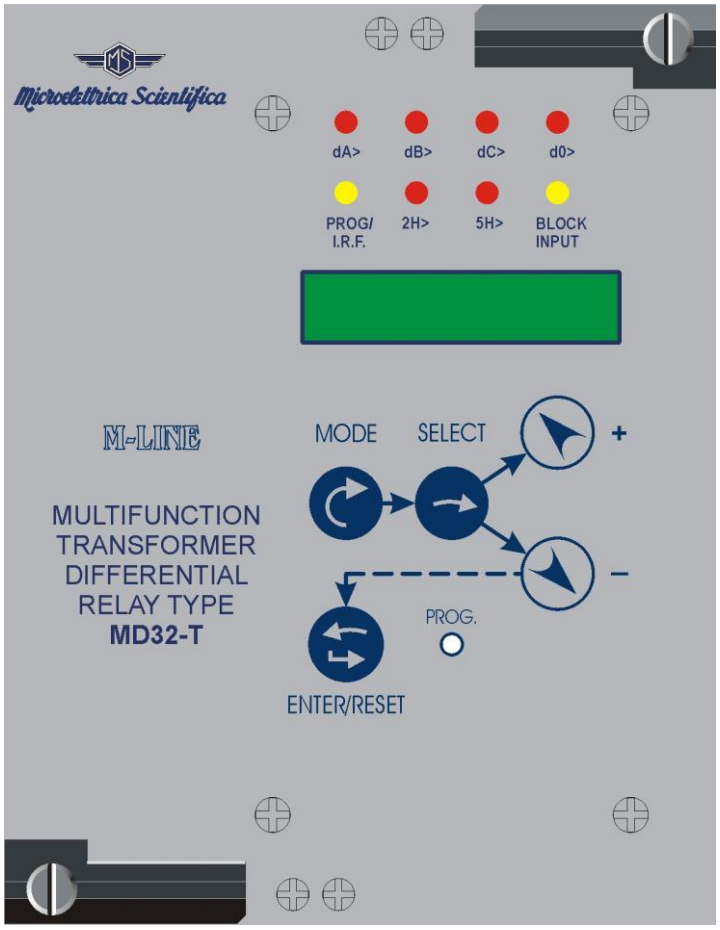
DIGITAL-MULTIFUNCTION
TRANSFORMER DIFFERENTIAL
PROTECTION RELAY

TYPE

MD32-T

OPERATION MANUAL



CE

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1. General utilization and commissioning directions

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

1.1 - Storage and Transportation

must comply with the environmental conditions stated 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.

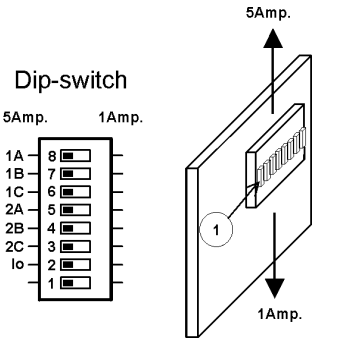
1.11 - Fault Detection and Repair

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

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

2. GENERAL

Input currents from system's CT.s are supplied to two internal sets of 3 CT.s.
An additional CT is used either for Restricted Earth Fault protection or for Neutral residual current protection (see connection diagrams).
Input rated current can be set to 1 of 5A by 7 dip-switches provided on relay's card.



2.1 - Power Supply

The auxiliary power is supplied by a built-in interchangeable module fully isolated an self protected. Two options are available :

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

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

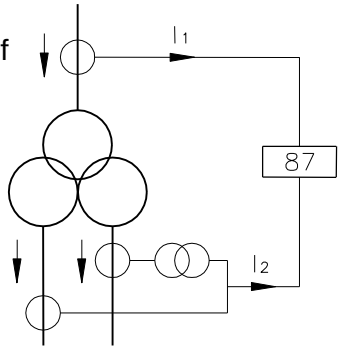
Before energising the unit check that supply voltage is within the allowed limits.

2.2 - Differential Protection F87T

The relay performs a percentage biased differential protection of two windings Power Transformers against:

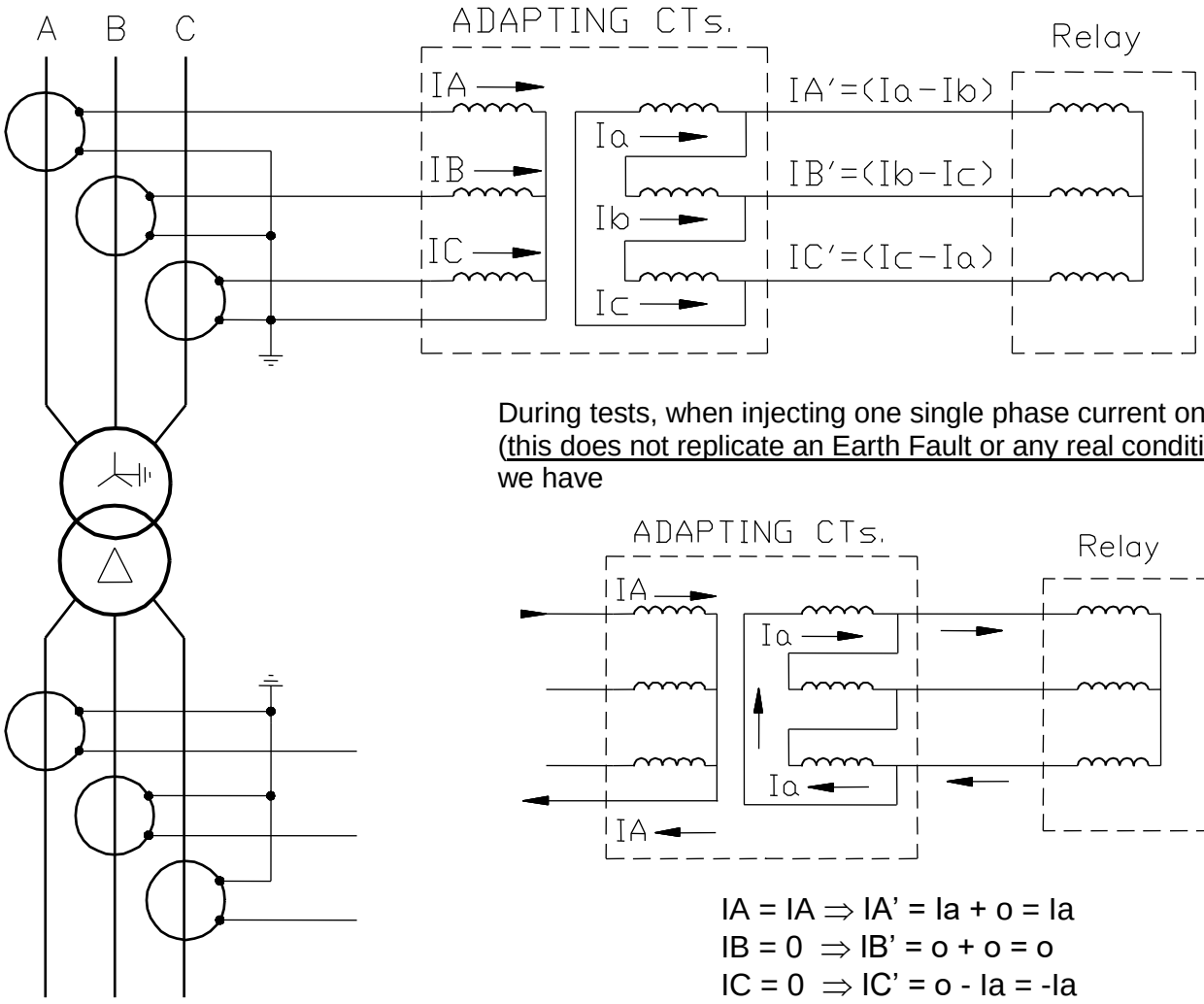
- Two or three phase internal faults
- Interturn faults
- Earth Fault in transformers with low-impedance or directly earthed neutral.
- Residual Earth Fault of Yn grounded windings

The relay can be as well used for protection of transformers having three or more windings provided that only one of the windings is connected to source of supply with the other feeding loads at different voltages.
In this application all the currents of the winding feeding loads must be summated by proper adapting transformers and then supplied to the inputs of one side of the relay, the other side being supplied only by the currents of the winding connected to the source of power



2.2.1 - CT's ratio and vector Group compensation

When protecting a two winding power transformer the relay is directly connected to the CT's on primary and secondary side: NO intermediate adapting transforms are needed.
The relay automatically compensates CT's ratio mismatch as well as phase displacement due to power transformer's vector group.
The relay internally reproduces the effect of an external set of adapting transformers also for what concerns the elimination of zero sequence current component coming out of the wye connected side of Power Transformers on external Earth Fault.
Therefore the operation of the relay is exactly the same as if an external set of adapting transformers were used. The following example shows the operation.

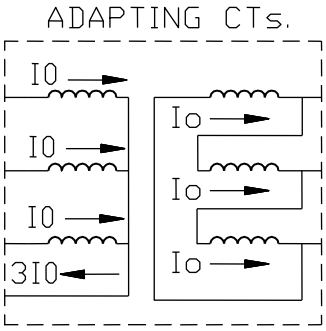


During tests, when injecting one single phase current only (this does not replicate an Earth Fault or any real condition) we have

IA = IA ⇒ IA' = Ia + o = Ia
IB = 0 ⇒ IB' = o + o = o
IC = 0 ⇒ IC' = o - Ia = -Ia

In the reality a single phase to Earth Fault on **Y** side would produce three equal currents Io in the three windings and therefore nothing out of the Delta Side

IA = I0 ⇒ IA' = Io - Io = o
IB = I0 ⇒ IB' = Io - Io = o
IC = I0 ⇒ IC' = Io - Io = o



Compensation is based on the setting of the following parameter

Fn = System frequency

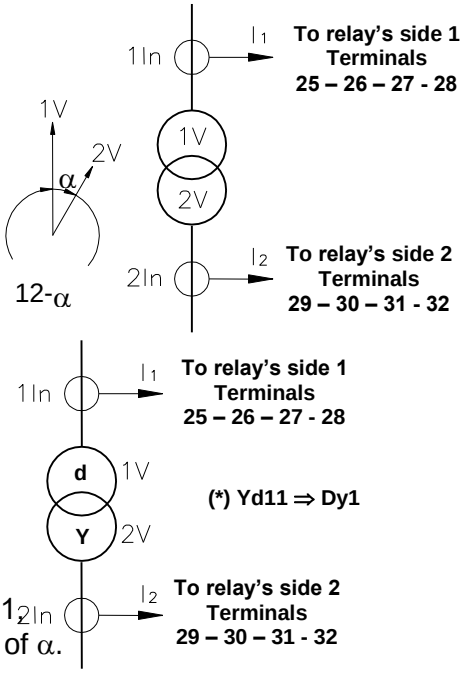
1In = Rated primary current of CT's on relay's side 1 (terminals 25-26-27-28)

2In = Rated primary current of CT's on relay's side 2 (terminals 29-30-31-32)

1V = Power Transformer's side 1 Voltage

2V = Power Transformer's side 2 Voltage

α = Vector group of Power Transformer
Yy0 – Yy6 – Dd0 – Dd6 – Dz0 – Dz6
Dy1 – Dy5 – Yd5 – Yd11 – Yz5 – Yz11
Yd1 – Yd7 – Dy7 – Dy11 – Yz1 – Yz7

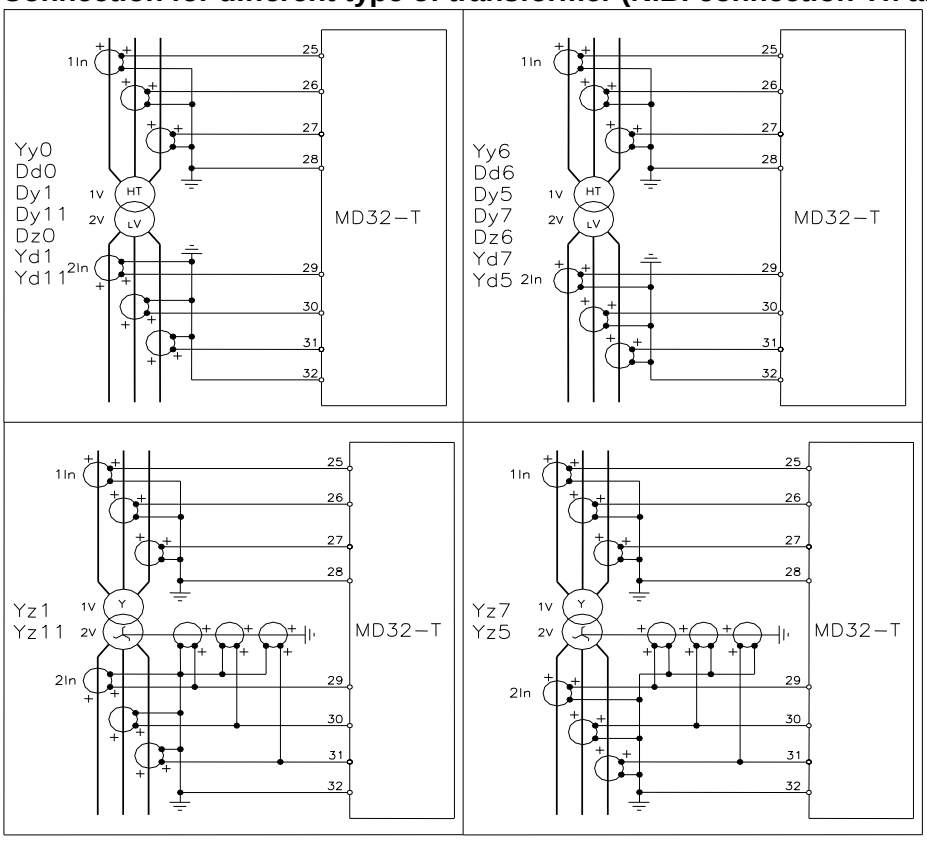


N.B.

1 - If Current Transformers of Power Transformer's High voltage windings are connected to relay's side 2 instead of relay's side 1 the relay must be programmed with Vector Group 12-α instead of α.

(*) Example: Transformer Yd11 with Y side connected to relays side 2 ⇒ Program α = Dy (12-11) = Dy1

Connection for different type of transformer (N.B. connection Yn and yn are same as Y and y)



N.B.
If Current Transformers of Power Transformer's High voltage windings are connected to relay's side 2 instead of relay's side 1, the relay must be programmed with Vector Group 12-α instead of α.

Example:

Transformer Yd11 with Y side connected to relays side 2 ⇒ Program α = Dy(12-11) = Dy1

2 – CT ratio mismatch is computed as follows $K = \frac{2In}{1In} \cdot \frac{2V}{1V}$

Theoretically, CTs should be selected so that “K” is as near as possible to “1”.
The relay MD32-T can compensate CT mismatch up to “K=2”.
Larger mismatch cannot be compensated and adapting transformers are required.
Anyhow selection of CTs on the transformer sides with ratio mismatch larger than “2” is incorrect and can cause spurious tripping even if adapting transformers are used.

2.2.2 - Low set differential level 1F87T

For each phase the relay measures :

- The R.M.S. value of the Vector Difference between side 1 current and side 2 current, internally compensated to recover CT’s ratio mismatch and Vector Group

$$dA = |\bar{I}(1A) - \bar{I}(2A) \cdot K| \qquad dB = |\bar{I}(1B) - \bar{I}(2B) \cdot K| \qquad dC = |\bar{I}(1C) - \bar{I}(2C) \cdot K|$$

- The second harmonic component **$d2_x$** and the fifth harmonic component **$d5_x$** of d_x (per unit of d_x)

d2A, d2B, d2C - d5A, d5B, d5C

- The Power Transformer’s “Through current” (per unit of rated relay’s input current In)

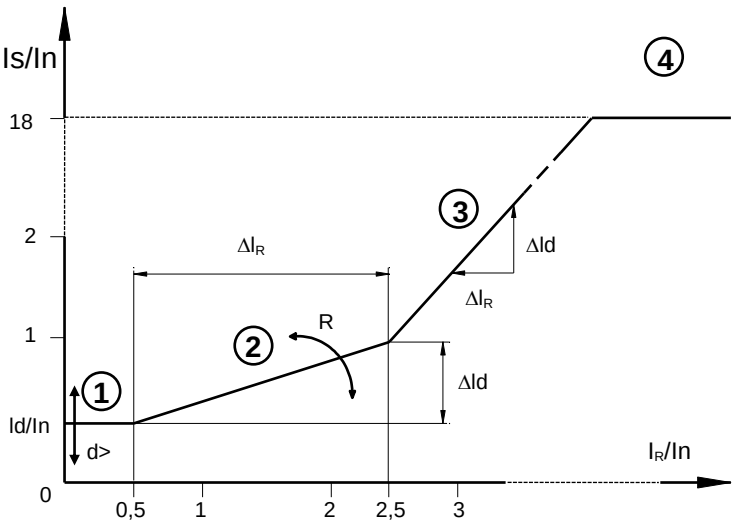
$$Ir(A) = \frac{|\bar{I}(1A)| + |\bar{I}(2A)| \cdot K}{2} \qquad Ir(B) = \frac{|\bar{I}(1B)| + |\bar{I}(2B)| \cdot K}{2} \qquad Ir(C) = \frac{|\bar{I}(1C)| + |\bar{I}(2C)| \cdot K}{2}$$

The operation is based on the above measurements and on the following programmable levels :

- Basic minimum differential pick-up level : **d>** = (0.1 - 0.5)In, step 0.01
- Second harmonic restraint level **2H** = (0.1 - 0.3)d, step 0.01
- Fifth harmonic restraint level **5H** = (0.2 - 0.4)d, step 0.01
- Percent bias level **R%** = (10 - 50)%, step 1%

To compensate differential current produced by errors of the CTs and/or to variation of the Power Transformator ratio (Voltage tap changers) the set differential current minimum pick-up level **d>** is dynamically adjusted in function of the real Through Current **Ir** depending on the set percent bias **R%**.

Fig.1



$$R\% = 100\frac{\Delta I_d}{\Delta I_R} \qquad I_R = \frac{I_1 + I_2}{2}$$

① $\frac{Is}{In} = \frac{I_d}{In}$

② $\frac{Is}{In} = \frac{I_d}{In} + (\frac{I_R}{In} - 0{,}5) \cdot \frac{R\%}{100}$

③ $\frac{Is}{In} = \frac{I_d}{In} + \frac{2R\%}{100} + (\frac{I_R}{In} - 2{,}5)$

④ $\frac{Is}{In} \cong 18$

Is= Effective relay's operation differential current
Id= Relay set differential current = [d>]
I_R= Relay's through Current

The low set differential element 1F87T operates instantaneously (less than 30ms) when the measured differential current $\mathbf{I_{dx}}$ of any phase exceeds the pick-up level **Is**, provided that the second and/or fifth harmonic components of the differential current of any phase are below the restraint levels set for **2H** and **5H**.

Trip conditions for 1F87T

$$\begin{cases} Idx \geq Is \\ d2x < [2H] \quad (x = A,B,C) \\ d5x < [5H] \end{cases}$$

Harmonic restraint is very important to avoid spurious tripping on Transformer energization, but if too sensitive, could block or delay relay's operation on real faults.

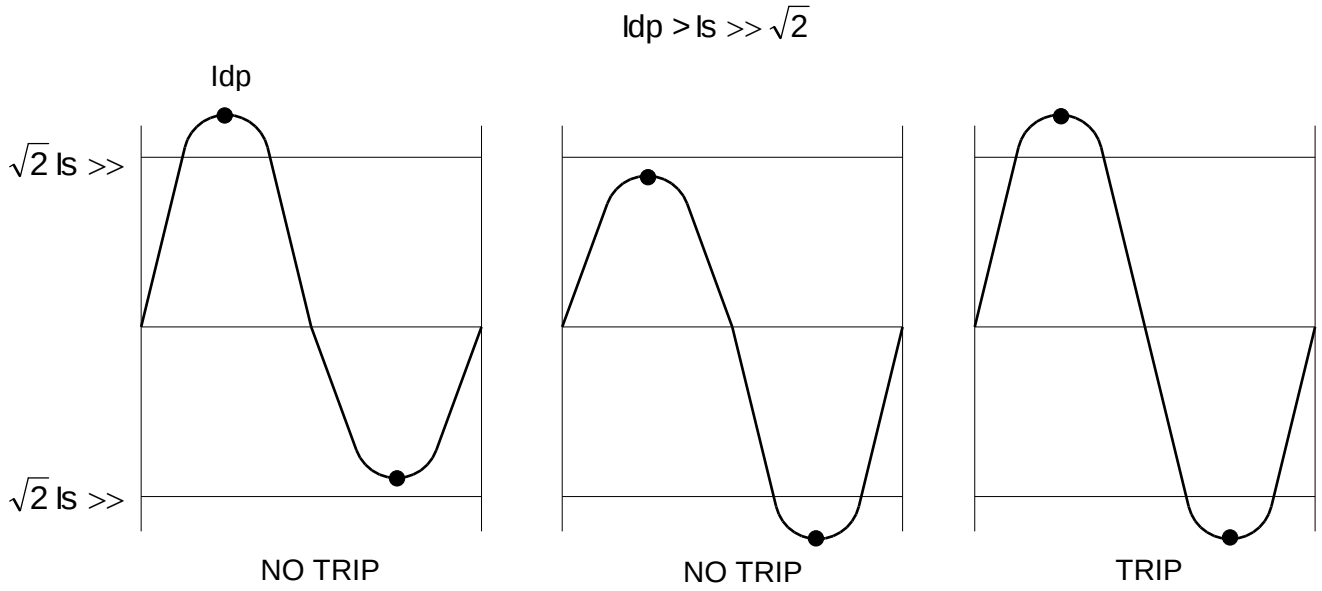
For this reason it is possible to set the threshold 2H and 5H at relatively high levels and decrease these levels only during a programmable time **tH** from Transformer's switch-on.

- Time **tH** is started on activation of relay's digital input B2 (activated by a cold N/O contact of the Main Transformer Primary Circuit Breaker) **tH** = (0.05 - 9.9)s step 0.01s
- Second harmonic restraint reduction during **tH** : **R2H** = (0.5 - 1)2H, step 0.01
- Fifth harmonic restraint reduction **tH** : **R5H** = (0.5 - 1)5H, step 0.01

  Example : **R2H** = 0.7 → during **tH** the level is 2H = 0.7 [2H]

2.2.3 - High set differential level 2F87T

For each phase the relay measures the peak value of the positive and negative wave of the differential current. The relay operates instantaneously **if both** the values are above the minimum pick-up level.



This practically avoids spurious tripping on unidirectional current component.

- Basic minimum differential pick-up level : **d>>** = (2 - 20)In, step 0.1

2.3 - Earth Fault protection F87N/F51N

The relays measures the system frequency component only of the current feeding the input terminals 32-33. Depending upon connection this element can perform:

- Restricted Earth Fault Protection of one **Y** connected winding
- Residual current protection (3Io) of one winding
- Neutral current protection of one **Y** connected winding.

The adjustable parameters are :

- Minimum pick-up level : **do>** = (0.01 - 1)Ion, step 0.01
  (Ion = Rated current of CT feeding input terminals 32-33)
- Instantaneous element : t ≤ 30ms
- Time delay element : **tdo** = (0.05 - 9.99)s, step 0.01
  (trip level do> same as instantaneous element)

The Earth Fault element can be blocked during the time tH (see § 2.2.2) by programming the variable **Bdo** :

Bdo = ON = Lock-out during tH
Bdo = OFF = Normal Operation

2.4 - Functions Blocking

Any function can be permanently disactivated setting to **Dis** the relevant variable, or temporarily blocked via the digital input B1
The operation of the blocking input B1 can be programmed to block (when activated) any of the relay functions by programming the variable B

- **B =** d>, d>>, do

any combination is possible :

B =	-	-	-
B =	d>	-	-
B =	-	d>>	-
B =	-	-	do
B =	d>	d>>	-
B =	d>	-	do
B =	d>	d>>	do
B =	-	d>>	do

2.5 - Characteristics required for C.Ts.

2.5.1 - Relay burden on inputs at rated current

- Phase inputs : **PB = 0.01VA** for C.T. 1A; **PB = 0.2VA** for C.T. 5A
- Neutral inputs : **EB = 0.02VA** for C.T. 1A; **EB = 0.3VA** for C.T. 5A

2.5.2 - C.T.'s requirements for phase differential protection

- Class 5P10 (or better)
- Minimum burden 10xPB+(R_{CT}+R_L), where: R_{CT} = Resistance of C.T.'s secondary winding
  R_L = Resistance of the loop lead between C.T. and relay plus relay internal resistance

2.5.3 - Additional requirements for R.E.F. protection

- Minimum Knee-point voltage **Vm = 2If(R_{CT}+R_L)**, where If is the maximum expected Earth Fault current (C.T.'s secondary).
- The effective minimum C.T.'s. secondary current that produces relay pick-up is:
  Ido = [do>] - 4Im, where:
  [do>] = Relay setting current
  Im = C.T. excitation current at Vm/2.

As a consequence to operate on a Fault Current **Ido** the relay setting current shall be

[do>] ≤ Ido - 4Im

2.6 - Value of the stabilising resistor

- The value of the externally mounted series resistor R is calculated as follows:

$$R = \frac{Vm/2 - EB/[do>]}{[do>]}$$

Continuously variable resistors are normally used:

- **for 1A C.T.: (0-200)Ohm 100W rated**
- **for 5A C.T.: (0-50)Ohm 100W rated**

In the unlikely case where the maximum prospective current **If** during internal Earth Fault can produce at C.T.'s terminals a voltage **Vm = If(R+R_{TC}+R_L) >2kV** a non linear voltage limiting device **Z** is available

2.7 - Clock and Calendar

The unit features a built in clock calendar with Years, Months, Days, Hours, Minutes, Seconds, Tenths of seconds and Hundredths of seconds.

2.7.1 - Clock synchronization.

The clock can be synchronized via the serial communication interface.
The following synchronization periods can be set: 5, 10, 15, 30, 60 minutes.
Synchronization can also be disabled, in which case the relay ignores the serial broadcast signal.
In case synchronization is enabled, the unit expects to receive a sync signal at the beginning of every hour and once every T_{syn} minutes. When a sync signal is received, the clock is automatically set to the nearest expected synchronization time.
For example: if T_{syn} is 10min and a sync signal is received at 20:03:10 January the 10th, 98, then the clock is set to 20:00:00 January the 10th, 1998.
On the other hand, if the same sync signal were received at 20:06:34, the clock would be set to 20:10:00, January the 10th 98.
Note that if a sync signal is received exactly in the middle of a T_{syn} period, the clock is set to the previous expected synchronization time.

2.7.2 - Date and time setting.

When the PROG/SETTINGS menu is entered, the current date is displayed with one of the groups of digits (YY, MMM or DD) blinking.
The DOWN key operates as a cursor. It moves through the groups of digits in the sequence YY => MMM => DD => YY => …
The UP key allows the user to modify the currently blinking group of digits.
If the ENTER button is pressed the currently displayed date is set.
Pressing the SELECT button the current time is displayed which can be modified using the same procedure as for the date.
If synchronization is enabled and the date (or time) is modified, the clock is stopped until a sync signal is received via the serial port. This allows the user to manually set many units and have them to start their clocks in a synchronized fashion.
If synchronization is disabled the clock is never stopped.
Note that the setting of a new time always clears 10ths and 100ths of sec.

2.7.3 - Time resolution.

The clock has a 10ms resolution. This means that any event can be time-stamped with a 10ms accuracy, although the information concerning 10ths and 100ths of sec. can be accessed only via the serial communication interface.

2.7.4 - Operation during power off.

The unit has an on board Real Time Clock which maintains time information for at least 1 hour in case of power supply failure.

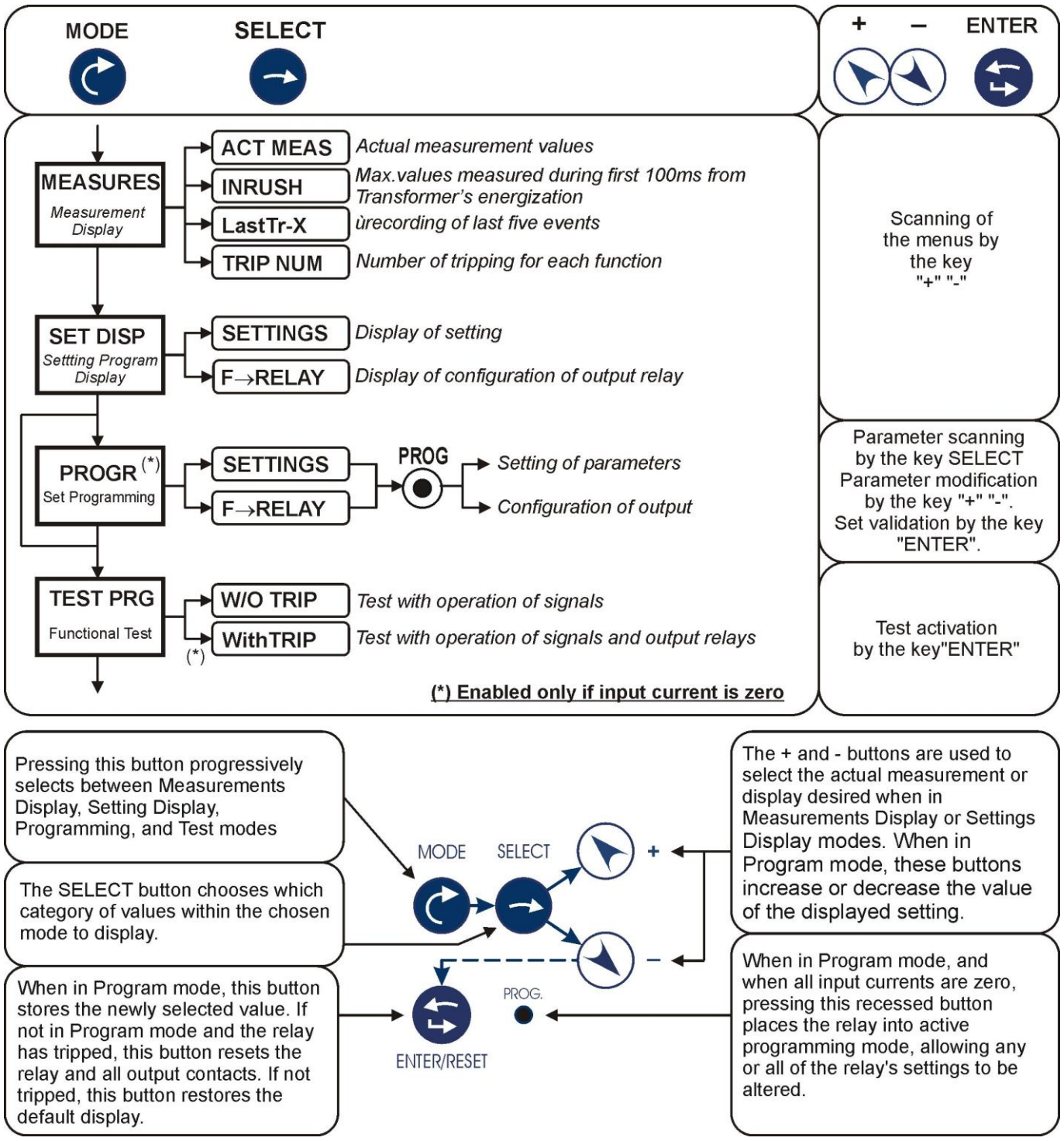
2.7.5 - Time tolerance.

During power on, time tolerance depends on the on board crystal (+/-50ppm typ, +/-100ppm max. over full temperature range).
During power off, time tolerance depends on the RTC's oscillator (+65 /–270 ppm max over full temperature range).

3. CONTROLS AND MEASUREMENTS

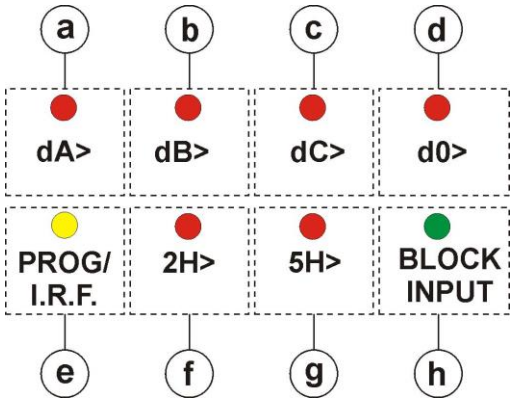
Five key buttons allow for local management of all relay's functions.
A 8-digit high brightness alphanumerical display shows the relevant readings **(xxxxxxxx)**
(see synoptic table fig.1)

FIG.1



4. SIGNALIZATIONS

Eight signal leds (normally off) provide the following information:



a)	Red LED	**dA>**	❑	Illuminated on tripping of differential elements phase A (d> and/or d>>)
b)	Red LED	**dB>**	❑	Illuminated on tripping of differential elements phase B (d> and/or d>>)
c)	Red LED	**dC>**	❑	Illuminated on tripping of differential elements phase C (d> and/or d>>)
d)	Red LED	**d0>**	❑ ❑	Illuminated on tripping of the earth fault element (Io>[do>]) Flashing during the time delay tdo
e)	Yellow LED	**PROG/ I.R.F.**	❑	Flashing during the programming of the parameters or in case of Internal Relay Fault.
f)	Red LED	**2H>**	❑	Illuminated when 2nd harmonic component of differential current in any phase exceeds the set level [2H]
g)	Red LED	**5H>**	❑	Illuminated when 5th harmonic component of differential current in any phase exceeds the set level [5H]
h)	Yellow LED	**BLOCK INPUT**	❑	Flashing when digital input B1 is activated

The reset of the leds takes place as follows:

- ❑ From flashing to off, automatically when the lit-on cause disappears.
- ❑ From ON to OFF, by "ENTER/RESET" push button only if the tripping cause has disappeared.

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

5. OUTPUT RELAYS

Five output relays are available (R1, R2, R3, R4, R5)

a) The relays **R1,R2,R3,R4** are normally deenergized (energized on trip): these output relays are user programmable and any of them can be associated to any of the MD32's functions.
For function **do>** both instantaneous and time delayed elements are provided.
Any relay associated to of any function picks-up as soon as the measured input value gets into the operation zone.
The reset after tripping of the relays (when tripping cause has been cleared) can be programmed as Manual or Automatic (Variable FRes=Man/Aut).
FRes = Aut : Automatic Reset as soon as pick-up cause has been cleared.
FRes = Man : Reset by ENT/RESET KEY on relay's front or via serial port

b) The relay **R5**, normally energized, is not programmable and it is deenergized on:

- internal fault
- power supply failure
- during the programming

6. SERIAL COMMUNICATION

The relays fitted with the serial communication option can be connected via a cable bus or (with proper adapters) a fiber optic bus for interfacing with a Personal Computer (type IBM or compatible).
All the operations which can be performed locally (for example reading of measured data and changing of relay's settings) are also possible via the serial communication interface.
Furthermore the serial port allows the user to read the demand recording data.
The unit has a RS232 / RS485 interface and can be connected either directly to a P.C. via a dedicated cable or to a RS485 serial bus, thus having many relays to exchange data with a single master P.C. using the same physical serial line. A RS485/232 converter is available on request.
The communication protocol is MODBUS RTU (only functions 3, 4 and 16 are implemented).
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 95/98/NT4 SP3 (or later) is available.
Please refer to the MSCom instruction manual for more information Microelettrica Scientifica.

7. OSCILLOGRAPHY RECORDS

The relay continuously records in a buffer the samples of the six input phase currents and the residual zero sequence current.
The buffer contains samples for approximately 12 periods.
Recording is stopped after approximately 6 periods after a trigger signal and the content of the buffer is stored into memory.
Therefore in the memory are stored the wave forms for 6 cycles before and 6 cycles after the trigger instant.
The trigger can be operated either internally on tripping of any function d>, d>>, do>, or externally by activation of the digital input B3.
Selection between the two modes is made by programming the variable **TRG** = d>, d>>, do>, EXT
The last two oscillographic records are stored; a third trigger replaces the first of the two records.

8. DIGITAL INPUTS

Three inputs active when the relevant terminals are shorted are provided:

- **B1** (terminals 1 - 2) : For function blocking
- **B2** (terminals 1 - 3) : To activate harmonic restraint variation at inrush
- **B3** (terminals 1 - 14) : External trigger for oscillographic records

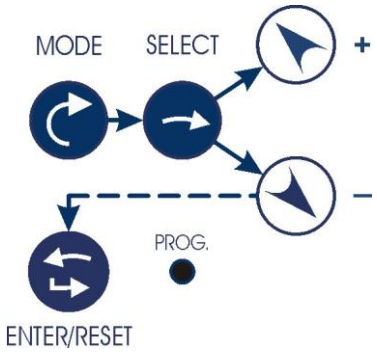
9. TEST

Besides the normal "WATCHDOG" and "POWERFAIL" functions, a comprehensive program of self-test and self-diagnostic provides:

- Diagnostic and functional test, with checking of program routines and memory's content, run every time the aux. power is switched-on: the display shows the type of relay and its version number.
- Dynamic functional test run during normal operation every 15 min. (relay's operation is suspended for less than ≤4 ms). If any internal fault is detected, the display shows a fault message, the Led "PROG/IRF" illuminates and the relay R5 is deenergized.
- Complete test activated by the keyboard or via the communication bus either with or without tripping of the output relays.

9. KEYBOARD AND DISPLAY OPERATION

All controls can be operated from relay's front or via serial communication bus.
The keyboard includes five hand operable buttons **(MODE) - (SELECT) - (+) - (-) - (ENTER/RESET)** plus one indirect operable key **(PROG)** (see synoptic table a fig.1):



a) -	**MODE**	:	When operated it enters one of the following operation modes indicated on the display :
	MEASURES	=	Reading of all the parameters measured and of those recorded in the memory
	SET DISP	=	Reading of the settings and of the configuration of the output relays as programmed.
	PROG	=	Access to the programming of the settings and of relay configuration.
	TEST PROG	=	Access to the manual test routines.
b) -	**SELECT**	:	When operated it selects one of the menus available in the actual operation MODE When in the program mode scroll the parameters.
c) -	"**+**" AND "**-**"	:	The + and - buttons are used to select the actual measurement or display desired when in Measurements Display or Settings Display modes. When in Program mode, these buttons increase or decrease the value of the displayed setting.
d) -	**ENTER/RESET**	:	It allows the validation of the programmed settings - the actuation of test programs - the forcing of the default display indication - the reset of signal Leds.
e) -	**PROG.**	:	Enables access to the programming.

11. READING OF MEASUREMENTS AND RECORDED PARAMETERS

Enter the MODE "MEASURE", SELECT the menus "ACT.MEAS"-"MAX VAL"-"LASTTRIP"-"TRIP NUM", scroll available information by key "+" or "-" .

11.1 - ACT.MEAS

Actual values as measured during the normal operation. The values displayed are continuously updated.

Display			Description
xxXXXxx			Date : Day, Month, Year
xx:xx:xx			Hour : Hours, Minutes, Seconds
dA	xx.xx	n	R.M.S. value of differential current of phase A : (0 - 99.99) per unit of rated phase input current (*)
dB	xx.xx	n	As above phase B
dC	xx.xx	n	As above phase C
do	x.xx	n	System frequency component of current Io :(0-9.99) per unit of rated phase input current
1A	xxxxx	A	R.M.S. value of phase A current at relay input 25-28: (0-99999) CT's primary Amp
1B	xxxxx	A	R.M.S. value of phase B current at relay input 26-28: (0-99999) CT's primary Amp
1C	xxxxx	A	R.M.S. value of phase C current at relay input 27-28: (0-99999) CT's primary Amp
2A	xxxxx	A	R.M.S. value of phase A current at relay input 29-32: (0-99999) CT's primary Amp
2B	xxxxx	A	R.M.S. value of phase B current at relay input 30-32: (0-99999) CT's primary Amp
2C	xxxxx	A	R.M.S. value of phase C current at relay input 31-32: (0-99999) CT's primary Amp
d2A	x.xx	d	2nd Harmonic component of differential current of phase A: (0-1.00) per unit of differential current phase A
d5A	x.xx	d	5th Harmonic component differential current of phase A: (0-1.00) per unit of differential current phase A
d2B	x.xx	d	2nd Harmonic component of differential current of phase B: (0-1.00) per unit of differential current phase B
d5B	x.xx	d	5th Harmonic component differential current of phase B: (0-1.00) per unit of differential current phase B
d2C	x.xx	d	2nd Harmonic component of differential current of phase C: (0-1.00) per unit of differential current phase C
d5C	x.xx	d	5th Harmonic component differential current of phase C: (0-1.00) per unit of differential current phase C
IR	x.xx	n	Bias through current

(*) Rated phase input current is the rated current of the CTs connected to side 1 of the relay (terminals 25 – 26 – 27 – 28).

11.2 - INRUSH

Highest inrush values recorded within the first 100ms from Breaker closing, (updated any time the breaker closes).

Display			Description
dA	xx.xx	**n**	Differential current of phase A : (0-99.99) per unit of rated phase input current
dB	xx.xx	**n**	As above phase B
dC	xx.xx	**n**	As above phase C
do	x.xx	**n**	System frequency component of current Io : (0-9.99) p.u. of rated phase input current
1A	xxxxx	**A**	Current of phase A at relay input 25-28 : (0-99.9) p.u. of rated phase input current
1B	xxxxx	**A**	Current of phase B at relay input 26-28 : (0-99.9) p.u. of rated phase input current
1C	xxxxx	**A**	Current of phase C at relay input 27-28 : (0-99.9) p.u. of rated phase input current
2A	xxxxx	**A**	Current of phase A at relay input 29-32 : (0-99.9) p.u. of rated phase input current
2B	xxxxx	**A**	Current of phase B at relay input 30-32 : (0-99.9) p.u. of rated phase input current
2C	xxxxx	**A**	Current of phase C at relay input 31-32 : (0-99.9) p.u. of rated phase input current
d2A	x.xx	**d**	2nd Harmonic component of differential current of phase A: (0-1.00) per unit of differential current phase A
d5A	x.xx	**d**	5th Harmonic component differential current of phase A: (0-1.00) per unit of differential current phase A
d2B	x.xx	**d**	2nd Harmonic component of differential current of phase B: (0-1.00) per unit of differential current phase B
d5B	x.xx	**d**	5th Harmonic component differential current of phase B: (0-1.00) per unit of differential current phase B
d2C	x.xx	**d**	2nd Harmonic component of differential current of phase C: (0-1.00) per unit of differential current phase C
d5C	x.xx	**d**	5th Harmonic component differential current of phase C: (0-1.00) per unit of differential current phase C

11.3 - LASTTRIP

Display of the function which caused the tripping of the relay plus values of the parameters at the moment of tripping. The memory buffer is refreshed at each new relay tripping.

Display			Description
LastTr-x			Indication of the recorded event (x= 0 to 4) Example: Last event (LastTr -0) Last but one event (LastTr-1) etc...
xxXXXxx			Date : Day, Month, Year
xx:xx:xx			Hour : Hours, Minutes, Seconds
Cau:	xxxx		Function which produced the event being displayed: **dA>,dB>,dC>,dA>>,dB>>,dC>>,do>**
dA	xx.xx	**n**	Differential current phase A p.u. of rated phase input current
dB	xx.xx	**n**	Differential current phase B p.u. of rated phase input current
dC	xx.xx	**n**	Differential current phase C p.u. of rated phase input current
do	x.xx	**n**	Residual current Io p.u. of rated phase input current
1A	xxxx	**n**	Current of phase A at relay input 25-28 : (0-99.9) p.u. of rated phase input current
1B	xxxx	**n**	Current of phase B at relay input 26-28 : (0-99.9) p.u. of rated phase input current
1C	xxxx	**n**	Current of phase C at relay input 27-28 : (0-99.9) p.u. of rated phase input current
2A	xx.x	**n**	Current of phase A at relay input 29-32 : (0-99.9) p.u. of rated phase input current
2B	xx.x	**n**	Current of phase B at relay input 30-32 : (0-99.9) p.u. of rated phase input current
2C	xx.x	**n**	Current of phase C at relay input 31-32 : (0-99.9) p.u. of rated phase input current

Display			Description
d2A	x.xx	**d**	2nd Harmonic component of differential current of phase A: (0-1.00) per unit of differential current phase A
d5A	x.xx	**d**	5th Harmonic component differential current of phase A: (0-1.00) per unit of differential current phase A
d2B	x.xx	**d**	2nd Harmonic component of differential current of phase B: (0-1.00) per unit of differential current phase B
d5B	x.xx	**d**	5th Harmonic component differential current of phase B: (0-1.00) per unit of differential current phase B
d2C	x.xx	**d**	2nd Harmonic component of differential current of phase C: (0-1.00) per unit of differential current phase C
d5C	x.xx	**d**	5th Harmonic component differential current of phase C: (0-1.00) per unit of differential current phase C

11.4 - TRIP NUM

Counters of the number of operations for each of the relay's function.
The memory is non-volatile and can be cancelled only with a secret procedure.

Display		Description
dA>	xxxxx	Low set differential element phase A
dB>	xxxxx	Low set differential element phase B
dC>	xxxxx	Low set differential element phase C
dA>>	xxxxx	High set differential element phase A
dB>>	xxxxx	High set differential element phase B
dC>>	xxxxx	High set differential element phase C
do>	xxxxx	Earth fault element

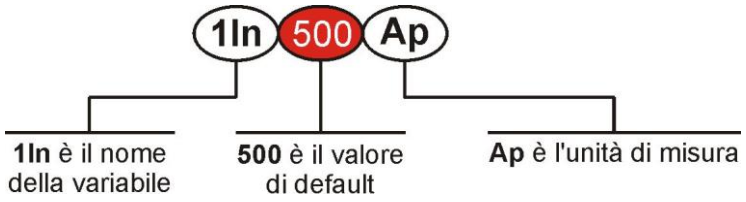
12. READING OF PROGRAMMED SETTINGS AND RELAY'S CONFIGURATION

Enter the mode "SET DISP", select the menu "SETTINGS" or "F→RELAY", scroll information available in the menu by keys "+" or "-".
SETTINGS= values of relay's operation parameters as programmed
F→RELAY= output relays associated to the different functions as programmed.

13. PROGRAMMING

The relay is supplied with the standard default programming used for factory test. [Values here below reported in the " Display " column].
All parameters can be modified as needed in the mode PROG and displayed in the mode SET DISP
Local Programming by the front face key board is enabled only if no input current is detected (main switch open).
Programming via the serial port is always enabled but a password is required to access the programming mode. The default password is the null string; in the standard application program for communication "MS-COM" it is also provided an emergency password which can be disclosed on request only.
As soon as programming is enabled, the Led PRG/IRF flashes and the reclosing lock-out relay R5 is deenergized.
Enter MODE "PROG" and SELECT either "SETTINGS" for programming of parameters or "F→RELAY" for programming of output relays configuration; enable programming by the indirect operation key PROG.
The key SELECT now scrolls the available parameters. By the key (+) , (-) the displayed values can be modified; to speed up parameter's variation press the key SELECT while "+" or "-" are pressed.
Press key "ENTER/RESET" to validate the set values.

13.1 - Programming of functions settings



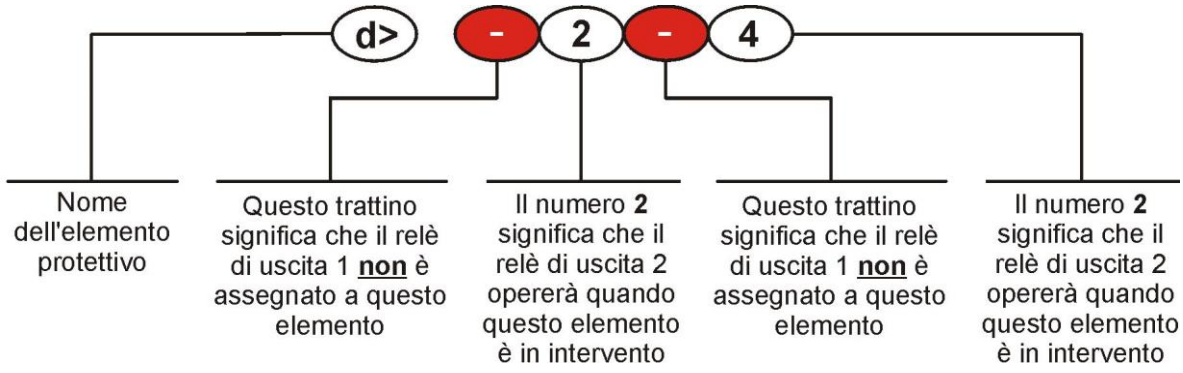
Mode PROG menu SETTINGS. (Production standard settings here under shown).

Display			Description	Setting Range	Step	Unit
xxxxxxx			Current date	DDMMMYY	-	-
xx:xx:xx			Current time	HH:MM:SS	-	-
Fn	50	**Hz**	System frequency	50 - 60	10	Hz
1In	500	**A**	Rated primary current of Cts on Transformer's side 1	1 - 9999	1	A
2In	500	**A**	Rated primary current of Cts on Transformer's side 2	1 - 9999	1	A
1V	1.00	**kV**	Rated voltage of Transformer's side 1 (phase to phase voltage)	0.20 - 380	0.01	kV
2V	1.00	**kV**	Rated voltage of Transformer's side 2 (phase to phase voltage)	0.20 - 380	0.01	k V
α	**Yy**0		Transformer connection and vector group	Yy0..... YZ0	see § 2.2.1	
d>	0.15	**n**	Basic minimum pick-up level of low set phase differential element	0.10-0.50-Dis	0.01	In
d>>	10.0	**n**	Minimum pick-up level of high set phase differential element	2.0-20.0-Dis	0.01	In
R	20	**%**	Bias percentage	10-50	1	%
2H	0.15	**d**	2nd harmonic restraint level (p.u. of measured differential current)	0.10-0.30-Dis	0.01	d
5H	0.30	**d**	5th harmonic restraint level (p.u. of measured differential current)	0.20-0.40-Dis	0.01	d

Display			Description	Setting Range	Step	Unit
R2H	1.00		Reduced 2nd harmonic restraint level during the time tH from Transformator swith-on	0.50-1.00	0.01	p.u.2H
R5H	1.00		Reduced 5th harmonic restraint level during the time tH from Transformator switch-on	0.50-1.00	0.01	p.u.5H
tH	0.50	**s**	Time during which harmonic restraint level's reduction is active	0.01-90.00	0.01	s
do>	0.10	**n**	Minimum pick-up level of Earth Fault element	0.01-1.0-Dis	0.01	In
tdo	0.50	**s**	Time delay of Earth Fault element	0.05-9.99	0.01	s
Bdo:	OFF		Earth Fault element can be blocked during tH (Bdo = ON) or active (Bdo = OFF)	ON-OFF	ON-OFF	-
B1	------		Digital input B1 blocks the function selected (dL=d> - dH=d>>)	dL - dH - do	Any combination	
Trg:	EXT		Trigger for oscillography records is Internal or External via digital input B3	EXT - d> d>> - do>	-	-
Tsyn	Dis	**m**	Synchronization Time Expected time interval between sync. pulse.	5 - 60 - Dis	5-10 15-30 60-Dis	m
NodAd	1		Identification number for connection on serial communication bus	1 - 250	1	-

The setting Dis indicates that the function is disactivated.

13.2 - Programming the configuration of output relays



Mode PROG menu F→RELAY (Production standard settings here under shown).
The key "**+**" operates as cursor; it moves through the numbers corresponding to the four programmable relays in the sequence 1,2,3,4,(1= relay R1, etc.) and makes start flashing the information actually present in the digit. The information present in the digit can be either the number of the relay (if this was already associated to the function actually on programming) or a dot (-) if the relay was not yet addressed.
The key "**-**" changes the existing status from the dot to the relay number or viceversa.
After having programmed all the four relay, press " ENTER " to validate the programmed configuration.

Display					Description	
d>	1	-	-	-	Low set differential element	operates relay R1,R2,R3,R4.
d>>	-	2	-	-	High set differential element	operates relay R1,R2,R3,R4.
do>	-	-	3	-	Instantaneous Earth Fault element	operates relay R1,R2,R3,R4.
tdo	-	-	-	4	Time delayed Earth Fault element	operates relay R1,R2,R3,R4.
FRes:	Aut				Reset of output relays after tripping is: **Aut.** = Automatic **Man.** = Manually key Enter /Reset or via serial bus	

14. MANUAL AND AUTOMATIC TEST OPERATION

14.1 - Mode "TESTPROG" subprogram "W/O TRIP"

Operation of the yellow key activates a complete test of the electronics and the process routines.
All the leds are lit-on and the display shows (TEST RUN). If the test routine is successfully completed the display switches-over to the default reading (xx:xx:xx).
If an internal fault is detected, the display shows the fault identification code and the relay R5 is deenergized. This test can be carried-out even during the operation of the relay without affecting the relay tripping in case a fault takes place during the test itself.

14.2 - Mode "TESTPROG" subprogram "WithTRIP"

Access to this program is enabled only if the current detected is zero (breaker open).
Pressing the yellow key the display shows "TEST RUN?". A second operation of the yellow key starts a complete test which also includes the activation of all the output relays.
The display shows (TEST RUN) with the same procedure as for the test with W/O TRIP.
Every 15 min during the normal operation the relay automatically initiates an auto test procedure (duration ≤ 10ms). If any internal fault is detected during the auto test, the relay R5 is deenergized, the relevant led is activated and the fault code is displayed.

⚠ WARNING

Running the **WithTRIP** test will operate all of the output relays. Care must be taken to ensure that no unexpected or harmful equipment operations will occur as a result of running this test.
It is generally recommended that this test be run only in a bench test environment or after all dangerous output connections are removed.

15. MAINTENANCE

No maintenance is required. Periodically a functional check-out can be made with the test procedures described under MANUAL TEST chapter. 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.

⚠ WARNING

In case of Internal Relay Fault detection, proceed as here-below indicated :

- If the error message displayed is one of the following “DSP Err”, “ALU Err” ,”KBD Err” ,”ADC Err”, switch off power supply and switch-on again. If the message does not disappear send the relay to Microelettrica Scientifica (or its local dealer) for repair.
- If the error message displayed is “E2P Err”,try to program any parameter and then run “W/OTRIP”
- If message disappear please check all the parameters.
- If message remains send the relay to Microelettrica Scientifica (or its local dealer) for repair.

16. 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 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 modules must be drawn-out of their enclosures and the test must only include the fixed part of the relay with its terminals and the relevant connections. 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.

17. ELECTRICAL CHARACTERISTICS

APPROVAL : CE - RINA - UL and CSA approval File : E202083
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 ENV50204	level 3	80-2000MHz 900MHz/200Hz	10V/m 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			

CHARACTERISTICS

❑ Accuracy at reference value of influencing factors	2% In for measure 0,2% On 2% +/- 10ms for times
❑ Rated Current	In = 1 or 5A - On = 1 or 5A
❑ Current overload	200 A for 1 sec; 10A continuous
❑ Burden on current inputs	Phase : 0.01VA at In = 1A; 0.2VA at In = 5A Neutral : 0.015VA at In = 1A ; 0.35VA at In = 5A
❑ Average power supply consumption	8.5 VA
❑ Output relays	rating 5 A; Vn = 380 V A.C. resistive switching = 1100W (380V max) make = 30 A (peak) 0,5 sec. break = 0.3 A, 110 Vcc, L/R = 40 ms (100.000 op.)

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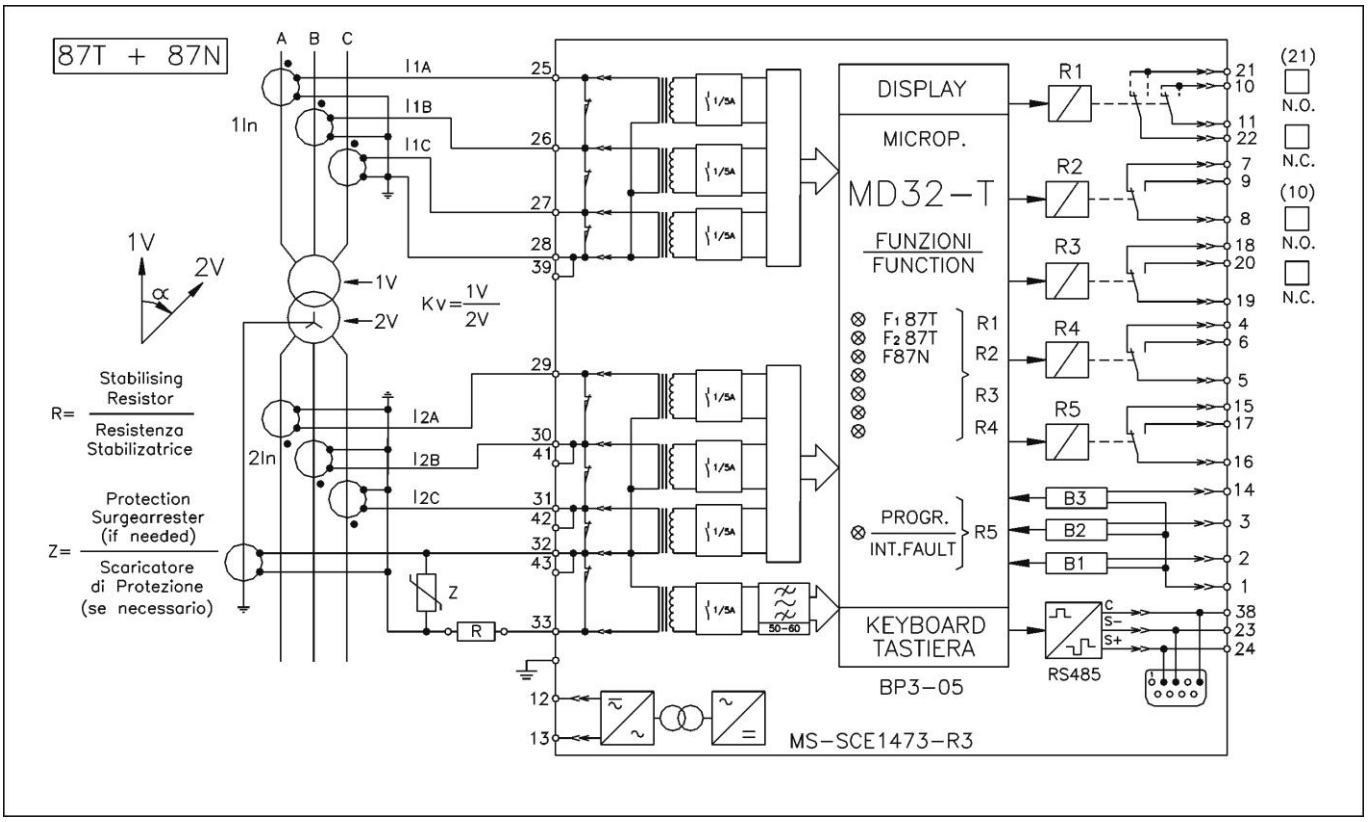
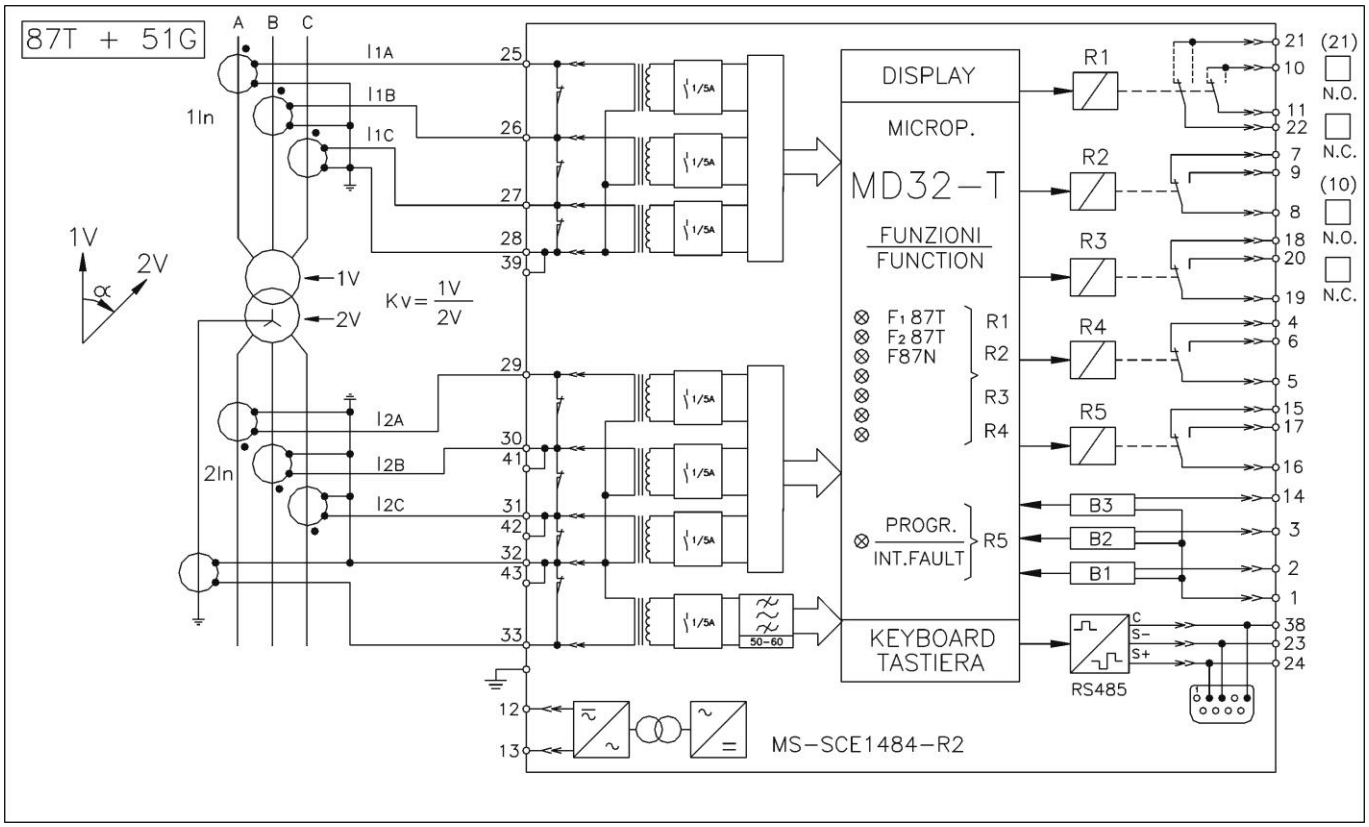
Tel. (+39) 02 575731 - Fax (+39) 02 57510940
http://www.microelettrica.com **e-mail :** sales.relays@microelettrica.com

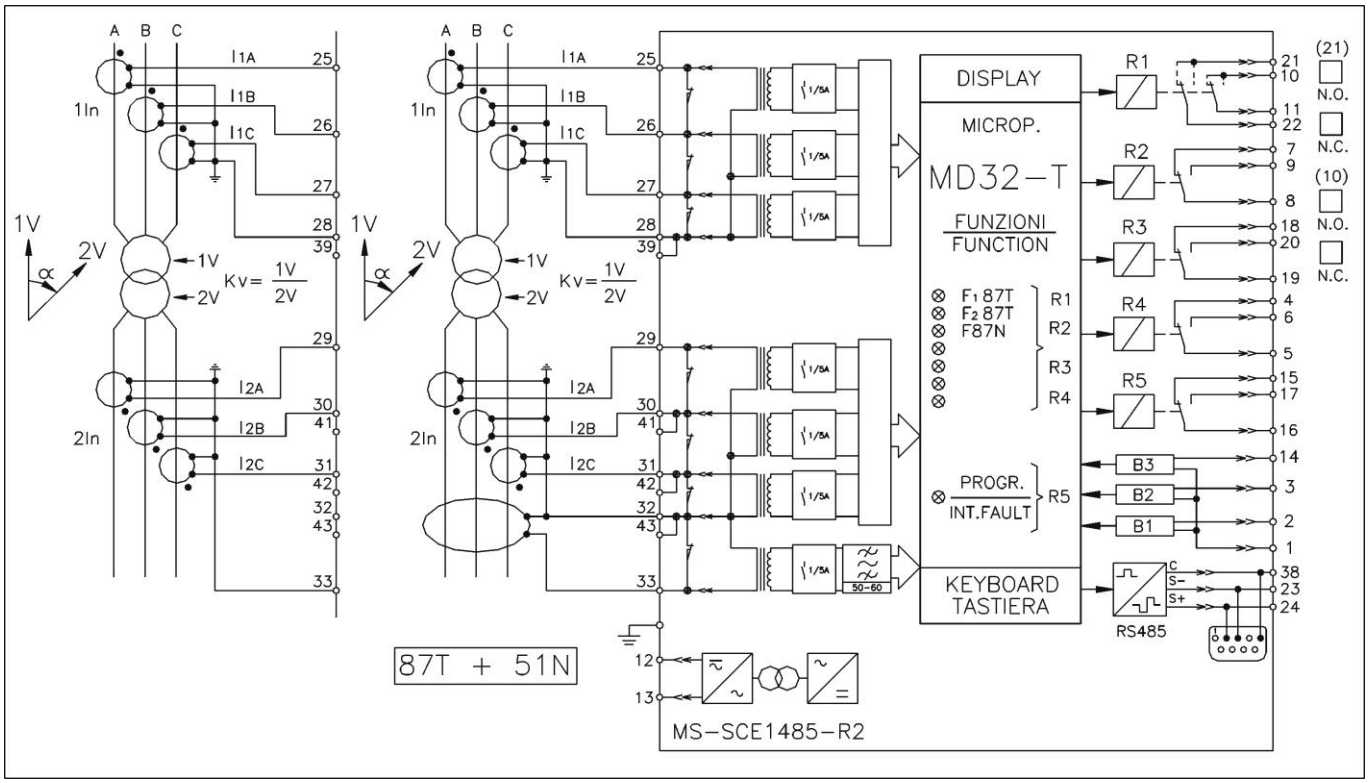
18. Connection Diagram - 87T + 87N - (SCE1473 Rev.3 Standard Output)



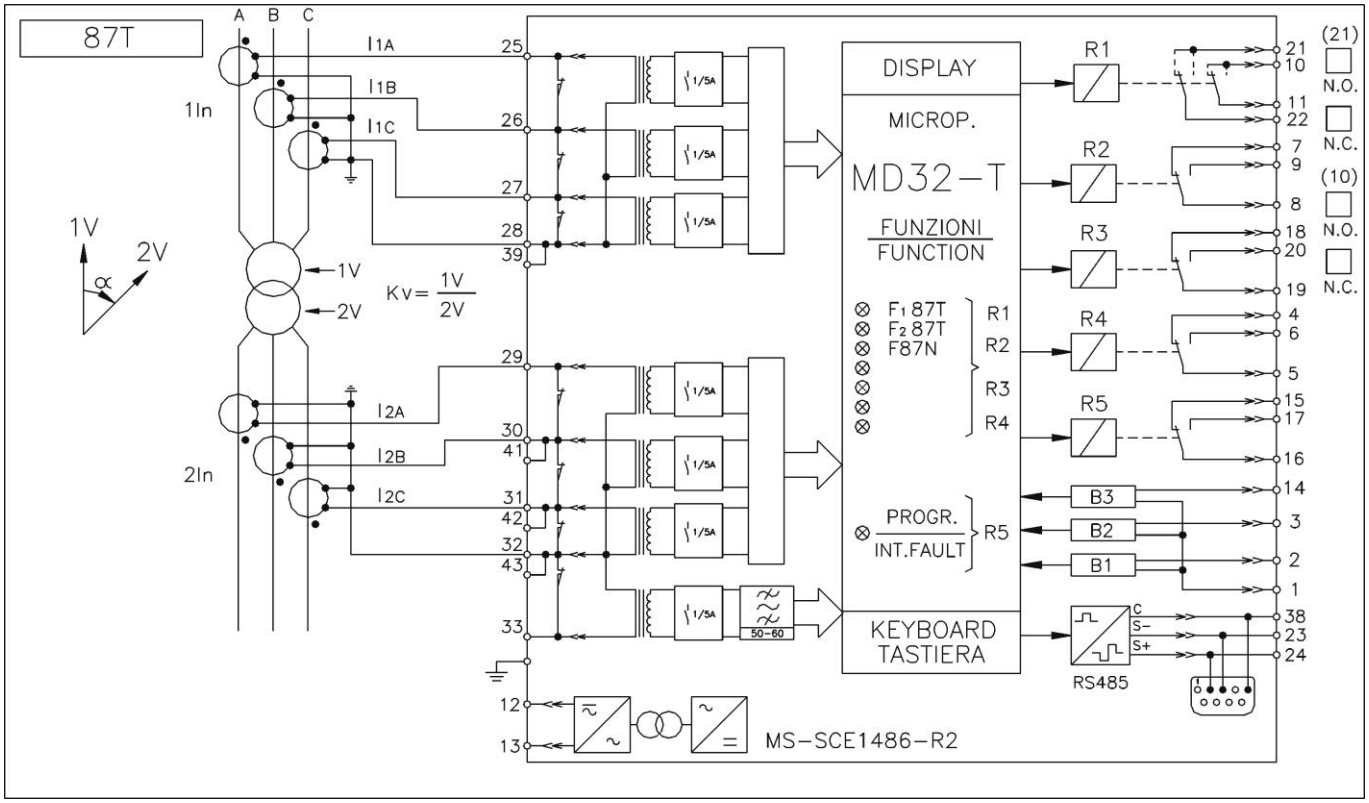
18.1 - Connection Diagram - 87T + 51G - (SCE1484 Rev.1 Standard Output)



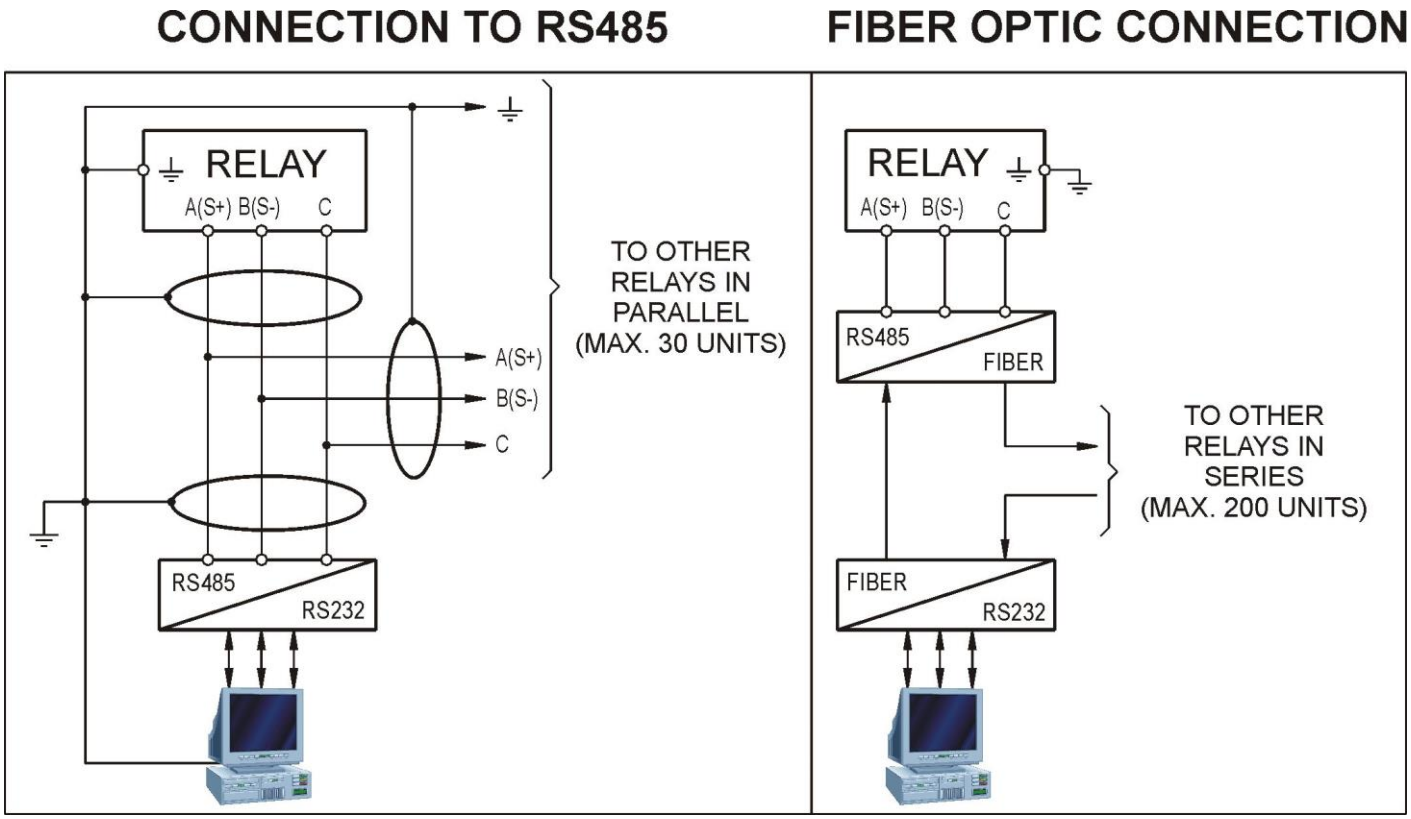
18.2 - Connection Diagram - 87T + 51N - (SCE1485 Rev.2 Standard Output)



18.4 - Connection Diagram - 87T - (SCE1486 Rev.2 Standard Output)

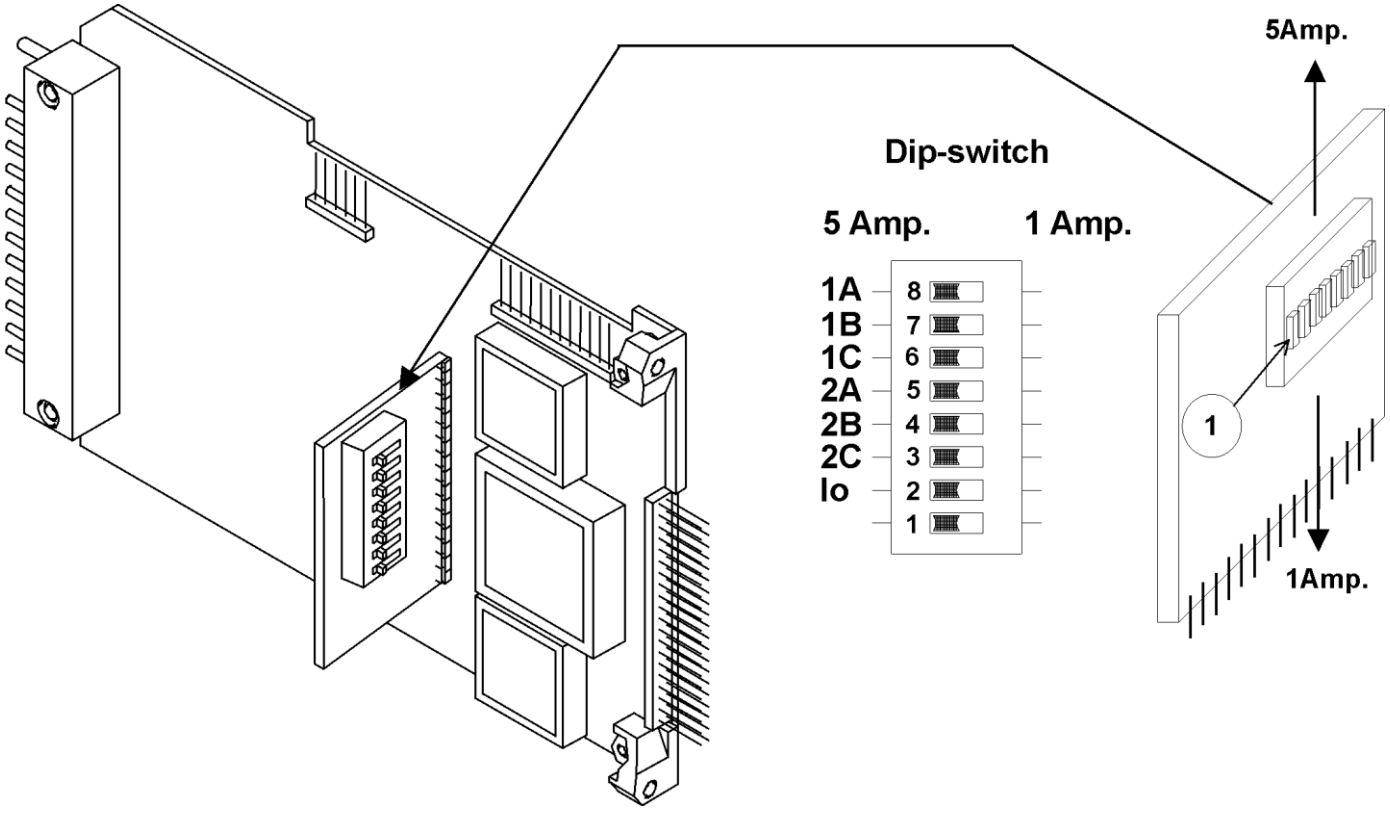


19. WIRING THE SERIAL COMMUNICATION BUS (SCE1309 Rev.0)



20. CHANGE PHASE CURRENT RATED INPUT 1 OR 5A

Phase current input can be 1 or 5A (movable jumpers on relay's card).



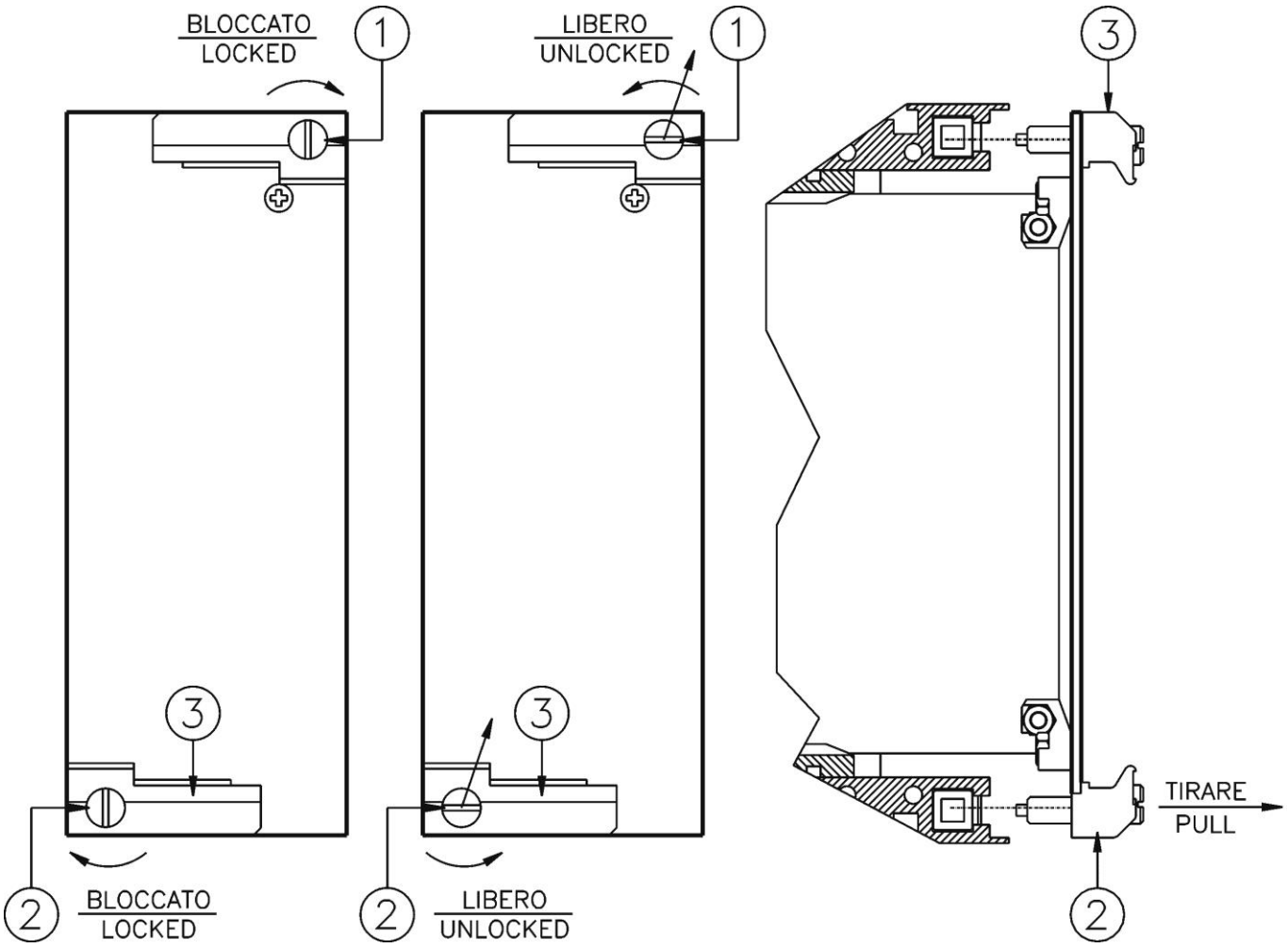
21. DIRECTION FOR PCB'S DRAW-OUT AND PLUG-IN

21.1 - Draw-out

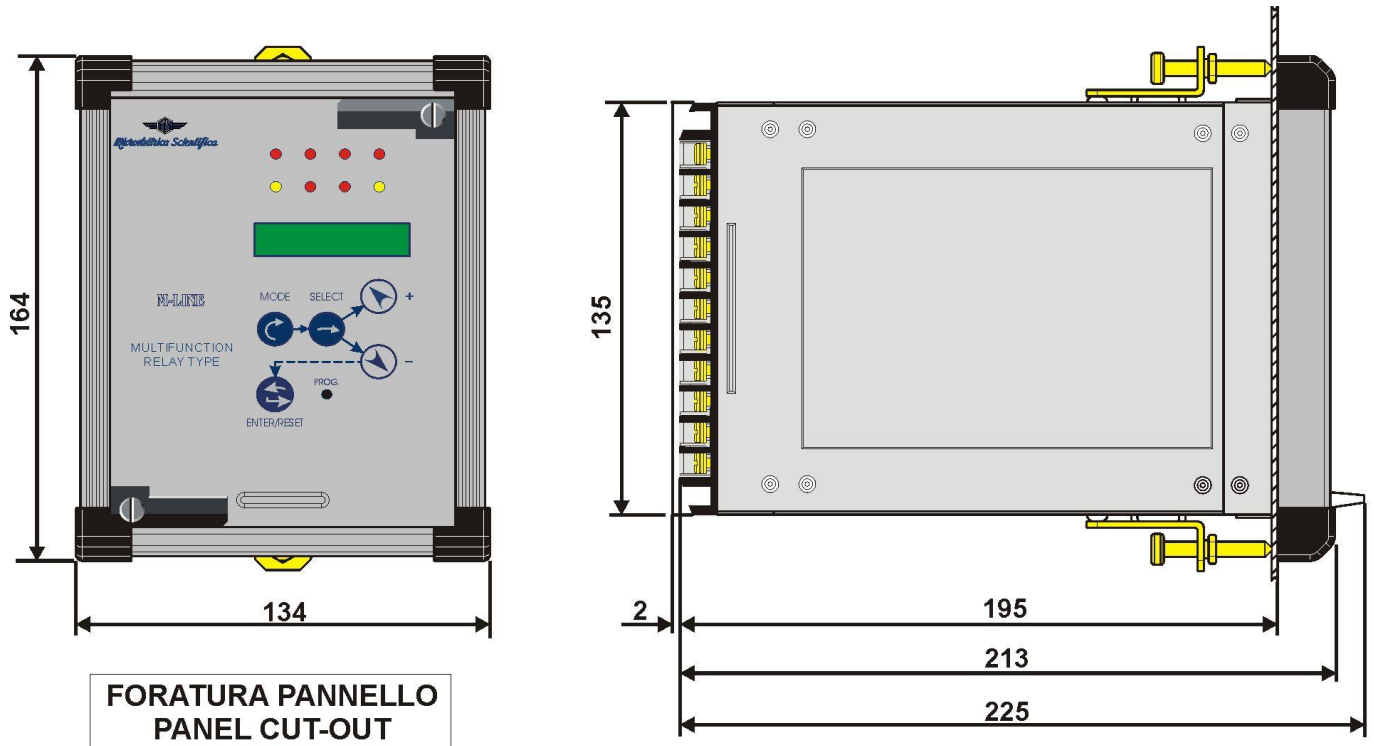
Rotate clockwise the screws ① and ② in the horizontal position of the screws-driver mark.
Draw-out the PCB by pulling on the handle ③

21.2 - Plug-in

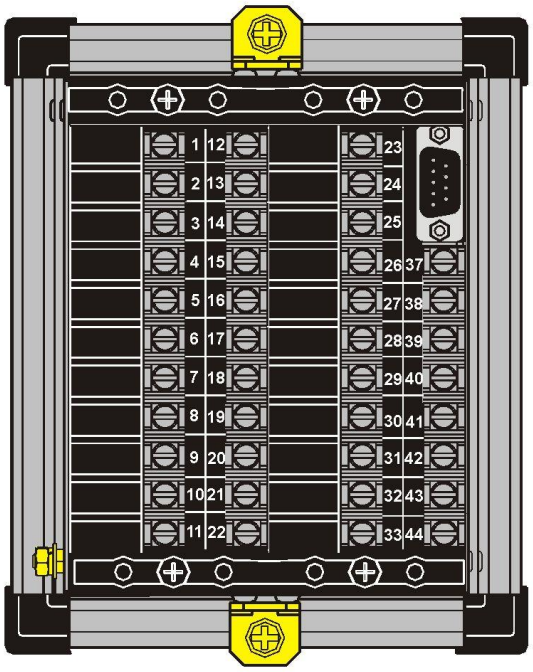
Rotate clockwise the screws ① and ②in the horizontal position of the screws-driver mark.
Slide-in the card on the rails provided inside the enclosure.
Plug-in the card completely and by pressing the handle to the closed position.
Rotate anticlockwise the screws ① and ② with the mark in the vertical position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



22. OVERALL DIMENSIONS / MOUNTING

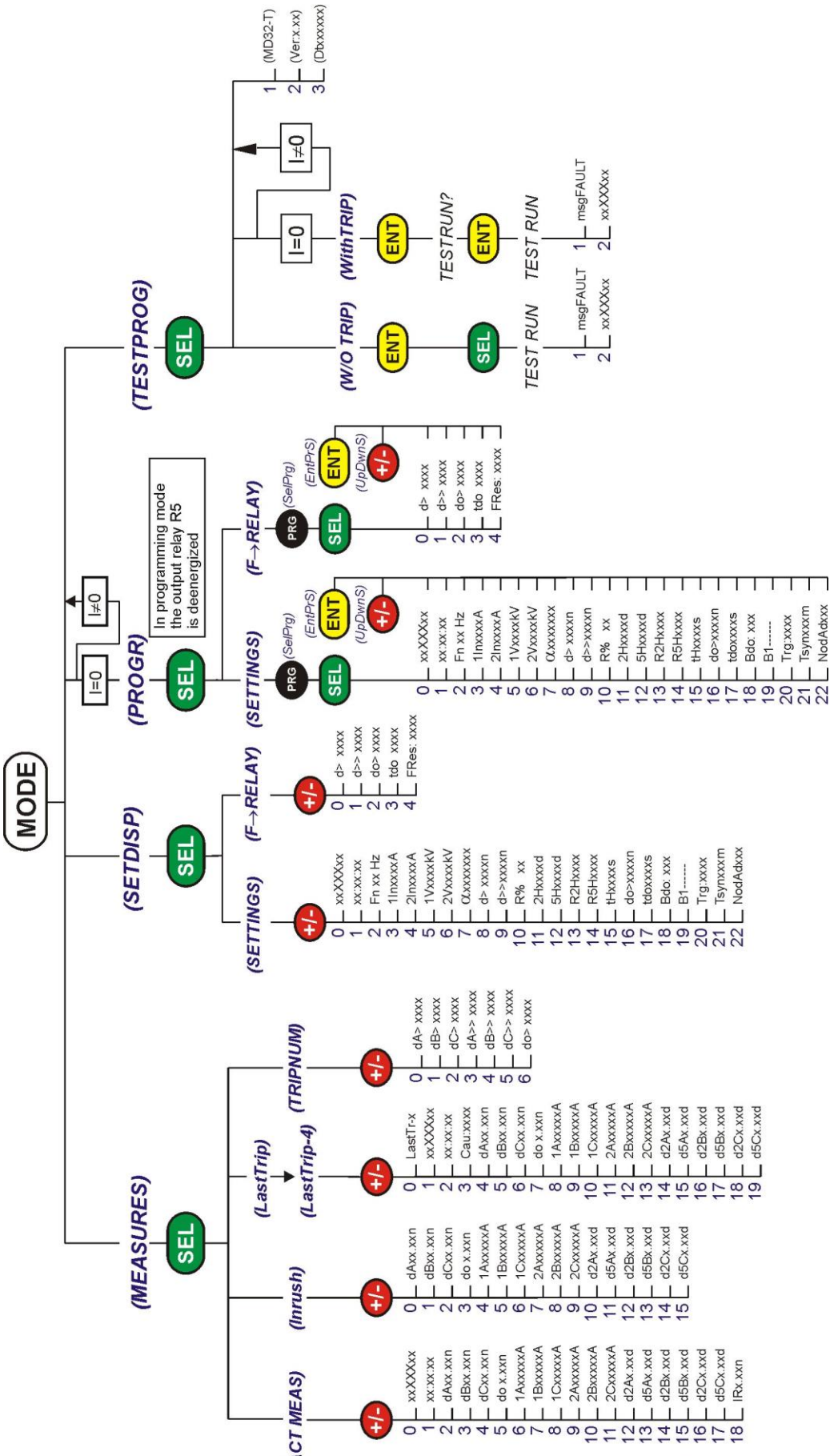


FORATURA PANNELLO
PANEL CUT-OUT
115x137 (LxH)



VISTA POSTERIORE - MORSETTI DI CONNESSIONE
VIEW OR REAR - TERMINAL CONNECTION

23. KEYBOARD OPERATIONAL DIAGRAM



24. SETTING FORM – Commissioning Test Record

Relay Type	**MD32-T**	**Station :**		**Circuit :**	
Date :	**/ /**	**FW Version:**		**Relay Serial Number :**	
Power Supply	☐ 24V(-20%) / 110V(+15%) a.c.	24V(-20%) / 125V(+20%) d.c.	**Rated Current**	☐ **1A**	☐ **5A**
	☐ 80V(-20%) / 220V(+15%) a.c.	90V(-20%) / 250V(+20%) d.c.			

RELAY PROGRAMMING

Variable	Description	Setting Range		Default Setting	Actual Setting	Test Result	
						Pick-up	Reset
xxxxxxx	Current date	DDMMMYY	**-**	Random			
xx:xx:xx	Current time	HH:MM:SS	**-**	Random			
Fn	System frequency	50 - 60	**Hz**	50			
1In	Rated primary current of Cts on Transformer's side 1	1 - 9999	**A**	500			
2In	Rated primary current of Cts on Transformer's side 2	1 - 9999	**A**	500			
1V	Rated voltage of Transformer's side 1	0.20 - 380	**kV**	1.00			
2V	Rated voltage of Transformer's side 2	0.20 - 380	**kV**	1.00			
α	Transformer connection and vector group	Yy0..... YZ0	-	**Yy**0			
d>	Basic minimum pick-up level of low set phase differ.element	0.10-0.50-Dis	**n**	0.15			
d>>	Basic minimum pick-up level of high set phase differ. elem.	2.0-20.0-Dis	**n**	10.0			
R	Bias percentage	10-50	**%**	20			
2H	2nd harmonic restraint level	0.10-0.30-Dis	**d**	0.15			
5H	5th harmonic restraint level	0.20-0.40-Dis	**d**	0.30			
R2H	Reduced 2nd harmonic restraint level during the time tH from Transformator swith-on	0.50-1.00	-	1.00			
R5H	Reduced 5th harmonic restraint level during the time tH from Transformator switch-on	0.50-1.00	-	1.00			
tH	Time during which harmonic restraint level's reduction is active	0.01-90.00	**s**	0.50			
do>	Minimum pick-up level of Earth Fault element	0.01-1.0-Dis	**n**	0.10			
tdo	Time delay of Earth Fault element	0.05-9.99	**s**	0.50			
Bdo:	Earth Fault element can be blocked during tH (Bdo = ON) or active (Bdo = OFF)	ON-OFF	-	OFF			
B1	Digital input B1 blocks the function selected	dL - dH - do	-	------			
Trg:	Trigger for oscillographic records is Internal or External via digital input B3	EXT - d> d>> - do>	-	EXT			
Tsyn	Synchronization Time	5 - 60 - Dis	**m**	Dis			
NodAd	Identification number for connection on serial comm. bus	1 - 250	-	1			

CONFIGURATION OF OUTPUT RELAYS

Default Setting					Description	Actual Setting				
Protect. Element	**Output Relays**					**Protect. Element**	**Output Relays**			
d>	1	-	-	-	Low set differential element	**d>**				
d>>	-	2	-	-	High set differential element	**d>>**				
do>	-	-	3	-	Instantaneous Earth Fault element	**do>**				
tdo	-	-	-	4	Time delayed Earth Fault element	**tdo**				
tFRes:	A				Relay reset mode A = Automatic, M = Manual	**tFRes:**				

Commissioning Engineer : _____ **Date :** _____

Customer Witness : _____ **Date :** _____