MICROPROCESSOR OVERCURRENT and EARTH FAULT RELAY

TYPE

MC20-SR

OPERATION MANUAL

CE

Microelettrica Scientifica S.p.A. - 20089 Rozzano (MI) - Italy - Via Alberelle, 56/68 **Errore. Il segnalibro non è definito.**

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 need to be at the same potential.
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, selfpowered 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)

Fig.1

The Measuring Ranges of the different inputs respectively are:

Phase Currents	:	(0.1-40) In
Neutral Current	:	(0.01-10) 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 and self-protected.

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 - Operation and Algorithms

3.1 - Reference Input Values

Display			Description	Setting Range			Step	Unit
I1	100	A	Rated Primary current of phase C.T.	1	-	9999	1	A
I2	1	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	-	5	1/5	A
In	100	A	Reference primary current of the relay	1	-	9999	1	A
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) $$t(I) = \left[\frac{A}{\left(\frac{I}{Is} \right)^{a^{\alpha}} - 1} + B \right] \bullet K \bullet T_s + t_r$$ where:

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

I = Maximum of the three input currents.

Is = Set minimum pick-up level

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

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**" 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 "10xOn" for the neutral elements.

3.3 - Time Current Curves IEC (TU1029 Rev.0)

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

4 - Functions and Settings (Function)

4.1 - I> (1F51) - First overcurrent protection level

FuncEnab	→		Enable		[Disable / Enable]			
Options	→	***TCC***	D		[D / A / B / C / MI / VI / I / EI / / SI]			
	→	***BI***	Disable		[Disable / Enable]			
	→	***Trg***	Enable		[Disable / Enable]			
TripLev	→	***I>***	0.5	In	(0.10 ÷ 4.00)	step	0.01	In
Timers	→	***tI>***	2.00	s	(0.05 ÷ 60.00)	step	0.01	s

Description of variables

FuncEnab	:	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
Trg	:	Function operation triggers the oscillographic wave form capture
I>	:	Minimum phase current pick-up level (limited to 40 times In)
tI>	:	Trip time delay

4.2 - I>> (2F51) - Second overcurrent protection level

FuncEnab	→		Enable		[Disable / Enable]			
Options	→	***BI***	Disable		[Disable / Enable]			
	→	***2xI***	Disable		[Disable / Enable]			
	→	***Trg***	Enable		[Disable / Enable]			
TripLev	→	***I>>***	2.00	In	(0.50 ÷ 40.00)	step	0.01	In
Timers	→	***tI>>***	1.00	s	(0.05 ÷ 60.00)	step	0.01	s
	→	***t2xI***	0.10	s	(0.02 ÷ 9.99)	step	0.01	s

Description of variables

FuncEnab	:	If disable the function is disactivated
BI	:	Operation controlled by Blocking Digital Input
2xI	:	Automatic threshold doubling on inrush
Trg	:	Function operation triggers the oscillographic wave form capture
I>>	:	Minimum phase current pick-up level (limited to 40 times In)
tI>>	:	Trip time delay
t2xI	:	Trip time delay

4.3 - IH (3F51) - Third overcurrent protection level

FuncEnab	→		Enable		[Disable / Enable]			
Options	→	***BI***	Disable		[Disable / Enable]			
	→	***2xI***	Enable		[Disable / Enable]			
	→	***Trg***	Enable		[Disable / Enable]			
TripLev	→	***IH***	5.00	In	(0.50 ÷ 40.00)	step	0.01	In
Timers	→	***tIH***	0.05	s	(0.05 ÷ 60.00)	step	0.01	s
	→	***t2xI***	0.10	s	(0.02 ÷ 9.99)	step	0.01	s

Description of variables

FuncEnab	:	If disable the function is disactivated
BI	:	Operation controlled by Blocking Digital Input
2xI	:	Automatic threshold doubling on inrush
Trg	:	Function operation triggers the oscillographic wave form capture
IH	:	Minimum phase current pick-up level (limited to 40 times In)
t2xI	:	Trip time delay
tIH	:	Trip time delay

4.3.1 – Automatic doubling or 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.

4.4 - Io> (1F51N) - First Earth Fault protection level

FuncEnab	→		Enable		[Disable / Enable]			
Options	→	***TCC***	D		[D / A / B / C / I / VI / EI / MI / SI]			
	→	***BI***	Disable		[Disable / Enable]			
	→	***Trg***	Enable		[Disable / Enable]			
TripLev	→	***Io>***	0.10	Ion	(0.01 ÷ 4.00)	step	0.01	Ion
Timers	→	***tIo>***	2.00	s	(0.05 ÷ 60.00)	step	0.01	s

Description of variables

FuncEnab	:	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
Trg	:	Function operation triggers the oscillographic wave form capture
Io>	:	Minimum Zero Sequence Residual Current Pick-up level
tIo>	:	Trip time delay

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

FuncEnab	→		Enable		[Disable / Enable]			
Options	→	***BI***	Disable		[Disable / Enable]			
	→	***Trg***	Enable		[Disable / Enable]			
TripLev	→	***Io>>***	0.50	Ion	(0.01 ÷ 9.99)	step	0.01	Ion
Timers	→	***tIo>>***	1.00	s	(0.05 ÷ 60.00)	step	0.01	s

Description of variables

FuncEnab	:	If disable the function is disactivated
BI	:	Operation controlled by Blocking Digital Input
Trg	:	Function operation triggers the oscillographic wave form capture
Io>>	:	Minimum Zero Sequence Residual Current Pick-up level
tIo>>	:	Trip time delay

4.6 - IoH (3F51N) - Third Earth Fault protection level

FuncEnab	→		Enable		[Disable / Enable]			
Options	→	***BI***	Disable		[Disable / Enable]			
	→	***Trg***	Enable		[Disable / Enable]			
TripLev	→	***IoH***	2.00	Ion	(0.01 ÷ 9.99)	step	0.01	Ion
Timers	→	***tIoH***	0.10	s	(0.05 ÷ 60.00)	step	0.01	s

Description of variables

FuncEnab	:	If disable the function is disactivated
BI	:	Operation controlled by Blocking Digital Input
Trg	:	Function operation triggers the oscillographic wave form capture
IoH	:	Minimum Zero Sequence Residual Current Pick-up level
tIoH	:	Trip time delay

4.7 - BF (F51BF) - Breaker Failure

FuncEnab	→		Enable		[Disable / Enable]			
Options	→	***TrR***	Relay1		Relay1 – Relay2 – Relay3 – Relay4			
TripLev	→		No Param		No Parameters			
Timers	→	***tBF***	0.20	s	(0.05 ÷ 0.75)	step	0.01	s

Description of variables

FuncEnab	:	If disable the function is disactivated
TrR	:	Output relay programmed for trip command to the Circuit Breaker
tBF	:	Trip time delay

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 "BF" function is operated (relay another than TrR).

4.8 - RTD - Remote Trip

Remote trip is controlled via the Digital Input D2.

FuncEnab	→	Disable	[Disable / Enable]
Options	→	No Param	No Parameters
TripLev	→	No Param	No Parameters
Timers	→	No Param	No Parameters

Description of variables

FuncEnab	:	If disable the function is disactivated

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

FuncEnab	→		No Param	No Parameters
Options	→	**OpI**	NoTrip	[NoTrip / Trip]
TripLev	→		No Param	No Parameters
Timers	→		No Param	No Parameters

Description of variables

OpI	:	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).

4.10 – F86 – Lockout

The function it is used to latch the output relay until a reset command has been released.

FuncEnab	→		Enable	[Disable / Enable]
Options	→	***1I>***	Disable	[Disable / Enable]
	→	***2I>***	Disable	[Disable / Enable]
	→	***IH***	Disable	[Disable / Enable]
	→	***1Io***	Disable	[Disable / Enable]
	→	***2Io***	Disable	[Disable / Enable]
	→	***IoH***	Disable	[Disable / Enable]
	→	***IRF***	Disable	[Disable / Enable]
TripLev	→		No Param	No Parameters
Timers	→		No Param	No Parameters

Description of variables

FuncEnab	:	If disable the function is disactivated
F86	:	Time current curves
		1I> = First overcurrent element
		2I> = Second overcurrent element
		IH = Third overcurrent element
		1Io = First earth fault element
		2Io = Second earth fault element
		IoH = Third earth fault element
		IRF = Internal Relay Fault

4.11 - Osc - Oscillographic Recording

FuncEnab	→		Enable		[Disable / Enable]			
Options	→	**Trg**	Trip		[Disable / Start / Trip / Ext.Inp.]			
TripLev	→		No Param		No Parameters			
Timers	→	**tPre**	0.30	s	(0.10 ÷ 0.50)	step	0.1	s
	→	**tPost**	0.30	s	(0.10 ÷ 1.50)	step	0.1	s

Description of variables

FuncEnab	:	If disable the function is disactivated		
Trg	:	*Disab*	=	Function Disable (no recording)
		Start.	=	Trigger on time start of protection functions
		Trip	=	Trigger on trip (time delay end) of protection functions
		Ext.Inp.	=	Trigger from the Digital Input D3
tPre	:	Recording time before Trigger		
tPost	:	Recording time after Trigger		

When the option "Start" or "Trip" is selected:

The oscillographic recording is started respectively by the "Time Start" or by the "Time End" of any of the functions that have been programmed to Trigger the Wave Form Capture (I>, I>>, IH, Io>, Io>>, IoH).

The "Osc" Function includes the wave Form Capture of the input quantities (IA, IB, IC, Io) 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 events stored cannot exceed ten (10 x 0.3 sec).
Any new event beyond the 3 sec capacity of the memory, cancel and overwrites the former records (FIFO Memory).

4.12 - Comm – Communication Parameters

FuncEnab	→	No Param	No Parameters
Options	→ ***Lbd***	9600	[9600 / 19200 / 38400]
	→ ***Rbd***	9600	[9600 / 19200]
	→ ***Rmd***	8,n,1	[8,n,1 / 8,o,1 / 8,e,1]
	→ ***Rpr***	Modbus	[Iec103 / Modbus]
TripLev	→	No Param	No Parameters
Timers	→	No Param	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)
Rmd	:	Remote mode (communication parameters) **Note**: Any change of this setting becomes valid at the next power on
Rpr	:	Remote Protocol

4.13 - LCD – Display and Buzzer operation

FuncEnab	→	No Param	No Parameters
Options	→ ***Key***	BeepON	[BeepOFF / BeepON]
	→ ***LCD***	Auto	[Auto / On]
TripLev	→	No Param	No Parameters
Timers	→	No Param	No Parameters

Description of variables

Key	:	Buzzer "Beep" on operation of Keyboard buttons.
LCD	:	LCD Backlight continuously "ON" or switched-on Automatically on operation of Keyboard buttons.

5. Logic Blocking of Functions

5.1 - Blocking output

The instantaneous element of each of the protection functions (1F50, 2F50, 3F50, 1F50N, 2F50N, 3F50N) 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 system
. As above explained, in case of Breaker Failure, the blocking output is released, and the back-up protection enabled.

5.2 – Blocking Input

The time delayed tripping of any of the Protection functions (1F51, 2F51, 3F51, 1F51N, 2F51N, 3F51N) can be controlled by the activation of the Digital Input D1 (BI=Enable): in this case the set trip time delay of the function is increased by "2xtBF" so that other Protection Relays (set with the same trip time delay) that send the activation signal to the blocking Input D2, can trip before open and the C/B nearest to the Fault.
Also in this case, however, another "2xtBF" seconds from the expiry of the set trip time delay, the blocking input is disregarded so allowing the protection relay to trip in case of Failure to open of the upstream Circuit Breaker.

6. Output Relays

Four user programmable Output Relays are normally available R1, R2, R3, R4.
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 and Internal Relay Fault.
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).
As an option (to be required when ordering the relay), the output relay "R4" can be replaced by a Field Bus output (CANBUS) that controls additional I/O modules for increasing as needed the number of user programmable Output Relays and Digital Inputs controlled from the MC relay.

7. Digital Inputs

Three optoisolated, selfpowered Digital Inputs D1, D2, D3 are provided.
A Digital Input is activated when its terminals are shorted by a cold contact.

D1	(Terminals 22 - 19)	:	It is usable as Function Blocking Input
D2	(Terminals 22 - 21)	:	It is used for Remote Trip
D3	(Terminals 22 - 20)	:	The digital Input indicates the position of the Circuit Breaker (Input Closed = C/B closed; Input Open = C/B open). If the option External Trigger = Enabled any time the DI passed from closed to open the oscillographic recording is started.

8. Self-diagnostic

The MC incorporates a sophisticated selfdiagnostic 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 operation is stored in the "Event Records" and the I.R.F. signal led is set to flashing.
If "I.R.F." is programmed to "NO Trip", and only the I.R.F. signal led is set to flashing.

9. 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.

10. 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

11. Keyboard Buttons

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

This button is besides used for the control of Open/Close C/B (see § Command).

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 -

12. Serial Communication Port

12.1 - 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 recommended.
(Please ask Microelettrica for accessories)

12.2 - 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.

13. Menu and Variables

13.1 - 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
IB	=	0 – 65535	A	RMS value of Phase B current
IC	=	0 – 65535	A	RMS value of Phase C current
Io	=	0.0 – 6553.5	A	RMS value of Zero Sequence Current (RMS Primary Amps)

13.2 - Meas (Instantaneous Measurements)

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

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

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)

13.3 - Counter (Operation Counters)

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

"**R**eal **T**ime **M**eas"
"Counter"
"1st counters" other counters
to go back to "Counter"

Display			Description
I>	=	0 – 65535	Number of 1st Overcurrent (time delayed) trip
I>>	=	0 – 65535	Number of 2nd Overcurrent (time delayed) trip
IH	=	0 – 65535	Number of 3rd Overcurrent (time delayed) trip
Io>	=	0 – 65535	Number of 1st time delayed Earth Fault trip
Io>>	=	0 – 65535	Number of 2nd time delayed Earth Fault trip
IoH	=	0 – 65535	Number of 3rd time delayed Earth Fault trip
BF	=	0 – 65535	Number of operations of Breaker Failure
RTD	=	0 – 65535	Number of External Trip commands
I.R.F.	=	0 – 65535	Number of Internal Relay Faults
HR	=	0 – 65535	Number of HW recovery operations

13.4 - LastTrip (Event Recording)

The MC 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>* = *1st Overcurrent (Short Circuit)* *I>>* = *2nd Overcurrent (Short Circuit)* *IH* = *3rd Overcurrent (Short Circuit)* *Io>* = *1st Earth Fault* *Io>>* = *2nd Earth Fault* *IoH* = *3rd Earth Fault* *RTD* = *External Trip commands* *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)

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

13.5 - R/W Set (Programming / Reading the Relay Settings)

"Main Menu"
select "Function"
select among following sub menus:

13.5.1 - CommAdd (Communication Address)

"Common"
"Add: #"
"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*
Add:	1	Identification number for connection on serial communication bus	1	-	250	1	-

13.5.2 - Time/Date (Time/Date)

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

13.5.3 - RatedVal (Rated Input Values)

"RatedVal"
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*
I1	100	A	Rated Primary current of phase C.T.	1	-	9999	1	A
I2	1	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	-	5	1/5	A
In	100	A	Reference primary current of the relay	1	-	9999	1	A
Freq	50	Hz	System rated frequency	50	-	60	10	Hz

13.5.4 - Function (Functions)

"Function",
1st function,
to scroll available Functions,
to Read/Write setting of the selected function,
to select the different definable fields - FuncEnab - TripLev - Options - Timers

to access the selected field and read the actual setting of the relevant variable
to modify the actual setting;
to set the new value.
to validate. Set Done!

Function	Type	Display	Variable	Default Setting	Unit	Description	Setting Range	Step
Password		=	0000-9999	1111	-	Password for programming enable (see § Password)		
I>	FuncEnab	→		Enable		Enable of the protection function	Enable/Disable	-
(1F51)	Options	→	*TCC*	D		Time Current Curves	D,A,B,C, I, VI, EI, MI, SI	-
			BI	Disable		Operation controlled by Blocking Digital Input	Enable/Disable	-
			Trg	Enable		Function operation triggers the oscillographic wave form capture	Enable/Disable	-
	TripLev	→	*I>*	0.50	In	Trip level of overcurrent protection	0.10 – 4.00	0.01
	Timers	→	*tI>*	2.00	s	Trip time delay	0.05 – 60.00	0.01
I>>	FuncEnab	→		Enable		Enable of the protection function	Enable/Disable	-
(2F51)	Options	→	*BI*	Disable		Operation controlled by Blocking Digital Input	Enable/Disable	-
			2xI	Disable		Automatic threshold doubling on inrush	Enable/Disable	-
			Trg	Enable		Function operation triggers the oscillographic wave form capture	Enable/Disable	-
	TripLev	→	*I>>*	2.00	In	Trip level of overcurrent protection	0.50 – 40.00	0.01
	Timers	→	*tI>>*	1.00	s	Trip time delay	0.05 – 60.00	0.01
			t2xI	0.10	s	Trip time delay Automatic threshold doubling	0.02 – 9.99	0.01
IH	FuncEnab	→		Enable		Enable of the protection function	Enable/Disable	-
(3F51)	Options	→	*BI*	Disable		Operation controlled by Blocking Digital Input	Enable/Disable	-
			2xI	Enable		Automatic threshold doubling on inrush	Enable/Disable	-
			Trg	Enable		Function operation triggers the oscillographic wave form capture	Enable/Disable	-
	TripLev	→	*IH*	0.50	In	Trip level of overcurrent protection	0.50 – 40.00	0.01
	Timers	→	*tIH*	0.05	s	Trip time delay	0.05 – 60.00	0.01
			t2xI	0.10	s	Trip time delay Automatic threshold doubling	0.02 – 9.99	0.01
Io>	FuncEnab	→		Enable		Enable of the protection function	Enable/Disable	-
(1F51N)	Options	→	*TCC*	D		Time Current Curves	D,A,B,C, I, VI, EI, MI, SI	-
			BI	Disable		Operation controlled by Blocking Digital Input	Enable/Disable	-
			Trg	Enable		Function operation triggers the oscillographic wave form capture	Enable/Disable	-
	TripLev	→	*Io>*	0.10	Ion	Trip level of Earth Fault protection	0.01 – 4.00	0.01
	Timers	→	*tIo>*	2.00	s	Trip time delay	0.05 – 60.00	0.01
Io>>	FuncEnab	→		Enable		Enable of the protection function	Enable/Disable	-
(2F51N)	Options	→	*BI*	Disable		Operation controlled by Blocking Digital Input	Enable/Disable	-
			Trg	Enable		Function operation triggers the oscillographic wave form capture	Enable/Disable	-
	TripLev	→	*Io>>*	0.50	Ion	Trip level of Earth Fault protection	0.01 – 9.99	0.01
	Timers	→	*tIo>>*	1.00	s	Trip time delay	0.05 – 60.00	0.01
IoH	FuncEnab	→		Enable		Enable of the protection function	Enable/Disable	-
(3F51N)	Options	→	*BI*	Disable		Operation controlled by Blocking Digital Input	Enable/Disable	-
			Trg	Enable		Function operation triggers the oscillographic wave form capture	Enable/Disable	-
	TripLev	→	*IoH*	2.00	Ion	Trip level of Earth Fault protection	0.01 – 9.99	0.01
	Timers	→	*tIoH*	0.10	s	Trip time delay	0.05 – 60.00	0.01

Function	Type	Display	Variable	Default Value	Unit	Description	Setting Range	Step
BF (F51BF)	*FuncEnab*	→		Enable		Enable of the protection function	Enable/Disable	-
	Options	→	*TrR*	Relay1		Output relay operated on BF tripping	Relay1- Relay2 Relay3- Relay4	-
	TripLev	→		No Param		No Parameters		
	Timers	→	*tBF*	0.20	s	Time delay for Breaker Failure alarm	0.05 – 0.75	0.01
RTD	*FuncEnab*	→		Disable		Enable of the protection function	Enable/Disable	-
	Options	→		No Param		No Parameters		
	TripLev	→		No Param		No Parameters		
	Timers	→		No Param		No Parameters		
IRF	*FuncEnab*	→		Enable		Enable of the protection function	Enable/Disable	-
	Options	→	*Opl*	NoTrip		Operation of output Relays on detection of Internal Relay Fault	NoTrip – Trip	-
				No Param		No Parameters		
	TripLev	→		No Param		No Parameters		
	Timers	→		No Param		No Parameters		
F86	*FuncEnab*	→		Enable		Enable of the protection function	Enable/Disable	-
	Options	→	*1I>*	Disable		First overcurrent element	Enable/Disable	-
			2I>	Disable		Second overcurrent element	Enable/Disable	-
			IH	Disable		Third overcurrent element	Enable/Disable	-
			1Io	Disable		First earth fault element	Enable/Disable	-
			2Io	Disable		Second earth fault element	Enable/Disable	-
			IoH	Disable		Third earth fault element	Enable/Disable	-
			IRF	Disable		Internal Relay Fault	Enable/Disable	-
	TripLev	→		No Parameters				
	Timers	→		No Parameters				
Osc	*FuncEnab*	→		Enable		Enable of the protection function	Enable/Disable	-
	Options	→	*Trg*	Trip		Trigger operation mode	Disable Start Trip Ext.Inp	-
	TripLev	→				No Parameters		
	Timers	→	*tPre*	0.30		Recording time before Trigger	0.10 – 0.50	0.1
		→	*tPost*	0.30		Recording time after Trigger	0.10 – 1.50	0.1
Comm	*FuncEnab*	→	No Parameters					
	Options	→	*Com Lbd*	9600		Local Baud Rate (Front panel RS232 communication speed)	9600 - 19200 38400	-
			Com Rbd	9600		Remote Baud Rate (Rear panel terminal blocks RS485 communication speed)	9600 - 19200	-
			Com Rmd	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	-
			Com Rpr	IEC103		Remote Protocol	IEC103-Modbus	-
	TripLev	→				No Parameters		
	Timers	→				No Parameters		
LCD	*FuncEnab*	→				No Parameters		
	Options	→	*Key*	BeepON		Buzzer "Beep" on operation of Keyboard buttons.	BeepON- BeepOFF	-
			BkL	ON		LCD Backlight continuously "ON" or switched-on Automatically on operation of Keyboard buttons.	ON - OFF	-
	TripLev	→				No Parameters		
	Timers	→				No Parameters		

Settings can also be programmed via the serial communication ports.

13.6 - RelayCfg (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	*Type*	*Display Default Value*	*Description*	*Setting Range*	*Step*
Relay1 (R1)	*Link*	→ tI>, tI>>,tIH, tIo>, tIo>>,tIoH	Association of functions to output relay R1	I> - tI> - I>> - tI>> - IH – tIH - Io> - tIo> - Io>> - tIo>> - tIoH -BF - RTD – IRF – HwRec – CBopen - CBclose	-
	OpMode	→ N.D.	N.D. (Normally Deenergized) N.E. (Normally Energized)	N.D./N.E.	-
Relay2 (R2)	*Link*	→ BF	Association of functions to output relay R2	I> - tI> - I>> - tI>> - IH – tIH - Io> - tIo> - Io>> - tIo>> - tIoH -BF - RTD – IRF – HwRec – CBopen - CBclose	-
	OpMode	→ N.D.	N.D. (Normally Deenergized) N.E. (Normally Energized)	N.D./N.E.	-
Relay3 (R3)	*Link*	→ I>, I>>, IH, Io>, Io>>, IoH	Association of functions to output relay R3	I> - tI> - I>> - tI>> - IH – tIH - Io> - tIo> - Io>> - tIo>> - tIoH -BF - RTD – IRF – HwRec – CBopen - CBclose	-
	OpMode	→ N.D.	N.D. (Normally Deenergized) N.E. (Normally Energized)	N.D./N.E.	-
Relay4 (R4)	*Link*	→ IRF	Association of functions to output relay R4	I> - tI> - I>> - tI>> - IH – tIH - Io> - tIo> - Io>> - tIo>> - tIoH -BF - RTD – IRF – HwRec – CBopen - CBclose	-
	OpMode	→ N.E.	N.D. (Normally Deenergized) N.E. (Normally Energized)	N.D./N.E.	-

13.7 - Commands

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

Display		*Description*
Clear	:	Erase memory of Trip Counters, Event Records.
Test	:	Starts a relay diagnostic test
Reset	:	Reset after trip
CBopen	:	Manual Open - Close Breaker
CBclose	:	Manual Close - Close Breaker

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

The menu displays the Relay Model and the Firmware Version

"**R**eal **T**ime **M**eas"
"Info/Ver",
"Model XXXXXX", Model Relay
"RelayVrs ###.#.#*X*", Firmware Version
to go back to "Info&Ver".
to go back to "**R**eal **T**ime **M**eas"

14. Keyboard Operational Diagram

15. 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.

15.1 - 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.

16. 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.

17. 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.

18. Connection Diagram

17. Overall Dimensions

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

19.1 - 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

19.2 - 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).

20. 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			

Electric Rated Value		
Accuracy at reference value of influencing factors	2% In (*)	for measure
(*) In, On = Nominal Current of the System's Current Transformer	0,2% On	
	2% + to (to=20÷30ms @ 2xIs)	for times
Rated Current	In = 1A/5A - On = 1A/5A	
Current overload	400 A for 1 sec; 20A continuous	
Burden on current inputs	Phase : 0.05VA at In = 1A ; 0.2VA at In = 5A	
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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