



POWER FACTOR REGULATOR

Computer-6e

INSTRUCTION MANUAL

(M 981 605 / 00D)

(c) CIRCUTOR S.A.

POWER FACTOR REGULATOR COMPUTER- 6e

1.- POWER FACTOR REGULATORS COMPUTER-6e

Power factor regulator **Computer-6e** series permit the visualization on a digital display of power system $\cos \varphi$, and the automatic connection and disconnection of capacitors in function of this $\cos \varphi$.

Built with a microprocessor and based on the FCP system (FAST Computerized Program), the power factor regulator becomes an intelligent instrument, able to accurately inform about the power system status, and to take complex decisions that most times require a high quantity of calculations. This series compiles the CIRCUTOR's large experience with power factor regulators, so improving their previous features by the application of latest technology.

Main features:

- **True r.m.s. measurements:** The regulator measure the reactive power in the facility, and will connect or disconnect available capacitors according to setup data.
- Regulator from 3 to 6 output relays.
- Led Display with TWO seven segment digits.
- Setting actions from a frontal keyboard (3 keys).
- Size as per DIN 43 700 : 144 x 144 mm

2.- Connection instructions



The manual you hold in your hands contains information and warnings about the **Computer 6e** that the user should respect in order to guarantee a proper operation of all the instrument functions and keep its safety conditions.

3.- GENERAL DESCRIPTION

3.1.- VISUALIZATION OF PARAMETERS :

The regulator provides following indications from a frontal panel:

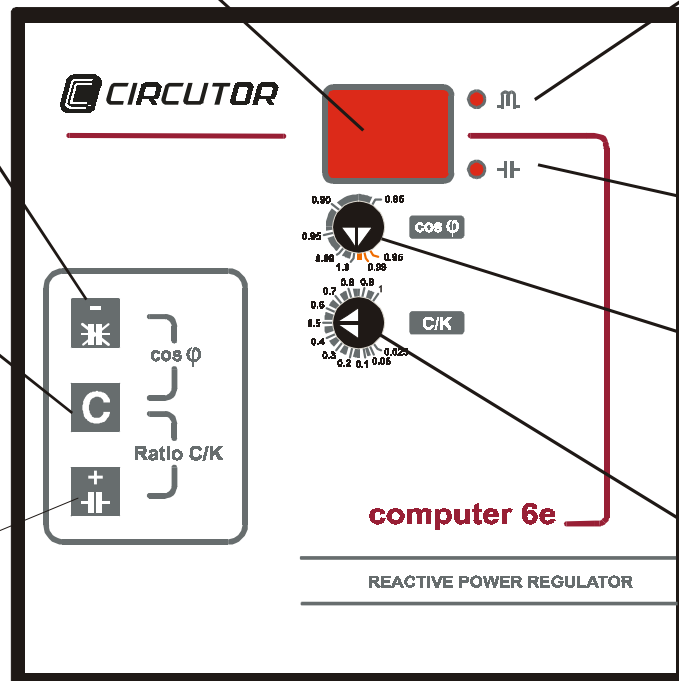
DISPLAY (2 digits) : visualization of $\cos \varphi$ (0.xx)
i.e. : **95** means that measured $\cos \varphi$ is 0.95


(The display "00" indicates that the measured current is below the limits to enable correct reading).


(-) Push button :
It permits a manual disconnection of capacitors

(C) Push button:
to read the number of capacitors steps connected at that time

(+) Push button :
It permits a manual connection of capacitors



Led : Indication of an inductive $\cos \varphi$ 

Led : Indication of a capacitive $\cos \varphi$ 

$\cos \varphi$ setting control
(From 0.85 induct. to 0.95 capacitive)

Reactive current setting (C/K)
(From 0.025 to 1)

3.2.- KEYBOARD FUNCTIONS.

The frontal cover of the regulator presents three push-buttons (**+**, **C**, **-**) to carry following actions out:

1.- Manual connection :

- The key (**+**) permits a MANUAL CONNECTION of capacitors. Whether the key is kept press, all capacitors will be sequentially connected according to the defined delay times (T_r (s) & T_s (s)).
- The key (**-**) permits a MANUAL DISCONNECTION of capacitors.
- For both cases, the key must be hold pressed for at least 1 s. When the key is not press anymore, the regulator turns back to automatic operation mode.

2.- Number of capacitor steps :

- The key (**C**) permits to read the number of capacitor steps connected at that time. When this key (**C**) is released , the display returns to its normal $\cos \varphi$ indication.

3.- $\cos \varphi$ and C/K setting:

- By simultaneously pressing keys (**-** and **C**), the display shows the preset target $\cos \varphi$ according to the position of the frontal setting knob.
- By simultaneously pressing keys (**C** and **+**) the display shows the preset C/K ratio according to the position of the frontal setting knob.

4.- INSTALLATION AND START-UP



The manual you hold in your hands contains information and warnings about the **Computer 6e** that the user should respect in order to guarantee a proper operation of all the instrument functions and keep its safety conditions

The regulator must not be used until its definitive assembly inside the switchgear board.

Whether the instrument is not used as manufacturer's specifications, the protection of the instrument may result damaged.

When any protection failure is suspected to exist (for example, it presents external visible damages), the instrument must be immediately powered off. In this case contact a qualified service.

4.1.- INSTALLING THE REGULATOR

Before powering the regulator up, check following points:

a.- **Supply voltage** : see rear part of your Computer-6e

- Frequency : 45 ... 65 Hz
- Supply tolerance : + 15 % / --15 %
- Connection terminals : 3 - 4 or 3 - 5 (see drawings at the regulator)
- Burden : 5 VA

b.- Current measurement: - In/ 5 A a.c. Current transformer
- Connection terminals 1 and 2 .

c.- Working conditions : - Working temperature : -10° to +50°C
- Working humidity : 25 to 80 % RH

d.- Safety : Category III, as per EN 61010. Protection against electric shock by double isolation system (class II equipment)

4.2.- CONNECTIONS

The regulator is to be mounted on panel (cut out $138^{+1} \times 138^{+1} \text{ mm}$. as per DIN 43 700) .



All connections keep inside the cabinet .

Note that with the instrument powered on, the terminals could be dangerous to touching and cover opening actions or elements removal may allow accessing dangerous parts. Therefore, the instrument must not be used until this is completely installed.



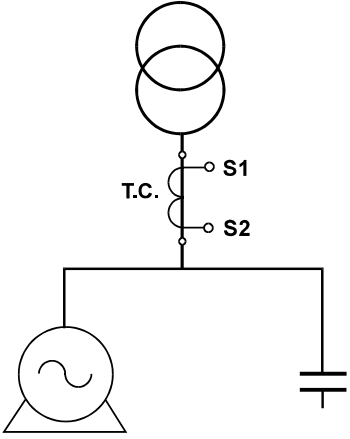
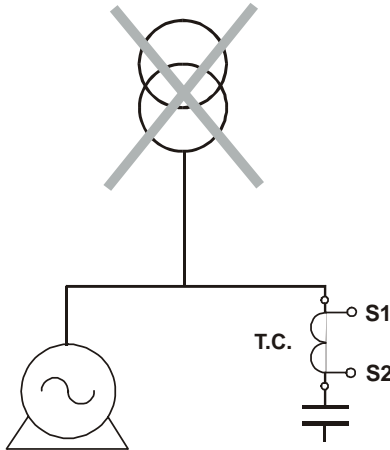
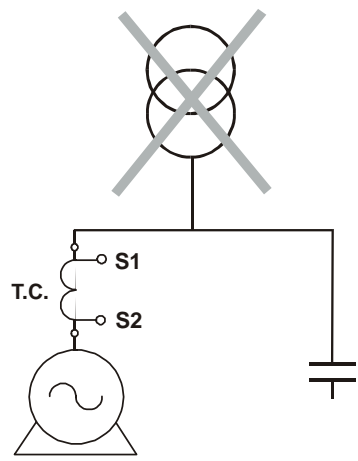
The regulator must be powered from a power source protected with gl type (IEC 269) or M type fuses (IEC 127) rated between 0.5 and 2 A. This circuit should be provided with an automatic switch (I/O) or any equivalent element to connect (ON) or disconnect (OFF) the instrument from the power supply network. Power supply circuit as well as connections to different relays will be wired with cables of a minimum cross-section of 2.5 mm^2 . The circuit from de current transformer secondary will be also wired with a cable with a have a minimum cross-section of $2,5 \text{ mm}^2$.

COMPUTER-6e CONNECTION TERMINALS

| Terminal N° | Terminal description |
|--------------------|-----------------------------|
| 1 | Current input S2 |
| 2 | Current input S1 |
| 3 | Voltage input 0 V |
| 4 | Voltage input 230 V a.c. |
| 5 | Voltage input 400 V a.c. |
| 6 | Output relay 6 |
| 7 | Output relay 5 |
| 8 | Output relay 4 |
| 9 | Output relay 3 |
| 10 | Output relay 2 |
| 11 | Output relay 1 |
| 12 - 13 | Relay common C1 to C6 |

Connect the regulator according to the connection drawing attached at the rear part of the regulator. Take following points into account:

- To start-up the regulator it is necessary to install a current transformer (normally **In / 5 A**) suitable for **the whole current of loads in the facility**. The circuit from the C.T. secondary will be wired with a cable of a cross-section adequate to the distance between the C.T. and the regulator.
- The regulator is powered between **two phases** (except for a single-phase model). **The phase in the power system where the C.T. is placed can or not coincide with any of the phases the regulator is powered from.**
- The C.T. must be placed at any point of the power system entrance where the whole current of the facility, even the own current of capacitors, can be measured.

| RIGHT | WRONG | |
|---|--|--|
|  <p data-bbox="217 1424 603 1525">- The C.T. must be obligatory placed before the capacitor bank and loads (motors, etc).</p> |  <p data-bbox="695 1357 919 1391">Display 00</p> <p data-bbox="639 1424 1038 1626">- No capacitor is connected as the C.T. does not provide any signal - Check that the C.T. is not at short-circuit or placed out from load circuit.</p> |  <p data-bbox="1142 1357 1374 1391">Display XX</p> <p data-bbox="1062 1424 1477 1626">- All capacitors of the bank are connected, but none will be disconnected when the load falls. The power system may be over-compensated when no load exists.</p> |

Connect the C.T. secondary (S1-S2) to the terminals marked as S1-S2 (1 & 2). Whether the display shows an incoherent value for the $\cos \varphi$, a discrepancy with the set phase relation may exist: inverted the voltage phase connections (or S1-S2 of the current transformer have to be inverted) .



Other points to take into account:

- Whether the display shows "**0.00**", no enough current signal is provided to the regulator, and therefore this cannot measure the $\cos \varphi$. In case that loads are in operation, check the circuit coming from the C.T. secondary (this could be open or in short-circuit at any point).
- Whether no measuring signal is received by the regulator ("**00**" indication on display) and some capacitor stages are energized, these will be automatically switched off for safety purposes. Check the circuit coming from the C.T. secondary (this could be open or in short-circuit at any point).
- When the regulator measures a very leading (capacitive) $\cos \varphi$, active capacitor stages will be automatically switched off for safety purposes.
- In case that the regulator measures GENERATED active power, and this situation is confirmed during 6 s, the display will start blinking and all active capacitor stages will be automatically switched off.
- For a voltage signal loss longer than 30 ms, the regulator will automatically switch off all active capacitor stages and will perform an internal reset.

5.- SETUP MODE

5.1.- USER-PROGRAMMABLE PARAMETERS

- Directly by means of knobs on the frontal cover:
 - 1.- Cos φ setting control from 0.85 ind. to -0.95 Cap.
 - 2.- C/K setting (reactive current ratio) : from 0.025 to 1
- Other available setting options (**see Section 5.5.- SETUP computer-6e**):
 - 3.- Switching sequence : 5 sequences
 - 4.- capacitor switching / reconnection time delay : 4 60 s / 20....300 s
 - 5.- Number of output relays : 1.....6

5.2.- cos φ setting

The **cos φ** knob must be set at the desired target value. Generally this value will be set at 1.0.

Checking the preset target cos φ : By simultaneously pressing keys [**C**] and [**-**] the preset target cos φ appears up in display.

5.2.- REACTIVE CURRENT (C/K SETTING)

To obtain a right performance from the regulator, the user must set the relationship between the rated current of the first capacitor stage and the current transformer that supply the current signal to the regulator. This operation is done by the frontal placed knob marked as **C/K**.

This control can be set by calculation with the following formula :

$$\text{Transformer ratio } \frac{I_t}{5} = K$$

Reactive current adjustment $C / K = \frac{I_c}{K}$

with : I_t = Primary current of C.T. transformer.
 I_c = Current of the first capacitor stage.

Example:

Transformer ratio : $\frac{500}{5} = K = 100$

First capacitor stage: 60 kvar at 400 V $\equiv 86.7$ A

Setting of the C/K current control $C / K = \frac{I_c}{K} = \frac{86.7}{100} = 0.867$

Checking the preset target C/K : By simultaneously pressing keys [**C**] and [**+**] the preset C/K ratio appears up in display.



IMPORTANT :

- If the adjustment of the C/K is too low: the regulator can repeatedly switch on/off a capacitor stage at low time intervals.
- If the adjustment of the C/K is too high : No dienergized capacitor stage could be switched on although the preset target cos ϕ has not been reached.

OTHER SETUP PARAMETERS (see Section 5.5.- SETUP computer-6e)**5.3.-SELECTION OF SWITCHING SEQUENCE (OPERATION PROGRAM)**

The switching sequence of the regulator will depend on the power (kvar) of different capacitor stages that compose the capacitor bank.

| <i>Switching sequence</i> | <i>Description</i> | <i>Example: Capacitor bank arrangement (kvar)</i> |
|---------------------------|---|---|
| 1.1.1.1.1 | All capacitor stages have the same power value | 20 + 20 + 20 + 20 |
| 1.2.2.2.2 | All capacitor stages from the second one have a power value that doubles the first capacitor one | 20 + 40 + 40 + 40 |
| 1.2.4.4.4 | The power value of the second stage doubles the first capacitor one, and the power value of additional stages from the third one is 4 times the first capacitor one. | 20 + 40 + 80 + 80 |
| 1.1.2.2.2 | All capacitor stages from the third one have a power value that doubles the first and second capacitor one. | 20 + 20 + 40 + 40 |
| 1.2.4.8.8 | The power value of the second stage doubles the first capacitor one, the third stage is 4 times higher, and the power value of additional stages from the third one is 8 times the first capacitor one. | 10 + 20 + 40 + 80 |

Any of above listed switching sequences can be set (**see Section 5.5.- SETUP computer-6e**). The regulator is set by default at the 1.1.1 switching sequence.

5.4.- SWITCHING DELAY TIME

Delay time (T_r) for switching on/off operations between capacitor stages is by default set at **10 s**, and the safety (reconnection) time at **50 s**. This switching delay time can be set at **4, 10, 30 or 60 s** (see Section 5.5.- **SETUP computer-6e**)

| T_r = Switching delay time between two capacitor stages | T_s = Safety time delay between successive switching on/off operation of the same capacitor stage (s). The safety time is 5 times higher than switching delay time between two capacitor stages ($T_s = 5 T_r$) |
|---|---|
| 4 | 20 |
| 10 | 50 |
| 30 | 150 |
| 60 | 300 |



When the regulator is powered up, it will wait the safety time (T_s) before switching on the first capacitor stage.

5.5.- **SETUP** computer-6e

The computer-6e has been equipped with a configuration system by means of the keyboard:



Accessing the setup mode:

- To access the **SETUP** mode, the regulator must be powered off, and then, holding pressed keys (**-**) and (**+**) powered back on. In case of a correct operation, the display will show for 1 s the messaged “**SU**”, and then the following options are enabled :

| | |
|-----------|--|
| r- | Setting of the number of output relays |
| P- | Switching sequence setting |
| t- | Switching / reconnection delay time setting |

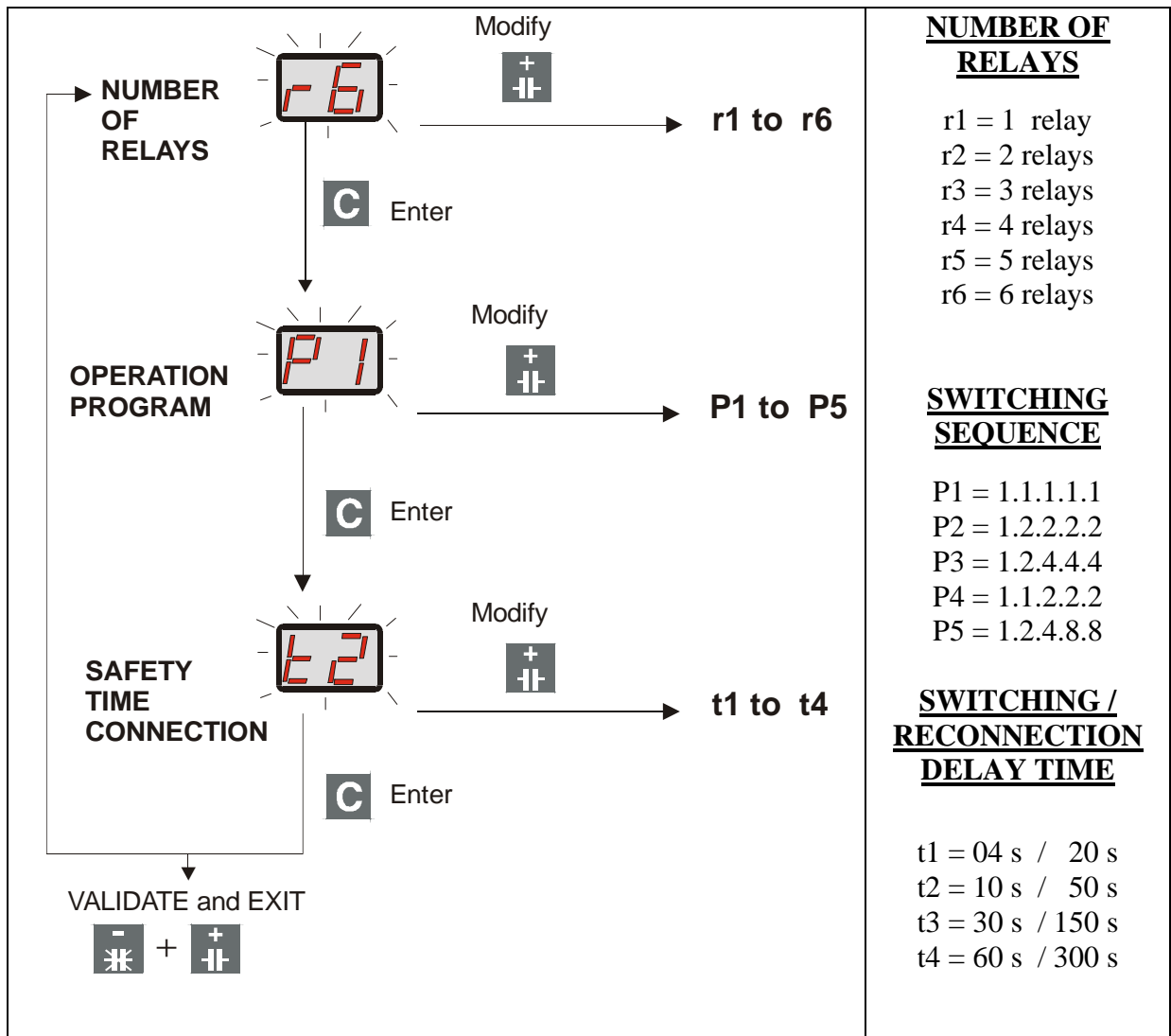
Once one option is accessed, use the key (**+**) to modify the value at the desired one. To pass to the next option just press the key (**C**). (see following attached drawing) .



The setup mode can be exited by three means:

- By simultaneously pressing again the keys (**-**) and (**+**), the setup mode is exited and modifications are kept in the regulator internal memory.
- If no key is pressed during more than 50 s, the regulator will perform an automatic reset and no modification will be kept in memory.
- If the regulator is powered off no modification will be kept in memory.

SETUP process:



6.- INTERNAL PERFORMANCE OF THE FCP SYSTEM

With data received from the external circuit (voltage and current), the regulator calculates the phase angle and the capacitor value necessary to reach the pre-set target $\cos \phi$. Once this value has been obtained, the FCP system takes the decision to switch on appropriate steps.

In case that, for instance, the switching sequence is 1.2.2, the regulator will decide, according to the reactive demand, whether the most convenient decision is to connect the first step or directly to switch on a double-power one (this system avoid unnecessary switching operations of the first step) thus increasing the life span of the whole power factor correction unit.

Besides, in order to get a uniform wear of the automatic bank, the FCP system keeps in memory the time each capacitor remains switched off, so that when a capacitor is required to be connected, this capacitor will be the one switched off for the longest time. A safety system avoids a capacitor to be re-connected if the user-defined safety time (T_s) has not passed yet.

Example : Required switching operations for a 100 % demand from zero for a regulator set at 6 steps.

STANDARD SYSTEM

| Steps | 1 | 2 | 2 | 2 | 2 | 2 |
|-------|---|---|---|---|---|---|
| 1° | x | | | | | |
| 2° | | x | | | | |
| 3° | x | x | | | | |
| 4° | | x | x | | | |
| 5° | x | x | x | | | |
| 6° | | x | x | x | | |
| 7° | x | x | x | x | | |
| 8° | | x | x | x | x | |
| 9° | x | x | x | x | x | |
| 10° | | x | x | x | x | x |
| 11° | x | x | x | x | x | x |


Total number of operations = 16

FCP System

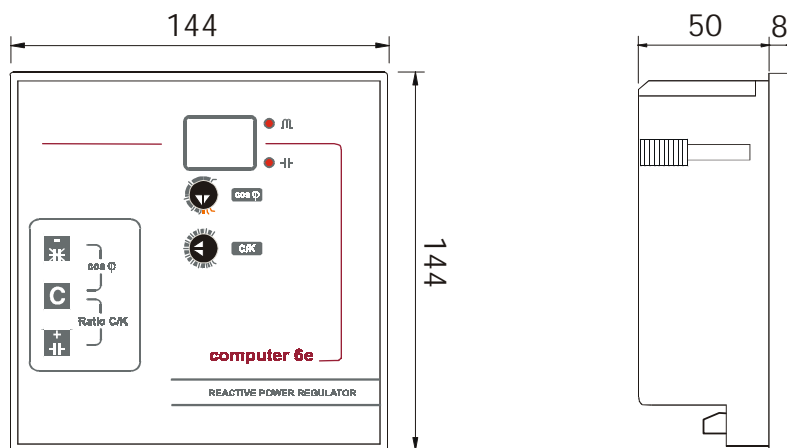
| Steps | 1 | 2 | 2 | 2 | 2 | 2 |
|-------|---|---|---|---|---|---|
| 1° | | x | | | | |
| 2° | | x | x | | | |
| 3° | | x | x | x | | |
| 4° | | x | x | x | x | |
| 5° | | x | x | x | x | x |
| 6° | x | x | x | x | x | x |

Total number of operations = 6

7.- TECHNICAL FEATURES

| | |
|--|---|
| Supply voltage : | 230 / 400 V a.c.  other voltages on request |
| Voltage circuit : Tolerance Burden Frequency | + 15 % / - 15 % 5 VA 45 ... 65 Hz |
| Current circuit : Rated current Permanent overload Short-time overload Burden | Isolated In / 5 A a.c. 2 x In 5 x In during 10 s 0,5 VA |
| Control system | FCP |
| Cos φ setting | 0,85 ind 0,95 Cap. |
| Cos φ visualization | By display - 2 digits |
| Switching sequences | 1:1:1:1 / 1:2:2:2 / 1:2:4:4 / 1:1:2:2 / 1:2:4:8 |
| Output relays | According to the model : 6 relays |
| Connection time Tr | 10 s (4, 10 , 30 , 60 s) |
| Safety time Ts | 50 s (20, 50 , 150 , 300 s) |
| Output relay : Maximum voltage Ui Thermal current Ith AC11 Ie / Ue DC11 Ie / Ue Mechanic endurance Electric endurance | 277 V a.c. / 30 V d.c. 10 A 4 A / 277 V a.c. 1 A / 30 V c.c. 10 ⁷ operations 10 ⁵ operations (full load) |

| | |
|---|--|
| Safety | Installation class III, as per EN 61010. Protection against electric shock by double isolation system (class II equipment) |
| Environmental conditions Working temperature Maximum relative humidity | -10° to +50 °C 95 % no-condensation |
| Mechanic characteristics : Connection Case material Protection class External dimensions Net weight | Through connection terminal Self-extinguishing, V0, plastic (UL-94) Assembled instrument (frontal) : IP 52 Not-assembled instrument (rear plate) : IP 21 144 x 144 mm - total depth : 58 mm 0.670 kg |
| Standards : | EN 61010, EN 61000-3-2, EN 61000-3-3, EN 50081-2, EN 50082-1, EN 50082-2, EN 61000-4-2, EN 61000-4-4, EN 61000-4-8, EN 61000-4-5, EN 61000-4-11 , UL 94, |
| Codes : | 1 11 2** |



8.- SAFETY WARNINGS

The user should take into account all installation instructions referred in sections related with INSTALLATION AND STARTUP, CONNECTION INSTRUCTIONS and TECHNICAL FEATURES of the regulator.

Note that with the instrument powered on, the terminals could be dangerous to touching, and cover opening or elements removal actions may allow accessing dangerous parts. The regulator is factory-shipped in proper conditions.

9.- MAINTENANCE

The **Computer 6e** does not require any special maintenance. No adjustment, maintenance or repairing actions should be done over the instrument open and, should those are essential, high-qualified operators must perform them.

Before any adjustment, replacement, maintenance or repairing operation is carried out, the instrument must be disconnected from any power supply source. When any protection failure is suspected to exist, the instrument must be immediately put out of service. The own instrument design permits a quick replacement in case of damage.

10.- TECHNICAL SERVICE

For any inquiry about the instrument operation mode or in case of malfunction, you can contact CIRCUTOR S.A.'s technical service.

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