MULTIFUNCTION MICROPROCESSOR PROTECTION RELAY TYPE IM30-G

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 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 semiconductor devices mounted on the modules can be seriously damaged by electrostatic voltage discharge which can be experienced when handling the modules.
The damage caused by electrostatic discharge may not be immediately apparent but the design reliability and the long life of the product will have been reduced. The electronic circuits produced by M.S. are completely safe from electrostatic discharge (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 altered 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 CHARACTERISTICS AND OPERATION

Input currents are supplied to 4 current transformers: - three measuring phase current - one measuring the earth fault zero-sequence current. Phase current input can be 1 or 5A
For zero-sequence current, taps for 1A and 5A input are provided on relay’s terminal board.
Input phase to phase voltage is supplied to one voltage transformer with rated input programmable 100-125V.
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.

2.1 AUXILIARY SUPPLY

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

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 Measuring input

The relay computes the RMS value of current and voltage and the relevant phase displacement.

2.2.1 Current inputs

Phase and ground currents are supplied to four current transformers with 5A rated primary. By movable jumpers on the relay card, the secondary can be switched-on to two different taps to obtain a relay rated input current In = 5 or 1 Amp (different values can be provided on request).
The measuring dynamics of the C.Ts. runs from 0.001 through 50 times In.
For the phase current the measuring range of the A/D Converters runs from 0 to 13 In automatically switched over two channels one measuring from 0 to 1.3 In and the second from 0.1 to 13 In. The theoretical accuracy of the measurement is 0.13% In from 0 to 1.3 In and 1.3% In from 1.3 In through 13 In.

- $\varepsilon_1 = \pm 0.02$ M ± 0.002 In from 0 to 1.3 In
- $\varepsilon_2 = \pm 0.02$ M ± 0.02 In from 1.3 to 13 In

For ground current the measuring range of the A/D converter runs from 0 to 2 On
The actual absolute error on each measurement M can be:

- $\varepsilon_0 = \pm 0.02$ M ± 0.004 On

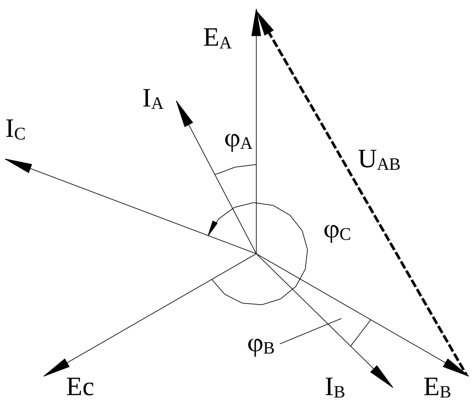
2.2.2 Voltage input

Phase-to-phase voltage U_{AB} is supplied to one Potential transformers rated 220V. Relay's rated phase-to-phase input voltage (Uns) can be adjusted from 100 through 125V.
The ADC converter measuring range runs up to 2 x Uns.
The theoretical accuracy is 0.2%Uns.
The actual absolute error can be :

- $\varepsilon_v = \pm 0.02$ M ± 0.003 Uns

2.2.3 Phase displacement

The relay detects the displacement between the input voltage and each phase current IA, IB, IC.
The displacement angles are therefore :



$\varphi_A = (I_A \wedge U_{AB})+30°$; $\varphi_B = (I_B \wedge U_{AB})+150°$; $\varphi_C = (I_C \wedge U_{AB})-90°$;

This means that the voltage system is considered to be balanced as it normally it whereas the currents can be however unbalanced. (see figure)
Angles are measured anticlockwise from 0° to 359° with accuracy ±2°.
Displacement is not measured if current or voltage are null.

2.3 Algorithms of the different functions

2.3.1 Setting range of the reference input quantities :

- System frequency : **Fn** = (50-60)Hz
- Rated primary current of phase C.Ts. : **In** = (0-9999)A, step 1A
- Rated primary current of ground C.T. : **On** = (0-9999)A, step 1A
- Rated secondary phase-to-phase voltage of P.Ts. : **Uns** = (100-125)V, step 1V
- Relay basic current (Generator's rated current) : **Ib** = (0.5-1.1)In, step 0.1In

2.3.2 **F50/51** - Dual level 3-phase overcurrent

F1 50/51 : Low set overcurrent

- Pick-up (operation) level : **I>** = (1-2.5)**Ib**, step 0.01**Ib**
  Setting **I>** = Dis blocks function's operation
- Drop-out ratio ≥ 0.95
- Minimum operation time of instantaneous element : ≤ 30ms
- Trip time delay in the definite time operation mode **F(I>) = D**
  t = **tI>** = (0.05-30)s, step 0.01s
- Trip time delay in the inverse time operation mode **F(I>) = SI**

$$t = \frac{0.033 \bullet tI>}{(I/I>)^{0.02} - 1}$$ (**tI>** = trip time delay at I/I> = 5) (see curves TU0311)

F2 50/51 : High set overcurrent

- Pick-up (operation) level : **I>>** = (1-12)**Ib**, step 0.1**Ib**
  Setting **I>>** = Dis blocks function's operation
- Drop-out ratio ≥ 0.95
- Minimum operation time of the instantaneous element : ≤ 30ms
- Independent trip time delay t = **tI>>** = (0.05-3)s, step 0.01s

2.3.3 **F50/51G** - Stator Ground Fault

- Pick-up (operation) level : **O>** = (0.02-0.4)On, step 0.01 On
  Setting **O>** = Dis. blocks function's operation
- Drop-out ratio ≥ 0.95
- Minimum operation time of the instantaneous element : ≤ 30ms.
- Independent trips time delay : t = **tO>** = (0.05-30)s, step 0.01s

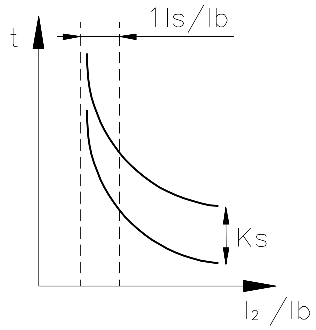
2.3.4 F46 - Current unbalance : Measurement of RMS Negative Sequence Current I_2

- **F1 46** : $I_2^2\ t = K$ (adiabatic heating)
- Generator's continuous I_2 rating : **1Is** = (0.05-0.5)**Ib**, step 0.01**Ib**

  Setting **1Is** = Dis blocks function's operation
- Time multiplier : **Ks** = (5-80)s, step 1s ; Ks = Trip time when $I_2 = I_b$
- Trip time delay from cold status $t_h = \frac{Ks}{(I_2 / I_b)^2}$;

  Heat accumulation only takes place if $I_2 \geq$ **1Is**

- **tc** = (10-1800)s, step 1s Cooling time from trip level to cold status



Cooling $t_1 = \frac{tc}{Ks}\left(\frac{I_2}{I^b}\right)^2 \bullet t$ time t_l = **tc** when $\left(\frac{I_2}{I_b}\right)^2 \cdot t = Ks$

Cooling only takes places $\frac{I_2}{I_b} < 1Is$ if (see curves TU0312)

Reset : takes places when heat accumulation drops to 90% of the trip level.

F2 46 : Alarm

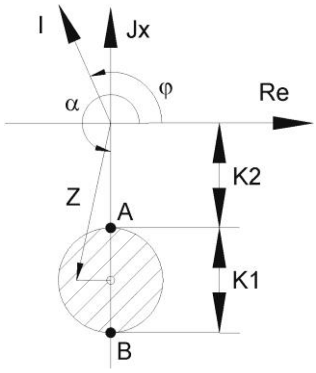
- Alarm level : **2Is** = (0.03-1)Ib, step 0.01Ib
- Setting **2Is** = Dis blocks function's operation
- Independent trip time delay : **t2Is** = (1-100)s, step 1s

2.3.5 F32 - Reverse Active Power

- Reverse active current **Ir>** = (0.02-0.2)In, step 0.01In

  Setting **Ir>** = Dis blocks function's operation
- Operation level = Ic cos (φc-180°) ≥ [Ir]
- Independent trip time delay **tIr>** = (0.1-60)s, step 0.1s
- Operation zone (-90°+180°)<φc<(90°+180°)

2.3.6 F21/40 - Directional Underimpedance / Loss of excitation



- The relay computes the impedance

$$Z\alpha = \frac{E}{I\cos(\varphi - \alpha°)}$$

- Characteristics angle of the impedance α = (0°-330°), step 30°

Setting of impedance angle	Max torque of current	Current components at max torque angle
α = 0° R	φ = 0° (360°)	Forward Resistive
α = 330° R+C	φ = +30°	Forward Resistive + Forward Capacitive
α = 300° R+C	φ = +60°	Forward Resistive + Forward Capacitive
α = 270° C	**φ = +90°**	**Forward Capacitive (Loss of Field)**
α = 240° C-R	φ = +120°	Forward Capacitive + Reverse Resistive
α = 210° C-R	φ = +150°	Forward Capacitive + Reverse Resistive
α = 180° -R	φ = +180°	Reverse Resistive
α = 150° R-R	φ = +210° (-150°)	Forward Inductive + Reverse Resistive
α = 120° L-R	φ = +240° (-120°)	Forward Inductive + Reverse Resistive
α = 90° L	φ = +270° (-90°)	Forward Inductive
α = 60° L+R	φ = +300° (-60°)	Forward Inductive + Forward Resistive
α = 30° L+R	φ = +330° (-30°)	Forward Inductive + Forward Resistive

The direction α is that of the axle where the center of the circle is located.

N.B. By definition the relation between current displacement φ and impedance displacement α is :
α = 360°- φ
Angles are counted counterclockwise from 0° (real axis = direction of phase-to-neutral voltage E) through 359°.
For example : the displacement of a totally capacitive current is φ = 90°;
the angle of a totally capacitive impedance is α = 270°.

- Operation zone is that included in the circle (see figure) having :

Center on the axle displaced by α at distance $K2 + \frac{K1}{2}$ from the origin :

- Circle offset : **K2** = (5-50)%Zb, step 1%

- Circle diameter : **K1** = (50-300)%Zb, step 1%
  Setting **K1** = Dis blocks the function's operation

- $Zb = \frac{Uns}{\sqrt{3}\,Ib}$

- Independent trip time delay : **tz** = (0.2-60)s, step 0.1s
- Integration time : **ti** = (0-10)s, step 0.1s
  In case of impedance oscillation reset of the timer **tz** only takes place if Z remains outside the trip area for at least **ti**.
- Undervoltage inhibition level : Ex $< 0.3\frac{Uns}{\sqrt{3}}$
- Undercurrent inhibition level : Ix $<$ 0.2Ib
- Testing :

  For testing the Field loss protection operate as follows :

  - Impedance characteristic angle set to α_Z = 270° capacitive (this corresponds to current leading voltage by 90°).
  - Circle off-set to any value (recommended value for testing K_2 = 50%)
  - Circle diameter to any value (recommended value for testing K_1 = 200%)
  - Time delay **tz** to any value (recommended value for testing tz = 0.2s)

2.3.7 <u>Using a single phase apparatus</u>

- Voltage input at rated value to terminals 32-33
- Current input to phase A terminals 25-26
- Phase displacement of input current on input voltage :

$(I_A \Lambda U_{AB})$ = 60° (current 90° leading phase-to-neutral voltage E_A : φ_A = 90°)

The relay's rated impedance is $Z_b = \frac{Uns}{\sqrt{3}I_b}$

The trip area is that inside the circle which intersects the axel of the characteristic impedance in the two points :

$$A \equiv Z_A = K2\% \bullet Zb \quad ; \quad B \equiv Z_B = (K1 + K2)\% \bullet Zb$$

With input voltage = Uns, the currents corresponding to Z_A nad Z_B are respectively :

$$I_A = \frac{Ib \cdot 100}{K2} \quad ; \quad I_B = \frac{Ib \cdot 100}{K1 + K2}$$

Example : Ib = 0.8 In = 4A (secondary) K1 = 200% , K2 = 50%

$$I_A = \frac{4 \cdot 100}{50} = 8A \quad ; \quad I_B = \frac{4 \cdot 100}{200 + 50} = 1.6A$$

Injecting into the terminals 25-26 a current I 60° leading the voltage supplied to terminals 32-33 the relay must trip when :

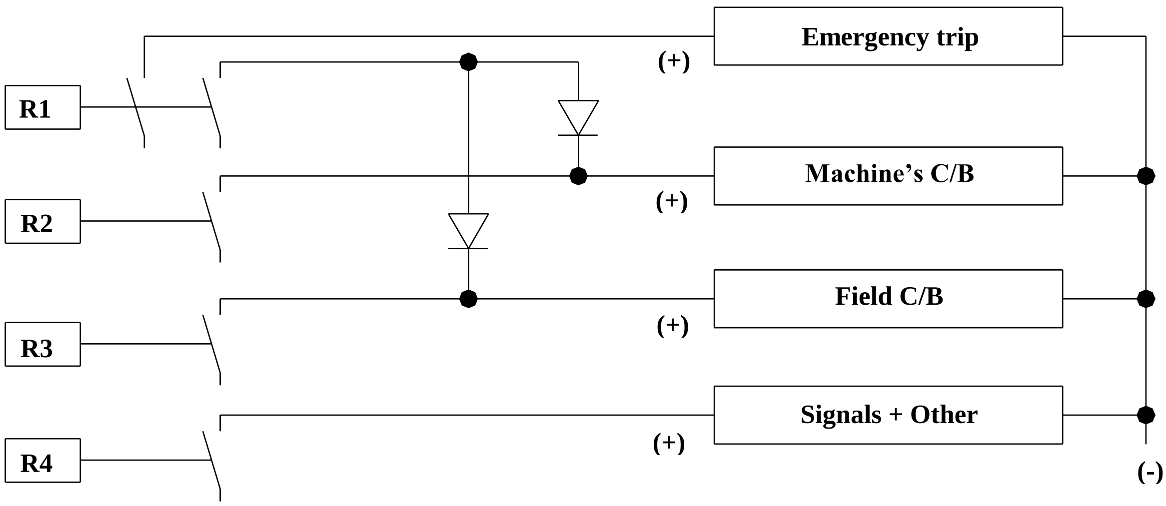
$$Ib \leq I \leq I_A \text{ and must reset when } I_A < I < Ib$$

2.4 Configuration of the output relays (see § 5)

The different functions of the relay can be programmed to operate any of the output relays as explained in § 5.
The relay's functions are more than the available output relays but some of them can be grouped to operate the same relay according to the needs of the protection system.
For generator protection the different functions normally operate the trippings shown in the table here below.

PROTEC. FUNCTION	DEVICE OPERATED				OUTPUT RELAY CONTROLLED			
	EMERG. TRIP	MACHINE C/B	FIELD C/B	SIGNALS OR OTHER	R1	R2	R3	R4
32 = Ir>		X	X			X	X	
40 = Zc<		X				X		
46-1 = 1Is		X		X		X		
46-2 = 2Is		(X)						X
50-1 = I>				(X)				(X)
50-2 = I>>				(X)				(X)
51-1 = tI>	X	X	X		X			
51-2 = tI>>	X	X	X		X			
50G = O>				(X)				
51G = tO>	(X)	X	X	(X)	(X)	X	X	(X)

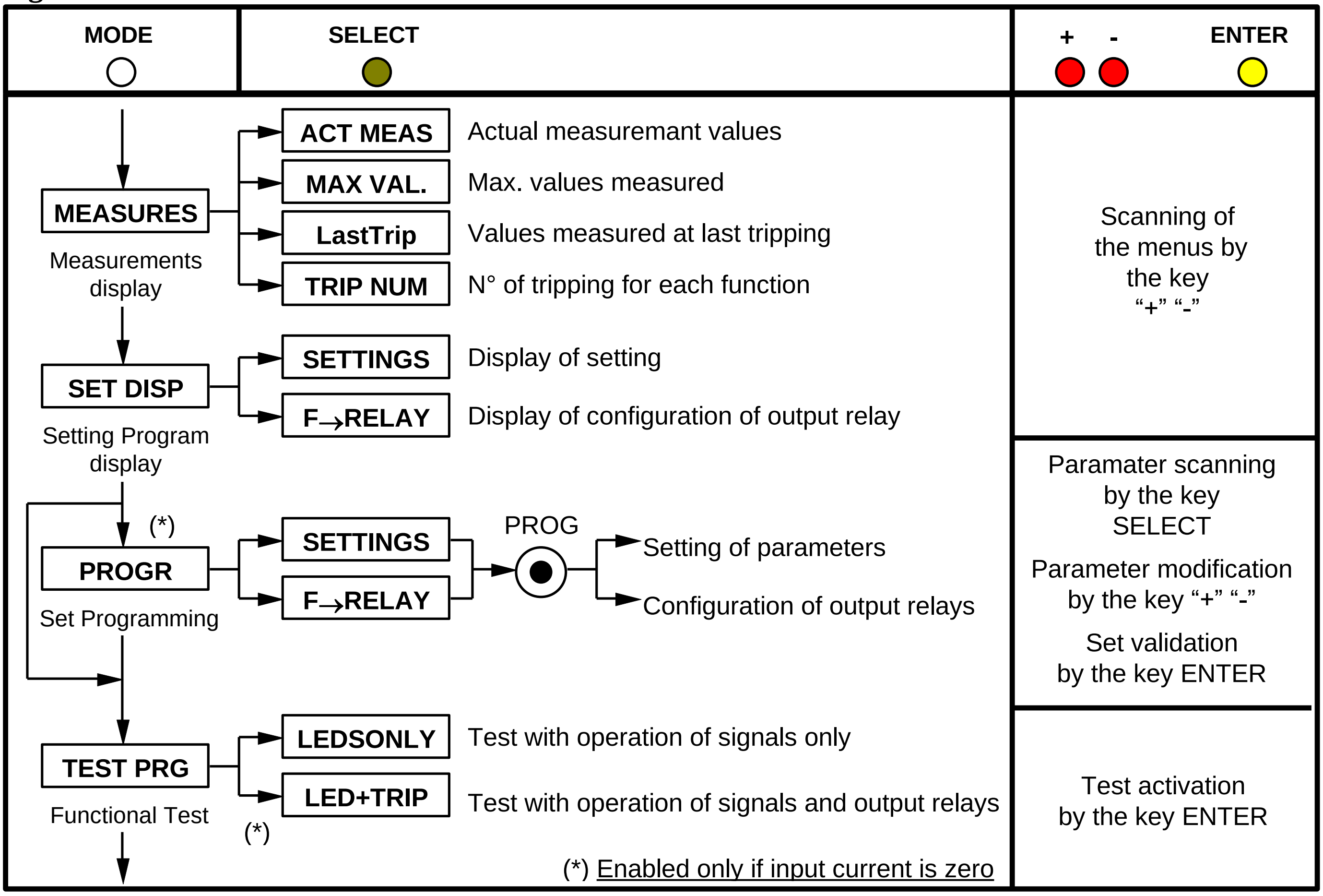
(X) = a richiesta ; X = necessari

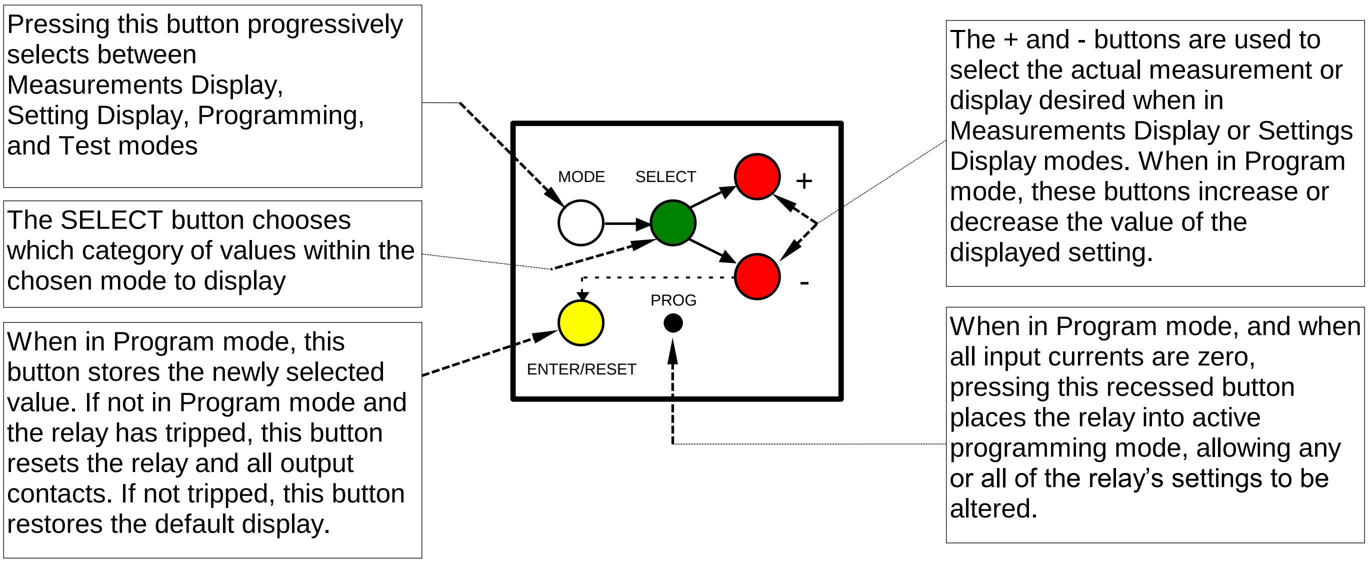


3. CONTROLS AND MEASUREMENTS

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) are provided:

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

b) Red LED **I$_2$>->>** : same as above related to [1Is], [2Is].
←

c) Red LED **Ir** : same as above related to [Ir>], [tIr>].

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

e) Red LED **Z<** : same as above related to [Z<], [tz].

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

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

h) Yellow LED **BI/FD** : Lit-on when the operation of one or more of the relay functions has been disactivated in the programming; Flashing when a blocking signal is present at the relevant input terminals.

The reset of the leds takes place as follows:

- Leds a,b,c,d,e : -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 f,g,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 one of the IM30-G's functions.
One relay eventually associated to the instantaneous element of one of the functions, after pick-up normally drops-out as soon as the tripping cause disappears (current below the set trip level).
If the current remains above the trip level longer than the time delay programmed for the relevant function, the drop-out of the instantaneous relay is anyhow forced after an adjustable waiting time [tBF].(Diasactivation of the blocking output eventually used to block a relay upstream in the distribution system). Moreover any of the relays R1,R2,R3,R4, can be programmed to be energised at the end of the delay tBF(Breaker Failure function)
Reset of the output relays associated to any time delayed function can be programmed to take place "Automatically" (tFRES= A) as soon as the tripping cause has disappeared, or "Manually" (tFRES= M) only by operating the ENTER/RESET key on relay's front or via the serial bus.
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 it 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 (type IBM or compatible).
Via the communication bus all settings and commands available on 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. DIGITAL INPUTS FOR FUNCTION BLOCKING AND FOR SETTING PROGRAM’S CHANGE-OVER

Two inputs are provided: they are active when the relevant terminals are shorted

- **2** (terminals 1 - 2) : it blocks the operation of the time delayed elements relevant to phase or ground fault protection; programming allows to block the operation of the functions I>(Il) or I>>(Ih) or O>(Io).

- **3** (terminals 1 - 3) : it blocks the operation of the time delayed elements relevant to Under Impedance or Reverse Power protection; programming allows to block the operation of the function Z< only or Ir only or both.

When a function is blocked the pick-up of its output is inhibited. For input -2- programming allows to have the inhibition either permanent as long as the blocking input is active (t_2=OFF) or automatically removed after the expiry of the set trip time delay of the function involved plus additional time 2tBF (t_2=2tBF). By proper interconnection of the blocking inputs and blocking outputs of 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.
- Dynamic functional test run during normal operation every 15 min. (relay's operation is suspended for less than 10 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) - White key MODE: when operated it enters one of the following operation modes indicated on the display:
- **MEASURE** = 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) - Green key SELECT : when operated it selects one of the menus available in the actual operation MODE

c) - Red key"+" AND "-" : when operated they allow to scroll the different information available in the menu entered by the key SELECT

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.

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 refreshed.

Display	Description
IAxxxxx**A**	True R.M.S. value of the current of phase A displayed as primary Amps. (0 - 99999)
IBxxxxx**A**	As above, phase B
ICxxxxx**A**	As above, phase C.
Ioxxxxx**A**	As above, earth fault current
Usxxxxx**%**	R.M.S. voltage as % of rated VTs secondary
I2xxx**%Ib**	R.M.S. Negative sequence current as % of basic setting Ib
φxxxxx°	Symmetric phase displacement (I∧E).

N.B:If no key is operated within 60 sec. the display is automatically switched to the default indication (IAxxxxxA)

MAX VAL = Maximum 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).

Display	Description
IAxxxx**In**	Max. value of phase A current after the first 100ms, displayed as p.u. of C.Ts rated current
IBxxxx**In**	As above, phase B
ICxxxx**In**	As above, phase C.
Ioxxxx**On**	As above, earth fault current
I2xxx**%Ib**	As above, negative sequence current
Usxxxx**%**	Max. val. of input voltage after the first 100ms, as % of rated input.
SAxxxx**In**	Max. current of phase A during the first 100ms.
SBxxxx**In**	As above, phase B.
SCxxxx**In**	As above, phase C.
Soxxxx**On**	As above, earth fault current.
SUxxxx**%**	Max. input voltage during the first 100ms

LASTTRIP = Display of the function which caused the tripping of the relay plus values of the parameters at the moment of tripping.

Display	Description
F:xxxxxx	Function which produced the last event being displayed and faulty phase in case of phase current element's trip **I>, I>>, Io>, 1Is, 2Is, Ir>, Z<.**
IAxxxx**In**	Current of phase A. (value recorded at the moment of tipping)
IBxxxx**In**	Current of phase B. (as above)
ICxxxx**In**	Current of phase C. (as above)
Ioxxxx**On**	Earth fault current. (as above)
I2xxx**%Ib**	Negative sequence current. (as above)
Usxxxx**%**	Input voltage. (as above)

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

Display	Description
I> xxxx	Trip number of Low set overcurrent time delayed element [tI>].
I>>xxxx	Trip number of High set overcurrent time delayed element [tI>>].
Io> xxxx	Trip number of earth fault time delayed element [tO>].
1Isxxxx	Trip number of Low set unbalance time delayed element.
2Isxxxx	Trip number of High set unbalance time delayed element.
Ir>xxxx	Trip number of Reverse Power time delayed element.
Z<xxxx	Trip number of Under Impedance time delayed element.

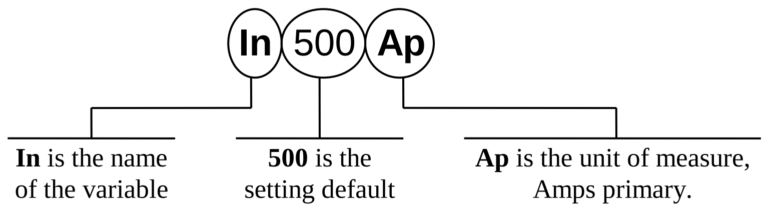
11. READING OF PROGRAMMED SETTINGS AND RELAY'S CONFIGURATION

Enter the mode "SET DISP", select the menu "SETTINGS" or "F→RELAY", scroll information available in the menu by keys "+" or "-".
SETTING= values of relay's operation parameters as programmed; the setting program actually active is displayed with steady light whereas the stand-by program is displayed with flashing light.
F→RELAY= output relay 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 switch 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.

12.1 PROGRAMMING OF FUNCTIONS SETTINGS



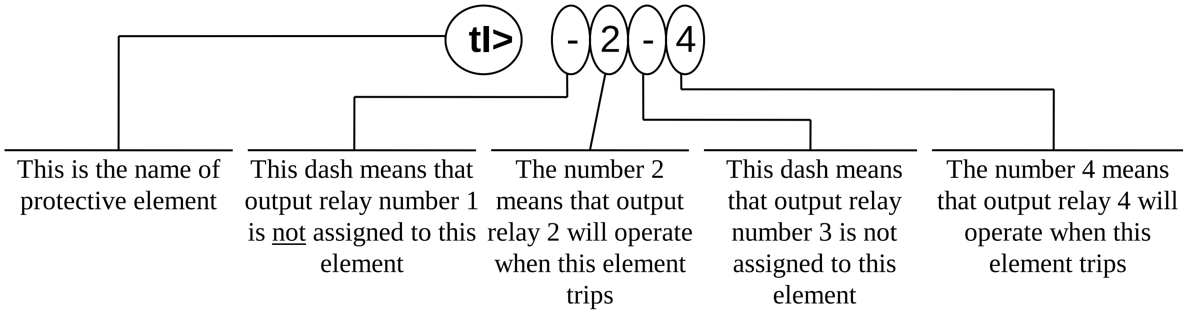
Mode PROG menu SETTINGS. (Production standard settings here under shown).

Display	Description	Setting Range	Step	Unit
NodAd 1	Identification number for connection on serial communication bus	1 - 250	1	-
Fn 50 **Hz**	Mains frequency: setting range	50 - 60	10	Hz
In 500**Ap**	Rated primary current of the phase C.Ts.	1 - 9999	1	A
On 500**Ap**	Rated primary current of the C.Ts. or of the tore C.T. supplying the zero sequence current	1 - 9999	1	A
Uns 100**V**	Rated secondary voltage of Vts (phase to phase)	100 –1 25	1	V
Ib .5**In**	Generator's rated current as p.u. of Cts rated current	0.5 - 1.1	0.1	In
F(I>) D	Operation characteristic of the low-set overcurrent element D = Independent definite time. SI = Dependent normal inverse time.	D SI	D SI	-

Display	Description	Setting Range	Step	Unit
I> 1.0**Ib**	Trip level of low-set overcurrent element (p.u. of Ib)	1- 2.5 - Dis	0.01	Ib
tI> .05**s**	Trip time delay of the low-set overcurrent element In the inverse time operation [tI>] is the trip time delay at I = 5x[I>].	0.05 - 30	0.01	s
I>> 1**Ib**	Trip level of high-set overcurrent element (p.u. of Ib)	1 – 12 - Dis	0.1	Ib
tI>> .05**s**	Trip time delay of the high-set overcurrent element	0.05 - 3	0.01	s
O>.02**On**	Trip level of earth fault element (p.u. of the rated current of the C.Ts. for zero sequence detection)	0.02 – 0.4 - Dis	0.01	On
tO> .05**s**	Trip time delay of low-set earth fault element	0.05 - 30	0.01	s
1Is .05**Ib**	Generator's max. continuous negative sequence current rating (p.u. of Ib)	0.05 – 0.5 - Dis	0.01	Ib
Ks 5**s**	Time multiplier of the I^2t time-current curve	5 - 80	1	s
tc 10**s**	Cooling time from trip level to cold state	10 - 1800	1	s
2Is .03**Ib**	Negative sequence current alarm level	0.03 - 1 - Dis	0.01	Ib
t2Is 1**s**	Independent trip time delay of alarm element	1 - 100	1	s
Ir>.02**In**	Trip level of the reverse power element (Active component of current as p.u. of In)	0.02 - 0.2 - Dis	0.01	In
tIr> .1**s**	Independent trip time delay of reverse power element	0.1- 60	0.01	s
α**z**270 **C**	Impedance characteristic angle (Max. sensitivity direction)	0 - 330	30	°
$K_1$300**%Zb**	Diameter of the circle	50 - 300	1	%
K_2 50**%Zb**	Offset of the circle including the underimpedance tripping zone (% of Zb=Vn/($\sqrt{3}$ Ib) **Underimpedance trip is inhibited on undervoltage U<0,3Un and undercurrent I<0,2Ib**	5 - 50	1	%
tz .2**s**	Trip time delay of the underimpedance element	0.2 - 60	0.1	s
ti .0**s**	Integration time of underimpedance element. To avoid non operation in case of impedance swinging the reset of the trip time delay (tZ) only takes place if the measured impedance remains outside the tripping zone for at least ti. **N.B. (ti)must be always shorter than (tz)**	0 - 10	0.1	s
tBF .05**s**	Max. reset time delay of the instantaneous elements after tripping of the time delayed elements and time delay for activation of the output relay associated to the Breaker Failure function	0.05 - 0.5	0.01	s

The setting Dis indicates that the function is disactivated.

12.2 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 digits 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.

Display	Description
I> --3-	Instantaneous element of low-set overcurrent operates relays R1,R2,R3,R4. (only one or more, whatever combination)
tI> 1---	As above, time delayed element
I>> --3-	Instantaneous element of high-set overcurrent operates relay R1,R2,R3,R4
tI>> 1---	As above, time delayed element
O> --3-	Instantaneous element of low-set earth fault element operates relay R1,R2,R3,R4.
tO> 1---	As above, time delayed element
1Is 1---	First unbalance element (time delayed) operates relay R1,R2,R3,R4
2Is -2--	As above, second unbalance element
Ir> 1---	Reverse power time delayed element operates relay R1,R2,R3,R4
Z< 1---	Underimpedance time delayed element operates relay R1,R2,R3,R4
tBF ---4	Breaker Failure function operates output relay R1,R2,R3,R4.
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.
2:--Ih--	The input (2) for blocking the time delayed elements relevant to phase and ground faults operate on I>(Il) or I>>(Ih) or O>(Io) as programmed
t_2 OFF	The operation of the blocking input (2) can be programmed so that it lasts as long the blocking input signal is present (t_2=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 2xtBF (t_2=2xtBF).
3: --Ir	The blocking input (3) operate on function Z< or IR> as programmed

13. MANUAL AND AUTOMATIC TEST OPERATION

- 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 (IAxxxxxA).
  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 "**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.

⚠ CAUTION

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.

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.

WARNING

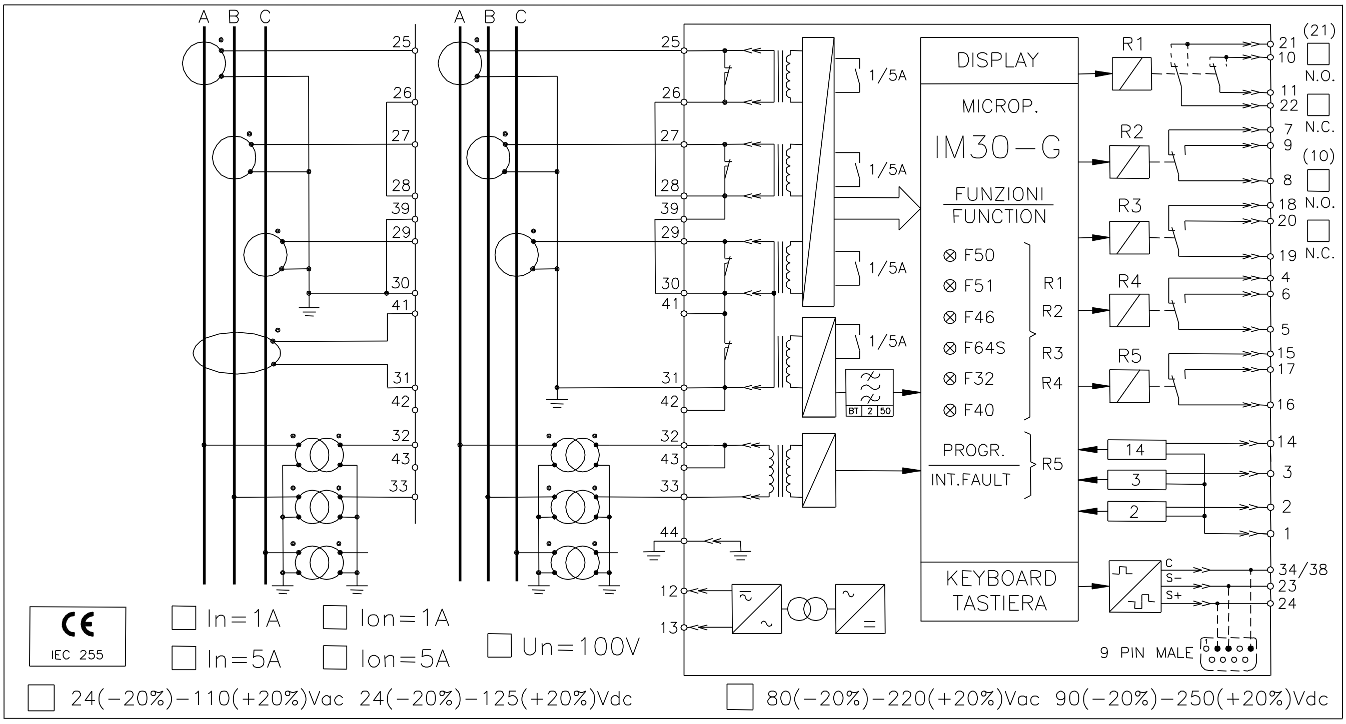
In case of Internal Relay Fault detection, proceed as here-below indicated :

- 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” , send the relay to Microelettrica Scientifica (or its local dealer) for repair.

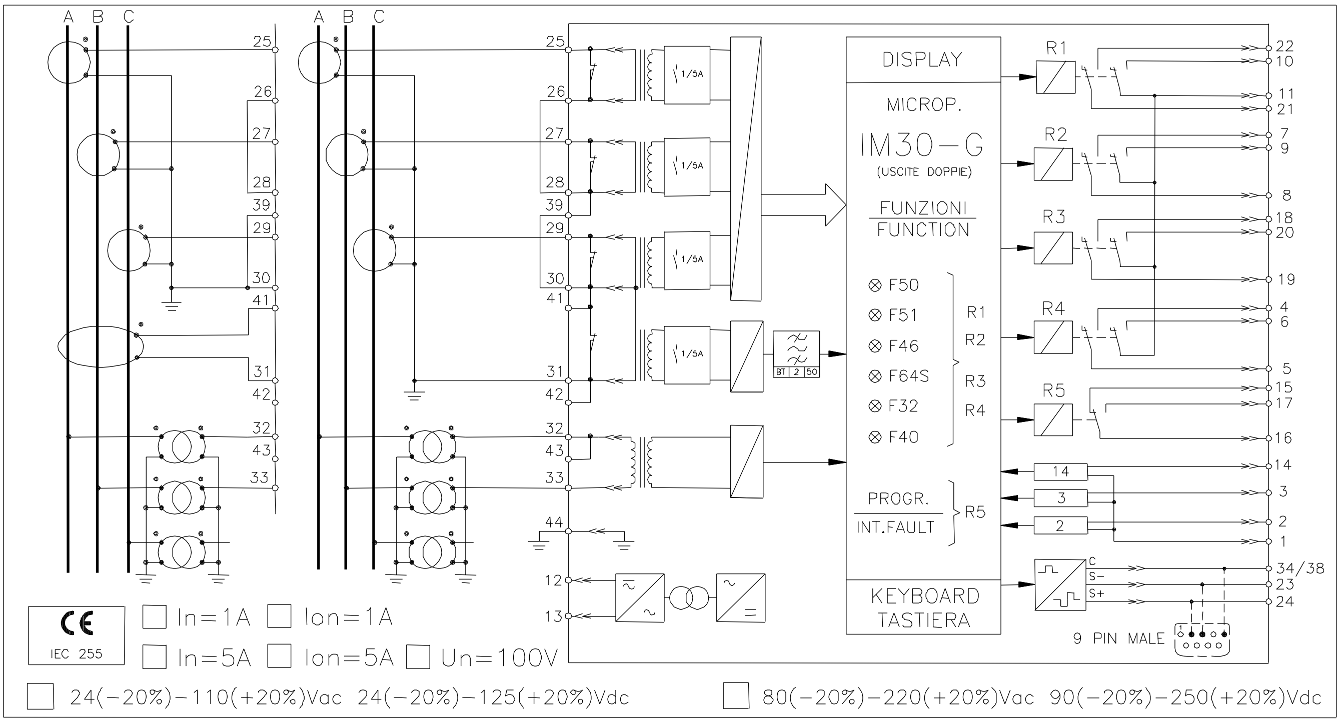
15. ELECTRICAL CHARACTERISTICS

- Reference standards	IEC 255, IEC1000; IEEE C37; CE Directive	
- Dielectric test voltage	IEC 255-5	: 2kV, 1 min.
- Impulse test voltage	IEC 255-5	: 5kV (c.m.), 2 kV (d.m.) - 1,2/50μs
- HF disturbance test with damped oscillatory wave (1MHz burst test)	IEC255-22-1 class 3	: 2,5kV (m.c.), 1kV (d.m.)
- Electrostatic discharge test	IEC1000-4-2 level 4	: 15 kV
- Conducted disturbances immunity test	IEC1000-4-6 level 3	: 0.15-80MHz, 10V/m
- Radiated electromagnetic field immunity test	IEC1000-4-3 level 3	: 80-1000MHz, 10V/m
- Electrical fast transient/burst	IEC1000-4-4 level 4	: 4kV, 2.5kHz, 15/300ms (c.m.) 2kV, 5kHz, 15/300ms (d.m.)
- Surge immunity test	IEC1000-4-5 level 4	: 4kV(c.m.), 2kV(d.m.)
- Oscillatory waves (Ring waves)	IEC1000-4-12 level 4	: 4kV(c.m.), 2kV(d.m.)
- Power frequency magnetic test	IEC1000-4-8	: 1000A/m
- Pulse magnetic field	IEC1000-4-9	: 1000A/m, 8/20μs
- Damped oscillatory magnetic field	IEC1000-4-10	: 1000A/m, 0.1-1MHz
- Immunity test for voltage dips, short interruptions and voltage variations	IEC1000-4-11	
- HF inducted voltage	IEC1000-4-1 A.2.6 level 4	: 100V, 0.01-1MHz
CE EMC Compatibility:		
- Electromagnetic emission	EN50081-2	
- Radiated electromagnetic disturbance test	EN50082-2	
- Resistance to vibration and shocks	IEC255-21-1, IEC255-21-2	
- Accuracy at reference value of influencing factors	1% In; 0,1% On for measure +/- 10ms for times	
- Rated input current	In = 1 or 5A, On = 1 or 5A	
- Current overload	200A for 1 sec; 10A continuos	
- Burden on current inputs	Phase : 0.01VA at In = 1A; 0.2VA at In = 5A 0.02VA at On = 1A; 0.4VA at On = 5A	
- Rated Voltage	Un = 100V (different on request)	
- Voltage overload	2 Un continuous	
- Burden on voltage input	0,04 VA at Un	
- 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.)	
- Operation ambient temperature	-20°C / +60°C	
- Storage temperature	-30°C / +80°C	

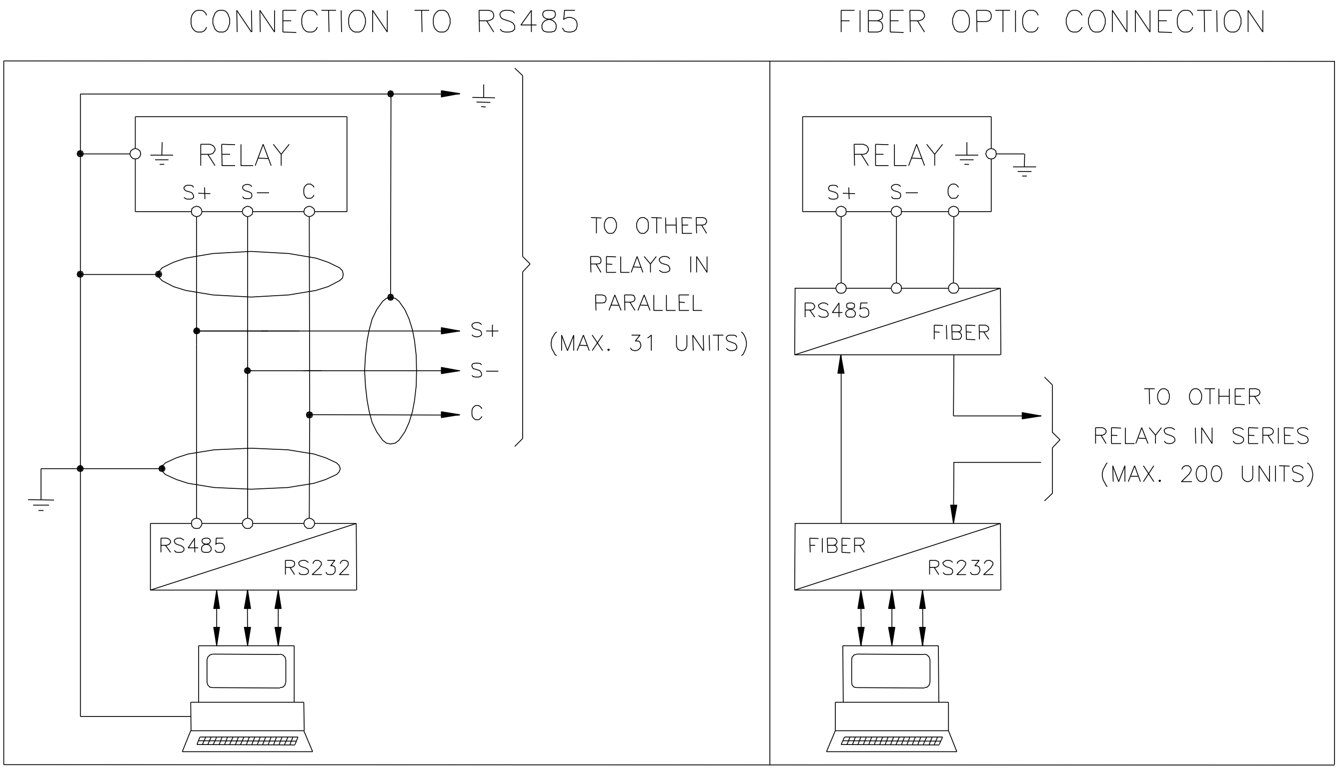
16. CONNECTION DIAGRAM (SCE1395 Rev.3 STANDARD OUTPUT)



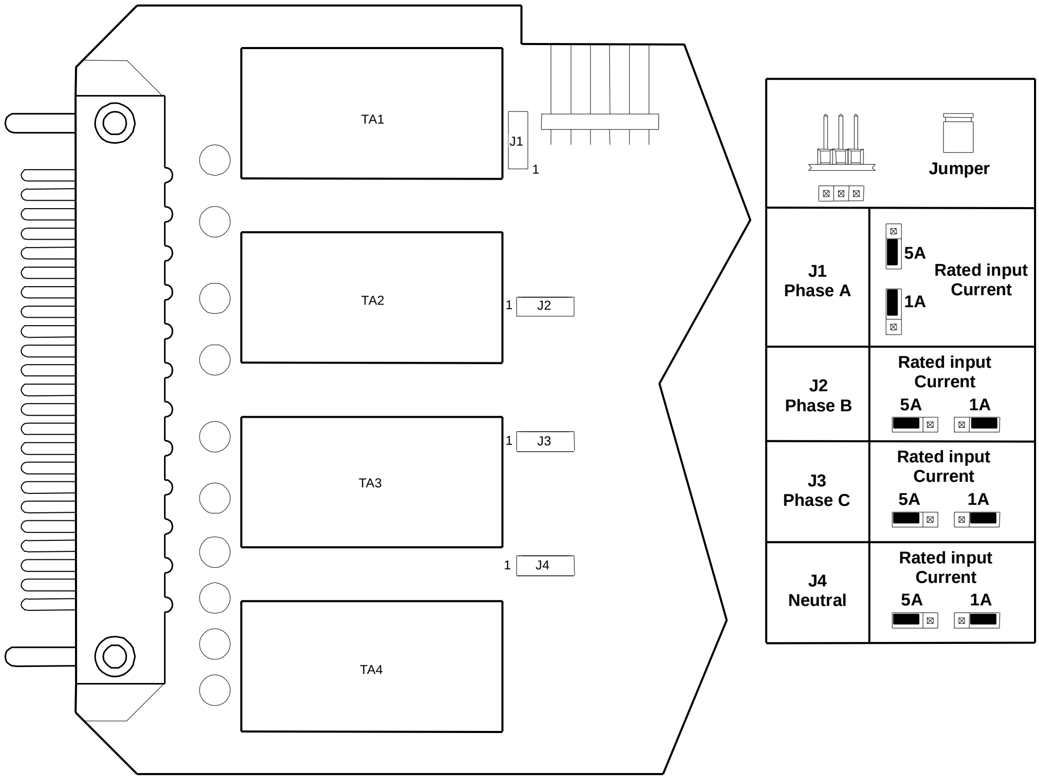
CONNECTION DIAGRAM (SCE1468 Rev.0 DOUBLE OUTPUT)



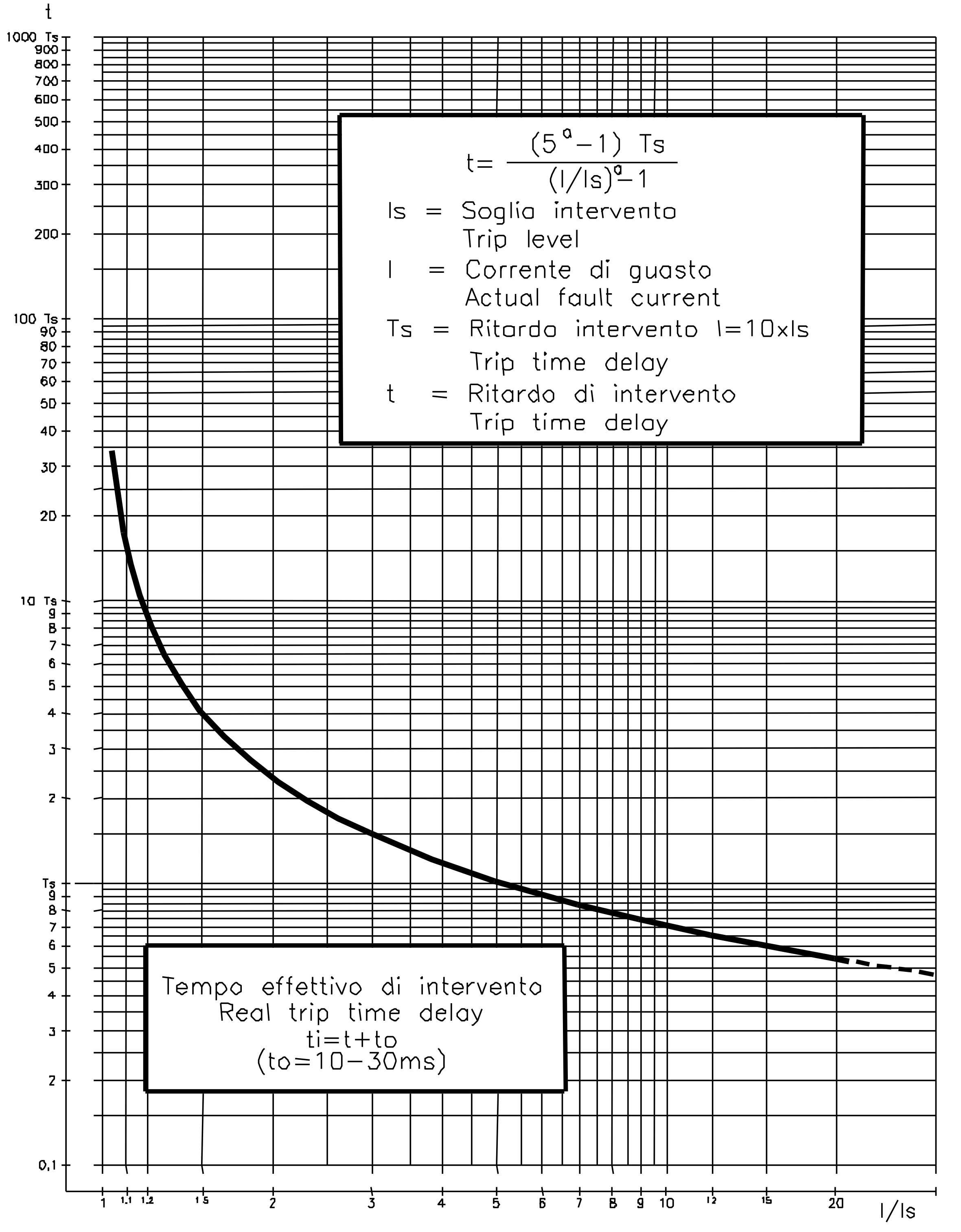
17. WIRING THE SERIAL COMMUNICATION BUS (SCE1309 Rev.0)



18. CHANGE PHASE CURRENT RATED INPUT 1 OR 5A



19. TIME CURRENT CURVES F51 (TU0311 Rev.0)

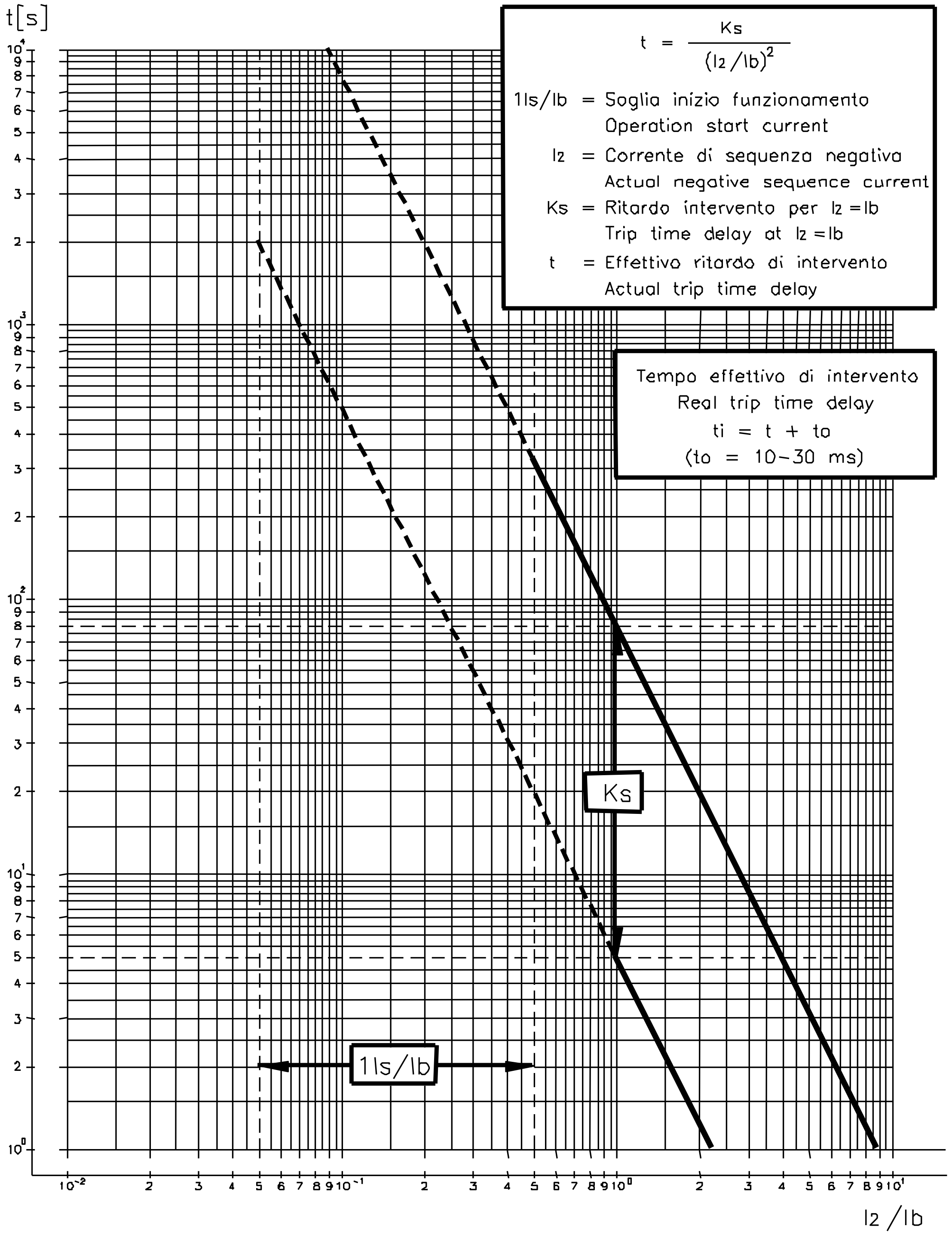


Tempo normalmente inverso
Normal inverse time

a=0.02

F51
Is = I> = (1 – 2,5)Ib
Ts = tI> = (0.05–30)s

20. I^2t = constant element F46 (TU0312 Rev.0)



I_2 = (0.05 − 0.5)Ib step 0.01In

Ks = (5 − 80)sec. @ I_2 = Ib step 1sec.

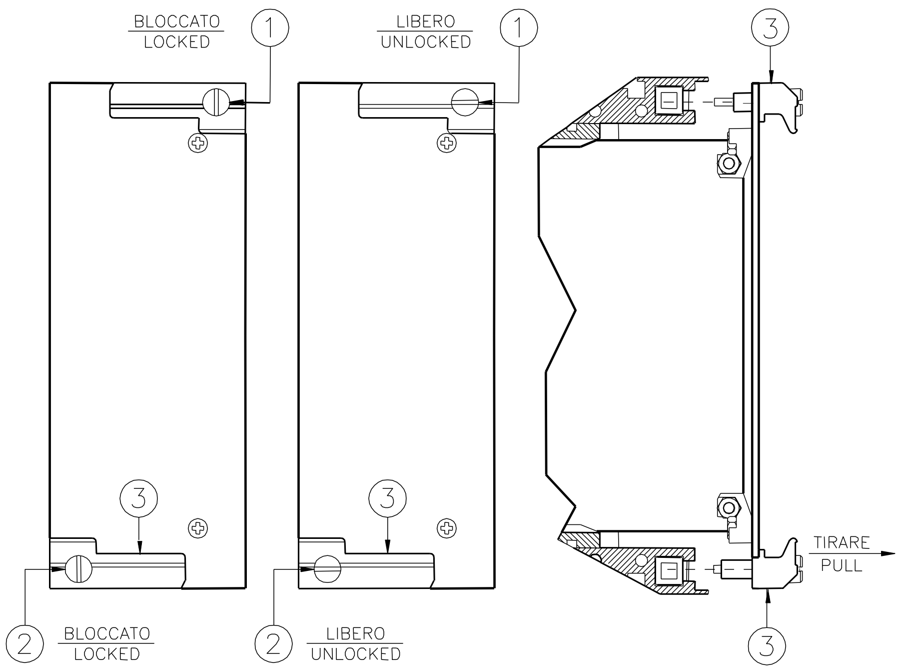
21. DIRECTION FOR PCB'S DRAW-OUT AND PLUG-IN

DRAW-OUT

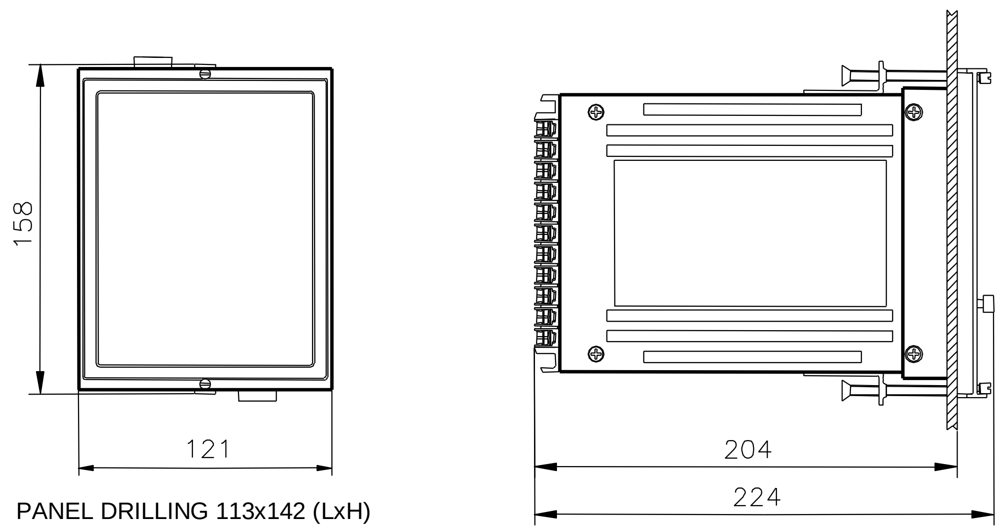
Rotate clockwise the screws ① and ② in the horizontal position of the screws-driver mark.
Draw-out the PCB by pulling on the handle ③

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).

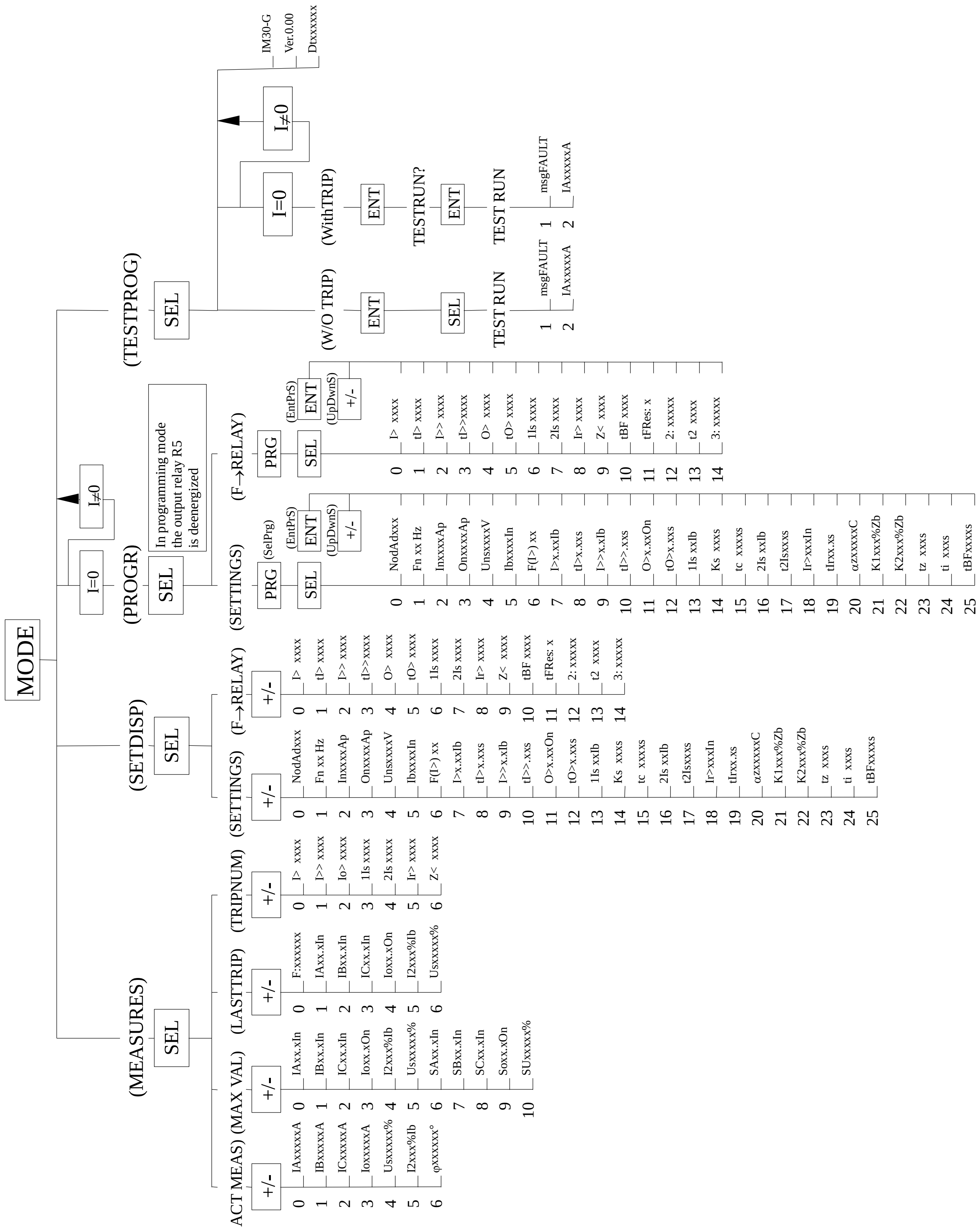


22. OVERALL DIMENSIONS



PANEL DRILLING 113x142 (LxH)

23. KEYBOARD OPERATIONAL DIAGRAM (D46387 Rev.2)



24. SETTING'S FORM

Date :			Number Relay:		
RELAY PROGRAMMING					
Default Setting			Actual Setting		
Variable	**Value**	**Measurement Unit**	**Variable**	**Value**	**Measurement Unit**
NodAd	1	-------------	**NodAd**		-------------
Fn	50	**Hz**	**Fn**		**Hz**
In	500	**Ap**	**In**		**Ap**
On	500	**Ap**	**On**		**Ap**
Uns	100	**V**	**Uns**		**V**
Ib	.5	**In**	**Ib**		**In**
F(I>)	D	-------------	**F(I>)**		-------------
I>	1.0	**Ib**	**I>**		**Ib**
tI>	.05	**s**	**tI>**		**s**
I>>	1	**Ib**	**I>>**		**Ib**
tI>>	.05	**s**	**tI>>**		**s**
O>	.02	**On**	**O>**		**On**
tO>	.05	**s**	**tO>**		**s**
1Is	.05	**Ib**	**1Is**		**Ib**
Ks	5	**s**	**Ks**		**s**
tc	10	**s**	**tc**		**s**
2Is	.03	**Ib**	**2Is**		**Ib**
t2Is	1	**s**	**t2Is**		**s**
Ir>	.02	**In**	**Ir>**		**In**
tIr>	.1	**s**	**tIr>**		**s**
αz	270	**C**	**αz**		**C**
K1	300	**%Zb**	**K1**		**%Zb**
K2	50	**%Zb**	**K2**		**%Zb**
tz	.2	**s**	**tz**		**s**
ti	.0	**s**	**ti**		**s**
tBF	.05	**s**	**tBF**		**s**

CONFIGURATION OF OUTPUT RELAYS									
Default Setting					Actual Setting				
Protective Elem.	**Output Relays**				**Protective Elem.**	**Output Relays**			
I>	-	-	3	-	**I>**				
tI>	1	-	-	-	**tI>**				
I>>	-	-	3	-	**I>>**				
tI>>	1	-	-	-	**tI>>**				
O>	-	-	3	-	**O>**				
tO>	1	-	-	-	**tO>**				
1Is	1	-	-	-	**1Is**				
2Is	-	2	-	-	**2Is**				
Ir>	1	-	-	-	**Ir>**				
Z<	1	-	-	-	**Z<**				
tBF	-	-	-	4	**tBF**				
tFRes:	A				**tFRes**:				
2:	--,Ih,--				**2:**				
t2	OFF				**t2**				
3:	--Ir				**3:**				