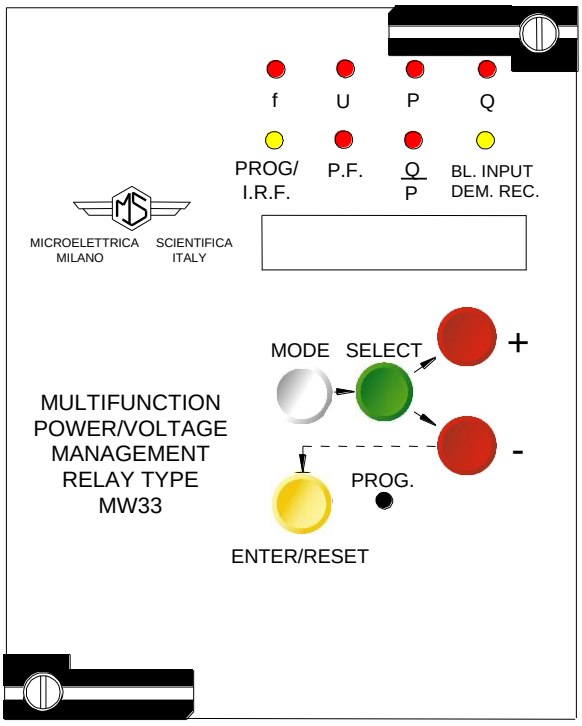
MICROPROCESSOR CONTROLLED POWER/VOLTAGE MANAGEMENT RELAY TYPE MW33

OPERATION MANUAL



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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 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.

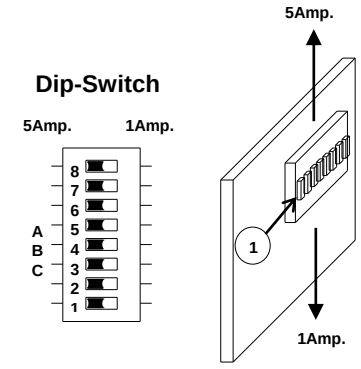
1.11 FAULT DETECTION AND REPAIR

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 CHARACTERISTICS

Input quantities are supplied to 3 current transformers and 3 potential transformers respectively measuring phase currents and phase-to-neutral voltages.
Input rated current can be set to 1 or 5A by 3 dip-switches provided on relay's card (A-B-C).
Rated voltage input can be programmed from 100 to 125V (phase to phase) 50 or 60Hz.
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 and self protected.



2.1 POWER 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.

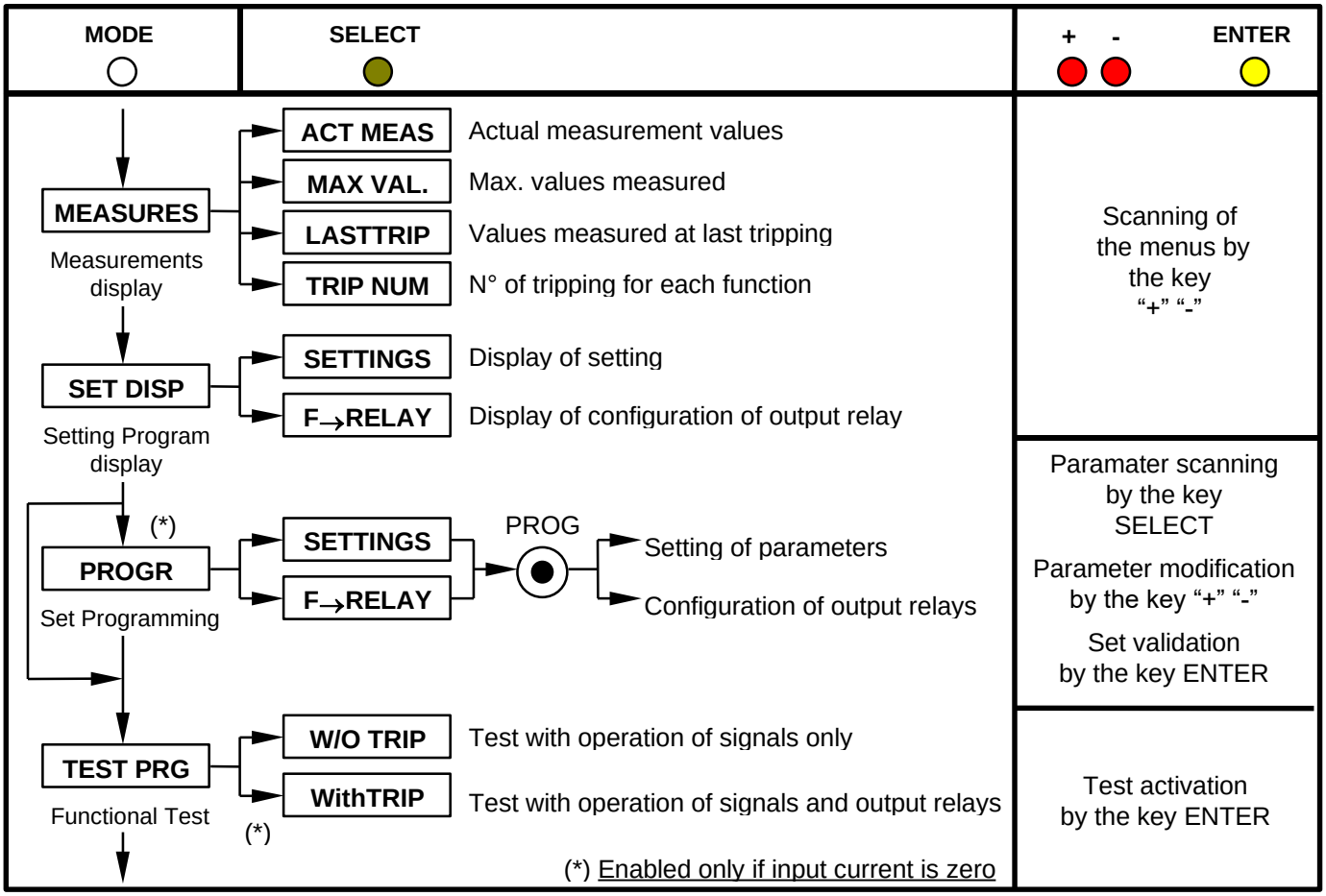
b) - { 80V(-20%) / 220V(+15%) a.c. / 90V(-20%) / 250V(+20%) d.c.

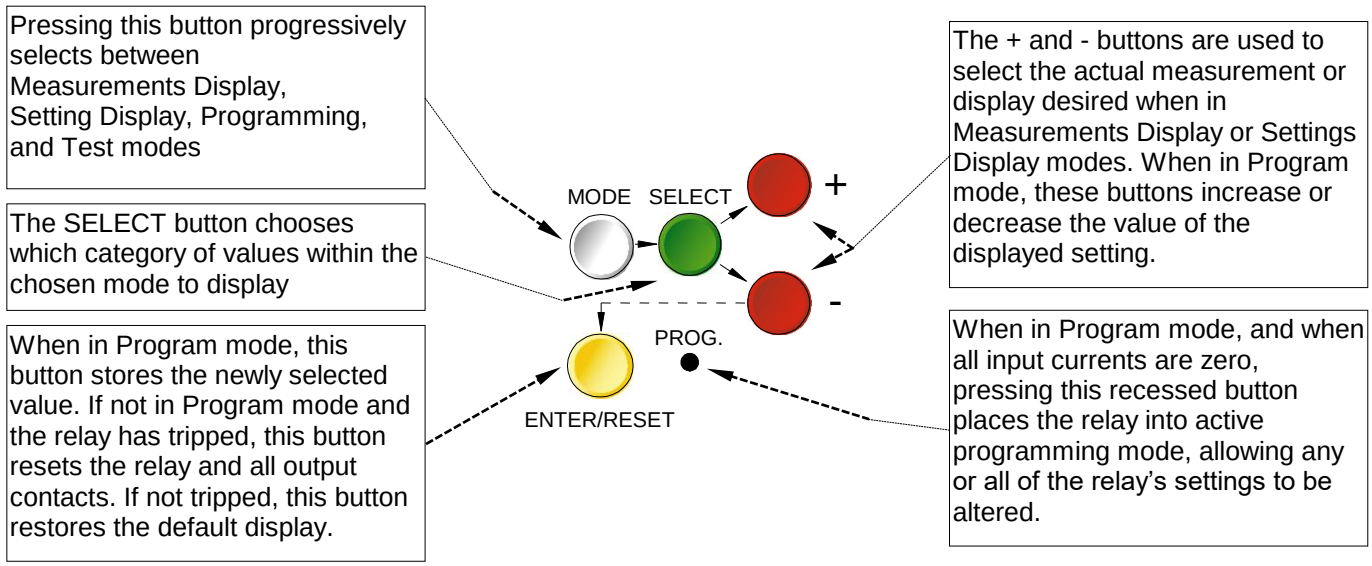
Before energising the unit check that supply voltage is within the allowed limits.

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)

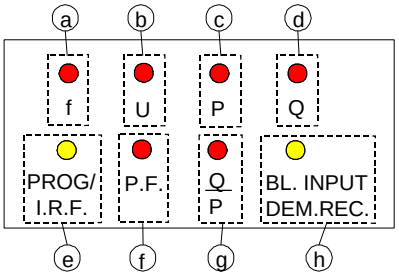
FIG.1





4. SIGNALIZATIONS

Eight signal leds (normally off) are provided:



a) Red LED **f**
- Flashing when one of the frequency elements 1f, 2f starts operating.
- Illuminated on trip after expiry of the set trip time delay [t1f],[t2f]

b) Red LED **U**
- Same as above related to 1U, 2U, t1U, t2U.

c) Red LED **P**
- Same as above related to 1P, 2P, t1P, t2P.

d) Red LED **Q**
- Same, as above related to 1Q, 2Q, t1Q, t2Q.

e) Yellow LED **PROG/IRF**
- Flashing during the programming of the parameters
- Illuminated of Internal Relay Fault.

f) Red LED **P.F.**
- Flashing when the Power Factor element P.F. starts operating
- Illuminated on trip after expiry of the set trip time delay [tPF].

g) Red LED **Q/P**
- As above related to Q/P, tQ/P.

h) Yellow LED **BL. INPUT DEM. REC.**
- Flashing during Demand Recording.
- Lit-on when a blocking signal is present at the terminals of the Blocking Input.

The reset of the leds takes place as follows:

- From flashing to off, automatically when the flashing cause disappears.
- From steady light to OFF, by "ENTER/RESET" push button only if the tripping cause has disappeared. (for LED h, when Block Input signal is removed)

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

5. OUTPUT RELAYS

5.1 OUTPUT RELAYS

Five output relays are available (R1, R2, R3, R4, R5) for external signalization and trip.

a) - The relays **R1, R2, R3, R4** are normally deenergized (energized on trip): one or more of them can be associated to one or more of the MW33's functions (user programmable configuration). One relay associated to more than one function will be operated by the function which is set to operate first.
The reset after trip can only take place if the relevant tripping cause has been cleared.
The reset function is programmable as follows :

- Automatic instantaneous (Rxtr AUT.)
- Automatic after adjustable time delay 0,1 to 9,9 sec. (Rxtr x,x s)
- Manual (Rxtr MAN.) : in this mode the reset is operated either by the ENTER/RESET push button on the relay's front face or via serial bus

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

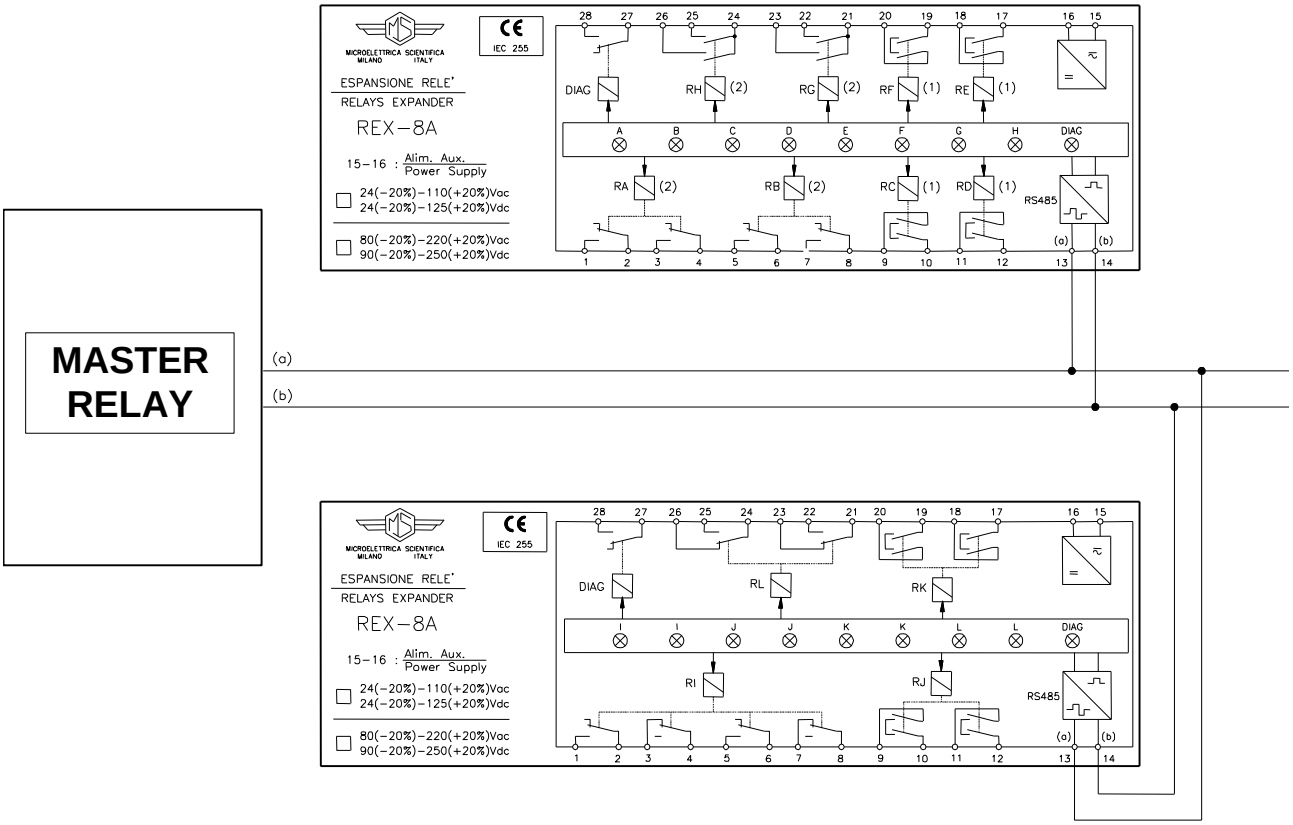
- internal fault
- power supply failure
- during the programming

5.2 VERSION MW33-X

The unit MW33-X includes four (R1, R2, R3, R4) user programmable plus one diagnostic (R5) output relays as in the standard version.
The number of output relays can be increased by the addition of one or two optional Relay Expansion modules REX-8.
The modules REX-8 are for protruding mounting and are controlled by the master module MW33-X via a screened twisted pairs of cables connecting dedicated RS485 serial ports (see diagram herebelow).
The module REX-8 includes eight (RA, RB, RC, RD, RE, RF, RG, RH) user programmable plus one (R-Diag) diagnostic output relays
The master module MW33-X can control altogether up to sixteen output relays

- internal R1 – R2 – R3 – R4
- from the first optional REX-8 module RA – RB – RC – RD – RE – RF – RG – RH
- from a second optional REX-8 module RI(RA+RB) – RJ(RC+RD) – RK(RE+RF) – RL(RG+RH)

This second unit REX-8 is configured (by internal Dip-Switch) to operate the eight relays two by two in parallel (only four user programmable outputs with double number of available contacts)



a) The user programmable relays (All but R5 and RDIAG) are normally deenergized (energised on trip). Any of the function featured by the MW33-X can be programmed to control up to four out of the sixteen user programmable output relays.
One relay associated to more than one function will be operated by the function which is set to operate first.
The reset after trip can only take place if the relevant tripping cause has been cleared.
The reset function is programmable as follows :

- Automatic instantaneous (Rxtr AUT.)
- Automatic after adjustable time delay 0,1 to 9,9 sec. (Rxtr x,x s)
- Manual (Rxtr MAN.) : in this mode the reset is operated either by the ENTER/RESET push button on the relay's front face or via serial bus

b) The relays R5, R DIAG, are not user programmable; they are normally energized and get deenergized on :

R5
- internal fault of MW33-X
- MW33-X power supply failure
- during the programming

R DIAG
- Internal fault of REX-8
- REX-8 power supply failure
- Interruption/fault on the serial control communication

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).
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 allowing 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 (or later) is available.
Please refer to the MSCOM instruction manual for more information.

7. DIGITAL INPUTS.

The relay is fitted with three digital inputs activated when the relevant terminals are shorted by a cold contact:

- **BI** (terminals 1-2) : It blocks the operation of the output relay(s) associated to the function(s) programmed for being blocked (see programming of function setting § 12.1) The blocking input inhibits the pick-up of the output relay(s), but does not block the operation of the Function(s) and timing: when the block input is disactivated the out-put relay will trip instantaneously (if the function's trip time delay is already expired) or after the remaining time delay.

- **DR** (terminals 1-3) : Start/stop toggle input for Demand recording. When this input is activated the built-in demand recorder is started (if not running) or stopped (if running) (see § 16) and all the formerly recorded MAXIMUM VALUES are instantaneously reset.

- **SO** (terminals 1-14) : synchro. When this input is activated, the unit's clock-calendar is synchronized (see § 15).

8. TEST

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

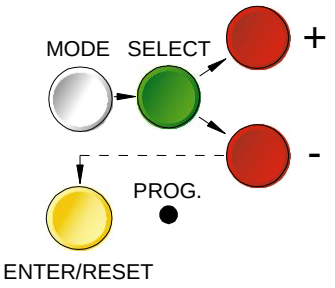
- Diagnostic and functional test, with checking of program routines and memory's content, run every time the aux. power is switched-on: the display shows the type of relay and its version number.

- 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 :

- **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) - 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 and to increase-decrease the settings.

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 ● : 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 "-" .
Pushing the ENTER button while the ACT. MEAS menu is active makes the relay enter the AUTOMATIC DISPLAY SCROLLING mode. While running in this mode the unit cyclically displays all the available measurements for 5s each. If the ENTER button is pressed again, the relay switches back to the normal display mode (the UP and DOWN buttons have to be pressed to scroll the menu).

10.1 ACT.MEAS (Actual Measurement values)

Real time values as measured during the normal operation.
The values displayed are continuously refreshed.

Display	Description
xxxxxxx	Current date in the DDMMMYY format.
xx**:**xx**:**xx	Current time in the HH:MM:SS format.
Fxx.xx**Hz**	Input Frequency
IAxxxxx**A**	True R.M.S. value of the phase A current displayed as primary Amps.
IBxxxxx**A**	As above, phase B
ICxxxxx**A**	As above, phase C
Ixxxxxx**A**	Average phase current [(IA+IB+IC)/3]
EAxxxx**En**	True R.M.S. value of the phase A voltage (phase to neutral), displayed as p.u. of the rated phase-to-neutral input voltage En=Un:√3
EBxxxx**En**	As above, phase B
ECxxxx**En**	As above, phase C
Exxxxx**En**	As above, average phase to neutral voltage [(EA+EB+EC)/3]
pfAx.xx**C** **pfA**x.xx**L**	Phase A power factor (C ⇔ capacitive, L ⇔ inductive)
pfBx.xxx**C** **pfB**x.xxx**L**	As above, phase B
pfCx.xxx**C** **pfC**x.xxx**L**	As above, phase C
pF x.xx**C** **pF** x.xx**L**	Average power factor (P/(V*I)) (C ⇔ capacitive, L ⇔ inductive)
PA x.xx**n** **PA -**x.xx**n**	Active power of phase A, displayed as p.u of the rated single-phase input power (SA=[Un/√3]•In)
PB x.xx**n** **PB -**x.xx**n**	As above, phase B
PC x.xx**n** **PC -**x.xx**n**	As above, phase C
P x.xx**n** **P -** x.xx**n**	Total active power (PA + PB + PC) displayed as p.u. of the rated 3-phase input power (Sn= √3•Un•In)
QA x.xx**n** **QA -** x.xx**n**	Reactive power of phase A, displayed as p.u of the rated single-phase input power (SA=[Un/√3]•In)
QB x.xx**n** **QB -** x.xx**n**	As above, phase B
QC x.xx**n** **QC -** x.xx**n**	As above, phase C
Q x.xx**n** **Q -** x.xx**n**	Total reactive power (QA + QB + QC) displayed as p.u. of the rated 3-phase input power (Sn= √3•Un•In)
Q/PA=x.xx	Ratio Reactive Power / Active Power phase A
Q/PB=x.xx	As above, phase B
Q/PC=x.xx	As above, phase C
Q/P=xxx	As above, Average three-phase

10.2 MAX VAL (Maximum Values measured)

Time stamped maximum demand values (reset can be done via the DR digital input or the serial communication interface).

Display	Description
xxxxxxx	Date of the last MAX VAL reset (in the DDMMMYY format)
xx**:**xx**:**xx	Time of the last MAX VAL reset (in the HH:MM:SS format)
IAxxxxx**A**	Maximum phase A current, displayed as primary A
xx**:**xx**:**xx	Time between the last MAX VAL reset and the recording of the IA maximum demand value.
IBxxxxx**A**	Maximum phase A current, displayed as primary A
xx**:**xx**:**xx	Time between the last MAX VAL reset and the recording of the IB maximum demand value.
ICxxxxx**A**	Maximum phase C current, displayed as primary A
xx**:**xx**:**xx	Time between the last MAX VAL reset and the recording of the IC maximum demand value.
P x.xx**n** **P -**x.xx**n**	Maximum total active power, displayed as p.u. (Sn= √3•Un•In)
xx**:**xx**:**xx	Time between the last MAX VAL reset and the recording of the P maximum demand value.
Q x.xx**n** **Q -**x.xx**n**	Maximum total reactive power, displayed as p.u. (Sn= √3•Un•In)
xx**:**xx**:**xx	Time between the last MAX VAL reset and the recording of the Q maximum demand value.
Q/P=x.xx	Maximum value of Q/P ratio.
xx**:**xx**:**xx	Time between the last MAX VAL reset and the recording of the Q/P maximum value.

10.3 LASTTRIP (Values measured al last tripping)

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

Display	Description
Causexxx	Function which produced the last event being displayed: **1f, 2f, 1u, 2u, 1p, 2p, 1q, 2q, PF, Q/P**
Fxx.xx**Hz**	Frequency
IAxxxxx**A**	Phase A current, displayed as primary A
IBxxxxx**A**	As above, phase B
ICxxxxx**A**	As above phase C
EAxxxx**En**	Phase A voltage, displayed as p.u. En
EBxxxx**En**	As above, phase B
ECxxxx**En**	As above, phase C
pfAx.xx**C** **pfA**x.xx**L**	Phase A power factor (C ⇔ capacitive, L ⇔ inductive)
pfBx.xx**C** **pfB**x.xx**L**	As above, phase B
pfCx.xx**C** **pfC**x.xx**L**	As above, phase C

10.4 TRIP NUM (N° of tripping for each function)

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

Display	Description
1uxxxxxx	1st voltage element
2uxxxxxx	2nd voltage element
1fxxxxxx	1st frequency element
2fxxxxxx	2nd frequency element
PFxxxxx	Power Factor element
Q/Pxxxxx	Q/P element
1pxxxxxx	1st active power element
2pxxxxxx	2nd active power element
1qxxxxxx	1st reactive power element
2qxxxxxx	2nd reactive power element

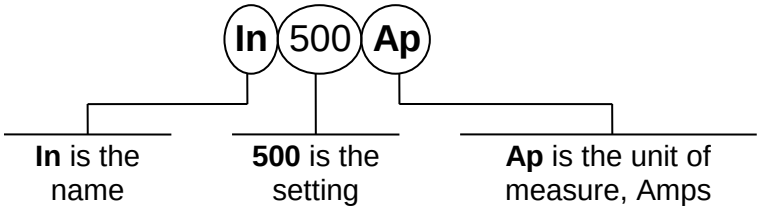
11. READING OF PROGRAMMED SETTINGS AND RELAY'S CONFIGURATION

Enter the mode "SET DISP", select the menu "SETTINGS" or "F→RELAY", scroll information available in the menu by keys "+" or "-".
SETTINGS = values of relay's operation parameters as programmed
F→RELAY = output relays associated to the different functions as programmed.
The SET DISP menu doesn't display current date and time.

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.
The setting of the built in clock calendar is described at paragraph 15.2

12.1 PROGRAMMING OF FUNCTIONS SETTINGS



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

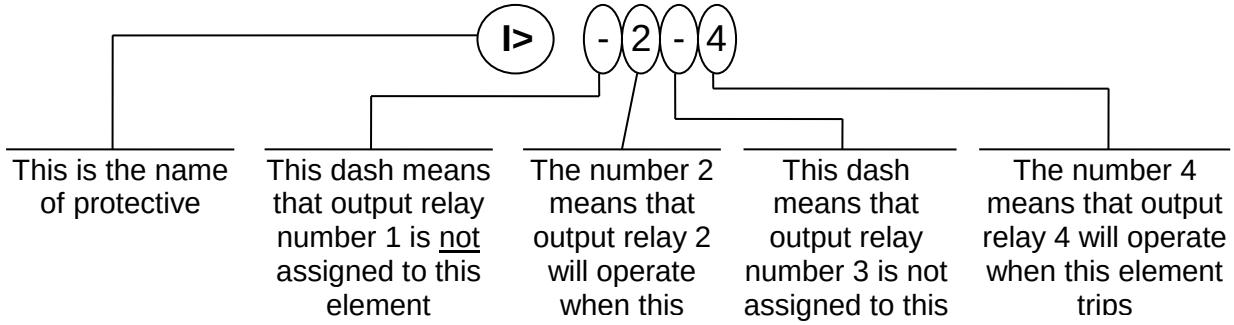
Display	Description	Setting range	Step	Unit
xxxxxxx	Current date	DDMMMYY	-	-
xx:xx:xx	Current time	HH:MM:SS	-	-
Tsyn Dis**m**	Sync period of the internal clock calendar	5-10-15 30-60-Dis	-	min
Fn 50 **Hz**	Mains frequency	50 – 60Hz	-	
In 500**Ap**	Rated primary current of phase CT's	1 – 9999	1	A
Un 100**V**	Rated secondary phase-to-phase voltage of system's P.T.s	100 – 125	1	V
TDR 60**s**	Time interval for Demand Recording	1 – 3600	1	s
Fn + **1f**	Operation mode of 1st frequency element (1f) : **Fn** + **1f** = over frequency **Fn** - **1f** = under frequency **Fn** +/- **1f** = over/under frequency **Fn** Dis **1f** = Function 1f disabled	+ - +/- Dis	+ - +/- Dis	-
1f 1.00 **Hz**	Trip differential level of 1st frequency element	0.05 – 9.99	0.01	Hz
t1f 1.0 **s**	Trip time delay of (1f)	0.0 – 99.9	0.1	s
R1f 0.1 **Hz**	Reset differential of (1f)	0.01 – 0.99	0.01	Hz
Fn +/- **2f**	Operation mode of 2nd frequency element (2f) : **Fn** + **2f** = over frequency **Fn** - **2f** = under frequency **Fn** +/- **2f** = over/under frequency **Fn** Dis **2f** = Function 2f disabled	+ - +/- Dis	+ - +/- Dis	-
2f 0.5 **Hz**	Trip differential level of 2nd frequency element	0.05 – 9.99	0.01	Hz
t2f 2.0 **s**	Trip time delay of (2f)	0.0 – 99.9	0.1	s
R2f 0.2 **Hz**	Reset differential of (2f)	0.01 – 0.99	0.01	Hz

Display	Description	Setting range	Step	Unit
Un + **1u**	Operation mode of 1st voltage element (1u) : **Un** + **1u** = over voltage **Un** – **1u** = under voltage **Un** +/- **1u** = over/under voltage **Un** Dis **1u** = Function 1U disabled	+ - +/- Dis	+ - +/- Dis	-
1u 20 **%Un**	Trip differential level of 1st frequency element	1 – 90	1	%Un
t1u 1.0 **s**	Trip time delay of (1u)	0.0 – 99.9	0.1	s
R1u 5 **%Un**	Reset differential of (1u)	1 - 20	1	%Un
Un +/- **2u**	Operation mode of 2nd voltage element (2u) : **Un** + **2u** = over voltage **Un** – **2u** = under voltage **Un** +/- **2u** = over/under voltage **Un** Dis **2u** = Function 2U disabled	+ - +/- Dis	+ - +/- Dis	-
2u 10 **%Un**	Trip differential level of 2nd frequency element	1 – 90	1	%Un
t2u 2.0 **s**	Trip time delay of (2U)	0.0 – 99.9	0.1	s
R2u 3 **%Un**	Reset differential of (2U)	1 – 20	1	%Un
φ Lg	Operation mode of Power Factor control element (PF<) : φ Ld = Lead φ Lg = Lag φ Ld/Lg = Lead / Lag φ Dis. = Function PF disabled	Ld Lg Ld/Lg Dis	Ld Lg Ld/Lg Dis	-
PF 0.90	Operation level of (PF<)	0.10 – 0.99	0.01	-
tPF 3.0 **s**	Trip time delay of (PF<)	0.0 – 99.9	0.1	s
RPF 0.95	Reset level of (PF<)	0.10 – 0.99	0.01	-
Q/P = 0.50	Operation level of the Q/P (tg φ) element Q/P> (φ = 6° - 85°)	0.10–9.99–Dis.	0.01	-
tQ/P 10.0 **s**	Trip time delay of (Q/P>)	0.0 – 99.9	0.1	s
RQ/P 0.45	Reset level of (Q/P>)	0.05 – 9.99	0.01	-
ts' 30 **s**	Start inhibition time	1 – 600	1	s
1p +/-	Operation direction of the 1st Active Power element (1p) : **1p** + = Export (forward) Power **1p** - = Import (reverse) Power **1p** +/- = Export / Import	+ - +/-	+ - +/-	-
1p >	Operation mode of the (1p) element: **1p** > = Over Power **1p** < = Under Power **1p** Dis = Function 1p disabled	> < Dis	> < Dis	-
1p 110 **%Sn**	Operation level of (1p)	2 – 200	1	%Sn
t1p 2 **s**	Trip time delay of (1p)	0.0 – 99.9	0.1	s
R1p 3 **%Sn**	Reset differential of (1p)	1 – 20	1	%Sn
2p +/-	Operation direction of the 2nd Active Power element (2p) : **2p** + = Export (forward) Power **2p** - = Import (reverse) Power **2p** +/- = Export / Import	+ - +/-	+ - +/-	-
2p <	Operation mode of the (2p) element: **2p** > = Over Power **2p** < = Under Power **2p** Dis = Function 2p disabled	> < Dis	> < Dis	-

Display	Description	Setting range	Step	Unit
2p 90 **%Sn**	Operation level of (2p)	2 – 200	1	%Sn
t2p 2 **s**	Trip time delay of (2p)	0.0 – 99.9	0.1	s
R2p 3 **%Sn**	Reset differential of (2p)	1 – 20	1	%Sn
1q +/-	Operation direction of the 1st Reactive Power element (1q) : **1q** + = Capacitive Reactive Power Exported **1q** - = Inductive Reactive Power Exported **1q** +/- = Reactive Power Capacitive / Inductive	+ - +/-	+ - +/-	-
1q >	Operation mode of the (1q) element: **1q** > = Over Reactive Power **1q** < = Under Reactive Power **1q** Dis. = Function 1Q disabled	> < Dis	> < Dis	-
1q120 **%Sn**	Operation level of (1q)	2 – 200	1	%Sn
t1Q 2 **s**	Trip time delay of (1q)	0.0 – 99.9	0.1	s
R1Q 5 **%Sn**	Reset differential of (1q)	1 – 20	1	%Sn
2q +	Operation direction of the 2nd Reactive Power element (2q) : **2q** + = Export (forward) Power **2q** - = Import (reverse) Power **2q** +/- = Export / Import	+ - +/-	+ - +/-	-
2q <	Operation mode of the (2q) element: **2q** > = Over Reactive Power **2q** < = Under Reactive Power **2q** Dis. = Function 2q disabled	> < Dis	> < Dis	-
2q 80 **%Sn**	Operation level of (2q)	2 – 200	1	%Sn
t2Q 3 **s**	Trip time delay of (2q)	0.0 – 99.9	0.1	s
R2Q10 **%Sn**	Reset differential of (2q)	1 – 20	1	%Sn
B→1f OFF	Blocking Input at terminals (1-2) BI blocks the output relay associated to the function 1f	ON - OFF	ON-OFF	-
B→2f OFF	Blocking Input at terminals (1-2) BI blocks the output relay associated to the function 2f	ON - OFF	ON-OFF	-
B→1u OFF	Blocking Input at terminals (1-2) BI blocks the output relay associated to the function 1U	ON - OFF	ON-OFF	-
B→2u OFF	Blocking Input at terminals (1-2) BI blocks the output relay associated to the function 2U	ON - OFF	ON-OFF	-
B→PF OFF	Blocking Input at terminals (1-2) BI blocks the output relay associated to the function PF	ON - OFF	ON-OFF	-
B→QP OFF	Blocking Input at terminals (1-2) BI blocks the output relay associated to the function Q/P	ON - OFF	ON-OFF	-
B→1p OFF	Blocking Input at terminals (1-2) BI blocks the output relay associated to the function 1P	ON - OFF	ON-OFF	-
B→2p OFF	Blocking Input at terminals (1-2) BI blocks the output relay associated to the function 2P	ON - OFF	ON-OFF	-
B→1q OFF	Blocking Input at terminals (1-2) BI blocks the output relay associated to the function 1Q	ON - OFF	ON-OFF	-
B→2q OFF	Blocking Input at terminals (1-2) BI blocks the output relay associated to the function 2Q	ON - OFF	ON-OFF	-
NodAd 1	Identification number for connection on serial communication bus	1 - 250	1	-

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			
1u	----	1st voltage element operates relays	R1, R2, R3, R4	Only for Version MW33-X	RA,RB→RL
2u	----	2nd voltage element operates relays	R1, R2, R3, R4		RA,RB→RL
1f	----	1st frequency element operates relays	R1, R2, R3, R4		RA,RB→RL
2f	----	2nd frequency element operates relays	R1, R2, R3, R4		RA,RB→RL
PF>	----	Power Factor element operates relays	R1, R2, R3, R4		RA,RB→RL
Q/P	----	Q/P element operates relays	R1, R2, R3, R4		RA,RB→RL
1p	----	1st active power element operates relays	R1, R2, R3, R4		RA,RB→RL
2p	----	2nd active power element operates relays	R1, R2, R3, R4		RA,RB→RL
1q	----	1st reactive power element operates relays	R1, R2, R3, R4		RA,RB→RL
2q	----	2nd reactive power element operates relays	R1, R2, R3, R4		RA,RB→RL
1tr	3**s**	Reset time delay of output relay R1 can be: - instantaneous (1tr Aut.) - time delayed (1tr 0,1- 9,9 s) step 0,1 s (3 s delay showed) - manual (1tr Man.)			
2tr	Aut.	As above for relay R2.			
3tr	Aut.	As above for relay R3.			
4tr	Aut.	As above for relay R4.			
Only for version MW33-X					
Atr	Aut.	As above for relay RA.			
Btr	Aut.	As above for relay RB.			
Ctr	Aut.	As above for relay RC.			
Dtr	Aut.	As above for relay RD.			
Etr	Aut.	As above for relay RE.			
Ftr	Aut.	As above for relay RF.			
Gtr	Aut.	As above for relay RG.			
Htr	Aut.	As above for relay RH.			
Itr	Aut.	As above for relay RI.			
Jtr	Aut.	As above for relay RJ.			
Ktr	Aut.	As above for relay RK.			
Ltr	Aut.	As above for relay RL.			

13. MANUAL AND AUTOMATIC TEST OPERATION

13.1 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 (current date).
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.

13.2 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.

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”, 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.

15 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.

15.1 Clock synchronization.

The clock can be synchronized via a digital input (terminals 1 – 14) or 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 only way to modify the current date and time is via the front panel keyboard (SETTINGS menu) or the serial communication interface.
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.

15.2 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 captured.
On the other hand pressing the SELECT button leaves the current date unchanged and scrolls the SETTINGS menu. Current time can now be modified using the same procedure described above.
If synchronization is enabled and the date (or time) is modified, the clock is stopped until a sync signal is received (via digital input or the serial port). This allows the user to manually set many units and have them to start their clocks in a synchronized fashion.
On the other hand if synchronization is disabled the clock is never stopped.
Note that the setting of a new time always clears 10ths and 100ths of sec.

15.3 Time resolution.

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

15.4 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.

15.5 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).

16 TIME STAMPING OF MAXIMUM DEMAND VALUES.

Maximum demand values are time stamped by means of the internal clock/calendar. To avoid overloading the MAX VAL menu with too many items, the time stamp is expressed as follows:

- Time of the last max. val. reset (DDMMMYY, HH:MM:SS)
- For each parameter, time elapsed between the last max. val. reset and the recording of the parameter itself (HH:MM:SS). (max. time is 99:59:59)

Note that all the times are also available with a 10ms resolution via the serial communication interface.

17 DEMAND RECORDING

Sequences of r.m.s values of the 6 input signals (3 currents + 3 voltages), plus the 3 computed power factors can be stored in a non-volatile memory.

Definition of terms.
We call **buffer** a set of adjacent memory locations containing consecutive samples coming from the same input channel. Let n be the number of samples which can be stored in a buffer.
For the MW33, n is equal to 400.

Operation.
As soon as a START signal is received (terminals xx..xx shorted), the current date/time is stored in the relay's non-volatile memory and demand recording begins.
The unit continuously collects samples and orderly stores them into its internal buffers. Sampling period can be selected from 1s to 3600s.
The same digital input must be used to STOP demand recording. If no STOP command is received and buffers get full of samples, they are rewritten in a circular way (oldest samples are overwritten first).
START and STOP commands can also be sent to the relay via the serial port.

17.1 Reading of the demand recording data.

The MW33 can permanently store a set of 9 buffers. Each buffer is 400 samples deep.
The unit internally represents data according to the following structure, which can be accessed via the serial port:

Offset (word)	Contents
0	Start time: Sec. / 100ths of sec, BCD format
1	Start time: Hours / Min., BCD format
2	Start date: Months / Days, BCD format
3	Start date: 00 / Years, BCD format
4	Index of start sample: 0 to n-1
5	Sampling period
6	Sample 0, buffer 0
.....	.....
6 + n - 1	Sample n, buffer 0
6 + n	Sample 0, buffer 1
.....	.....
6 + 2n – 1	Sample n, buffer 1
.....	.....
6 + (m -1) * n	Sample 0, buffer m
.....	.....
6 + m*n - 1	Sample n, buffer m

Table 1

Note that if the start command is issued via the serial port, the least significant digit of start time is meaningless (due to unpredictable communication delays).
The number of samples stored in the buffers is reset when a start signal is received and incremented every time the relay stores a new set of samples in the buffers.

For communication purposes, the memory area represented in Table 1 has been divided into 16 words wide blocks (also called windows). If a word has to be accessed, the proper window must first be selected. To do that, the user has to write the relevant window number into word 11001.

The following table lists the read only words concerning demand recording.

Word Number (MODBUS Address)	Contents
10999	Number of valid samples since last start command
11000	Reserved
11001	Number of buffers (9)
11002	Number of samples per buffer (400)
11003	Data available (0 => no , 1 => yes)
11004	Word 0 of currently selected window
11005	Word 1 of currently selected window
11006	Word 2 of currently selected window
11007	Word 3 of currently selected window
11008	Word 4 of currently selected window
11009	Word 5 of currently selected window
11010	Word 6 of currently selected window
11011	Word 7 of currently selected window
11012	Word 8 of currently selected window
11013	Word 9 of currently selected window
11014	Word 10 of currently selected window
11015	Word 11 of currently selected window
11016	Word 12 of currently selected window
11017	Word 13 of currently selected window
11018	Word 14 of currently selected window
11019	Word 15 of currently selected window

Example: to read the start date and time of the currently running demand recording session, the following procedure must be followed:

1) Since date/time words have offset ranging from 0 to 3, window 0 must be selected by writing 0 into word #11001.

2) Date and time are now available at MODBUS addresses 11004..11007

18. ELECTRICAL CHARACTERISTICS

❑	REFERENCE STANDARDS	IEC 60255 - EN50263 - 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		
❑	Climatic tests	IEC 68-2			

CE EMC Compatibility (EN50081-2 - EN50082-2 - EN50263)

❑	Electromagnetic emission	EN55022			
❑	Radiated electromagnetic field immunity test	IEC61000-4-3 ENV50204	level 3	80-1000MHz 900MHz/200Hz	10V/m 10V/m
❑	Conducted disturbances immunity test	IEC61000-4-6	level 3	0.15-80MHz	10V/m
❑	Electrostatic discharge test	IEC61000-4-2	level 4	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	
❑	Electrical fast transient/burst	IEC61000-4-4	level 4	2kV, 5/50ns, 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		200ms	
❑	Resistance to vibration and shocks	IEC60255-21-1 - IEC60255-21-2 – 10-50Hz – 1g			

CHARACTERISTICS

❑	Accuracy at reference value of influencing factors	2% Rated Input 2% +/- 10ms	for measure for times
❑	Rated Current	In = 1 or 5A	
❑	Current overload	200 A for 1 sec; 10A continuos	
❑	Burden on current inputs	Phase : 0.01VA at In = 1A; 0.2VA at In = 5A	
❑	Rated Voltage	Un = 100V (different on request)	
❑	Voltage overload	2 Un continuous	
❑	Burden on voltage input	0,08 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	-10°C / +55°C	
❑	Storage temperature	-25°C / +70°C	
❑	Humidity	93% Without Condensing	

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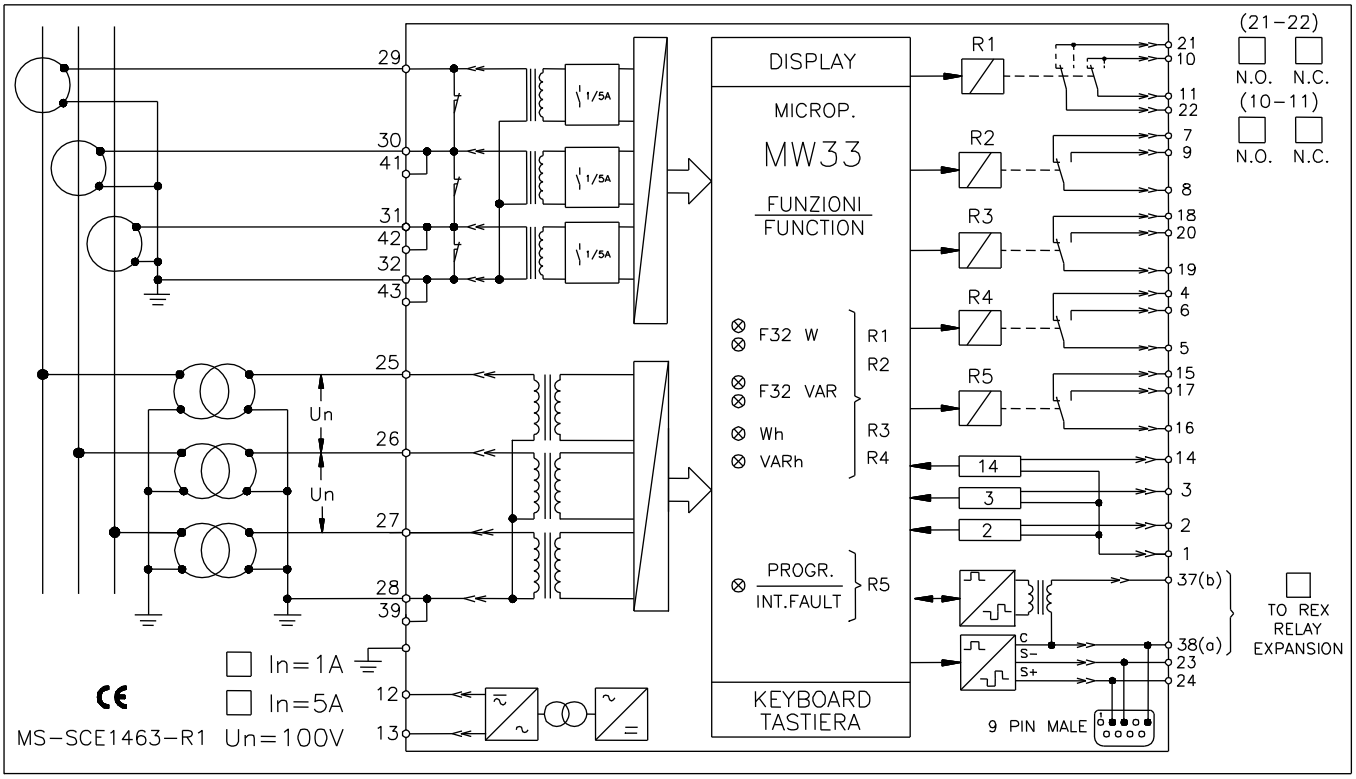
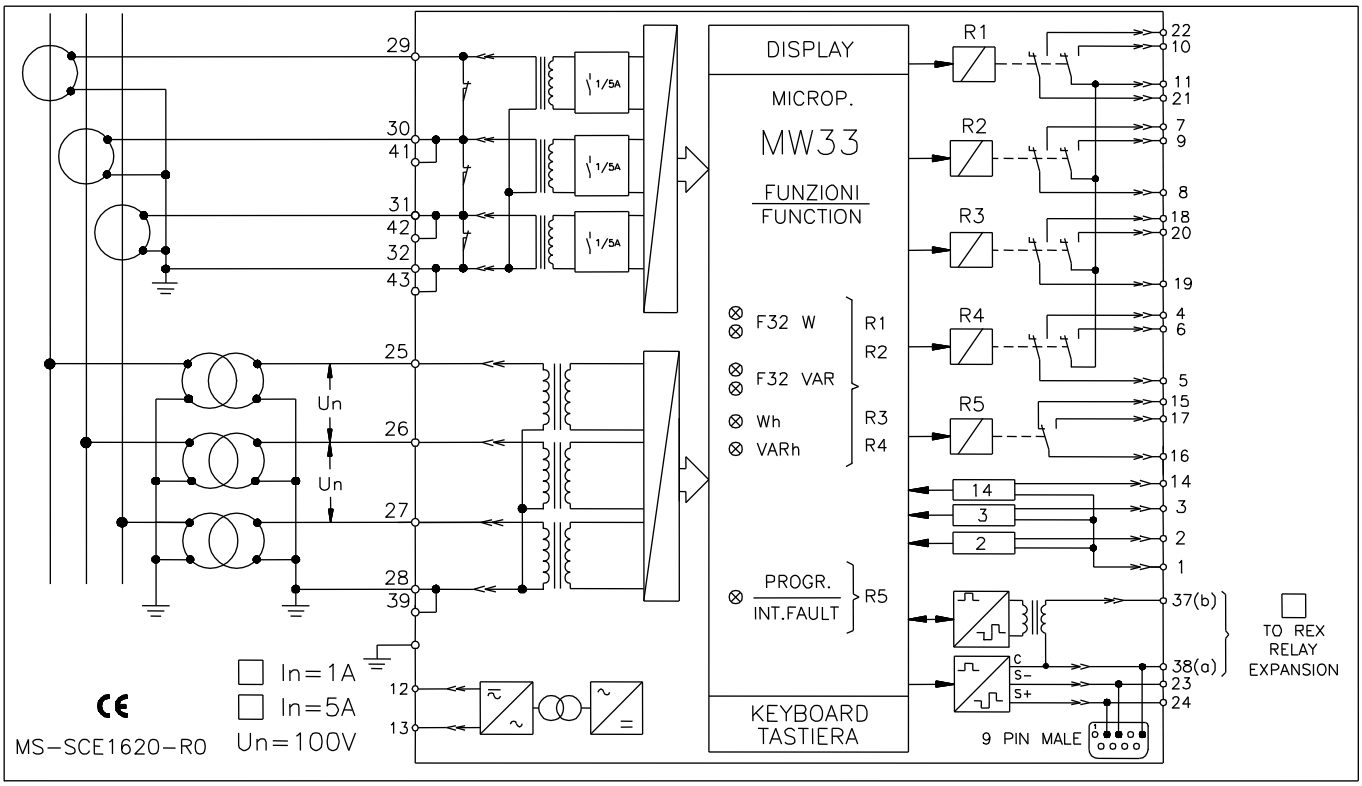
http://www.microelettrica.com **e-mail :** ute@microelettrica.com

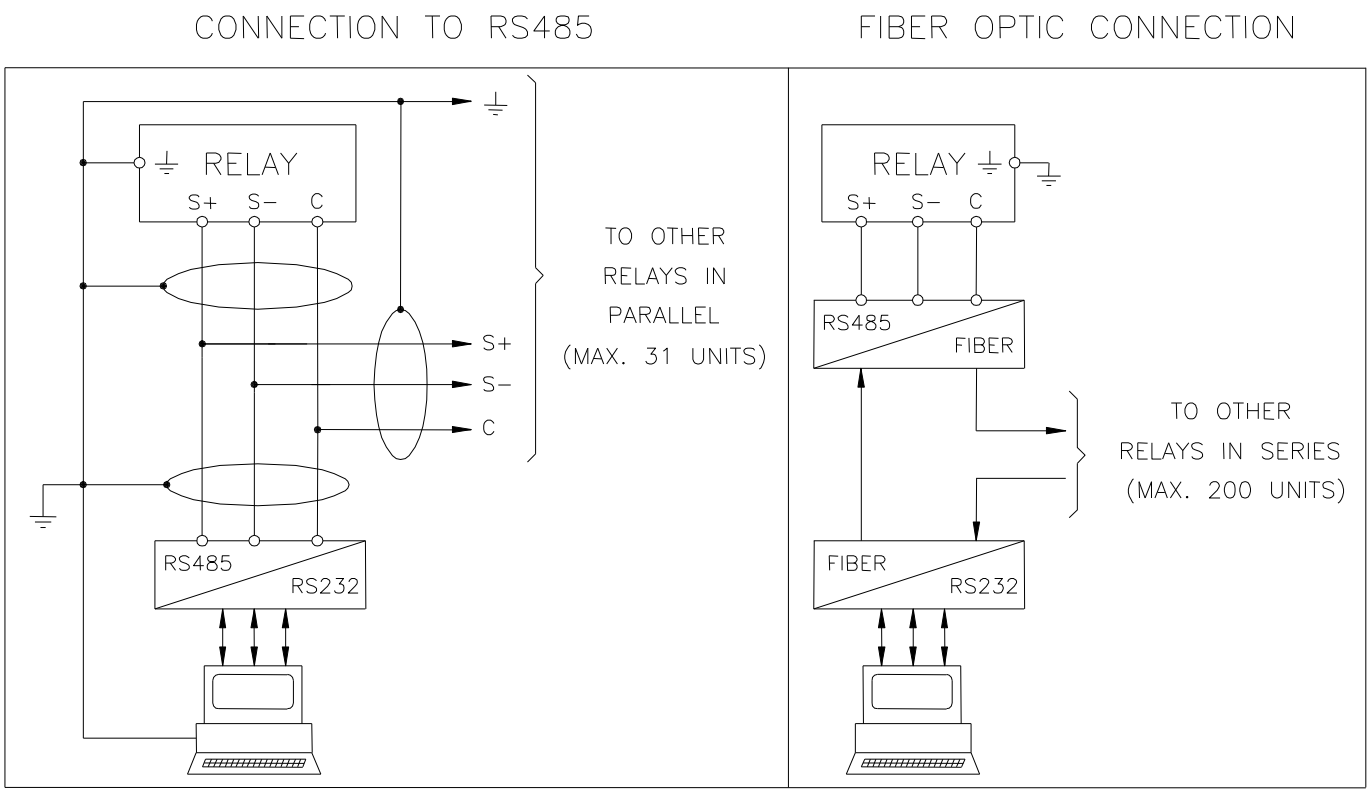
19. CONNECTION DIAGRAM (SCE1463 Rev.1 STANDARD OUTPUT)



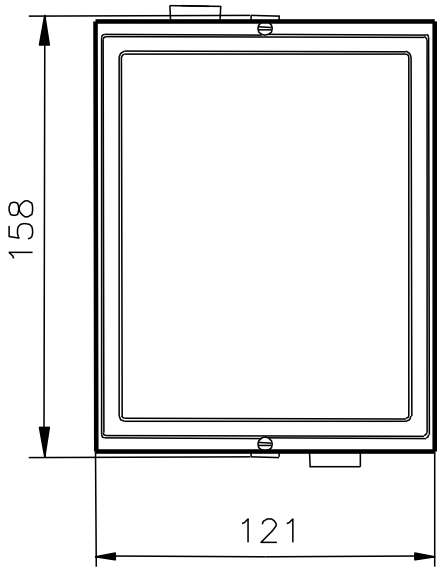
19.1 CONNECTION DIAGRAM (SCE1620 Rev.0 Double Output)



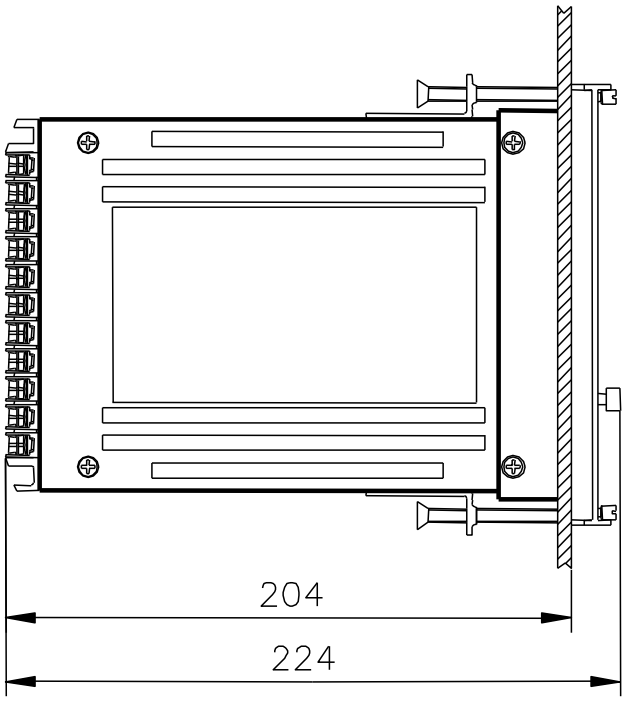
20. WIRING THE SERIAL COMMUNICATION BUS (SCE1309 Rev.0)



21. OVERALL DIMENSIONS



PANEL DRILLING 113x142 (LxH)



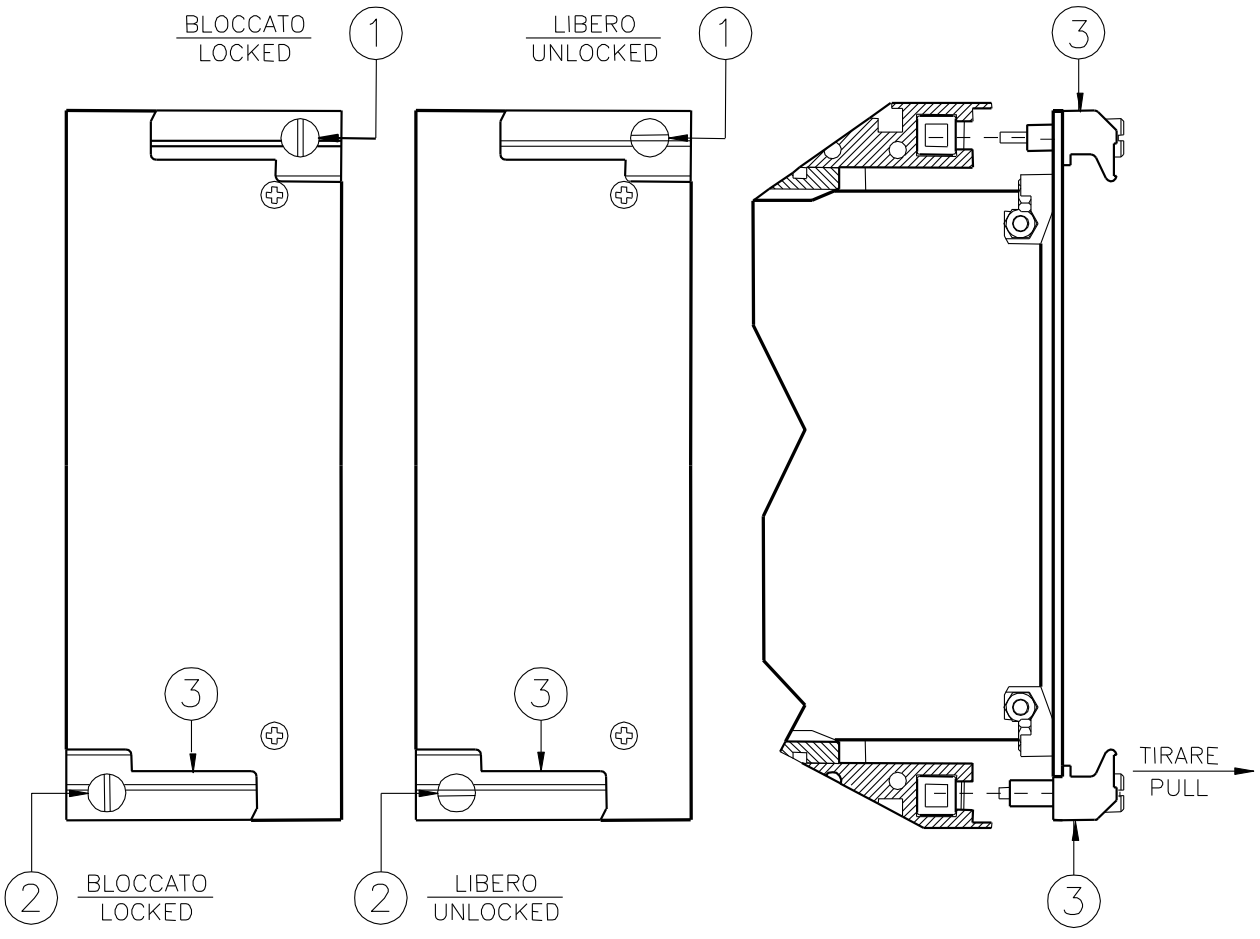
23. DIRECTION FOR PCB'S DRAW-OUT AND PLUG-IN

23.1 Draw-out

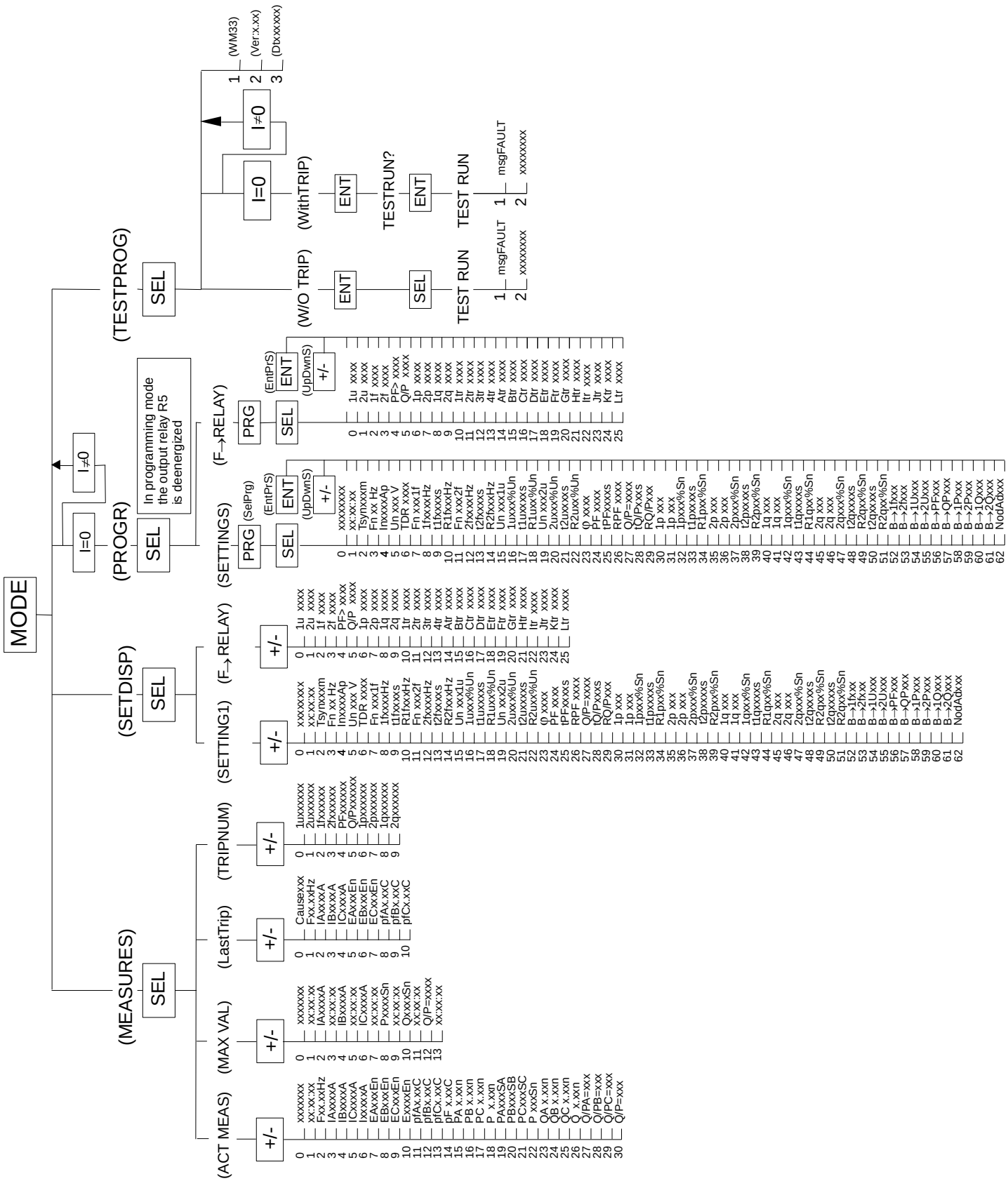
Rotate clockwise the screws ① and ② in the horizontal position of the screws-driver mark.
Draw-out the PCB by pulling on the handle ③

23.2 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).



24. KEYBOARD OPERATIONAL DIAGRAM



25. SETTING'S FORM

Date :		**Number Relay:**	

RELAY PROGRAMMING

Default Setting				**Actual Setting**		
Variable	**Value**	**Units**	**Description**	**Variable**	**Value**	**Units**
xxxxxxx	random	**-**	Current date	**xxxxxxx**		**-**
xx:xx:xx	random	**-**	Current time	**xx:xx:xx**		**-**
Tsyn	Dis	**m**	Sync period of the internal clock calendar	**Tsyn**		**m**
Fn	50	**Hz**	Mains frequency	**Fn**		**Hz**
In	500	**Ap**	Rated primary current of phase CT's	**In**		**Ap**
Un	100	**V**	Rated secondary phase-to-phase voltage of system's P.T.s	**Un**		**V**
TDR	60	**s**	Time interval for Demand Recording	**TDR**		**s**
Fn	+	**1f**	Operation mode of 1st frequency element (1f)	**Fn**		**1f**
1f	1.00	**Hz**	Trip differential level of 1st frequency element	**1f**		**Hz**
t1f	1.0	**s**	Trip time delay of (1f)	**t1f**		**s**
R1f	0.1	**Hz**	Reset differential of (1f)	**R1f**		**Hz**
Fn	+/-	**2f**	Operation mode of 2nd frequency element (2f)	**Fn**		**2f**
2f	0.5	**Hz**	Trip differential level of 2nd frequency element	**2f**		**Hz**
t2f	2.0	**s**	Trip time delay of (2f)	**t2f**		**s**
R2f	0.2	**Hz**	Reset differential of (2f)	**R2f**		**Hz**
Un	+	**1u**	Operation mode of 1st voltage element (1u)	**Un**		**1u**
1u	20	**%Un**	Trip differential level of 1st frequency element	**1u**		**%Un**
t1u	1.0	**s**	Trip time delay of (1u)	**t1u**		**s**
R1u	5	**%Un**	Reset differential of (1u)	**R1u**		**%Un**
Un	+/-	**2u**	Operation mode of 2nd voltage element (2u)	**Un**		**2u**
2u	10	**%Un**	Trip differential level of 2nd frequency element	**2u**		**%Un**
t2u	2.0	**s**	Trip time delay of (2U)	**t2u**		**s**
R2u	3	**%Un**	Reset differential of (2U)	**R2u**		**%Un**
φ	Lg	-	Operation mode of Power Factor control element (PF<)	**φ**		-
PF	0.90	-	Operation level of (PF<)	**PF**		-
tPF	3.0	**s**	Trip time delay of (PF<)	**tPF**		**s**
RPF	0.95	-	Reset level of (PF<)	**RPF**		-
Q/P =	0.50	-	Operation level of the Q/P (tg φ) element Q/P> (φ = 6° - 85°)	**Q/P** =		-
tQ/P	10.0	**s**	Trip time delay of (Q/P>)	**tQ/P**		**s**
RQ/P	0.45	-	Reset level of (Q/P>)	**RQ/P**		-
ts'	30	**s**	Start inhibition time	**ts'**		**s**
1p	+/-	-	Operation direction of the 1st Active Power element (1p)	**1p**		-
1p	>	-	Operation mode of the (1p) element	**1p**		-
1p	110	**%Sn**	Operation level of (1p)	**1p**		**%Sn**
t1p	2	**s**	Trip time delay of (1p)	**t1p**		**s**
R1p	3	**%Sn**	Reset differential of (1p)	**R1p**		**%Sn**
2p	+/-	-	Operation direction of the 2nd Active Power element (2p)	**2p**		-
2p	<	-	Operation mode of the (2p) element	**2p**		-
2p	90	**%Sn**	Operation level of (2p)	**2p**		**%Sn**
t2p	2	**s**	Trip time delay of (2p)	**t2p**		**s**
R2p	3	**%Sn**	Reset differential of (2p)	**R2p**		**%Sn**
1q	+/-	-	Operation direction of the 1st Reactive Power element (1q)	**1q**		-
1q	>	-	Operation mode of the (1q) element	**1q**		-
1q	120	**%Sn**	Operation level of (1q)	**1q**		**%Sn**
t1Q	2	**s**	Trip time delay of (1q)	**t1Q**		**s**
R1Q	5	**%Sn**	Reset differential of (1q)	**R1Q**		**%Sn**
2q	+	-	Operation direction of the 2nd Reactive Power element (2q)	**2q**		-
2q	<	-	Operation mode of the (2q) element	**2q**		-
2q	80	**%Sn**	Operation level of (2q)	**2q**		**%Sn**
t2Q	3	**s**	Trip time delay of (2q)	**t2Q**		**s**
R2Q	10	**%Sn**	Reset differential of (2q)	**R2Q**		**%Sn**

Default Setting				Actual Setting		
Variable	**Value**	**Units**	**Description**	**Variable**	**Value**	**Units**
B→1f	OFF	-	Blocking Input at term. (1-2) BI blocks the output relay associated to the funct. 1f	**B→1f**		-
B→2f	OFF	-	Blocking Input at term. (1-2) BI blocks the output relay associated to the funct. 2f	**B→2f**		-
B→1u	OFF	-	Blocking Input at term. (1-2) BI blocks the output relay associated to the funct. 1U	**B→1u**		-
B→2u	OFF	-	Blocking Input at term. (1-2) BI blocks the output relay associated to the funct. 2U	**B→2u**		-
B→PF	OFF	-	Blocking Input at term. (1-2) BI blocks the output relay associated to the funct. PF	**B→PF**		-
B→Q/P	OFF	-	Blocking Input at term. (1-2) BI blocks the output relay associated to the funct. Q/P	**B→QP**		-
B→1p	OFF	-	Blocking Input at term. (1-2) BI blocks the output relay associated to the funct. 1P	**B→1p**		-
B→2p	OFF	-	Blocking Input at term. (1-2) BI blocks the output relay associated to the funct. 2P	**B→2p**		-
B→1q	OFF	-	Blocking Input at term. (1-2) BI blocks the output relay associated to the funct. 1Q	**B→1q**		-
B→2q	OFF	-	Blocking Input at term. (1-2) BI blocks the output relay associated to the funct. 2Q	**B→2q**		-
NodAd	1	-	Identification number for connection on serial communication bus	**NodAd**		-

CONFIGURATION OF OUTPUT RELAYS

Default Setting						Actual Setting					
Protective Element	**Output Relays**				**Description**	**Protective Element**	**Output Relays**				
1u	-	-	-	-	1st voltage element operates relays	**1u**					
2u	-	-	-	-	2nd voltage element operates relays	**2u**					
1f	-	-	-	-	1st frequency element operates relays	**1f**					
2f	-	-	-	-	2nd frequency element operates relays	**2f**					
PF>	-	-	-	-	Power Factor element operates relays	**PF>**					
Q/P	-	-	-	-	Q/P element operates relays	**Q/P**					
1p	-	-	-	-	1st active power element operates relays	**1p**					
2p	-	-	-	-	2nd active power element operates relays	**2p**					
1q	-	-	-	-	1st reactive power element operates relays	**1q**					
2q	-	-	-	-	2nd reactive power element operates relays	**2q**					
1tr	3 **s**				Reset time delay of output relay R1	**1tr**					
2tr	Aut.				As above for relay R2.	**2tr**					
3tr	Aut.				As above for relay R3.	**3tr**					
4tr	Aut.				As above for relay R4.	**4tr**					
Only for version MW33-X											
Atr	Aut.				As above for relay RA.	**Atr**					
Btr	Aut.				As above for relay RB.	**Btr**					
Ctr	Aut.				As above for relay RC.	**Ctr**					
Dtr	Aut.				As above for relay RD.	**Dtr**					
Etr	Aut.				As above for relay RE.	**Etr**					
Ftr	Aut.				As above for relay RF.	**Ftr**					
Gtr	Aut.				As above for relay RG.	**Gtr**					
Htr	Aut.				As above for relay RH.	**Htr**					
Itr	Aut.				As above for relay RI.	**Itr**					
Jtr	Aut.				As above for relay RJ.	**Jtr**					
Ktr	Aut.				As above for relay RK.	**Ktr**					
Ltr	Aut.				As above for relay RL.	**Ltr**					