MULTIFUNCTION MICROPROCESSOR PROTECTION RELAY TYPE DM30/K DIRECTIONAL 3 PHASE OVERCURRENT + DIRECTIONAL EARTH FAULT

OPERATION MANUAL

INDEX

1. General utilisation 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 efficiency.

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 semiconducto evices

mounted on the modules can be seriously damaged by electrostatic voltage discharge which can be experienced when handling the modules.

The damage caused by electrostatic discharge may not be immediately apparent but the design reliability and the long life of the product will have been reduced.The electronic circuits produced by M.S. are completely safe from electrostatic discharge (15 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 – 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 quantities are supplied to 3 Voltage Transformers and to 4 Current Transformers (- three measuring phase current - one measuring the earth fault current)
Phase current inputs can be rated either 1 or 5A.
The voltage input is rated 100V. The zero sequence polarizing voltage is internally reconstructed.
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.
The auxiliary power is supplied by a built-in interchangeable module fully isolated an self protected.
The relay can be fitted with two different types of power supply module:

24V(-20%) / 110V(+15%) a.c. **80V(-20%) / 220V(+15%) a.c.**

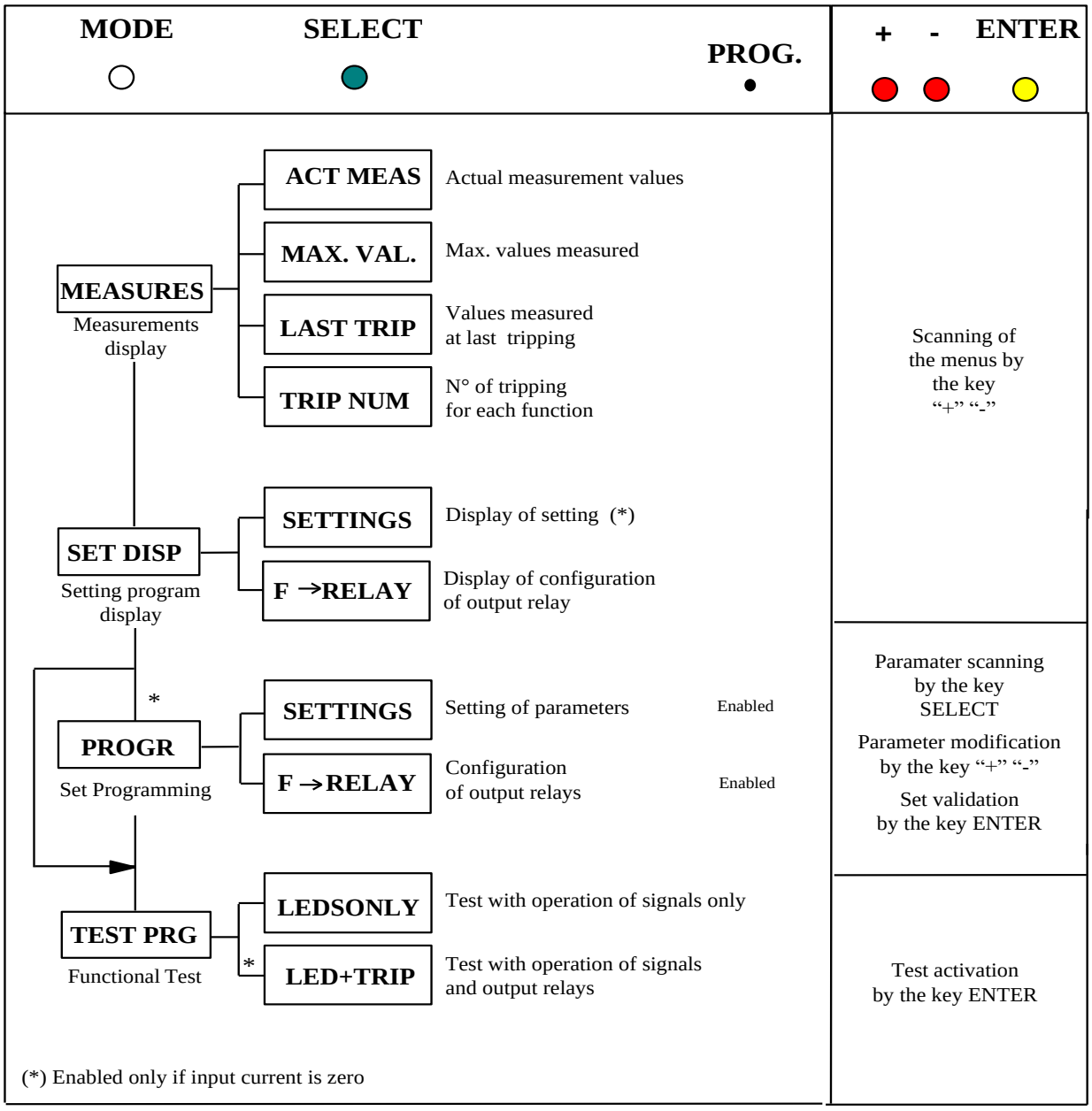
a) - **or** **b) -**

24V(-20%) / 125V(+20%) d.c. **90V(-20%) / 250V(+20%) d.c.**

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

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 **(xxxxxxx)**
(see synoptic table fig.1)



4. SIGNALIZATIONS

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

a) Red LED **I>:** Flashing when measured current overcomes the set level I>.
Illuminated on trip after expiry of the set trip time delay tI>.

b) Red LED **I>>:** same as above related to I>> and tI>>.

c) Red LED **O>:** same as above related to O> and tO>.

d) Red LED **O>>:** same, as above related to O>> and tO>>.

e) Yellow LED **PROG/IRF:**
Flashing during the programming of the parameters or in case of Internal Relay Fault.

f) Red LED **BLOCK INPUT:** Flashing when a blocking signals present at the relevant input terminals.

g) Red LED **BR. FAIL.:**
Lit-on when the BREAKER FAILURE function is activated.

h) Yellow LED **FUNC. DISAB.:**
Lit-on when the operation of one or more of the relay functions has been disactivated in the programming.

The reset of the leds takes place as follows:

- Leds a,b,c,d,g : -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.
- Leds e,f,h : -From ON to OFF, automatically when the lit-on cause disappears.

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 (energised on trip): these output relays are user programmable and any of them can be associated to any of the DM30's functions. For some function both instantaneous and time delayed elements are provided.

One relay eventually controlled by the instantaneous element of one function picks up or drops out as soon as the measured input value gets respectively into the operation or the reset zone.

When the time of the delayed element of the same function has expired, another output relay is supposed to trip the circuit breaker.

If after that time the input value still remains into the operation zone (Breaker Failure to open), the relay controlled by the instantaneous element is anyhow forced to reset after a programmable wait-time [tB0], thus eliminating any interlock of the backup protection.

The reset after tripping of the relays associated to the time delayed element can be programmed as Manual or Automatic (see page 11 : tFRes).

It has to be remarked that the programming structure does not allow to associate the same relay at the same time to instantaneous and delayed elements. Therefore any relay already associated to any time delayed element cannot be associated to any instantaneous element and viceversa.

b) - The relay **R5**, normally energised, is not programmable and is deenergized on:
- internal fault
- power supply failure
- during the programming

6. SERIAL COMMUNICATION (Optional: see relevant instruction manual)

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
Via the communication bus all settings and commands available from relay's keyboard can be operated from the computer and viceversa all information available at relay's level can be received at computer's level.
The transmission standard is RS485 (converter 485/232 available).
Each relay is identified by its programmable address code (NodeAd) and can be called from the P.C. fitted with a WINDOWS (version 3.1 or later) program driven by the application program supplied by Microelettrica Scientifica.

7. BLOCKING INPUTS

Two inputs active when the relevant terminals are shorted are provided:
- Bf (terminals 1 - 2) : it blocks the operation of the of the time delayed elements relevant to phase fault detection;.
- Bo(terminals 1 - 3) : it blocks the operation of the time delayed elements relevant to earth fault detection.
When a function is blocked the pick-up of its output is inhibited. Programming allows to have the inhibition either permanent as long as the blocking input is active or automatically removed with a programmable wait-time (see page 12 : tBf , tBo) after the operation of the time delayed function.
By proper interconnection of the blocking inputs output among different relays it is possible to configurate very efficient arrangements of logic fault discrimination as well as to feature a safe and quick breaker back-up protection.

8. 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 and then switches over to the default display.
- Dynamic functional test run during normal operation every 15 min. (relay's

operation is suspended for less than 10 ms).

- 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) - White key MODE: when operated it enters one of the following operation modes indicated on the display:

- **MEASURE** = Reading of all the parameters measured or stored 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 setting of parameter and of the configuration of output relays.
- **TEST PROG** = Access to the manual test routines.

b) - Green key SELECT: when operated it selects one of the menus available in the actual operation

MODE

c) - Red key"+" or "-" :when operated they allow to scroll the different information available in the menu entered by the key SELECT or, during the programming, to increase / decrease the setting values.

d) - Yellow key 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) - Indirect key PROG: enables access to the programming; it must be operated by a proper needle.

10. 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 "-" .

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

- **(I/In**xxx**%)** = Highest among the 3 phase-currents displayed as % of the rated current of C.Ts. (0 - 999%)
- **(IA**xxxxx**A)** = True R.M.S. value of the current of phase A displayed as primary Amps.(0 - 99999)
- **(IB**xxxxx**A)** = As above, phase B.
- **(IC**xxxxx**A)** = As above, phase C.
- **(Io**xxxxx**A)** = As above, earth fault current.
- **(U_0**xxx.x**V)** = True R.M.S. value of the zero sequence voltage at PT's secondary.
- **(φ_0**xxxxx^0**)** = Zero sequence current displacement degrees

(φ_a xxxxx^0) = Phase A displacement degrees
(φ_b xxxxx^0) = Phase B displacement degrees
(φ_c xxxxx^0) = Phase C displacement degrees

MAX VAL = Max demand values recorded starting from 100ms after closing of main Circuit Breaker plus highest inrush values recorded within the first 100ms from Breaker closing, (updated any time the breaker closes).

- **(Im**xx.x**In)** = Max value among the three phases after the first 100ms, displayed as p.u. of Cts rated current (0 - 99,9)
- **(IA**xx.x**In)** = Max value of phase A current after the first 100ms, displayed as p.u. of C.Ts rated current.
- **(IB**xxxx**In)** = As above, phase B.
- **(IC**xxxx**In)** = As above, phase C.
- **(Io**xxxx**On)** = As above, zero sequence current
- **(U_0**xxxx**V)** = As above, zero sequence voltage
- **(SA**xxxx**In)** = Max demand for phase A current during the first 100ms, displayed as p.u. of Cts rated current (0 - 99,9)
- **(SB**xxxx**In)** = As above, phase B.
- **(SC**xxxx**In)** = As above, phase C.
- **(So**xxxx**On)** = As above, zero sequence current.
- **(SU$_0$**xxx.x**V)** = As above, zero sequence voltage.

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

- **(Cause**xxx**)** = Display of the function which caused the last tripping: **I>; I>>; O>; O>>.**
- **(Im**xxx**In)** = Highest among the three phase currents
- **(IA**xxxx**In)** = Current of phase A.
- **(IB**xxxx**In)** = Current of phase B.
- **(IC**xxxx**In)** = Current of phase C.
- **(Io**xxxx**On)** = Earth fault current.
- **(U_0**xxx.x**V)** = Zero sequence voltage
- **(φo**xxxxx^0**)** = Zero sequence displacement degrees
- **(φ_a** xxxxx^0**)** = Phase A displacement degrees
- **(φ_b** xxxxx^0**)** = Phase B displacement degrees
- **(φ_c** xxxxx^0**)** = Phase C displacement degrees

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

- **(I>** xxxx**)** = Low set (F67) time delayed overcurrent
- **(I>>**xxxx**)** = As above, high set (F67) time delayed overcurrent
- **(I_0>**xxxx**)** = As above, low set (F67N) time delayed earth fault
- **(I_0>>**xxxx**)** = As above, high set (F67N) time delayed earth fault

11. 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.

12. PROGRAMMING

The relay is supplied with the standard default programming used for factory test. [Values here below reported **(-----)**].
All parameters can be modified as needed in the mode PROG and displayed in the mode SET DISP
Programming is enabled only if no input current is detected (main circuit breakers open).
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.

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

(Fn 50 Hz) = Mains frequency: setting range 50 - 60 Hz.
(In 500Ap) = Rated primary current of the phase C.Ts.: (1 - 9999)A by 1 A step.
(On 500Ap) = Rated primary current of the C.Ts. or of the tore C.T. supplying the earth fault element (1 and 5 A taps provided on terminal board)
(α = 0 Deg) = Characteristic direction of phase fault current (0 - 359°, Dis), step 1°.
If α = Dis, the overcurrent elements operate as non directional.
(F(I>) D) = Operation characteristic of the low-set overcurrent F67:
D = Independent definite time.
SI = Dependent normal inverse time.
VI = Dependent very inverse time.
EI = Dependent extr. inverse time.
(I> 1.0In) = Trip level of low-set overcurrent element (p.u. of the rated current of the phase C.Ts.): (DIS, - 0,5- 4)In, step 0.01 In.
(tI> 2.0S) = Trip time delay (sec.) of the low-set overcurrent element: (0,05 - 30)s step 0,1 sec.
In the dependent time operation it is the trip time delay at I = 10x[I>] (see Time Current Curves)
(I>> 2In) = Trip level of high-set overcurrent element in p.u. of the rated current of the phase C.Ts.: (Dis - 0,5 - 40)In, step 0,1In
(tI>> 1.0S) = Trip time delay of the high-set overcurrent element: (0,05 - 3)s, step 0,01s

(U_0>x10xV) = Minimum level of the zero-sequence polarizing input voltage for enabling operation

of the earth fault element: (2 - 25)V, step 1V

(α_0 =0 Deg) = Characteristic direction of earth fault current: (0° - 359°, Dis), step 1°.
If α_0 = Dis the earth fault element operates as non directional

(F(O>) D) = Operation characteristic of the low-set earth fault element (F67):
D = Independent definite time.
SI = Dependent normal inverse time.
VI = Dependent very inverse time.
EI = Dependent extr. inverse time.

(O> .1On) = Trip level of low-set earth fault element (F67) in p.u. of the rated current of the earth fault detection C.T. (Dis 0,10 - 1,00)On, step 0,01 On

(tO> 4.0S) = Trip time delay of low-set earth fault element: (0,05 - 30)s, step 0,01 s
In the inverse time operation it is the trip time delay at I_0 = 10x[O>]
(see Time Current Curves)

(O>> .5On) = Trip level of high-set earth fault element in p.u. of the rated current of the C.Ts. for unbalance detection: (Dis, 1,0 - 9,9)On, step 0,1 On

(tO>> 3.0S) = Trip time delay of the high-set earth fault element: (0,05 - 3)s step 0,01 s

(tBO .25S) = Max reset time delay of the instantaneous elements after tripping of the relevant delayed elements: (0,05 - 0,25) step 0,1 sec. See paragraph "Blocking Inputs"

(NodAd...) = Identification number for the connection on serial communication bus: (1-250) step 1

When DIS is programmed, the function is disactivated.

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.

(I> --3-) = Instantaneous element of low-set overcurrent (F67) operates relays R1,R2,R3,R4.

(tI> 1---) = As above, time delayed element.

(I>> --3-) = Instantaneous element of high-set overcurrent (F67) operates relay R1,R2,R3,R4.

(tI>> 1---) = As above, time delayed element.

(O> ---4) = Instantaneous element of low-set earth fault element (F67) operates relay R1,R2,R3,R4.

(tO> -2---) = As above, time delayed element.

(O>> ---4) = Instantaneous element of high-set earth fault element (F67) operates relay R1,R2,R3,R4.

(tO>> -2---) = As above, time delayed element.

(tFRes: A) = The reset after tripping of the relays associated to the time delayed elements can take place: **(A)** automatically when current drops below

the trip level. **(M)** manually by the operation of the "ENTER/RESET" key.

(Bf I>> I>) = The input for blocking the operation of the time delayed elements relevant to phase faults (I>>, I>) can act on the function I> only or I>> only, or on both.

(BoO>> O>) = The input for blocking the operation of the time delayed elements relevant to earth fault (O>>, O>) can act on the function O> only or O>> only, or on both.

(tBf 2tB0) = The blocking of the phase fault elements can be programmed so that it lasts as long the blocking input signal is present (tBf OFF) or so that, even with the blocking input still present, it only lasts for the set trip time delay of the function plus an additional time 2xtBO (tBf = 2tB0)

(tBo 2tB0) = As above for the earth fault functions.

13. MANUAL AND AUTOMATIC TEST OPERATION

Mode "TESTPROG" subprogram “LEDS ONLY":
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 (I/Inxxx%).
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.
Mode "TESTPROG" subprogram "LEDS+TRIP":
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 LEDSONLY.
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.
If at the next automatic test no internal fault is detected the display and R5 reset.

14. 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.

15. ELECTRICAL CHARACTERISTICS

Reference standards	IEC 255; 801; CEI 41-1; IEEE C37
Dielectric test voltage	2000 V, 50 Hz, 1 min.
Impulse test voltage	5kV (MC), 1 kV (MD) - 1,2/50μs
Immunity to high frequency burst	1 kV (MC), 0,5 kV (MD) - 0,1 MHz 2,5 kV (MC), 1 kV (MD) - 1 MHz
Immunity to electrostatic discharge	15 kV
Immunity to sinusoidal wave burst	100 V - (0,01-1) MHz
Immunity to radiated E.M. field	10 V/m - (20-1000) MHz
Immunity to high energy burst	4 kV (MC), 2 kV (MD) - (IEC 805-5)
Immunity to 50-60 Hz magnetic field	1000 A/m
Immunity to impulse magnetic field	1000 A/m - 8/20μs
Immunity to magnetic burst	100A/m - (0,1-1) MHz
Resistance to vibration and shocks	10-500 Hz - 1 g - 0,075 mm
Rated current	In = 1 or 5 A On = 1 or 5 A
Current overload	200 a for 1 sec; 10 A continuos
Burden on current inputs	0,2 VA/phase at In; 0,06 VA at On
Reted voltage	Un = 100V (different on request)
Burden on voltage inputs	0,2 VA at Un
Voltage overload	2 Un continuous
Max power supply consumption	8,5 VA
Output relays	rating 5 A; Vn = 380 V A.C. resistive switching = 1100 W (380 V max) make = 30 A (peak) 0,5 sec. break = 0,3 A, 110 Vcc, L/R = 40 ms (100.000 op.)
Operation ambient temperature	-20°C / +60°C
Storage temperature	-30°C / +80°C