OVERCURRENT AND DIRECTIONAL EARTH FAULT PROTECTION

ACCORDING TO CEI 0-16

TYPE

MC20-CEI

OPERATION MANUAL

CE

1. General Utilization and Commissioning Directions

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

1.1 - Storage and Transportation

must comply with the environmental conditions stated on the product's instruction 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 reduced 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.

a. Before removing a module, ensure that you are at the same electrostatic potential as the equipment by touching the case.
b. Handle the module by its front-plate, frame, or edges of the printed circuit board. Avoid touching the electronic components, printed circuit tracks or connectors.
c. Do not pass the module to any person without first ensuring that you are both at the same electrostatic potential. Shaking hands achieves equipotential.
d. Place the module on an antistatic surface, or on a conducting surface which is at the same potential as yourself.
e. Store or transport the module in a conductive bag.

More information on safe working procedures for all electronic equipment can be found in BS5783 and IEC 147-OF.

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 - Waste Disposal of Electrical & Electronic Equipment

(Applicable throughout the European Union and other European countries with separate collection program).
This product should not be treated as household waste when you wish dispose of it. Instead, it should be handed over to an applicable collection point for the recycling of electrical and electronic equipment.
By ensuring this product is disposed of correctly, you will help prevent potential negative consequence to the environment and human health, which could otherwise be caused by inappropriate disposal of this product. The recycling of materials will help to conserve natural resource.

1.12 - 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 Characteristics

The MC is a very innovative and versatile line of Protective Relays which takes advantage of the long and successful experience coming from the M-Line.

The main features of the MC-Line relays are:

Compact draw-out execution for Flush Mounting or for assembly in 19" 3U chassis for 19" Rack systems.

User friendly front face with 2x8 characters LCD Display, four signal Leds, four keys for complete local management and 9-pin socket for local RS232 serial communication.

Four user programmable Output Relays. On request one of the Output Relays can be replaced by a Can Bus port for control of additional I/O modules.

Three optoisolated, self-powered Digital Inputs.

RS485 communication port (independent from the RS232 port on front panel)

Totally draw-out execution with automatic C.T. shorting device.

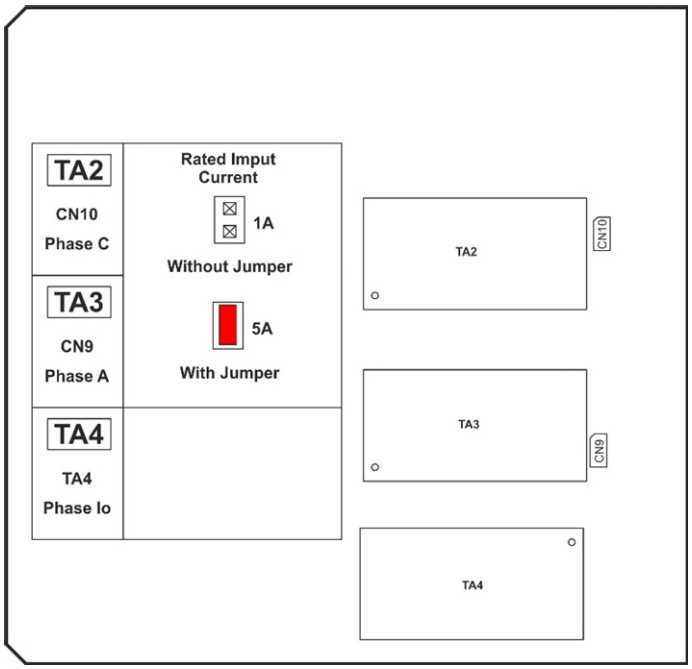
Input currents are supplied to 3 current transformers: - two measuring phase current - one measuring the earth fault zero-sequence current.
Current inputs can be 1 or 5A, selection between 1A or 5A is made by movable jumpers provided on the Relay card. (See Fig 1)

The Measuring Ranges of the different inputs respectively are:

Phase Currents	:	(0.1-40) In
Neutral Current	:	(0.01-4) On

Make electric connection in conformity with the diagram reported on relay's enclosure.

Check that input currents are same as reported on the diagram and on the test certificate.



2.1 - Power Supply

The auxiliary power is supplied by a built-in module fully isolated an self-protected.

Two options are available:

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 - Operation and Algorithms

3.1 - Reference Input Values

Display			Description	Setting Range			Step	Unit
In	300	A	Reference primary current of the relay	1	-	9999	1	A
I1	300	A	Rated Primary current of phase C.T.	1	-	9999	1	A
I2	5	A	Rated Secondary current of phase C.T.	1	-	5	1/5	A
Io1	100	A	Rated Primary current of the tore C.T. detecting earth fault current.	1	-	9999	1	A
Io2	1	A	Rated secondary current of the tore C.T. detecting earth fault current.	1	-	1	-	A
Vo1	10	kV	Rated primary voltage of VT phase to neutral	0.05	-	500	0.01	kV
Vo2	100	V	Rated secondary voltage of VT phase to neutral	50	-	115	0.01	V
Freq	50	Hz	System rated frequency	50	-	60	10	Hz

3.2 – Input quantities

3.2.1 - Mains Frequency (Freq)

The relay can operate either in 50Hz or 60Hz systems.
The rated Mains Frequency "Freq" must be set accordingly.

3.2.2 – Phase Current inputs (I1)

The relay directly displays the r.m.s. value of the Phase Currents "**IA**", "**IB**", "**IC**" flowing in the Primary of the input Current Transformers and refers all its measurements to that value.
To make the relay properly working with any C.T., when programming the relay settings, input the value "I1" of the primary current of the phase C.Ts
Only phase A and C currents are measured, whereas the current of the phase B is computed as vector summation of the currents of the other two phases.
The algorithm is based on the following considerations coming from well-known vector relations among the three-phase currents and the zero-sequence current.

- In any circumstance – currents balanced or not, sinusoidal, or not – it is always true that:

$$(1) \quad \overline{I_A} + \overline{I_B} + \overline{I_C} + \overline{I_0} = 0$$

- When no Earth Fault exists ($I_0 = 0$)

$$(2) \quad \overline{I_A} + \overline{I_B} + \overline{I_C} = 0 \quad \Rightarrow \quad \overline{I_B} = \left(\overline{I_A} + \overline{I_C}\right)$$

The earth fault protection element is independently supplied by the residual current coming either from the residual connection of 3 system C.Ts. or from the core balance C.T.

If any Earth Fault is experienced ($I_0 \neq 0$) the Earth Fault Protection Element trips independently from the phase current measuring elements.

If no Earth Fault is present ($I_0 = 0$), the equation (2) is valid, no matter if currents are balanced or not, sinusoidal, or not.

The third phase current is calculated, in real time, as vector summation of the other two-phase currents.

During Faults:

A)	*Single phase to earth Fault*	Trip of the earth fault element directly measuring the Residual Current.
B)	*Two Phase Fault*	In any case one of the currents directly measured is involved, so the relay trips correctly.
C)	*Two Phase to Earth Fault*	Same as A + B
D)	*Three Phase Fault*	All the three currents are correctly measured (in any case two directly).

3.2.3 – Earth Fault Current Input (Ion)

Same as for the Phase Currents, the relay directly displays the r.m.s. value of the Zero Sequence Residual Current flowing at the Primary of the Current Transformers.

If the input to the Earth Fault element is supplied by the residual connection of the 3 phase C.Ts., we shall set for the variable "**Io1**" the same value as "**I1**".

If the input to the Earth Fault element is supplied by a separated Core Balance C.T., or by another CT, "**Io1**" value will be the Rated Primary Current of this C.T., normally different from "**I1**".

3.2.4 - 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: $t(I) = T_s$ $\frac{I}{I_s}=10$ when

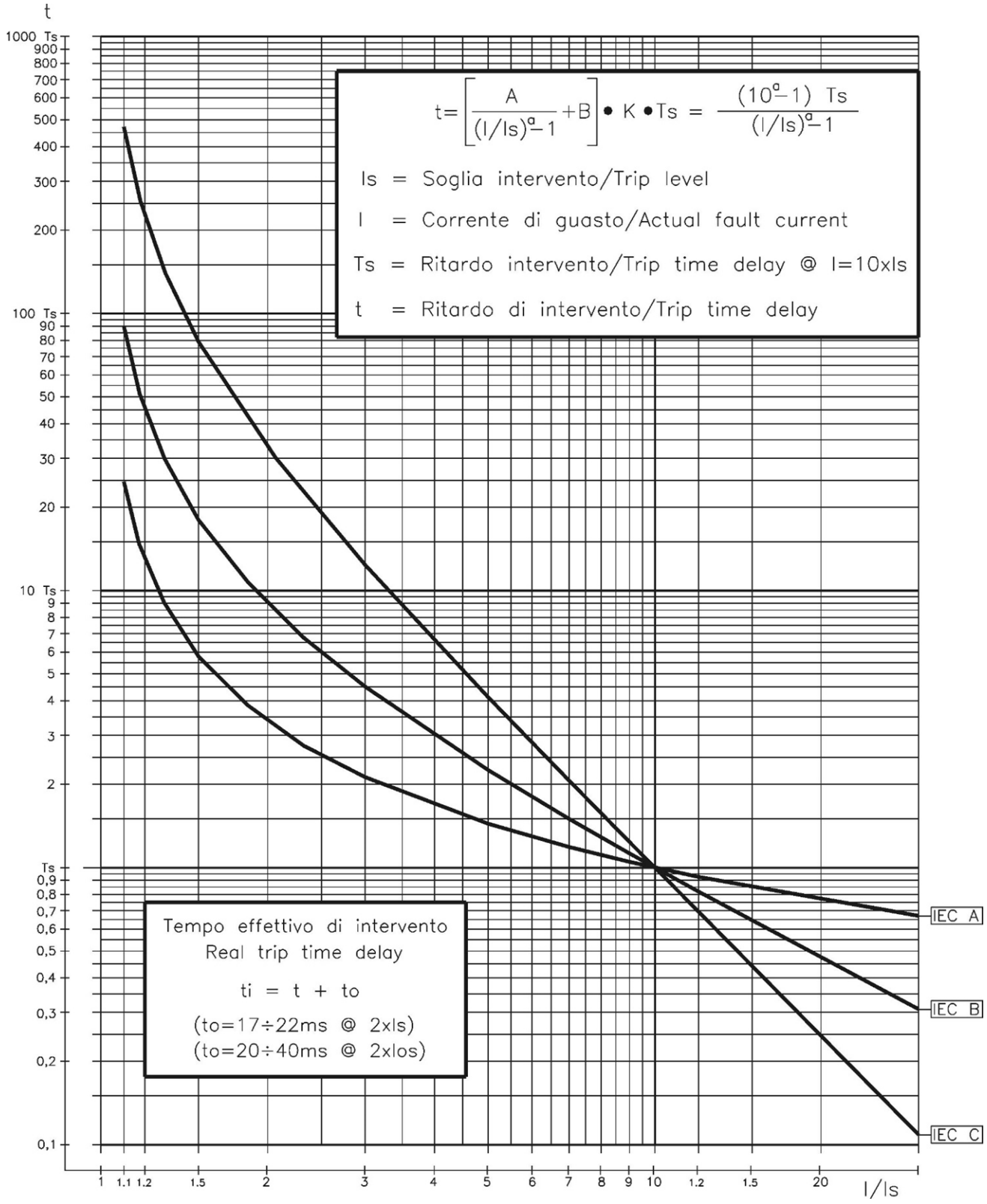
tr = Operation time of the output relay on pick-up

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

The maximum measuring current is "40xIn" for phase elements and "4xOn" for the neutral elements.

2.2.5 – Time Current Curves IEC (TU1029 Rev.0)



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

2.2.6 - Time Current Curves IEEE (TU1028 Rev.0)

4. Funzioni (Functions and Settings)

4.1 - I> – First overcurrent protection level

Stato (Status)	→		Abilit.		[Disabl.(Disable) / Abilit.(Enable)]			
Opzioni (Options)	→	***TCC***	D		[D / A / B / C / MI / VI / I / EI / SI]			
	→	***BI***	Disab.		[Disabl.(Disable) / Abilit.(Enable)]			
Livelli (Trip Level)	→	***I>***	0.5	In	(0.10 ÷ 4.00)	step	0.01	In
Tempi (Timer)	→	***tI>***	1.00	s	(0.05 ÷ 60.00)	step	0.01	s

Description of variables

Stato (Status)	:	If disable the function is disactivated
TCC	:	Time current curves
		D = Independent Definite Time
		A = IEC A Inverse
		B = IEC B Very Inverse
		C = IEC C Extremely Inverse
		MI = IEEE Moderate Inverse Curve
		VI = IEEE Very Inverse Curve
		I = IEEE Inverse Curve
		EI = IEEE Extremely Inverse Curve
		SI = IEEE Short Inverse Curve
BI	:	Operation controlled by Blocking Digital Input
I>	:	Trip level (limited to 40 times In)
tI>	:	Trip time delay

4.2 - I>> - Second overcurrent protection level

Stato (Status)	→		Abilit.		[Disabl.(Disable) / Abilit.(Enable)]			
Opzioni (Options)	→	***BI***	Disab.		[Disabl.(Disable) / Abilit.(Enable)]			
Livelli (Trip Level)	→	***I>>***	0.9	In	(0.50 ÷ 40.00)	step	0.01	In
Tempi (Timer)	→	***tI>>***	0.25	s	(0.05 ÷ 60.00)	step	0.01	s

Description of variables

Stato (Status)	:	If disable the function is disactivated
BI	:	Operation controlled by Blocking Digital Input
I>>	:	Trip level (limited to 40 times In)
tI>>	:	Trip time delay

4.3 – I>>> - Third overcurrent protection level

Stato (Status)	→		Abilit.		[Disabl.(Disable) / Abilit.(Enable)]			
Opzioni (Options)	→	***BI***	Disab.		[Disabl.(Disable) / Abilit.(Enable)]			
Livelli (Trip Level)	→	***I>>>***	2.00	In	(0.50 ÷ 40.00)	step	0.01	In
Tempi (Timer)	→	***tI>>>***	0.05	s	(0.05 ÷ 60.00)	step	0.01	s

Description of variables

Stato (Status)	:	If disable the function is disactivated
BI	:	Operation controlled by Blocking Digital Input
I>>>	:	Trip level (limited to 40 times In)
tI>>>	:	Trip time delay

4.4 - Io> - First Earth Fault protection level

Stato (Status)	→		Abilit.		[Disabl.(Disable) / Abilit.(Enable)]			
Opzioni (Options)	→	***BI***	Disab.		[Disabl.(Disable) / Abilit.(Enable)]			
Livelli (Trip Level)	→	***Io>***	0.50	Ion	(0.01 ÷ 4.00)	step	0.01	Ion
Tempi (Timer)	→	***tIo>***	0.50	s	(0.05 ÷ 60.00)	step	0.01	s

Description of variables

Stato (Status)	:	If disable the function is disactivated
BI	:	Operation controlled by Blocking Digital Input
Io>	:	Trip level
tIo>	:	Trip time delay

4.5 - Io>> (2F51N) - Second Earth Fault protection level

Stato (Status)	→		Abilit.		[Disabl.(Disable) / Abilit.(Enable)]			
Opzioni (Options)	→	***BI***	Disab.		[Disabl.(Disable) / Abilit.(Enable)]			
Livelli (Trip Level)	→	***Io>>***	0.90	Ion	(0.01 ÷ 5.00)	step	0.01	Ion
Tempi (Timer)	→	***tIo>>***	0.05	s	(0.05 ÷ 60.00)	step	0.01	s

Description of variables

Stato (Status)	:	If disable the function is disactivated
BI	:	Operation controlled by Blocking Digital Input
Io>>	:	Trip level
tIo>>	:	Trip time delay

4.6 – 67S1 – First Directional Earth Fault protection level

Stato (Status)	→		Abilit.		[Disabl.(Disable) / Abilit.(Enable)]			
Opzioni (Options)	→	***BI***	Disab.		[Disabl.(Disable) / Abilit.(Enable)]			
Livelli (Trip Level)	→	***Io.1***	1.00	%	(1 ÷ 10)	step	0.01	%
	→	***Uo.1***	3.50	%	(1 ÷ 40)	step	0.01	%
	→	***aA.1***	260	°	(0 ÷ 360)	step	1	°
	→	***aB.1***	350	°	(0 ÷ 360)	step	1	°
Tempi (Timer)	→	***t67.1***	1.00	s	(0.05 ÷ 1.00)	step	0.01	s

Description of variables

Stato (Status)	:	If disable the function is disactivated
BI	:	Operation controlled by Blocking Digital Input
Io.1	:	Trip level
Uo.1	:	Trip level
aA.1	:	First angle trip sector
aB.1	:	Second angle trip sector
t67.1	:	Trip time delay

4.7 – 67S2 – Second Directional Earth Fault protection level

Stato (Status)	→		Abilit.		[Disabl.(Disable) / Abilit.(Enable)]			
Opzioni (Options)	→	***BI***	Disab.		[Disabl.(Disable) / Abilit.(Enable)]			
Livelli (Trip Level)	→	***Io.2***	2.00	%	(1 ÷ 10)	step	0.01	%
	→	***Uo.2***	3.50	%	(1 ÷ 40)	step	0.01	%
	→	***aA.2***	100	°	(0 ÷ 360)	step	1	°
	→	***aB.2***	280	°	(0 ÷ 360)	step	1	°
Tempi (Timer)	→	***t67.2***	0.70	s	(0.05 ÷ 1.00)	step	0.01	s

Description of variables

Stato (Status)	:	If disable the function is disactivated
BI	:	Operation controlled by Blocking Digital Input
Io.2	:	Trip level
Uo.2	:	Trip level
aA.2	:	First angle trip sector
aB.2	:	Second angle trip sector
t67.2	:	Trip time delay

4.8 - I.R.F. - Internal Relay Failure

Stato (Status)	→	Non Disp.	Non Disp. (No Parameters)
Opzioni (Options)	→ **Opz**	NoScat.	[NoScat (No Trip) / Scatto (Trip)]
Livelli (Trip Level)	→	Non Disp.	Non Disp. (No Parameters)
Tempi (Timer)	→	Non Disp.	Non Disp. (No Parameters)

Description of variables

Opz	:	The variable "OpI" can be programmed to trip the output relays same as the other protection functions (OpI = TRIP), or to only operate the "IRF" signal led without tripping the output relays (OpI = NoTRIP).

4.9 - AnIn– Circuit Breaker Failure (F51BF)

Stato (Status)	→		Abilit.		[Disabl.(Disable) / Abilit.(Enable)]			
Opzioni (Options)	→ **TrR**		Rele1		Relay1 – Relay2 – Relay3			
Livelli (Trip Level)	→		Non Disp.		Non Disp. (No Parameters)			
Tempi (Timer)	→ **tBF**		0.25	**s**	(0.05 ÷ 0.75)	step	0.01	s
	→ **tInc**		0.25	**s**	(0.05 ÷ 5.00)	step	0.01	s

Description of variables

Stato (Status)	:	If disable the function is disactivated
TrR	:	Output relay programmed for trip command to the Circuit Breaker
tBF	:	Trip time delay
tInc	:	C/B Discrepancy time

Operation: If after the time "tBF" from pick-up of the programmed relay "TrR" the current measured still exceeds 5%In, the output relay associated to the "AnIn" function is operated (relay another than TrR).

4.10 - TCS (Trip Circuit Supervision)

Stato (Status)	→		Abilit.		[Disabl.(Disable) / Abilit.(Enable)]			
Opzioni (Options)	→		Non Disp.		Non Disp. (No Parameters)			
Livelli (Trip Level)	→		Non Disp.		Non Disp. (No Parameters)			
Tempi (Timer)	→	***tTCS***	1	**s**	(0.01 ÷ 50)	step	0.01	s

Description of variables

Stato (Status)	:	If disable the function is disactivated
tTCS	:	Trip time delay

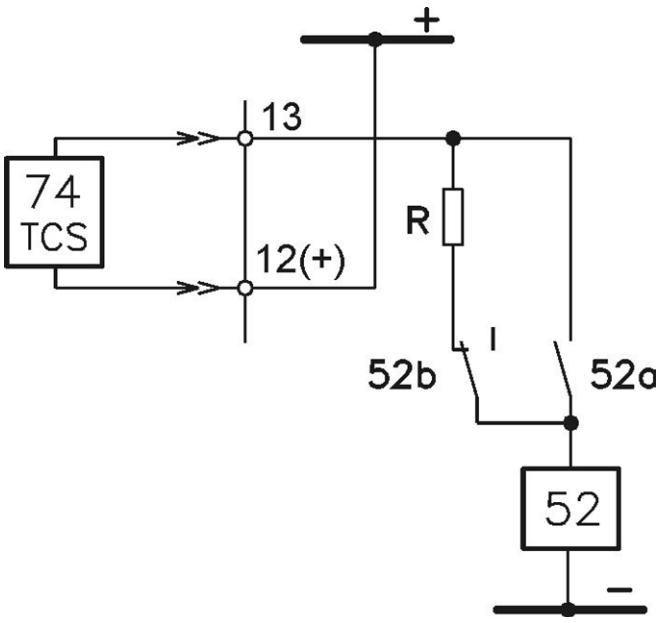
Operation:

The relay includes a complete Circuit Breaker Trip Circuit Supervision unit that is associated to the Contact "13-12(+)".
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 relay associated to "TCS" function trip, and the "Led Trip" is lit-on.
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".



4.11 - LCD – Display and Buzzer operation

Stato (Status)	→	Non Disp.	Non Disp. (No Parameters)
Opzioni (Options)	→ ***Bkl***	Auto	[Auto / On]
Livelli (Trip Level)	→	Non Disp.	Non Disp. (No Parameters)
Tempi (Timer)	→	Non Disp.	Non Disp. (No Parameters)

Description of variables

Bkl : Backlight.
ON = Backlight ON.
Auto = Switched-on Automatically on operation of Keyboard buttons. Off after 10sec of inactivity.

4.12 - Comm – Communication Parameters

Stato (Status)	→	Non Disp.	Non Disp. (No Parameters)
Opzioni (Options)	→ ***LBd***	9600	[9600 / 19200 / 38400 / 57600]
	→ ***RBd***	9600	[9600 / 19200]
	→ ***Mod***	8,n,1	[8,n,1 / 8,o,1 / 8,e,1]
	→ ***RPr***	Modbus	[Modbus]
Livelli (Trip Level)	→	Non Disp.	Non Disp. (No Parameters)
Tempi (Timer)	→	Non Disp.	Non Disp. (No Parameters)

Description of variables

LBd	:	Local Baud Rate (Front panel RS232 communication speed)
RBd	:	Remote Baud Rate (Rear panel terminal blocks RS485 communication speed)
Mod	:	Communication mode (communication parameters) **Note**: Any change of this setting becomes valid at the next power on
RPr	:	Remote Protocol

5. Data Logger

The "Data Logger" is a events recorder (100) that includes the date and time.
The events can be showed or exported (the export format is compliant with IEC 0-16) through the MSCom software.

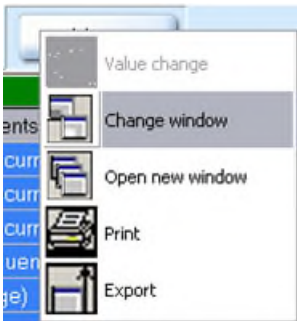
Available Elements:

Logic Events	:	Starts, Trips.
Changing	:	Change the setting parameters
Power Supply on	:	Power on, Power Fail

5.1 – Display

Open "MSCom2" program and connect to the relay (See MSCom2 operation manual)

Select "Change Windows" from "Menu" button



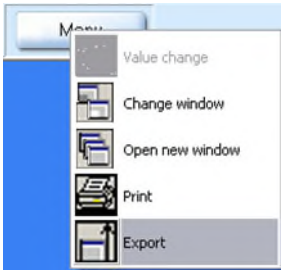
Select "Event Recorder" to view stored events:

A window will appear with all the events recordings

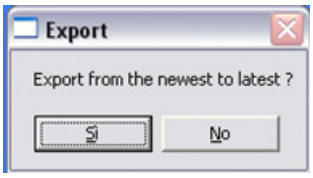
ID	Date	Action
0	-	23
1	20-10-2011, 15:49:40:940	Trip I> RISE
2	20-10-2011, 15:49:40:200	- RISE
3	20-10-2011, 15:49:40:190	Trip I>> RISE
4	20-10-2011, 15:49:39:040	Trip tI>>> RISE

5.2 – Export data stored

With the window display mode recordings (Event Recording), position the mouse on the "Menu" button, press the right mouse button and select "Export":

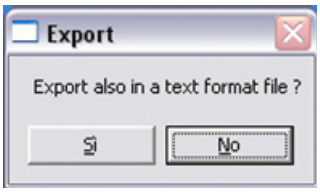


Select export mode:

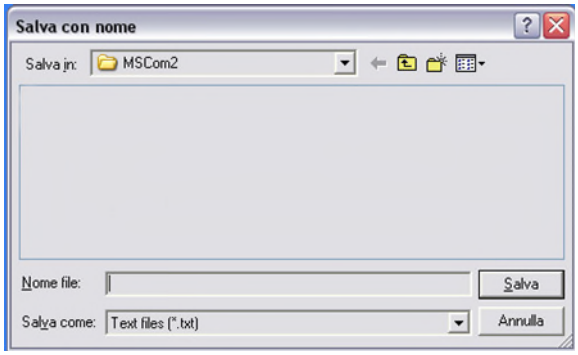


"YES", the events are sorted from newest to oldest
"NO" events will be sorted from oldest to newest

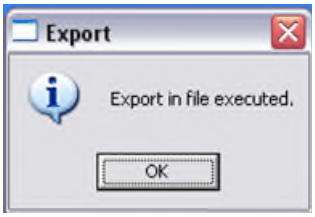
Select export:



"YES", the information will be exported to a test file (. txt)
"NO" will be exported to the information in memory (Clipboard)



If you selected to export to a text file (txt), show the window "Save As", choose the destination folder, enter the file name and press Save.



Will appear export mode window confirmation

If select export (txt) will appear export window confirmation

6. Logic Blocking of Functions

6.1 – Blocking output

The instantaneous element of each of the protection functions can be programmed to control one of the Output Relays.
This relay picks-up as soon as the input quantity exceeds the set trip level of the Protection Function and it automatically resets when the input quantity drops below the function reset level (≈95% of the trip level) or, in any case as soon as the time delay (tBF) of the Breaker Failure function is expired.
This instantaneous output can be used to activate the Blocking Input of another Protection Relay to implement a logic selectivity systems. As above explained, in case of Breaker Failure, the blocking output is released and the back-up protection enabled.

6.2 – Blocking Input

The blocking action of any protection functions can be controlled by activating the digital input:

- D1 (BI = Enable) (functions I>, I>>, I>>>, Io>, Io>>, 67S1, 67S2)

7. Output Relays

Three user programmable Output Relays are normally available R1, R2, R3.
Each of them can be programmed to be controlled by any element (instantaneous or time delayed) of any of the Relay Functions including Breaker Failure ("AnIn" (BF)) and Internal Relay Fault (IRF).
Each output relay can also be programmed to operate "OPEN" and "CLOSE" control of the C/B either by the Relay Keyboard or via the serial communication bus
Moreover, the operation of each of the output relays can be programmed to be either Normally Deenergized (energized on tripping of the controlling Functional Element) or Normally Energized (Deenergized on tripping of the controlling Functional Element)

8. Digital Inputs

Three optoisolated, self-powered Digital Inputs are provided.
A Digital Input is activated when its terminals are shorted by a cold contact.

D1	(Terminals 22 - 19)	:	Functions Blocking Input It is used to blocking the programmed functions ("BI" Parameter)
D2	(Terminals 22 - 21)	:	Input the condition Circuit Breaker OPEN (52a) (Input Closed = C/B open; Input Open = C/B closed).
D3	(Terminals 22 - 20)	:	Input the condition Circuit Breaker CLOSE (52c) (Input Closed = C/B closed; Input Open = C/B open).

9. Self-diagnostic

The relay incorporates a sophisticated self-diagnostic feature that continuously checks the following elements:

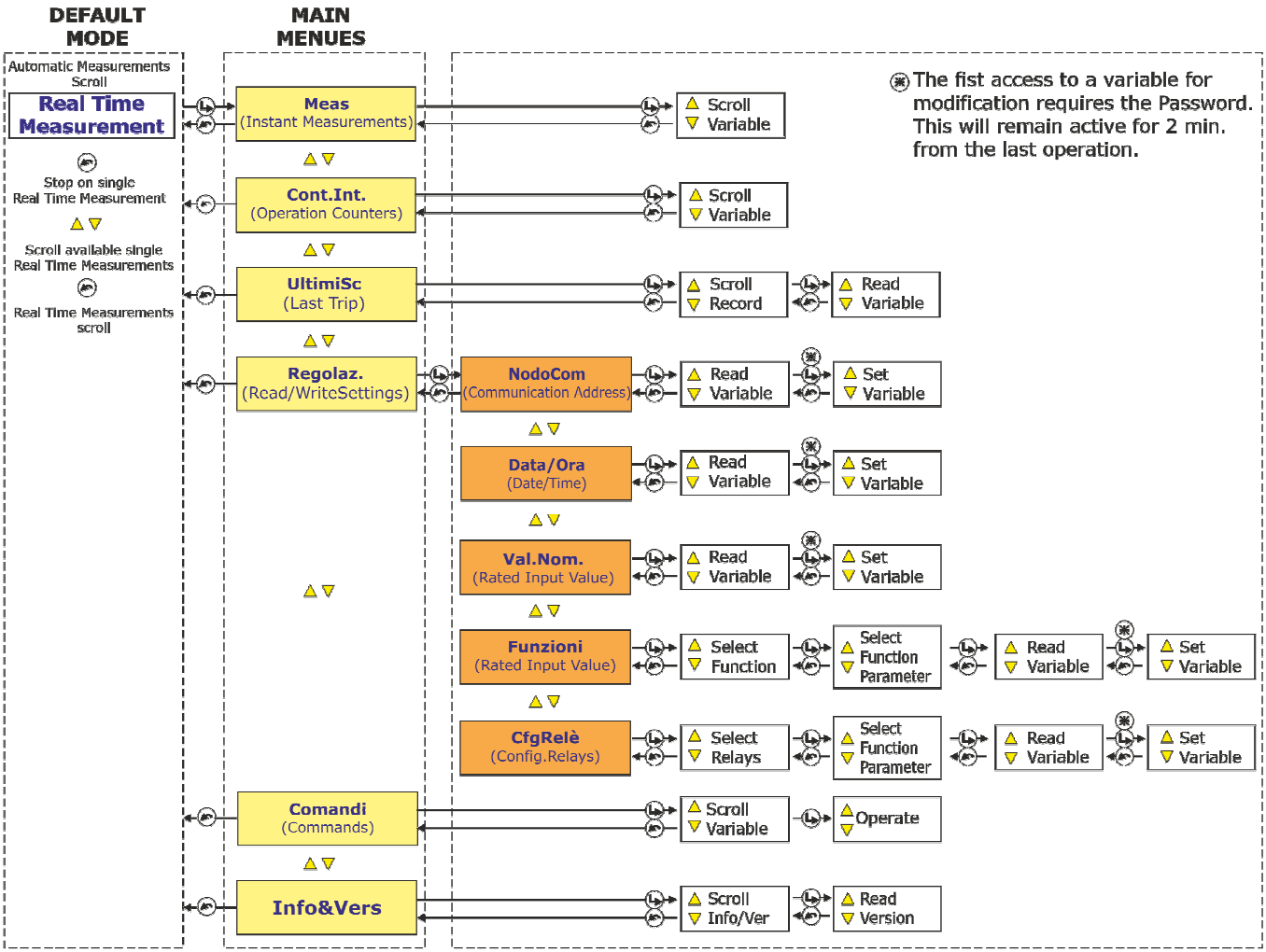
- A/D conversion
- Checksum of the settings stored into E^2Prom.
- DSP general operation (Power, Routines, etc.)
- Lamp test (only on manual test).

Any time Power is switched on, a complete test is run; then, during normal operation, the test runs continuously, and the checksum is done any time a parameter is stored into E^2Prom.
If during the test any Relay Internal Failure (I.R.F) is detected:

- If "I.R.F." is programmed to "Trip", the programmed output relays are operated same as on tripping of any protection function
- If set "NoScatto" (NoTrip), the trip of "I.R.F." function is recorded in "UltimiSc" (Last Trip)

10. Relay Management

The relay can be totally managed locally, either by the RS232 communication port or by the 4 key buttons and the LCD display, or remotely via the communication bus RS485 connected to the rear terminal blocks. The 2-line x 8 characters LCD display shows the available information.
Key buttons operate according to the flow-chart here-below.



11. Signalizations

Four signal leds are available on the Front Face Panel:

a)	GREEN LED	C/B OPEN	Illuminated when C/B open status is detected. (Digital Input D3 Open)
b)	RED LED	C/B CLOSED	Illuminated when C/B close status is detected. (Digital Input D3 closed) Flashing when Breaker Failure is detected.
c)	RED LED	TRIP (*)	Flashing when a timed function starts to operate. Illuminated when any function is tripped; reset takes places by pressing the reset button.
d)	YELLOW LED	PWR/ I.R.F.	Illuminated during normal operation when Power Supply is ON. Flashing when a Relay Internal Fault is detected.

(*) When any protection function is tripped besides the Led which gives the general trip indication.
The display shows the function that caused the tripping:

LastTrip "Cause"	steady blinking

12. Keyboard

Enter Give access to any menu or convalidate any programming changement.

Reset Return from the actual selected menu to the former menu.

Select + Scrolls variables available in the different menus or increases/decreases setting values.

Select -

13. Serial Communication

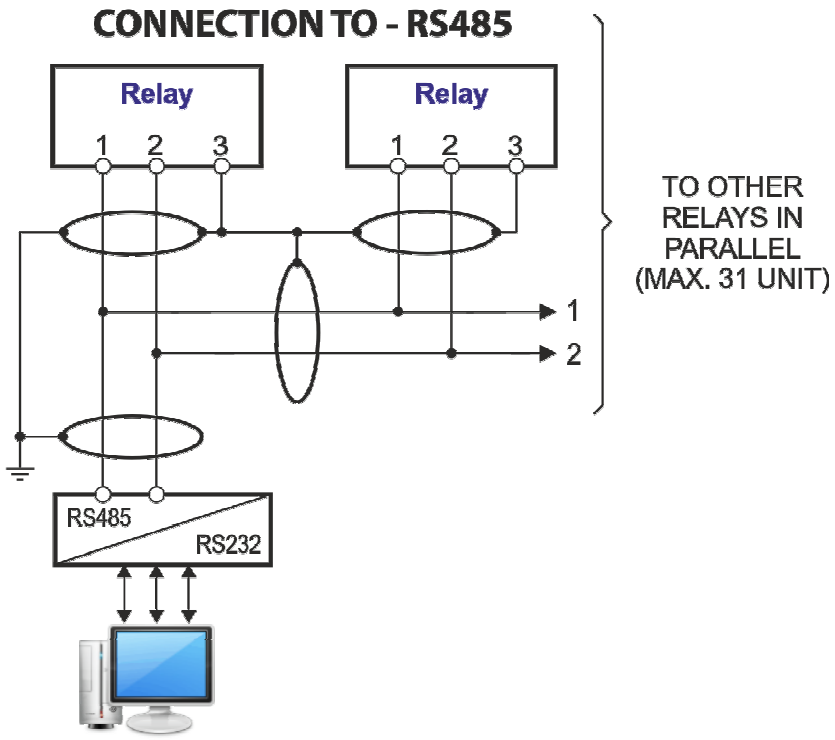
13.1 - Main RS485 Serial Communication Port

This port is accessible via the terminals 1-2-3 provided on the relay terminal board.
It is used for connection to a serial bus interfacing up to 31 units with the Central Supervision System (SCADA, DCS, ecc).
The serial bus is a shielded pair of twisted cables connecting in parallel (Multi Drop) the different units (slaves) by the relevant terminals.
The physical link is RS485 and the Communication Protocol is MODBUS/RTU / IEC60870-5-103.
The configuration of transmission parameters is selectable.

Baud Rate	:	9600/19200 bps	9600/19200 bps	9600/19200 bps
Start bit	:	1	1	1
Data bit	:	8	8	8
Parity	:	None	Odd	Even
Stop bit	.	1	1	1

Note: any change of this setting becomes valid at the next power on.

Each relay is identified by its programmable address code (NodeAd) and can be called from the P.C.
A dedicated communication software (MSCom) for windows is available on www.microelettrica.com.
Maximum length of the serial bus can be up to 200m.

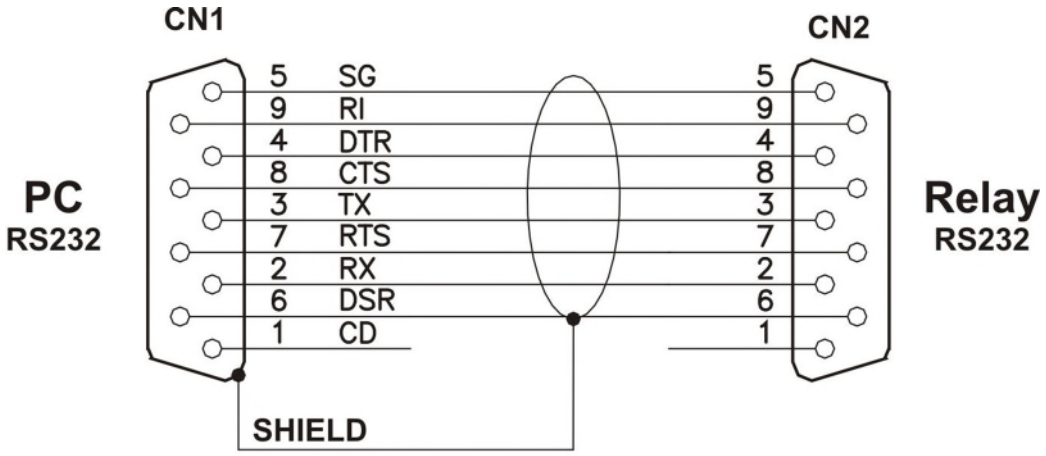


For longer distance and for connection of up to 250 Relays, optical interconnection is recommend.
(Please ask Microelettrica for accessories)

13.2 - Communication Port on Front Face Panel

This port is used for communication through the Front Face Panel between a local Lap-top PC.

The physical link is RS232 by the standard female 9-pin D-sub connector available on the Front Face Panel. Via this Port complete Relay management and data acquisition is possible.



14. Menu and Variables

14.1 - Misure in Tempo Reale (Real Time Measurements)

Scrolling display of the Real Time Measurements is the Default operation.
Scrolling can be stopped at any of the measurements and restarted by pressing the Reset button .
When stopped on one variable, appears aside the measurement and the different available measurements can be selected by the buttons.

Display				*Description*
I	=	0 – 65535	%In	Largest of the 3 phase-currents (% of rated current)
IA	=	0 – 65535	A	RMS value of Phase A current (Primary Amps)
IB	=	0 – 65535	A	RMS value of Phase B current (Primary Amps)
IC	=	0 – 65535	A	RMS value of Phase C current (Primary Amps)
Io	=	0.0 – 6553.5	A	RMS value of Zero Sequence Current (Primary Amps)
Vo	=	0 – 65535	V	Zero sequence voltage
alfa0	=	0 – 360	°	Displacement angle Io-Vo

14.2 – Misure (Instantaneous Measurements)

Real time measurements can be frozen at any moment selecting the menu "Misure (Instant Measure) ":

"**R**eal **T**ime **M**eas"
"Misure"
"1st Measurement" other measurements
to go back to "Misure"

Display				*Description*
I	=	0 – 65535	%In	Largest of the 3 phase-currents (% of rated current)
IA	=	0 – 65535	A	RMS value of Phase A current (Primary Amps)
IB	=	0 – 65535	A	RMS value of Phase B current (Primary Amps)
IC	=	0 – 65535	A	RMS value of Phase C current (Primary Amps)
Io	=	0.0 – 6553.5	A	RMS value of Zero Sequence Current (Primary Amps)
Vo	=	0 – 65535	V	Zero sequence voltage
alfa0	=	0 – 360	°	Displacement angle Io-Vo

14.3 – Cont.Int (Operation Counters)

The operation of any of the function here below reported, is counted, and recorded in the menu "Counters".

"Real Time Measurements"
"Cont.Int"
"1st counters" other counters
to go back to "Real Time Measurements "

Display			*Description*
I>	=	0 – 65535	Operations counters of first overcurrent element
I>>	=	0 – 65535	Operations counters of second overcurrent element
I>>>	=	0 – 65535	Operations counters of third overcurrent element
Io>	=	0 – 65535	Operations counters of first earth fault element
Io>>	=	0 – 65535	Operations counters of second earth fault element
67S1	=	0 – 65535	Operations counters of first directional earth fault element
67S2	=	0 – 65535	Operations counters of second directional earth fault element
I.R.F.	=	0 – 65535	Operations counters of Internal Relay Fault
DispB	=	0 – 65535	Operations counters of Breaker Discrepancy
BF	=	0 – 65535	Operations counters of Breaker Failure
TCS	=	0 – 65535	Operations counters of trip coil supervision element
HR	=	0 – 65535	Operations counters of HW recovery operations

14.4 – UltimiSc (Event Recording)

The relay records any tripping and stores the information relevant to the last 20 tripping of protection functions (FIFO). Each event recording includes the following information

"Real Time Meas"
"LastTrip"
1st event,
to scroll available events,
to "Rec #" selected,
to select the different fields;

Display				*Description*
Func		**xxxxx**		Indication of the protection function which caused the relay tripping. For indication of the TRIP Cause the following acronyms are used: *I>* = First overcurrent element (Short Circuit) *I>>* = Second overcurrent element (Short Circuit) *I>>* = Third overcurrent element (Short Circuit) *Io>* = First earth fault element *Io>>* = Second earth fault element *67S1* = First directional earth fault element *67S2* = Second directional earth fault element *TCS* = Trip circuit supervision *IRF* = Internal Relay Fault
Date	:	YYYY/MM/GG		Date: Year/Month/Day
Time	:	hh:mm:ss:cc		Time: hours/minutes/second/hundredths of seconds
IA	=	0 – 65535	A	RMS value of phase A current (Primary Amps)
IB	=	0 – 65535	A	RMS value of phase B current (Primary Amps)
IC	=	0 – 65535	A	RMS value of phase C current (Primary Amps)
Io	=	0.0 – 6553.5	A	RMS value of Zero Sequence Current (Primary Amps)
Vo	=	0 – 65535	V	Zero sequence voltage
°	=	0 – 65535	°	Displacement angle Io-Vo

to go back to "Rec #",
to go back to "Real Time Meas".

14.5 - Regolazioni (Programming / Reading the Relay Settings)

"Main Menu"
select "Regolazioni"
select among following sub menus

14.5.1 - NodoCom (Communication Address)

"NodoCom"	
"Ind: #"	
"Password ????"	(If not yet entered; see § Password)
to select the Address (1-250)	
to validate.	Set Done!

The default address is 1.

Display			Description	Setting Range			Step	Unit
Ind:	1		Identification number for connection on serial communication bus	1	-	250	1	-

14.5.2 – Data/Ora (Time/Date)

"Data/Ora"	Date: Current Date, Time: Current time
"20YY/……"	to set year,
"20XX/MM"	to set month,
"20XX/XX/DD"	to set day,
"20XX/XX/XX"	
"hh/mm"	to set hour,
"XX/mm"	to set minutes,
To validate	Set Done!
Exit	

14.5.3 – Val.Nom. (Rated Input Values)

"Val.Nom."	Rated Input Values
1st Variable	
to scroll variables	
to modify selected variable	
"Password???? "	(If not yet entered) or #??? (If not yet entered; see § Password)
to set variable value,	
to validate.	Set Done!

Display			Description	Setting Range			Step	Unit
In	300	A	Reference primary current of the relay	1	-	9999	1	A
I1	300	A	Rated Primary current of phase C.T.	1	-	9999	1	A
I2	5	A	Rated Secondary current of phase C.T.	1	-	5	1/5	A
Io1	100	A	Rated Primary current of the tore C.T. detecting earth fault current.	1	-	9999	1	A
Io2	1	A	Rated secondary current of the tore C.T. detecting earth fault current.	1	-	1	-	A
Vo1	10	kV	Rated primary voltage of VT phase to neutral	0.05	-	500	0.01	kV
Vo2	100	V	Rated secondary voltage of VT phase to neutral	50	-	115	0.01	V
Freq	50	Hz	System rated frequency	50	-	60	10	Hz

14.5.4 – Funzioni (Functions)

"Misure Istantanee**"** (**R**eal **T**ime **M**eas)
Press to access (Main Menu)
Select menu "Regolaz." (Read/Write) by
Press
Select menu "Funzioni" (Functions) by
Press
Select desired variables by
Press
Select menu by the menu

Stato *(Enable/Disable - Function)*
Opzioni *(Options)*
Livelli *(Trip Level)*
Tempi *(Trip time delay)*

Press
Select desired variables by
Press
Insert Password if request (see § password)
Press
Select by to set the new value
Press to validate the change and display show "Set Done!"
Press to go on Main Menu

Functions	*Type*	*Display Variable*	*Default*	*Unit*	*Description*	*Setting Range*	*Step*
Password		= 0000-9999	1111	**-**	Password for programming enable (see § Password)		
I>	Stato	→	Abilit.		Enable of the protection function	Abilit/Disabil.	-
	Opzioni	→ TCC	D		Time Current Curves	D,A,B,C, I, VI, EI, MI, SI	-
		BI	Disabil.		Operation controlled by Blocking Digital Input	Abilit/Disabil.	-
	Livelli	→ I>	0.50	In	Trip level	0.10 – 4.00	0.01
	Tempi	→ tI>	1.00	s	Trip time delay	0.05 – 60.00	0.01
I>>	Stato	→	Abilit.		Enable of the protection function	Abilit/Disabil.	-
	Opzioni	→ BI	Disabil.		Operation controlled by Blocking Digital Input	Abilit/Disabil.	-
	Livelli	→ I>>	0.9	In	Trip level	0.50 – 40.00	0.01
	Tempi	→ tI>>	0.25	s	Trip time delay	0.05 – 60.00	0.01
I>>>	Stato	→	Abilit.		Enable of the protection function	Abilit/Disabil.	-
	Opzioni	→ BI	Disabil.		Operation controlled by Blocking Digital Input	Abilit/Disabil.	-
	Livelli	→ I>>>	2.00	In	Trip level	0.50 – 40.00	0.01
	Tempi	→ tI>>>	0.05	s	Trip time delay	0.05 – 60.00	0.01
Io>	Stato	→	Abilit.		Enable of the protection function	Abilit/Disabil.	-
	Opzioni	→ BI	Disabil.		Operation controlled by Blocking Digital Input	Abilit/Disabil.	-
	Livelli	→ Io>	0.50	Ion	Trip level	0.01 – 4.00	0.01
	Tempi	→ tIo>	0.50	s	Trip time delay	0.05 – 60.00	0.01
Io>>	Stato	→	Abilit.		Enable of the protection function	Abilit/Disabil.	-
	Opzioni	→ BI	Disabil.		Operation controlled by Blocking Digital Input	Abilit/Disabil.	-
	Livelli	→ Io>>	0.9	**Ion**	Trip level	0.01 – 5.00	0.01
	Tempi	→ tIo>>	0.05	**s**	Trip time delay	0.05 – 60.00	0.01
67S1	Stato	→	Abilit.		Enable of the protection function	Abilit/Disabil.	-
	Opzioni	→ BI	Disabil.		Operation controlled by Blocking Digital Input	Abilit/Disabil.	-
	Livelli	→ Io.1	1.00	**%**	Trip level	1 – 10	0.01
		Uo.1	3.50	**%**	Trip level	1 – 40	0.01
		aA.1	260	**°**	First angle trip sector	0 – 360	1
		aB.1	350	**°**	Second angle trip sector	0 – 360	1
	Tempi	→ t67.1	1.00	**s**	Trip time delay	0.05 – 1.00	0.01
67S2	Stato	→	Abilit.		Enable of the protection function	Abilit/Disabil.	-
	Opzioni	→ BI	Disabil.		Operation controlled by Blocking Digital Input	Abilit/Disabil.	-
	Livelli	→ Io.2	2.00	**%**	Trip level	1 – 10	0.01
		Uo.2	3.50	**%**	Trip level	1 – 40	0.01
		aA.2	100	**°**	First angle trip sector	0 – 360	1
		aB.2	280	**°**	Second angle trip sector	0 – 360	1
	Tempi	→ t67.2	0.70	**s**	Trip time delay	0.05 – 1.00	0.01

Functions	Type	Display	Variable	Default	Unit	Description	Setting Range	Step
IRF	Stato	→		Abilit.		Enable of the protection function	Abilit/Disabil.	-
	Opzioni	→	Opz	NoScatto		Operation of output Relays on detection of Internal Relay Fault	NoScatto – Scatto	-
	Livelli	→		Non Disp.				
	Tempi	→		Non Disp.				
AnIn	Stato	→		Abilit.		Enable of the protection function	Abilit/Disabil.	-
	Opzioni	→	TrR	Relè1		Output relay operated on BF tripping	Relè1- Relè2 Relè3- Relè4	-
	Livelli	→		Non Disp.				
	Tempi	→	tBF	0.25	**s**	Trip time delay	0.05 – 0.75	0.01
			tInc	0.25	**s**	C/B Discrepancy time	0.05 – 5.00	0.01
TCS	Stato	→		Abilit.		Enable of the protection function	Abilit/Disabil.	-
	Opzioni	→		Non Disp.				
	Livelli	→		Non Disp.				
	Tempi	→	tTCS	1	**s**	Trip time delay	0.01 – 50	0.01
LCD	Stato	→		Non Disp.				
	Opzioni	→	BkL	Auto		Backlight	ON - OFF	-
	Livelli	→		Non Disp.				
	Tempi	→		Non Disp.				
Comm	Stato	→		Non Disp.				
	Opzioni	→	LBd	9600		Local Baud Rate (Front panel RS232 communication speed)	9600 - 19200 38400 - 57600	-
			RBd	9600		Remote Baud Rate (Rear panel terminal blocks RS485 communication speed)	9600 - 19200	-
			Mod	8,n,1		Remote mode (communication parameters) ***Note**: any change of this setting became valid at the next power on*	8,n,1 8,o,1 8,e,1	-
			RPr	Modbus		Remote Protocol	Modbus	-
	Livelli	→		Non Disp.				
	Tempi	→		Non Disp.				

Settings can also be programmed via the serial communication ports.

14.6 – Cfg.Relè (Relay Configuration)

To associate one of the Output Relays to one or more functions (see § Password): enter the menu "R/W Set", select "Relay Cfg", select the "Relay #" to be programmed, select "Link"; at this stage the list of the available functions is displayed. Scrolling the list by the "+" and "-" keys the function is selected and then assigned by the key "Enter". The assignation is confirmed by the function indication that switches from blinking to steady. Any of the Output Relays can be programmed to work in two different modes:

N.D.	Normally Deenergized	Relay is energized on trip of the associated functions
N.E.	Normally Energized	Relay is deenergized on trip of the associated functions

Programming of working mode is made as above selecting "OpMode" istead of "Link".

Relay	*Display Type*		*Default*	*Description*	*Setting Range*
Relay1 (R1)	Link	→	tI>, tI>>, tI>>>, tIo>, tIo>>,t67S1, t67S2	Association of functions to output relay R1	I> - tI> - I>> - tI>> - I>>> – tI>>> - Io> - tIo> - Io>> - tIo>> - 67S1 – t67S1 - 67S2 – t67S2 – IRF – pwrF – Accens. – inp1 – inp2 – inp3 - ApInt - ChInt - SincDat – AnIn(BF) - TCS – tTCS – HwRec –
	ModoOp	→	N.D.	N.D. (Normally Deenergized) N.E. (Normally Energized)	N.D./N.E.
Relay2 (R2)	Link	→	tTCS, AnIn (BF)	Association of functions to output relay R2	I> - tI> - I>> - tI>> - I>>> – tI>>> - Io> - tIo> - Io>> - tIo>> - 67S1 – t67S1 - 67S2 – t67S2 – IRF – pwrF – Accens. – inp1 – inp2 – inp3 - ApInt - ChInt - SincDat – AnIn(BF) - TCS – tTCS – HwRec –
	ModoOp	→	N.D.	N.D. (Normally Deenergized) N.E. (Normally Energized)	N.D./N.E.
Relay3 (R3)	Link	→	I.R.F.	Association of functions to output relay R3	I> - tI> - I>> - tI>> - I>>> – tI>>> - Io> - tIo> - Io>> - tIo>> - 67S1 – t67S1 - 67S2 – t67S2 – IRF – pwrF – Accens. – inp1 – inp2 – inp3 - ApInt - ChInt - SincDat – AnIn(BF) - TCS – tTCS – HwRec –
	ModoOp	→	N.D.	N.D. (Normally Deenergized) N.E. (Normally Energized)	N.D./N.E.

Functions	*Events*		*Description*
I>	I> tI>	*Start* *Trip*	*First Overcurrent element*
I>>	I>> tI>>	*Start* *Trip*	*Second Overcurrent element*
I>>>	I>>> tI>>>	*Start* *Trip*	*Third Overcurrent element*
Io>	Io> tIo>	*Start* *Trip*	*First Earth Fault element*
Io>>	Io>> tIo>>	*Start* *Trip*	*Second Earth Fault element*
67S1	67S1 t67S1	*Start* *Trip*	*First Directional Earth Fault element*
67S2	67S2 t67S2	*Start* *Trip*	*Second Directional Earth Fault element*
IRF	IRF tIRF	*Start* *Trip*	*Internal Relay Fault*
	pwrF Accens. inp1 inp2 inp3 ChInt ApInt SincDat AnIn (BF)		*Faulty Power Supply* *Turn-on relay* *Digital Input D1* *Digital Input D2* *Digital Input D3* *C/B Close* *C/B Open* *Date/Hour Synchronization* *Breaker Failure*
TCS	TCS tTCS	*Start* *Trip*	*Trip Coil Supervision*
	HwRecov		*HW recovery operations*

14.7 – Comandi (Commands)

"Comandi"
1st Control,
to select other available control,
to operate selected control.

Display		*Description*
CNT=0	:	Erase memory of trip counters
resDLog	:	Erase memory of Event recording (UltimiSc) and Data logger
LedTest	:	Test signalization leds
Riarmo	:	Reset after trip
ApInt	:	Manual Open - Close Breaker
ChInt	:	Manual Close - Close Breaker

14.8 - Info&Ver (Firmware - Info&Version)

The menu displays the Relay Model and the Firmware Version

"Misure in tempo reale"	**R**eal **T**ime **M**eas
"Info/Ver",	
"Modello XXXXXX",	Model Relay
"Ver.Fw. ###.#.#*X*",	Firmware Version
to go back to "Info&Ver".	
to go back to "Misure in tempo reale"	

15. Keyboard Operational Diagram

16. Password

This password is requested anytime the user wants to write in the "Settings" menu a command of the "Commands" menu.

The default password is "1111"

When password is required, proceed as follows

The Display shows the message "Password ????"

to select 1st digit (1-9)	↳ to validate
to select 2nd digit (1-9)	↳ to validate
to select 3rd digit (1-9)	↳ to validate
to select 4th digit (1-9)	↳ to complete procedure.

The "password" is required any time you attempt to modify one of the programmable variables at the first entrance in the "Settings" and/or "Commands" menus.

The "password" remains valid for 2 minutes from the last operation of the programming buttons or until the button is pressed to return to the default display (RT Meas).
Once the Password has been entered, a "#" appears before the variable that can be modified.

16.1 - MS-Com Password

This password is requested anytime the user wants to send to the relay a setting parameters modification or to issue a command through the relay itself using the managing software MSCom.
The user can decide whether inserting his own password (see MS-Com Operational Manual) or keeping the password disabled just clicking on the OK button when the password is requested.

17. Maintenance

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

18. Power Frequency Insulation Test

Every relay individually undergoes a factory insulation test according to IEC60255-5 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.

19. Wiring Diagram

20. Overall Dimensions (mm) – Protection Degree IP44 (on request IP55)

21. Direction for PCB's Draw-Out and Plug-In

21.1 - Draw-Out

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

21.2 - Plug-In

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

22. Electrical Characteristics

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	EN55022	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			

Electric Rated Value	
Accuracy at reference value of influencing factors	2% In (*) for measure 0,2% On 2% + to (to=20÷30ms @ 2xIs) for times
(*) In, On = Nominal Current of the System's Current Transformer	
Rated Current	In = 1A/5A - On = 1A
Current Overload	400 A for 1 sec; 20A continuous
Burden on current inputs	Phase : 0.05VA at In = 1A ; 0.2VA ta In = 5A Neutral : 0.05VA at On = 1A
Rated Voltage	Un = (50-115) Vac
Voltage Overload	2Un 1sec
Burden on voltage inputs	0,2VA at Un
Average power supply consumption	≤ 7 VA
Output relays	rating 6 A; Vn = 250 V A.C. resistive switching = 1500VA (400V max) make = 30 A (peak) 0,5 sec. break = 0.3 A, 110 Vcc, L/R = 40 ms (100.000 op.)

COMMUNICATION PARAMETERS	
RS485 (Back)	9600/19200/38400/57600 bps – 8,n,1 - 8,e,1 - 8,o,1 – Modbus RTU or IEC60870-5-103
RS232 (Front)	9600 – 8,n,1 – Modbus RTU

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