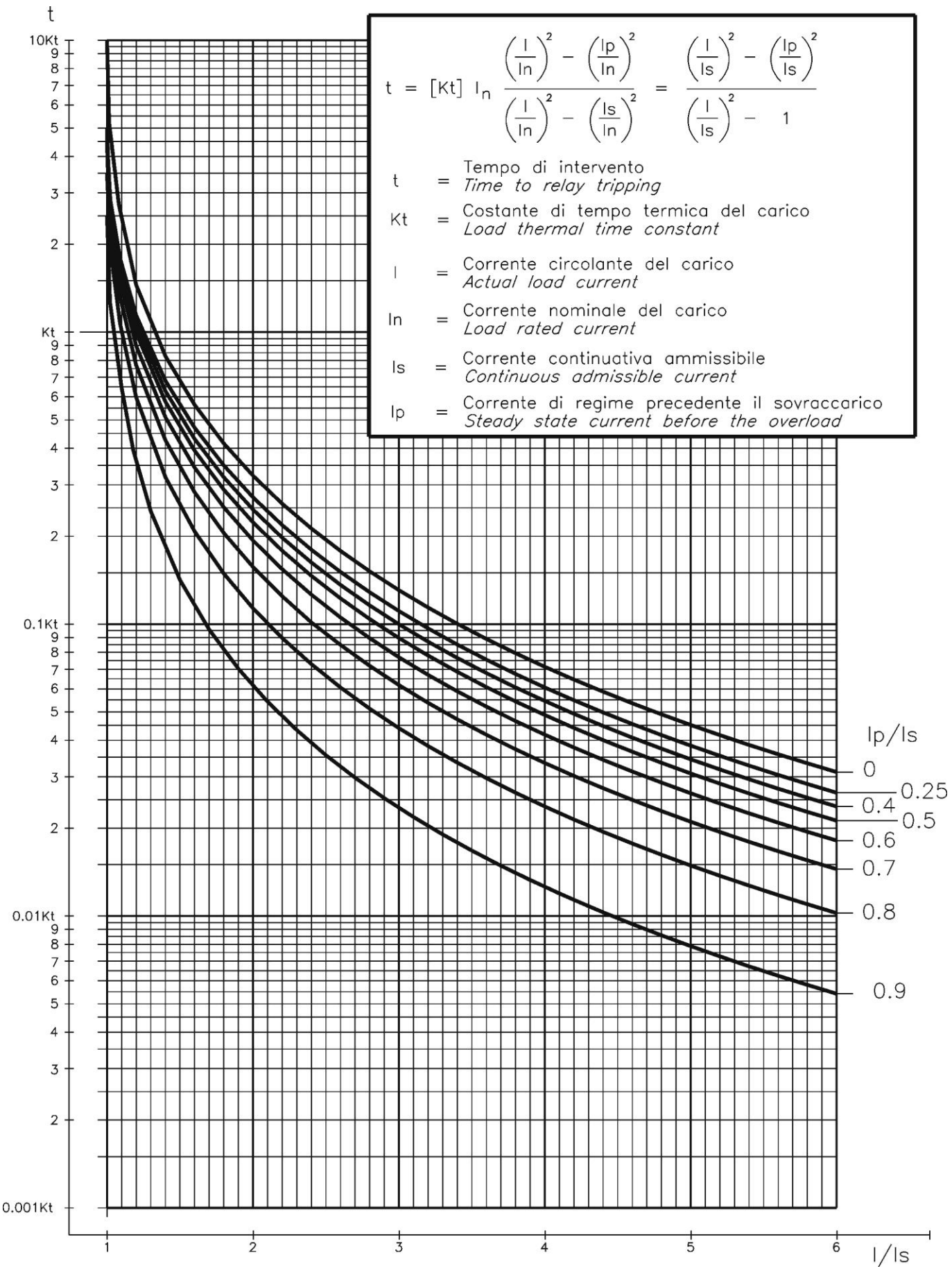
The trip time of the Thermal Image Element is a function of the current "I" flowing into the load and depends on its warming-up Time Constant "Kt", on the previous thermal status "Ip" and on the maximum admissible continuous current "Is" according to the equation:

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

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
ℓ **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): (see § 14.6.2)
  - (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 (see § 14.6.7)
  - Off = Permanent block
  - *2tBO* = Set 2xtBO.
- **f(a)** : Operation mode: (see § 14.6.5)
  - *Disable* = Non Directional
  - *Sup.* = Directional Supervision
  - *Dir.* = Total Directional
- **f(U)** : Voltage restraint (see § 14.6.6)
- **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. (see § 14.6.7)

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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:

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

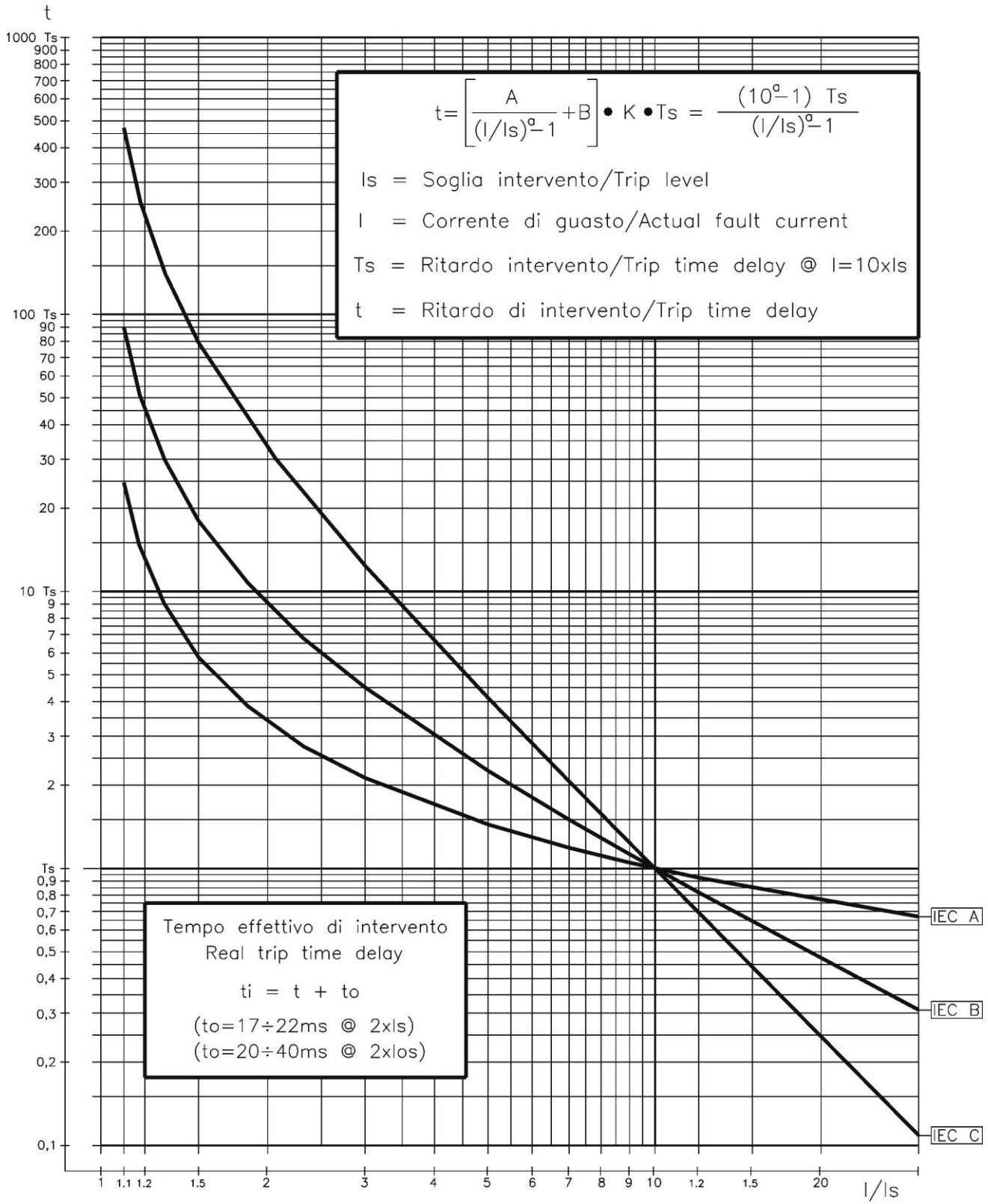
Where $Kt = (10^{a}-1)Ts$ is the time multiplier

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".

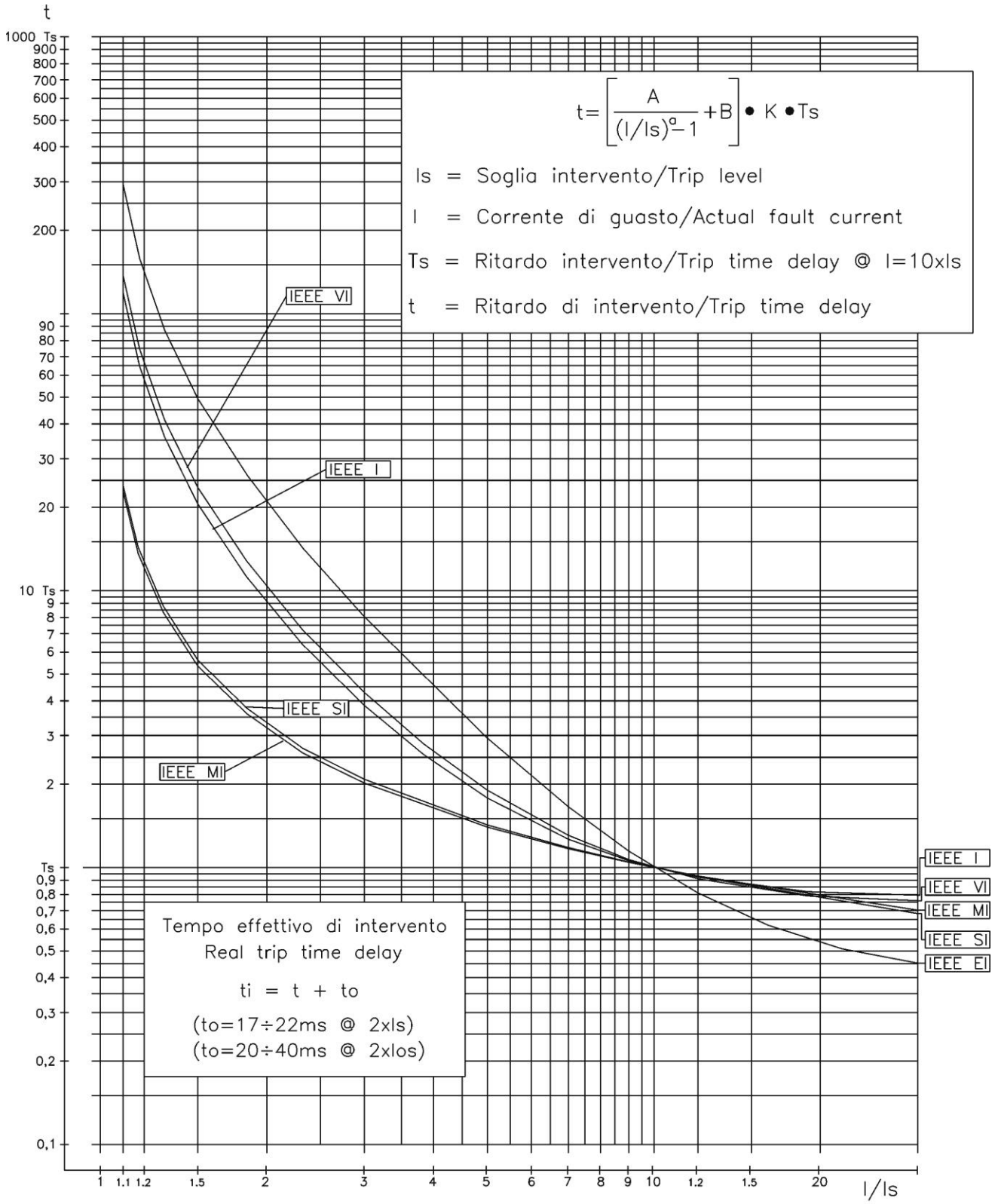
14.6.3 - IEC Curves



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

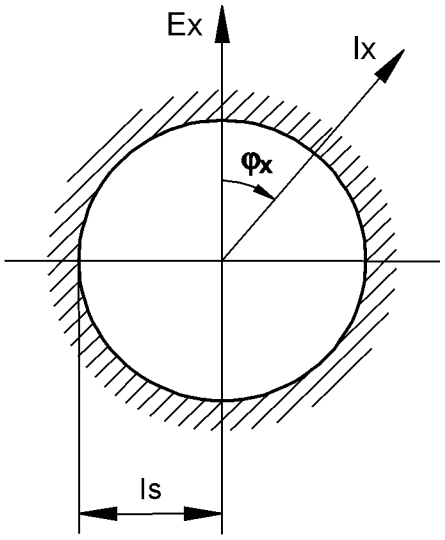
Max. "I" Phase = 40xIn
Max. "I" Neutral = 10xOn

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 "φ_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).
- φ_x = Phase displacement of current "Ix" from phase-to-neutral "Ex" (X = A, B, C).
- Idx = Component of "Ix" on the direction "a".

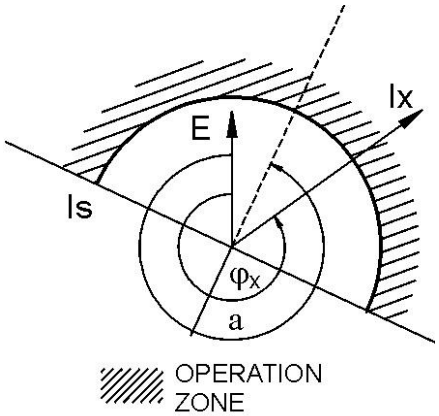
A) Set f(a) = Disab.



Ix>[Is]

The overcurrent element operates independently from the current direction.

B) Set f(a) = Sup.



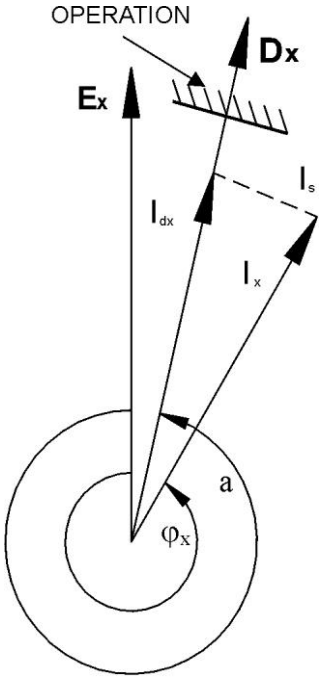
The Overcurrent element only supervises the direction of the current:

the operation conditions are:

- Input voltage above 1-2% of the rated input value.
- Input current above the set level: Ix > [Is]
- Phase displacement "φ_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).

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

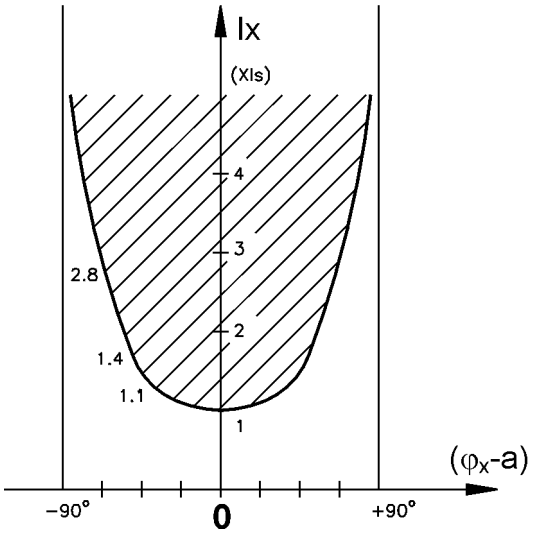
The overcurrent starts to operate when the component "Idx" of the input current in the direction "Dx" (versor displaced of "a°" from the phase-to-neutral voltage "Ex") exceeds the set level "Is".

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

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.

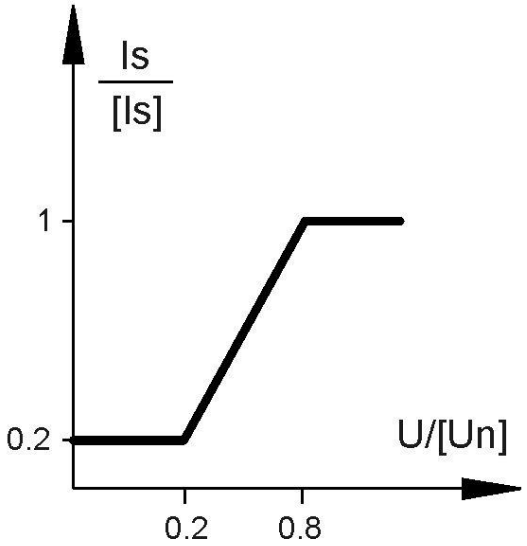


Recommended Reference angles for different applications:

- 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 (see § 14.6.2)
  Off = Permanent block
  2tBO = Set 2xtBO.
- **f(a)** : Operation mode: (see § 14.6.5)
  Disable = Non Directional
  Sup. = Directional Supervision
  Dir. = Total Directional
- **2xI** : Automatic doubling of trip level on inrush (see § 14.6.8)
- **f(U)** : Voltage restraint (see § 14.6.6)
- **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. (see § 14.6.7)
- **t2xI** : Maximum time of automatic threshold doubling on inrush (see § 14.6.8)
- **td2xI** : Time for calculation of current rate of rise.

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

Status	→	**Enab.**	No		[No / Yes]			
Options	→	**tBI**	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)
- **tBI** : Blocking input reset time (see § 14.6.5)
  Off = Permanent block
  2tBO = Set 2xtBO.
- **f(a)** : Operation mode: (see § 14.6.5)
  Disable = Non Directional
  Sup. = Directional Supervision
  Dir. = Total Directional
- **2xI** : Automatic doubling of trip level on inrush (see § 14.6.8)
- **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. (see § 14.6.7)
- **t2xI** : Maximum time of automatic threshold doubling on inrush (see § 14.6.8)
- **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): (see § 14.6.2)
  - (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 (see § 14.6.7)
  - *Off* = Permanent block
  - *2tBO* = Set 2xtBO.
- **f(a_o)** : Operation mode: (see § 14.9.2)
  - *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. (see § 14.6.7)

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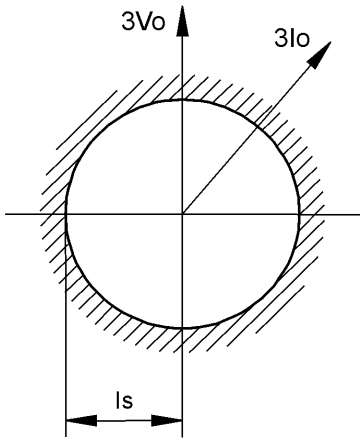
14.9.2 – Operation mode of the Earth Fault elements programming the variable "f(a_o)"

The relay measures the current "3Io" and the input voltage "3Vo" of the Earth Fault input and the displacement "φ_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.
- **φ_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 "φ_o".

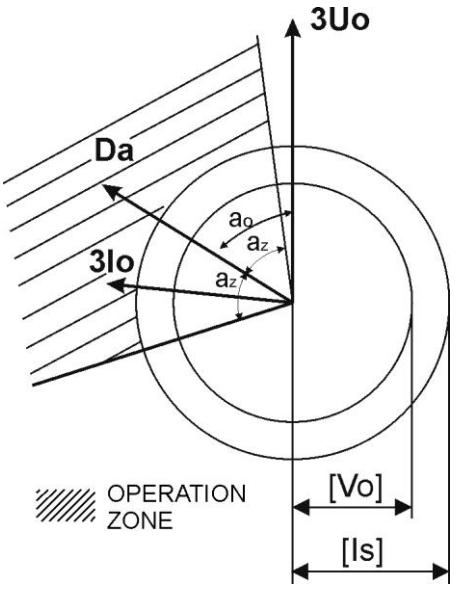
- Operation starts when : 3Io $\geq$ [Is]

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 "φ_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 (see § 14.6.7)
  Off = Permanent block
  2tBO = Set 2xtBO.
- ❑ **f(a_o)** : Operation mode: (see § 14.9.2)
  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. (see § 14.6.7)

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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 (see § 14.6.7)
  Off = Permanent block
  2tBO = Set 2xtBO.
- **f(a_o)** : Operation mode: (see § 14.9.2)
  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. (see § 14.6.7)

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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): (see § 14.12.2)
  - (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 (see § 14.6.7)
  - 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. (see § 14.6.7)

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. (see § 14.6.2)
- f(t) = I, VI, EI, MI, SI, A, B, C Dependent Inverse time operation (see § 14.6.2)

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. (see § 14.6.7)

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

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*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

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*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

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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

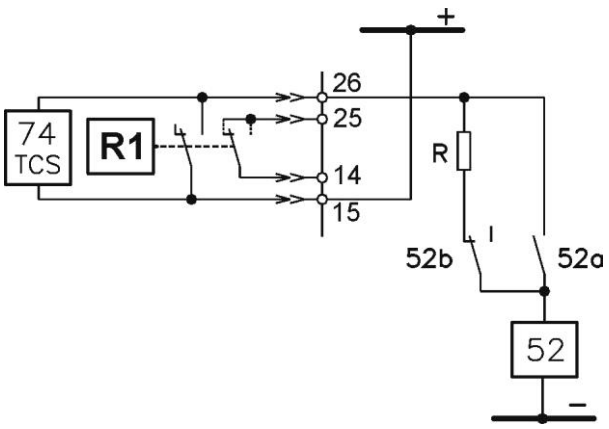
14.27.2 - Operation

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

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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 1 = AR Enable on shot 1 2 = AR Enable on shot 2 1+2 = AR Enable on shot 1+2 3 = AR Enable on shot 3 1+3 = AR Enable on shot 1+3 2+3 = AR Enable on shot 2+3 1+2+3 = AR Enable on shot 1+2+3 4 = AR Enable on shot 4 1+4 = AR Enable on shot 1+4 2+4 = AR Enable on shot 2+4 1+2+4 = AR Enable on shot 1+2+4 3+4 = AR Enable on shot 3+4 1+3+4 = AR Enable on shot 1+3+4 2+3+4 = AR Enable on shot 2+3+4 1+2+3+4 = AR Enable on shot 1+2+3+4 (*) 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

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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>).

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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.

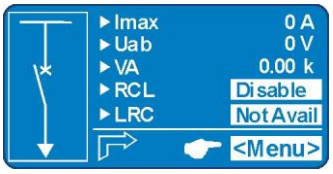
If during Tdx the C/B is again opened by any relay's protection element the relay goes in to L.O. status.

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.

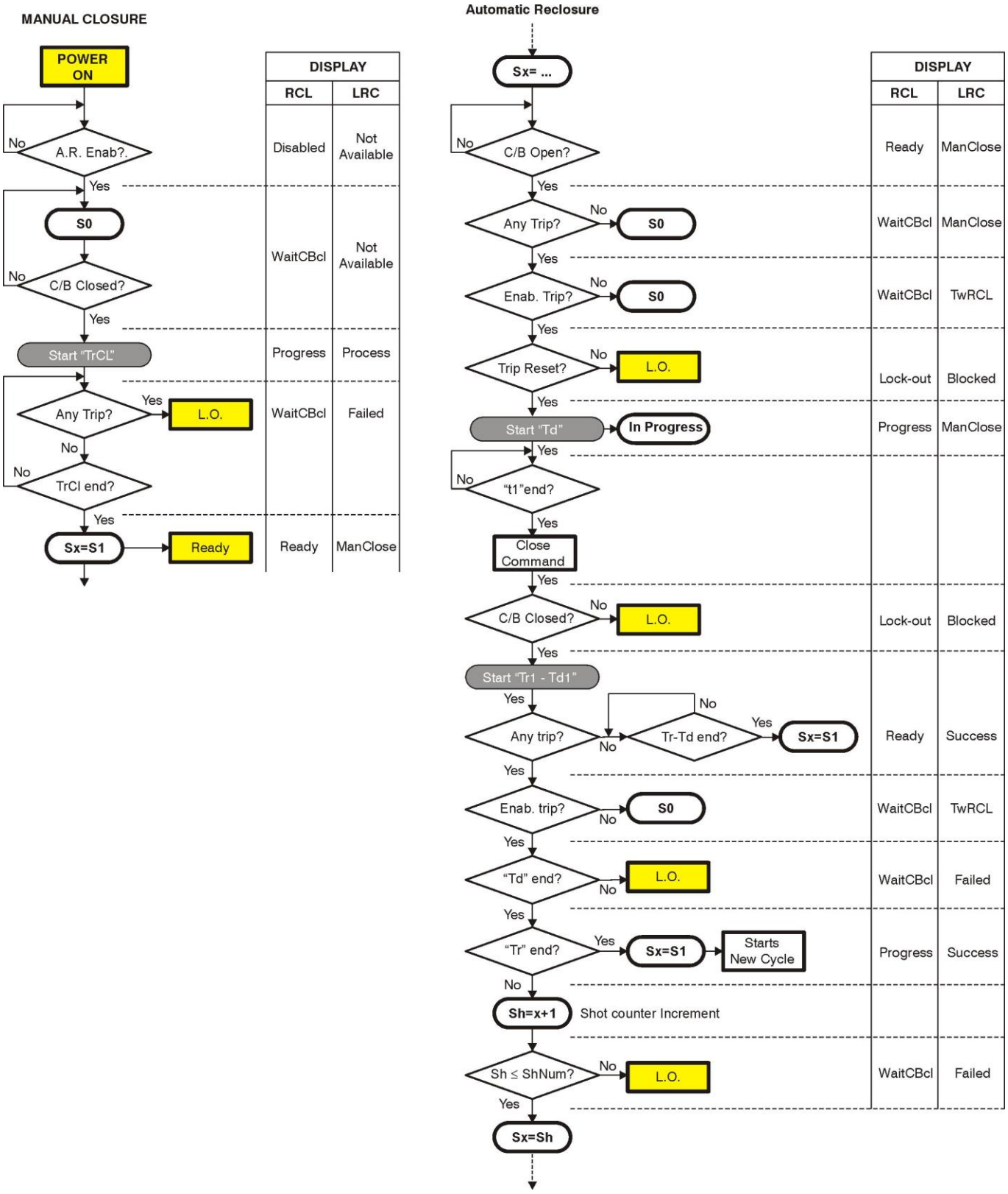
14.31.6 - Display Message



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

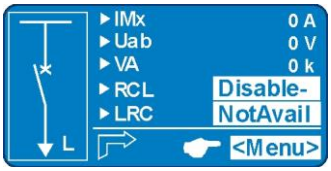
- **L/R** : Selection of Local/Remote C/B operation mode Ignored or Active
- **Key** : Disable = The pushbuttons on Front Panel are disabled; the operation of the C/B can be controlled by;
  1 - serial bus commands
  2 - commands available in the menu "***Local Cmd***" (Password protected).
  3 - Digital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

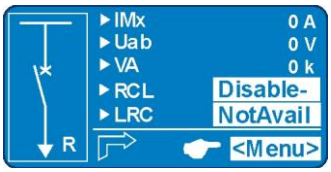
1



- L

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

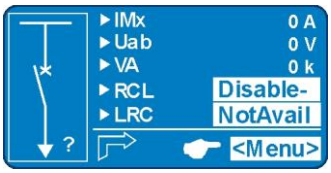
2



- R

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

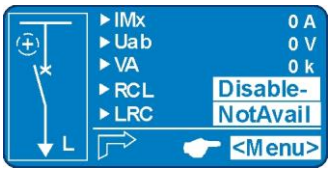
3



- ?

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).

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

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

16.34.1 - 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":

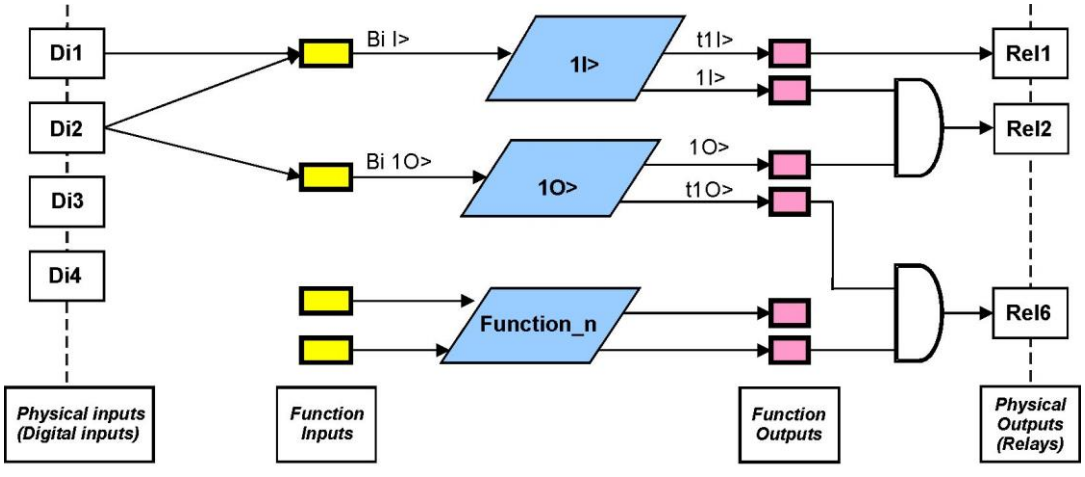
- Analogue Inputs : The measured input quantities
- Functional Inputs : The blocking input
- Physical Inputs : The Digital Inputs
- Functional Outputs : The functional elements
- Physical Outputs : The Output Relays

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.

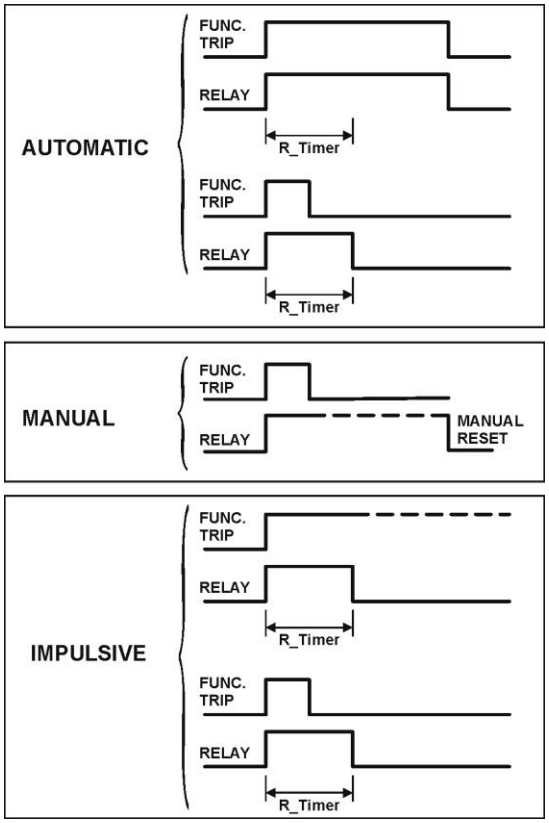
Operation Time: R_Timer:

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.

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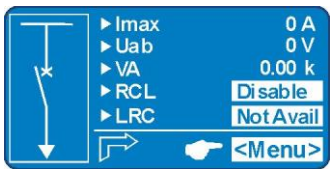
Any of the Digital Inputs can be programmed to control one or more of the following functions.

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)

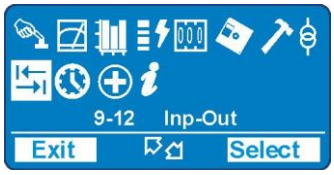
15.2.1 – Example

1



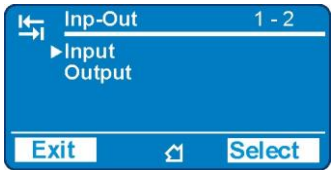
- Press "***Menu***" for access to the main menu with icons.

2



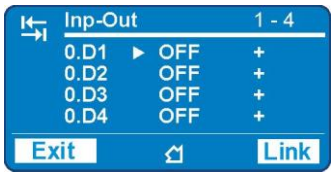
- Select icon "***Inp-Out***" by pushbuttons "***Increase***" or "***Decrease***".
- Press "***Select***".

3



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

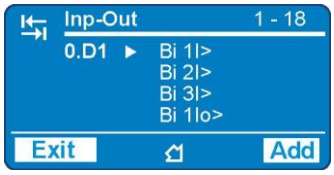
4



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

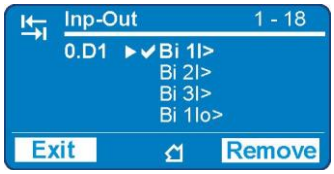
"***0.D1***" corresponding to physical digital input "***0.***D1".
"***0.D1***" corresponding to physical digital input "***0.***D2".
"***0.D1***" corresponding to physical digital input "***0.***D3".
"***0.D1***" corresponding to physical digital input "***0.***D4".
"***1.D--***" corresponding to physical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

5



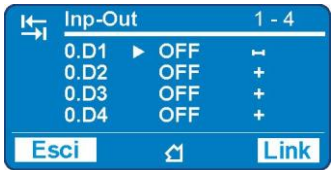
- Press "***Add***" to select and associate the function.
  (Digital Input 1 terminals 38-28).

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	By the interface program "MSCom II" it is possible to Activate/Deactivate the modules.
	→ **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	
	→ **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			

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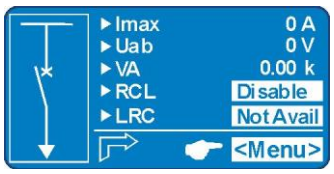
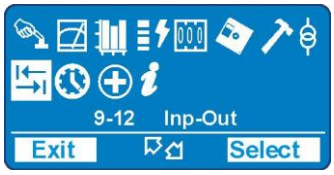
15.3.1 – Example

1



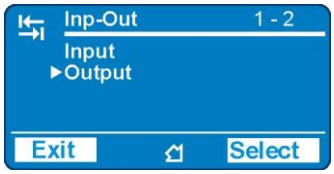
- Press "***Menu***" for access to the main menu with icons.

2



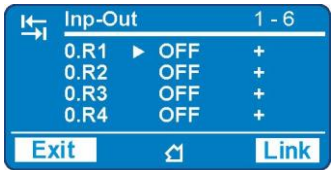
- Select icon "***Inp-Out***" by pushbuttons "***Increase***" or "***Decrease***".
- Press "***Select***".

3



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

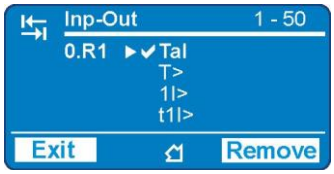
4



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

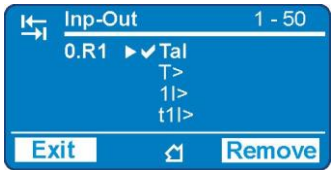
"***0.R1***" - "***0.Rx***" corresponding to physical output relay "**1**" - "**x**"
(**x** =available in the additional expansion modules)

5



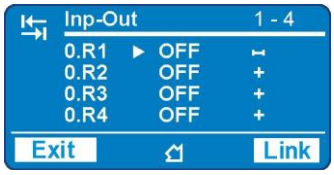
- Press "***Add***" to select and associate the function.

6



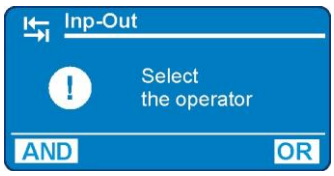
- When one or more function is associated this symbol shows
- To remove selection one function:
  Select function by pushbuttons "***Increase***" or "***Decrease***" and press "***Remove***"
- Press "***Exit***".

7



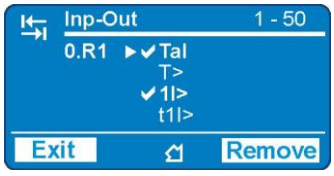
- Press "***Exit***"

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

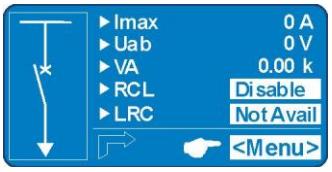
- The display show "***Confirm the change?***".
- Choose "***Yes*** " to convalidate the changes.
- Choose "***No*** " to **not** confirm the changes.

16. DATE and TIME

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

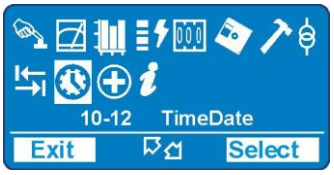
Date:	20YY	/	MM	/	DD	(2000/01/01 ÷ 2099/12/31) YY = Year / MM = Month / DD = Day
Time:	HH	:	MM	:	00	HH = hour / MM = Minutes / 00
DofW:	Day					Es: Wednesday

1



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

2



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

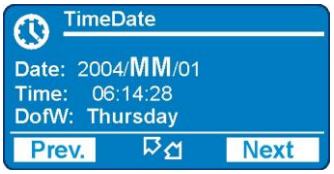
3

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

4

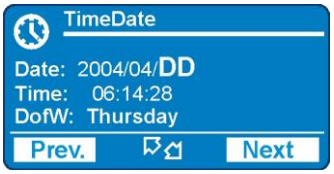
- The last two figures of the Year will appear in bold character; by pushbuttons "***Increase***" or "***Decrease***" set the new figures.
- Press "***Next***" to go to the next setting.

5



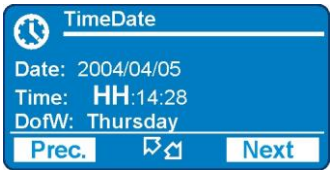
- As above for changing the "Month"
- Press "***Next***" to go to the next setting.

6



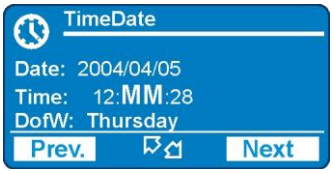
- As above for changing the "Day"
- Press "***Next***" to go to the next setting.

7



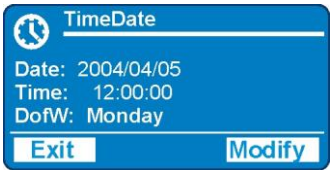
- As above for changing the “Hours”
- Press “***Next***” to go to the next setting.

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 standard “Time Synchronization” procedure of the “IEC870-5-103” protocol.
- Using the “MSCom 2” software or from the DCS with the Modbus RTU protocol.

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		→	###/###/###/####	Relay Serial Number
User Tag		→	FMR	Relay identification label.
Build		→	############	Build identification label.
Line		→	############	Line identification label.

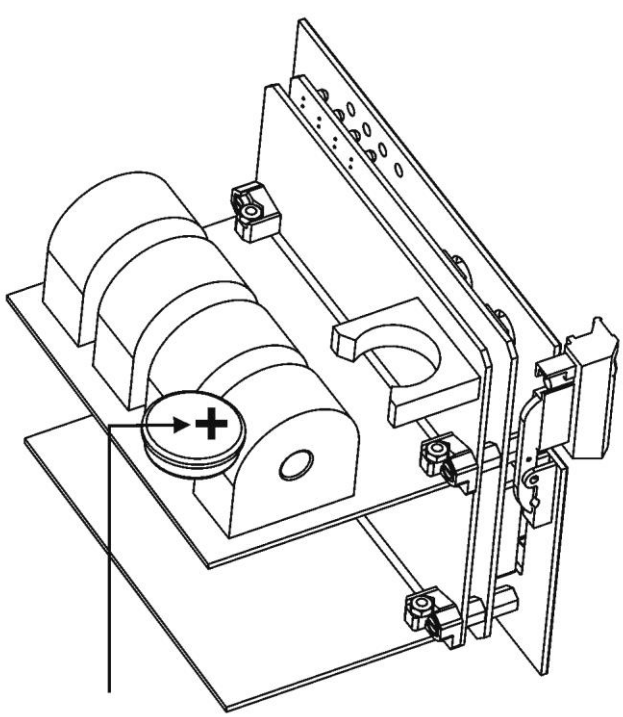
This information can only be modified by the interface program "MSCom II" and allows the user to give to the relay any suitable denomination.

19. BATTERY

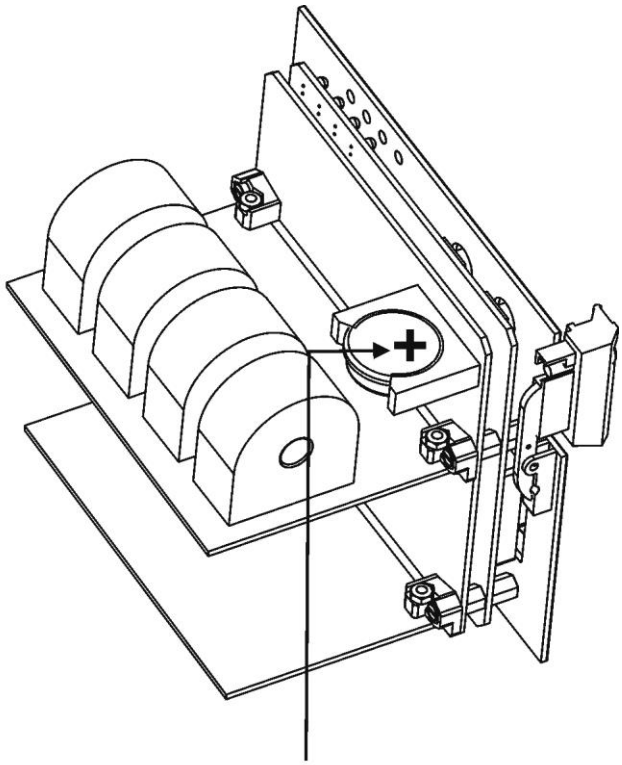
The relay is equipped with a lithium battery type “CR2477N 3V”, to support the internal clock and the oscillographic recording memory in case of programmed lack of power.
The expected minimum duration without power exceed 2 years.

Attention!! Use only battery specified.

Instruction for replacement the battery:



BATTERY



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.

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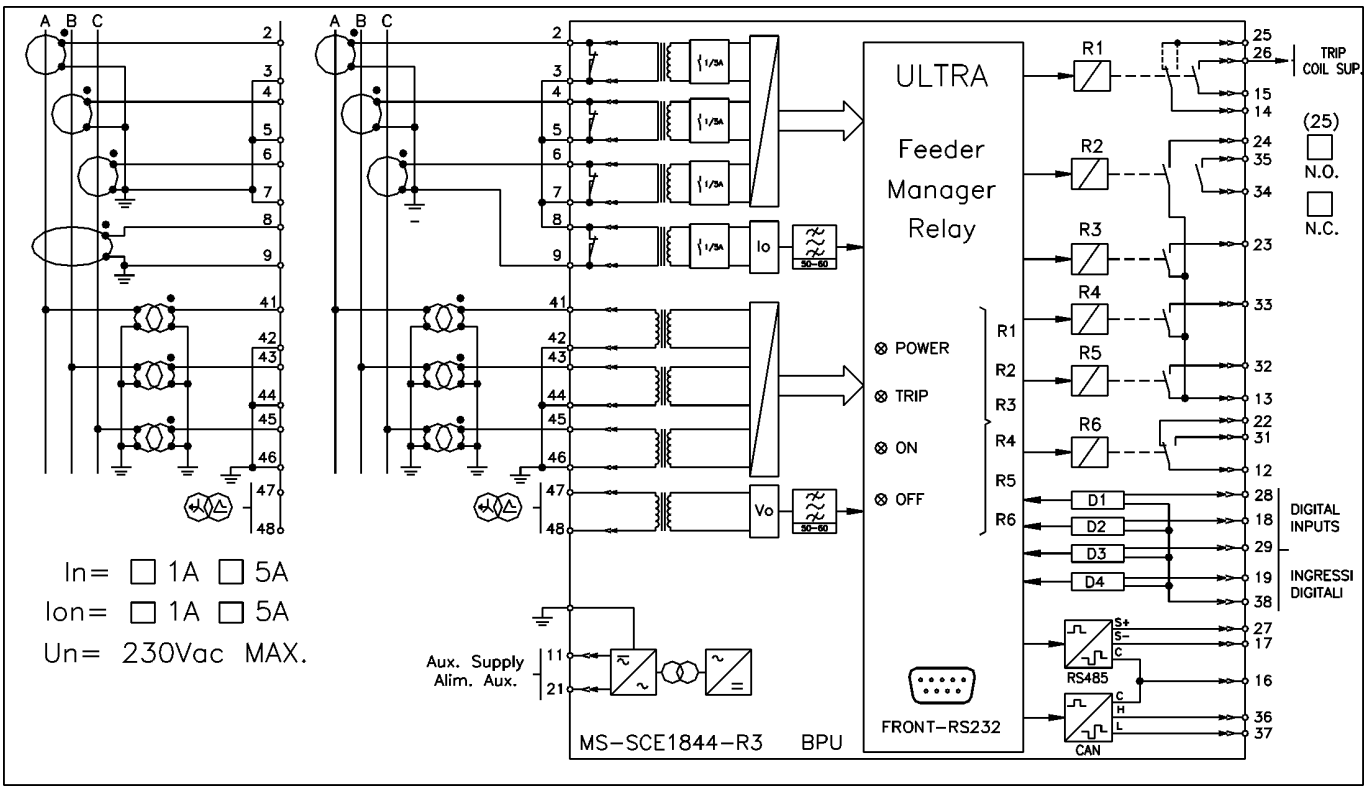
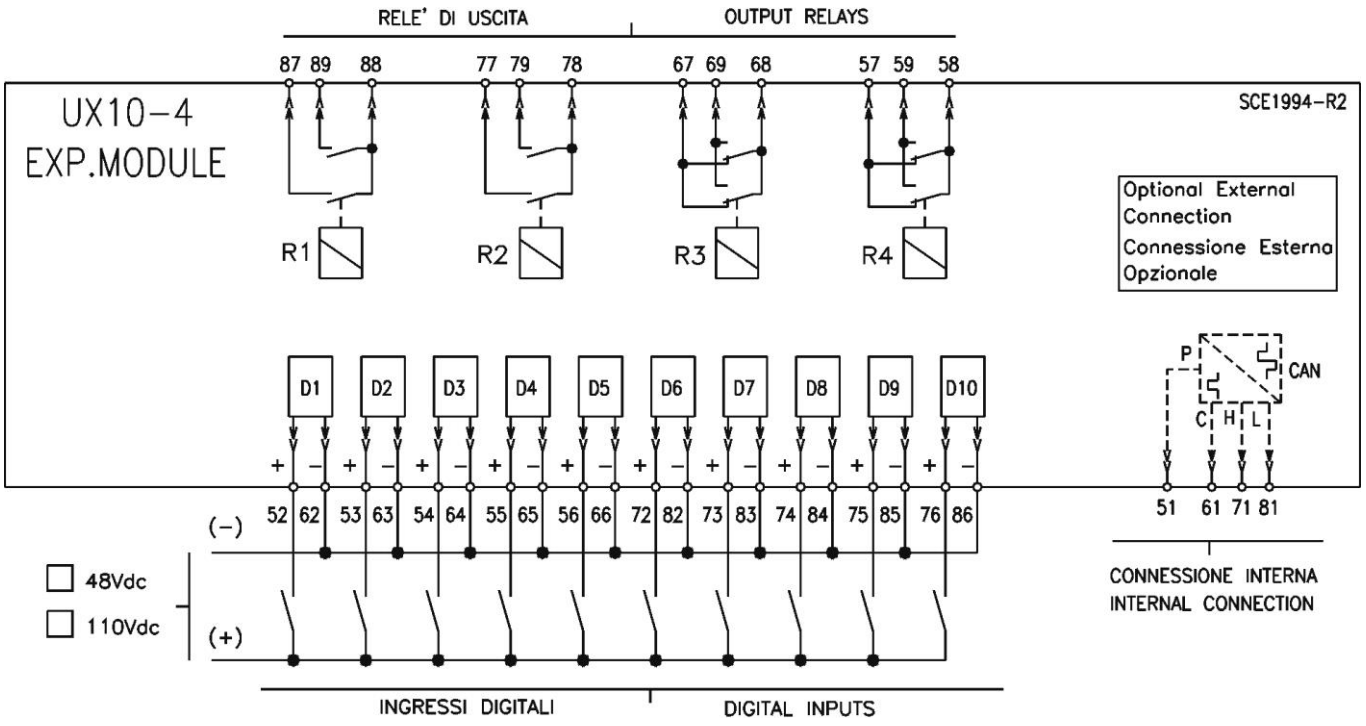
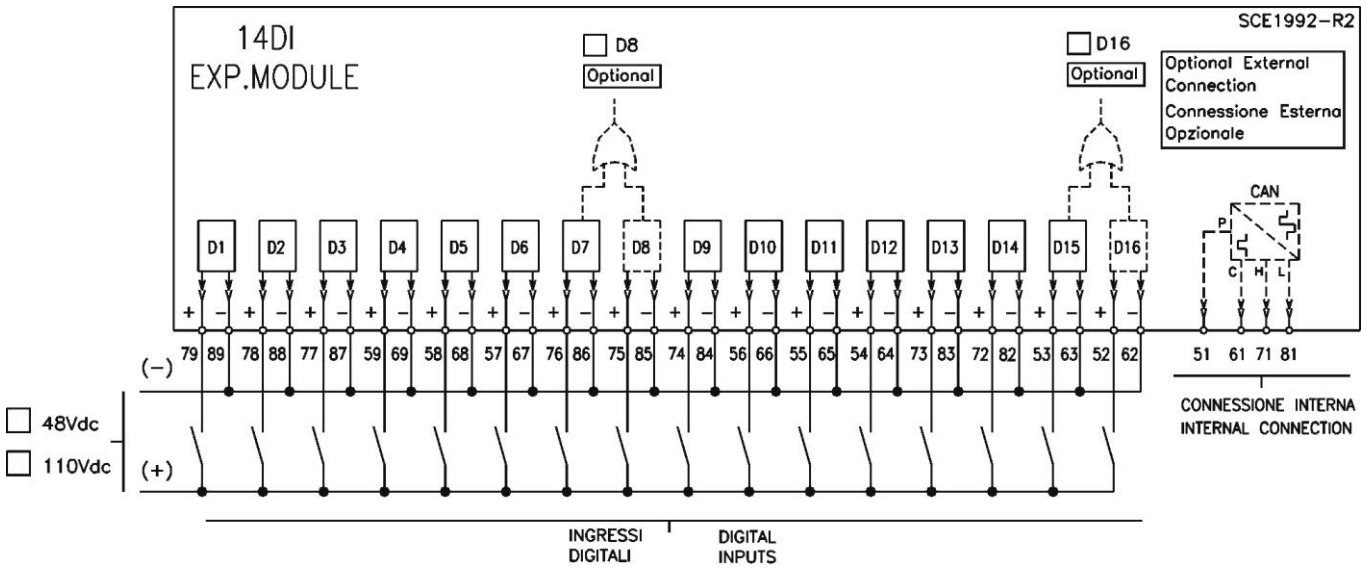
22. BASIC RELAY - WIRING DIAGRAM



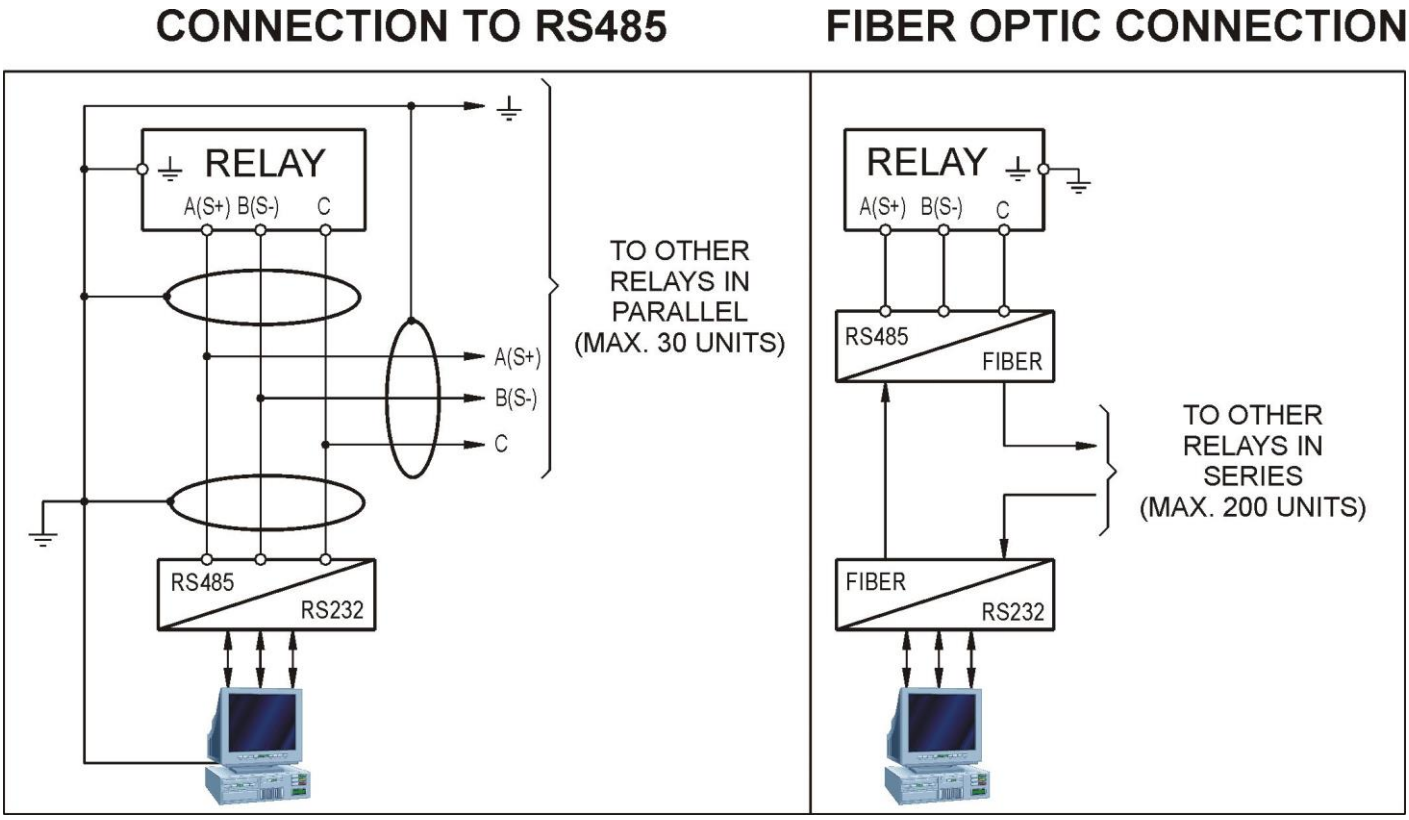
*22.1 – **UX10-4** - Expansion Module - WIRING DIAGRAM (10 Digital Inputs + 4 Output Relays)*



*22.2 – **UX14DI** - Expansion Module - WIRING DIAGRAM (14 Digital Inputs)*

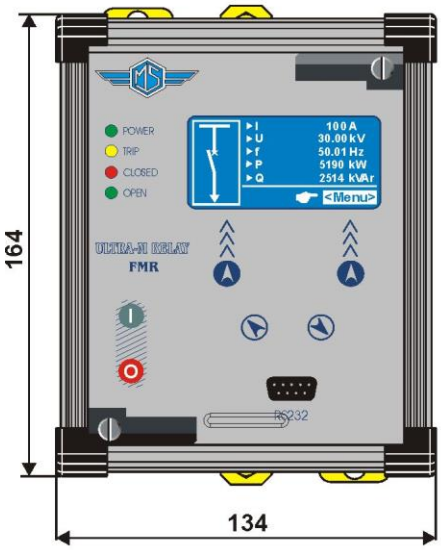


23. WIRING THE SERIAL COMMUNICATION BUS

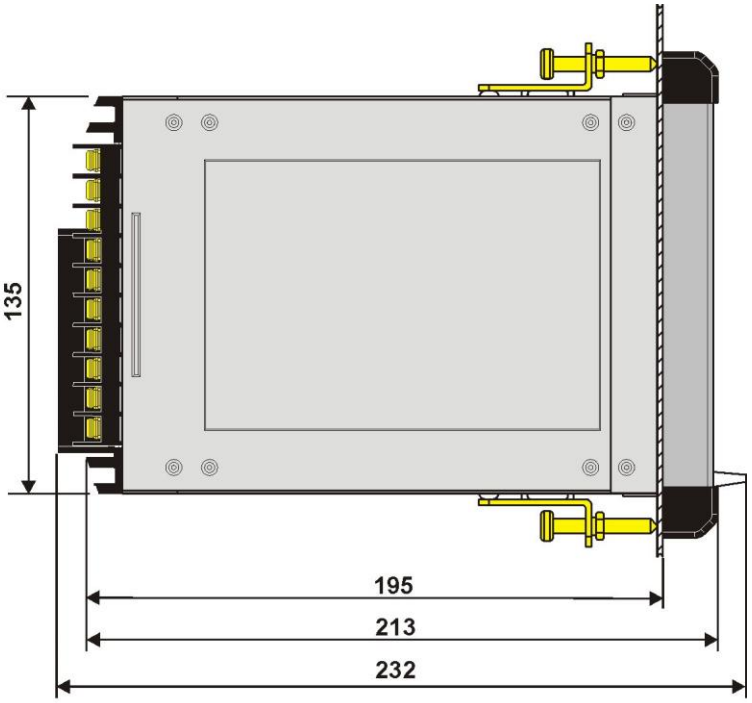


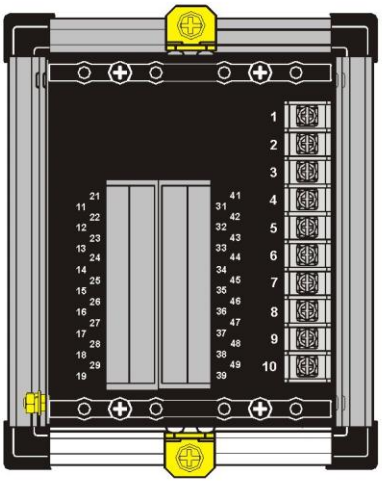
Each relay is identified by its programmable address code (NodeAd) and can be called from the P.C.
A dedicated communication software (MSCom2) for Windows 9x/2000/XP (or later) is available.
Please refer to the MSCom2 instruction manual for more information.
Maximum length of the serial bus can be up to 200m. For longer distance and for connection of up , to 250 Relays, optical interconnection is recommend (please ask Microelettrica for accessories).

24. Basic Relay - OVERALL DIMENSIONS



PANEL CUT-OUT
115x137 (LxH)



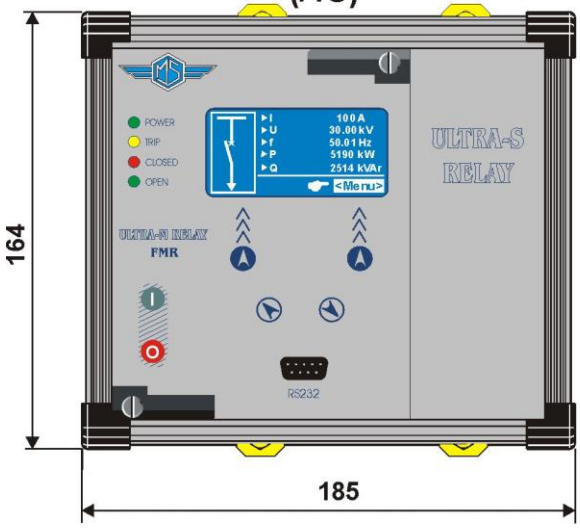


VIEW OR REAR - TERMINAL CONNECTION

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

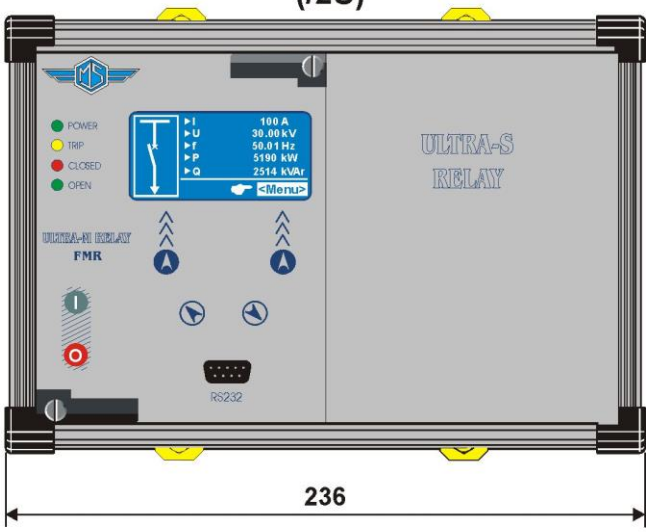
24.1 – /1S (1 Expansion Module) & /2S (2 Expansion Module) - Overall Dimensions

(/1S)

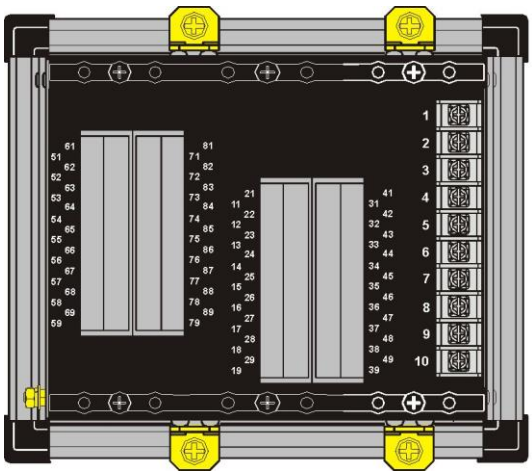


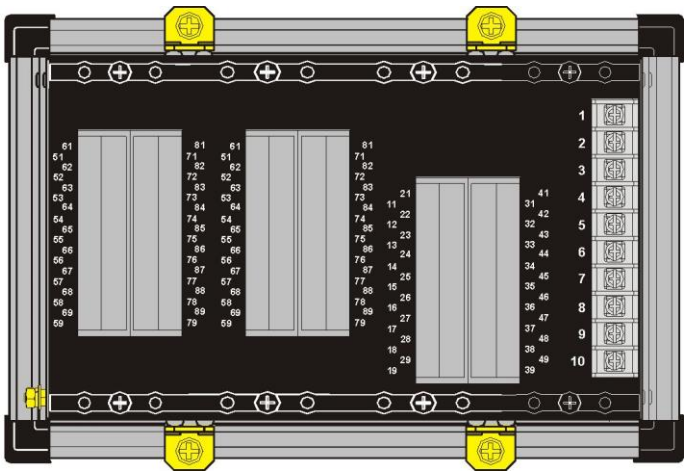
PANEL
CUT-OUT
165x137 (LxH)

(/2S)

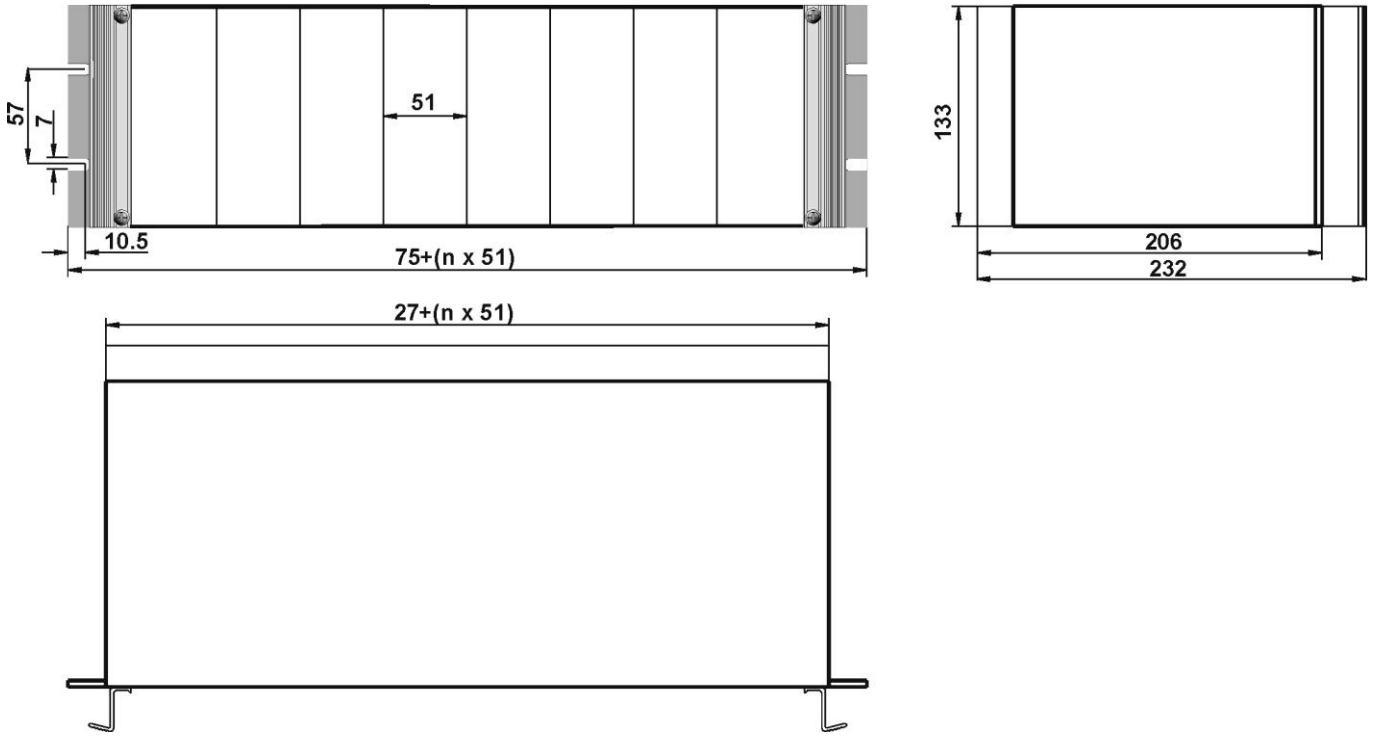


PANEL
CUT-OUT
217x137 (LxH)





24.2 – Rack 3U – OVERALL DIMENSIONS



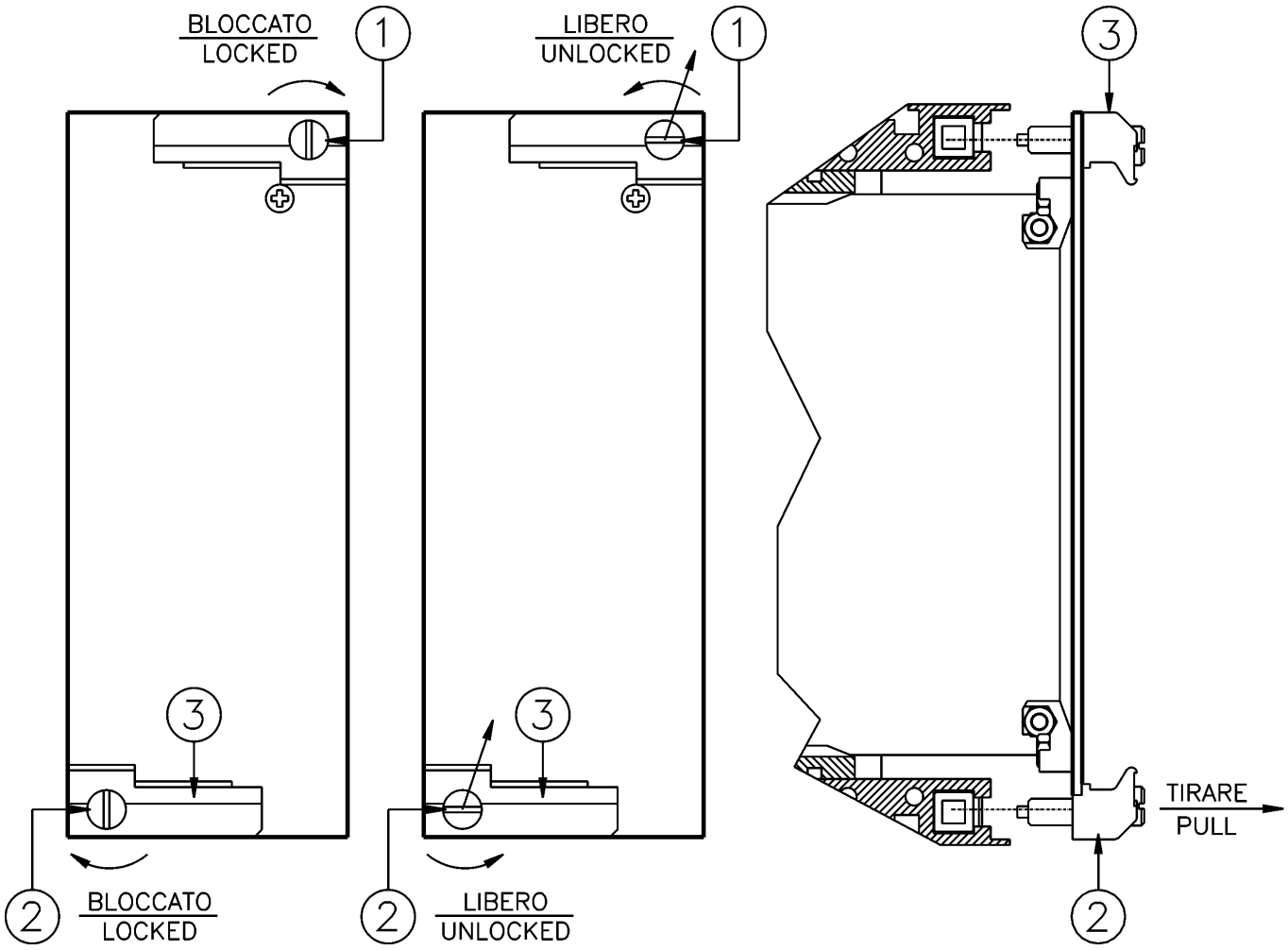
25. DIRECTION FOR PCB'S DRAW-OUT AND PLUG-IN

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	level 3	80-2000MHz	10V/m
		ENV50204		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			

CARATTERISTICHE

❑ Accuracy at reference value of influencing factors	1% In – 0.1%On 2% + to (to=20÷30ms @ 2xIs)	for measure 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 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 A.C. resistive switching = 1100W (380V max) make = 30 A (peak) 0,5 sec. break = 0.3 A, 110 Vcc, L/R = 40 ms (100.000 op.)	

COMMUNICATION PARAMETER

❑ Rear serial port	RS485 – 9600 to 38400 bps – 8,n,1 – Modbus RTU – IEC60870-5-103
❑ Front serial port	RS232 – 9600 to 57600 bps – 8,n,1 – Modbus RTU

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27. SOFTWARE & FIRMWARE VERSION

- **Firmware for version**

  IAU (Intelligent Acquisition Unit) 0.14.01.X
  IPU (Processor Unit) 0240.20.01.X

- **Application Software**

  MSCom 2

Microelettrica Scientifica S.p.A. - 20089 Rozzano (MI) - Italy - Via Alberelle, 56/68
Tel. (+39) 02 575731-Fax (+39) 02 57510940
http://www.microelettrica.com **e-mail :** sales.relays@microelettrica.com

The performances and the characteristics reported in this manual are not binding and can modified at any moment without notice