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**INSTRUCTION MANUAL - P.F. Correction equipments type G**



MOD 04.05.10 REV 00 06/01

**DICHIARAZIONE DI CONFORMITA'  
CONFORMITY CERTIFICATE  
DECLARATION DE CONFORMITE AUX NORMES  
DECLARACION DE CONFORMIDAD**



**COMAR Condensatori S.p.A.  
Via del Lavoro 80 - Crespellano (BO) Italy**

dichiara sotto la propria responsabilit , che i quadri di rifasamento automatici

*declares, under its own responsibility, that power factor correction equipments*

dclare, sous sa responsabilit , que les appareils automatiques de compensation

declara bajo su responsabilidad que el cuadro de compensacion

**G GE + R15 + B3 + B5 + AAR/5 + AAR/6**

ai quali si riferisce questa dichiarazione, sono conformi alle seguenti normative tecniche:

*which this declaration refers, are manufactured according to the following technical Stds:*

auxquels cette d claration fait r frence, sont r alis s conform ment aux indications donn es par les suivantes normes techniques:

al cual se refiere esta declaracion, es conforme a las siguientes normativas tecnicas

Apparecchiatura assiemata di protezione e manovra per BT

**CEI EN 60439-1 : 1995 (EN 60439-1 : 1994)**  
*Low-voltage switchgear and controlgear assemblies -*

Ensembles d appareillage basse tension

aparatos ensamblados de proteccion y maniobra de bt

**CEI EN 60831-1 : 1994 (EN 60831-1 : 1993)**  
**CEI EN 60831-2 : 1994 (EN 60831-2 : 1993)**

"Condensatori statici di rifasamento di tipo autorigenerabile per impianti di energia a corrente alternata con tensione nom. inferiore o uguale a 1000 V"

*Shunt power capacitors of the self-healing type for a.c. systems having a rated voltage up to and including 1000 V*

°°Condensateurs shunt de puissance autor g n rateurs destin s tre install s sur des r seaux courant alternatif de tension assign e inf rieur e ou gale 1000 V°°  
donc, ils r pondent aux caract ristiques fondamentales des r glements de la CEE concernant les Produits de Baisse Tension

°°Condensadores estaticos de compensacion de reactiva del tipo autoregenerable para instalaciones de energia a corriente alterna con tension nominal inferior o igual a 1000V el cual responde a los requisitos fundamentales de la directiva comunitaria sobre °° productos de baja tension°°

e quindi rispondenti ai requisiti essenziali della direttiva comunitaria sui Prodotti di Bassa Tensione

*so that they comply to basic elements of EC regulations about Low Voltage Products*

**73 / 23 CEE ( 93 / 68 CEE )**

Crespellano - BO  
Data

COMAR Condensatori S.p.a.

**Il Legale Rappresentante  
R. Bacchelli**

• **ENGLISH**

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## 1. GENERAL

The G series P.F.C. equipment is suitable for the centralized P.F. regulation of industrial loads. It may be installed to completely eliminate charges made by Electricity Authorities for any reactive energy used, to reduce the losses for the Joule effect and the voltage losses on the conductors, to take advantage of electrical machines and existing power lines. The P.F.C. equipment uses electronic P.F. Regulator, designed and manufactured by Comar, which controls the value of  $\cos\phi$ . The extensive range of this equipment makes it suitable for P.F. correction of a wide range of loads, especially in the case of heavy power users.

| <b>TECHNICAL DATA</b>  |  |
|--|--|
| Rated voltage  | <b>230V</b> Type 230 <b>400V</b> Type AAR/5-6-500 <b>415V</b> Type R15, B2,B3 <b>460V</b> Type B5, AAR/6 |
| Rated frequency  | 50Hz (60Hz upon request)   |
| Protection degree  | IP30 (IP40 and IP54 upon request)  |
| Protection degree with open doors  | IP00 (IP20 upon request)   |
| Paint  | RAL7032 (other on request)   |
| Type of service  | continuous for indoor operation  |
| Max. temperature range   | Ambient -25 / +40 °C   |
| Voltage of the auxiliary circuits  | 230 V (other on request)   |
| Max. capacitors losses   | 0.4 W / kvar   |
| Max. inductance losses AAR/500-5-6 type  | 180W for 25kvar banks<br>265W for 50kvar banks   |
| <b>Capacitors:</b> They are manufactured by self-healing metallized polypropylene film. They comply with CEI EN60831-1/2 and IEC 831/1-2 Standards, and are approved IMQ (MK-AS type). They are fitted with overpressure disconnecter and discharge resistor. Temperature category: -25 / +50°C. PCB free. |  |
| Max. harmonic distortion of current (THDI%):   | see the catalogue  |
| <b>REGULATOR</b>   |  |
| Type of measurement  | varmetric  |
| Amperometric signal (ratio)  | C.T. ... / 5 A   |
| Voltmetric signal  | 230Va.c. / 415Va.c. from inside cubicle  |
| Switching on/off times   | 25 (7 upon request)  |
| <b>REFERENCE STANDARDS</b>   |  |
| Capacitors   | CEI EN 60831-1/2 ; IEC 831-1/2 ; UL810   |
| Equipement   | CEI EN 60439-1; IEC 439-1  |

### HOW TO CHOOSE THE CURRENT TRANSFORMER (C.T.)

- Use a Current Transformer (C.T.) with 5A at secondary circuit and primary equal or slightly higher than the maximum absorbed by the loads. The C.T. must be chosen in such a way to obtain a good current signal in the secondary circuit. Current values between 0.5 and 5Amps are suitable to give good working conditions of the regulator.
- The C.T. must be good quality (first class) and with power equal or higher to 5VA. If the C.T. has been mounted far away from the equipment, it needs to add the normal demanded the power consumed from the cables of connection (normally 0.2VA per meter of bifilar lines with 2.5mm<sup>2</sup> section) and the power dissipated by others possible device connected in the circuit.

The equations, used to calculate the real losses, are the sequents:

$$R=2 \times \rho \times L / S \quad (\Omega) \quad \text{Total resistance of amperometric circuit}$$

$$P=(R+0,08) \times I^2 \quad (\text{VA}) \quad \text{Loss of amperometrical circuit}$$

$\rho$  is the electrical resistivity ( 0.018 for the copper )

$S$  is the cross sectional area (c.s.a) of cables at the secondary of CT

$I$  is I<sub>max</sub>. at the secondary of C.T.

$L$  is the length of amperometric circuit (mt)

$0,08$  is the internal resistance of P.F. regulator

- The cables at the secondary of C.T. have to be of 2,5mm<sup>2</sup> c.s.a.
- The C.T. connection must not to be protected with fuses or interrupted by switch.
- The C.T. has to be connected to the line, upstream the load and the P.F. Regulator: the C.T. can measure the current demanded by the load, inductive and capacitive. Possible capacitors for fixed P.F. Regulation will be mounted downstream of the C.T., as they aren't used and dimensioned for the no-load compensation of transformer that feeds the load. It's important to check that the phase, where the C.T. is connected to, is the same that the one connected to terminals of the main switch, inside the equipment, signed with the letter R (L1).
- Before doing any work on the C.T. circuit, be sure that the C.T. is short-circuited, otherwise dangerous voltages can rise, on open circuited C.T. s.
- P.F. correcting two or more lines (transformers in parallel), you need to use two or more C.T. (.../5) the secondary circuits of them will supply an add transformer with 5Amps at secondary: connect the current transformers at the same phase.
- Connecting two or more cables (for load and P.F. Regulator) on the same terminal - phase R (L1) - from the general main switch, It needs to lead through the hole of the C.T. all the derived cables.

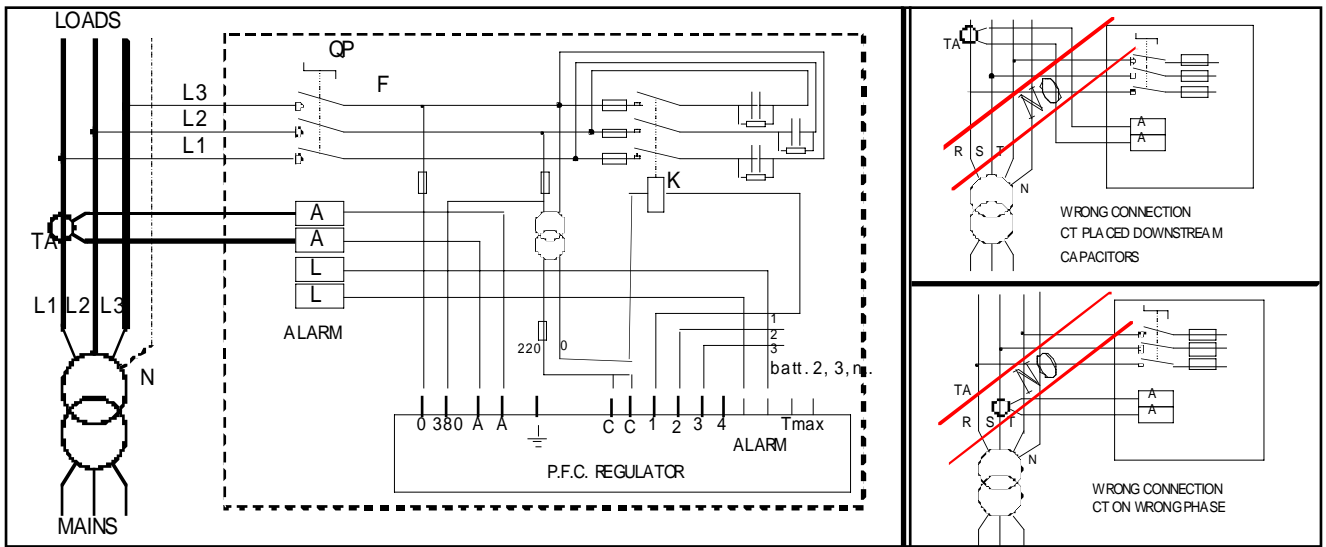
## 2. INSTALLATION

**Qualified technicians, according to this instruction manual, must carry out the installation.**

**The manufacturer cannot be considered liable for damages consequent to the wrong installation.**

- Open the door and connect the automatic P.F.C. equipment to the mains. Cable shall be dimensioned according to the table provided below. Protect the feeding line of the P.F. Regulator with switch fuses or automatic MCCB.
- The three terminals of the main switch are marked with letters R(L1)-S(L2)-T(L3). The phase connected to the terminal marked with letter R (L1) is the one to which the C.T. has to be connected (see the scheme in Fig.1). In the equipments till 43.5 kvar (special request excepted) it is necessary to connect the neutral wire to the fourth pole of the main switch, marked with letter N . Others equipments use isolated single-phase transformers to supply the auxiliary circuits.
- Connect the C.T. upstream the load to be compensated. Connect the automatic P.F.C. equipment downstream the C.T. When the C.T. is full loaded, the current in the secondary circuits must not exceed 5A. The C.T. must be chosen in such a way to obtain a good current signal in the secondary circuit. Current values between 0.5 and 5Amps are the best to obtain good working conditions of the regulator (see C.T. choice).
- Connect the secondary circuit of C.T. to the terminals A-A ( K-L ) which are near to the main switch.
- Connect the earth cable to the earth screw.
- If necessary an external alarm signal, a relay contact is available at terminals L-L or X1-X2 (5A 250Vac resistive loads).
- Check the above connections and close the door again. Put the AUT-MAN regulator switch on AUT
- Adjust the C/K value according to the table provided in the handbook of electronic P.F. Regulator or on back of the regulator.
- Close the main switch. Make sure the auxiliary circuits are supplied. During the working operations, the inductive LED  $\_ \cap \cap \cap \_$  of regulator shall light, then the LED s marked 1+6 or 1+8 shall light at regular intervals until the load has been compensated. To connect (or disconnect) capacitor banks, it will be necessary for the inductive (or capacitive) LED remain lit for at least 25 secs.
- When the load is compensated (P.F. medium  $>0,90$  ) inductive and capacitive LED s will be off.

| CONNECTING CABLES CROSS SECTION AREA - EACH PHASE - for 415Vac 50Hz PFC EQUIPMENTS |       |       |       |        |        |       |       |       |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
|--|-------|-------|-------|--------|--------|-------|-------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| kvar   | 50    | 75    | 100   | 125    | 150    | 175   | 200   | 225   | 250    | 275    | 300    | 350    | 400    | 450    | 500    | 550    | 600    | 650    | 700    | 750    | 800    | 900    | 1000   |
| $I_n$  | 70    | 104   | 139   | 174    | 209    | 243   | 278   | 313   | 348    | 385    | 417    | 487    | 556    | 626    | 696    | 765    | 835    | 904    | 974    | 1043   | 1113   | 1252   | 1391   |
| Cavo mmq   | 1x 35 | 1x 70 | 2x 50 | 1x 120 | 1x 150 | 2x 95 | 2x 95 | 2x 95 | 2x 120 | 2x 150 | 2x 150 | 2x 185 | 2x 185 | 2x 240 | 2x 240 | 4x 150 | 3x 240 | 3x 240 | 3x 240 | 4x 240 | 4x 240 | 4x 240 | 4x 240 |



**Operation anomalies:** all the P.F.C. equipments are tested in our factory. Most frequent anomalies are reported in the handbook of electronic P.F. Regulator. Please check again the correctness of the installation: a simple connection mistake can cause the P.F.C. Equipment to function incorrectly. If the P.F.C. equipment continues to work incorrectly, contact the Technical Office of the COMAR CONDENSATORI, referring to the serial number of the equipment (visible on the aluminium plate) and the value of measured current on the secondary circuit of the C.T.

**ENVIRONMENT:** the equipment is for indoor operation and in a well-ventilated environment; elevated temperatures considerably reduce the life of the internal components, particularly of the capacitors (consult the

enclosed brochure Recommendation for the safe use of static capacitors, banks and equipment for power-factor correction ).

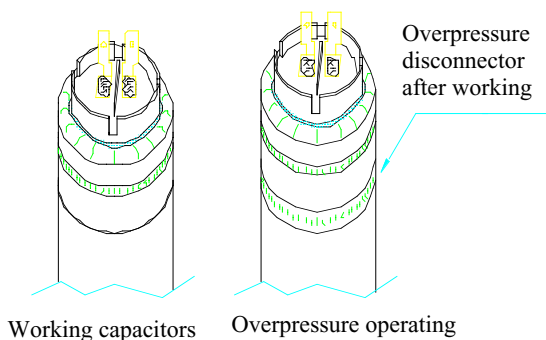
**CAPACITORS:** manufactured according to the more recent reference standards CEI EN 60831-1 60831-2 (IEC 831-1 831-2); they are fitted with overpressure disconnecter and discharge resistor, approved by IMQ. The capacitors are impregnated by biodegradable oil or by resin ( Dry type ).

The optimal temperature range to work without any problem is:

- MINIMUM TEMP.: -25°C
  - MAXIMUM TEMP.: +50°C (max. daily)
  - MEDIUM TEMP.: +40°C (daily average)
  - MEDIUM TEMP.: +30°C (yearly average)
- (reference standards 60831-1)

### 3. MAINTENANCE

The standardization of components has reduced the maintenance and working choke on the equipment. The automatic P.F. Correction Equipment of G type have been designed and manufactured to reduce any maintenance operation, but periodic checks are recommended:



- Each six months check:
    - There aren t loose connections (tighten all power connections )
    - Regular working of the regulator.
    - The discharge resistors of the capacitors aren t burnt or interrupted.
    - Check the current absorbed from each capacitor bank, measuring any phase, recording the values and comparing with rated currents. In case of variations higher than 15%, check if there are broken capacitors and eventually replace them.
  - Each twelve months:
    - Check the state of auxiliary contacts in the power contactors, to avoid the damages to the capacitors coming from the use of deteriorated contactors.
- N.B.** Don t ever use abrasive materials on the maintenance of contacts  
 -Check that the overpressure disconnectors hare not operated (see fig. Overpressure Disconnecter ).

Overpressure disconnecter working

**The reliability of the equipment is strictly related to maintenance operating performed during its own life.**

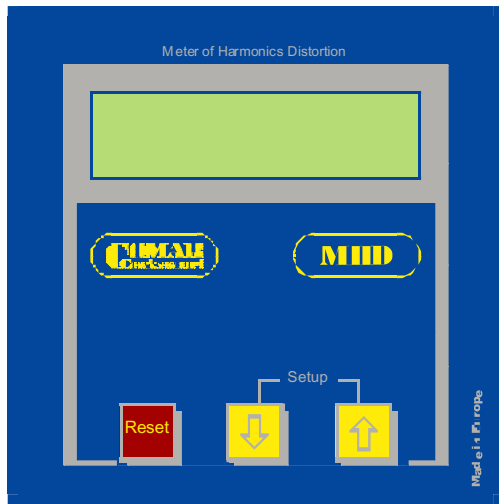
### 4. SPARE PARTS

Excluding the capacitors, it is easy to find most components, used to manufacture the COMAR equipment, on the open market. If there are some components that require repair, it's possible to contact the COMAR CONDENSATORI S.p.A. company and specify, the component part, type and serial number of the equipment - visible on the aluminium plate fixed to the right side of the P.F. Corrector. Our Commercial Office will send you the requested components or advise where you can find them.

### 5. CURRENT HARMONIC DISTORTION

**General data:** harmonics are undesirable signals, which are present in the electric network, they have a frequency which is multiple of the fundamental one. As they overlap it, they cause a new wave shape which is no longer sinusoidal. Harmonics are produced by non-linear loads. The harmonic distortion has a particular importance in the operation of an electrical power system because it creates a permanent modification of the sinusoidal wave shapes of voltage and current in each point of the system. This distortion has a detrimental effect on the equipment within the system creating incorrect functioning. On the capacitors, e.g., there is an increase of the loss which shortens their life. In plants where power factor correction capacitors are installed, the harmonics are shared among the banks of capacitors and the network but they can be increased because of the well-known parallel resonance or anti-resonance phenomena. In order to avoid this problem inductances can be added in series the capacitors creating in this way a detuned filter: such a power factor correction system is characterised by its own resonance frequency that must be lower than the ones of the harmonics in the network. For frequencies lower than the series resonance frequency, the system can be considered capacitive and improves the power factor value, reducing the total current absorbed by the plant; for frequencies higher than the series resonance frequency, the system behave inductively avoiding the danger of parallel resonance.

## MHD ANALYSER - Meter of Harmonics Distortion



The MHD analyser (Meter of Harmonics Distortion) is designed to protect automatic power factor correction units from harmonics current. It can also be used to detect those kind of problems.

The presence of current harmonics on the supply network exposes the capacitors to extreme working conditions, which could lead to premature failure.

MHD checks the current harmonics absorbed by the P.F. correction equipment (through external C.T.) and it is activated when the critical values are reached.

### OPERATIONAL HINTS

**Features of the analyser:** it records the RMS value of the fundamental current, the value of the total harmonics current (through digital filtration) and the value of every single odd harmonic (up to 19<sup>a</sup>) filtered on the respective gang. All data can be viewed on the display (type 2x16 back-lighted LCD).

**Characteristics of the alarm section:** the THD(I)% (Total Harmonics Distortion of current) level recorded, is compared with the level of threshold setting.

The calculation of the delay of intervention works accumulating manner, through a counter increasing every second if the distortion exceeds the threshold, decreasing if it does not overcome it.

The alarm is activated when more than 60 secs. are accumulated and it is stops when it goes under 30 secs.

During alarm condition, the RESET button is illuminated and flashes, while on the display the THD(I)% value as well as ALARM is shown. Furthermore the alarm determines the contemporary commutation of the relays Alarm 1 and Alarm 2

The types of reset are as follows:

- 🍎 MAN: manual Reset to stop over currents harmonics.
- 🍎 AUTO1: automatic Reset to stop over currents harmonics, but by exceeding three alarm conditions within one hour, the reset has to be carried out manually.
- 🍎 AUTO2: automatic and continuous Reset to stop over currents harmonics.

When the MHD is turned on the THD(I)% value and the reset mode are shown.

Through the buttons ↑ and ↓ it is possible to view sequentially the value of current D(I)% related to every odd harmonic.

By pressing the ↑ button together for three seconds, automatic scrolling of the measurements is achieved (every 7 seconds).

### SETTINGS

The set-up contains four parameters:

- 🍎 Rated frequency (50 or 60Hz)
- 🍎 Threshold of alarm (10, 25, 35, 40, 50, 60, 75, 100, 150, 200%)
- 🍎 Reset modes (MAN, AUTO1, AUTO2)
- 🍎 Type of connection (Single-phase or Three-phase)

### ELECTRICAL CONNECTION

By means of plug connector with terminal fixing screws, for cable 2,5 mm<sup>2</sup> c.s.a.

**Current signal:** connect the secondary of C.T. to the sealed clamps AL1 (single-phase type) or AL1+AL3 (three-phase type).

**Relay:** it has a clean contact to be used either for remote signalling of the alarm condition or incorrect and wrong connection (cumulative alarm). The contact NC - 10A - 400Vac (resistive load), changes condition in the standard operation (NO) and it is closed during missed or wrong operation (NC).

### TECHNICAL DATA

|  |
|--|
| <b>Rated supply voltage:</b> 85÷265Vac   |
| <b>Range frequency:</b> 1250Hz (25 <sup>a</sup> harmonica)   |
| <b>Rated frequency:</b> 50Hz or 60Hz select during set-up  |
| <b>Rated supply current:</b> by means of C.T. secondary side 5Amps max., class 1 - 5VA .                           |
| <b>Current circuit consumption:</b> 2VA  |
| <b>Current signal (In):</b> 0,5 ÷ 5Amps.   |
| <b>Continuous overload admitted:</b> 20% In  |
| <b>Output relays:</b> 10 Amps 400 Vac resistive load.  |
| <b>Digital monitoring:</b> alphanumeric 2x16 backlighted LCD display   |
| <b>Refresh measure:</b> 2  |
| <b>Range measure:</b> THD(I)% = 0% ÷ 400%  |
| <b>Measurement accuracy:</b> ±1,5% f.s. for 20% f.s. ≤ Irms < 100% f.s.<br>±5% f.s. for 10% f.s. < Irms < 20% f.s. |
| <b>Working temperature:</b> -0°C / + 50°C  |
| <b>Storage temperature:</b> -20°C / +60°C  |
| <b>Relative humidity:</b> < 90% at 20°C non condensing   |
| <b>Protection degree:</b> IP 54 front panel - IP20 rear panel  |
| <b>Dimensions:</b><br>96x96 mm FRONT (according to DIN 47000) - 60 mm thickness                                    |
| <b>Cut-out dimensions:</b> 92x92 mm (tolerance —0 / +1 mm)   |
| <b>Mechanical mounting:</b> through panel with clamps provided   |
| <b>Plastic case:</b> insulating self-extinguishing material, V0 class  |
| <b>Weight:</b> 0,3kg.  |
| <b>Type of service:</b> indoor service, no dusty condition. Do not place directly under sunlight.                  |

MU 03.12.ING REV.4

### DISPLAYS

# Maximum current protection PA6-R

## INTRODUCTION

The PA6-R card has specially designed to protect banks of capacitors from over-currents. As it is known, the current absorbed by the capacitors may exceed the rated value in various instances, including:

- **Increases in main voltage**
- **Presence of harmonics**
- **Conditions of antiresonance between the capacitors and the line.**

The last instance in the most dangerous, as the resulting current may exceed the rated level significantly, thus causing the capacitors to age precociously and leading to irreparable damages to both the capacitors and the line.

The function of the PA6-R protection is to switch off the capacitors when the maximum allowed current is exceeded.

## CONSTRUCTION FEATURES

Each card is capable of protecting up to a maximum of 6 banks of capacitors, and is set up remote signalling of operating status. **Assembly:** the card must be fixed using the special attachment holes in a ventilated area with a temperature of less than 50°C, to allow correct dissipation for the C.T. charge resistances.

## WARNING

- The cards must not operate with C.T. other than those provided.
- Banks with powers different than 12,5kvar - 25kvar and 50kvar are not sufficiently protected.
- Banks with powers greater than 50kvar must be made up of multiples of 25 and 50kvar; these are protected individually as described above.
- The trimmers T1...T6 adjust the thresholds at which the protection is tripped. They are pre-set in the factory and must not be tampered with by non-specialized personnel, and in any case not before receiving an approval from Comar Condensatori S.p.A technicians. In this regard, it is better to investigate the causes that tripped the ampere protection PA6-R to prevent the blockage from being repeated.

## OPERATION

The current signals are transmitted to the card by special C.T. with a 200mA secondary (one for each bank).

The C.T., of a special type, are supplied together with the card and may be used on 12,5 - 25 and 50kvar banks, as long as the electrical connection instruction are followed.

In normal operating conditions, the led L remains constantly lit. In the event of over-current on even a single banks among those controlled, the relay R of the PA6-R card orders all banks to be switched off, and the led L begins to flash. To return to normal operating conditions, press reset button P. On all Comar panels, the reset button is also located on the front of the panel, with a pilot light that remains lit in the event of an over-current, thus when the protection is tripped

## TRIPPING

The relay R has 5Amps 250Vac (resistive loads) exchange contact, the common point is marked CO. Use the normally open (AP) contact in series on the power circuit of the contact coils. The normally closed (CH) contact may be used for an alarm to signal when the protection has been tripped.

**Remote control and signalling:** in addition to the contact of the relay R, it is possible to move the alarm signal and the alarm reset button; there are two terminals marked UP1 on the contacts of this button.

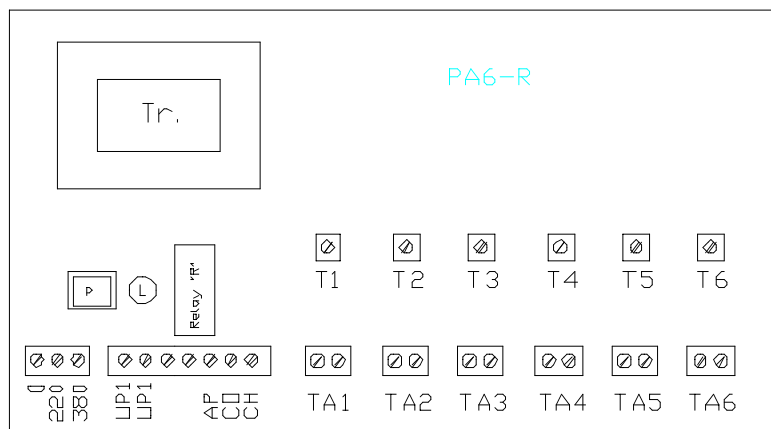
## ELECTRICAL CONNECTIONS

**Power supply:** the card can be supplied with 50-60Hz 220Vac ± 10% trough terminals 0 e 220 o with 110Vac ± 10% trough terminals 0 e 110.

**Amperometrical circuits:** there are 6 inputs (TA1...TA6) to be connected to the corresponding C.T. While only 1 or 2 banks are connected it is possible to use only input TA1 and TA2. The C.T. can be provided included to the card or already installed in the capacitors rack. They have nr.4 terminals:  
Terminal 1 is the common terminal  
Terminal 2 is the output to be connected while C.T. is for 12,5kvar  
Terminal 3 is for 25kvar bank  
Terminal 4 is for 50kvar bank

## DIMENSIONS

Dimensions are :  
AxBxH (mm.) = 185x115x h.35



## 7. INSTRUCTIONS, WARRANTY AND LIABILITY

### GENERAL INSTRUCTION

Recommendations of the manufacturers

- Read the instructions in this handbook because they furnish important indications about the safety of installation, use and maintenance. Take carefully this handbook for any information.
- Check the integrity of the equipment after unpacking it. In case of doubt, don't use the P.F. Corrector and ask for skilled staff.

N.B. If the equipment has fallen down or has been violently, shaken during shipping, it could suffer internal damages which may be dangerous.

- Before connect the equipment, check the data plate: this has to be in conformity with the network (the aluminium plate is fixed to the right side of the P.F. Corrector).
- This equipment will be assigned only to the use for which it has been specifically made. Each other use has to be considered improper and therefore dangerous.
- In order to have a correct functioning of the equipment, the limits of voltage, current and temperature, imposed by the CEI and IEC standards, must never be exceeded.
- The equipment has to be protected from atmospheric conditions. No type of tampering is permitted on the electronic circuits of P.F. Corrector.
- Possible interventions will be performed by COMAR staff.

### WARRANTY

Comar Condensatori S.p.A. guaranties its own products for twelve months from purchase date. The warranty covers the faults of materials and manufacture and it has to be understand for goods ex-works. Before the equipment works, all instructions, present on this handbook, have to be meticulously followed. Breakdowns, caused from improper use and/or not conformity to the enclosed instructions and faults caused from tampering by un qualified technicians, aren't covered.

**The misuse of any of the above points will erode the right of warranty.**

### LIABILITY

**Comar Condensatori S.p.A. is not liable for direct or indirect damages consequent the missing or wrong operation.**

In any case and for any reason COMAR Condensatori S.p.A. can not be considered liable for possible direct or indirect damages, consequent the malfunctioning of P.F. Corrector, caused from mistakes of assembly or from inadequate use of the same.

**The manufacturer reserves the right to modify data and sizes without previous notice.**