



**POWER FACTOR
REGULATOR**


**COMPUTER plus TF
(Three-phase Measurement -
Static Switching)**

**INSTRUCTION MANUAL
M98223301-03-09B**

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INTRODUCTION

CIRCUTOR S.A. would like to thank you for showing your trust by choosing one of our **Computer plus** series regulators

These units are constructed with state-of-the-art technology, including a powerful DSP to calculate the optimum algorithms for achieving the best compensation of $\cos \phi$.

The units comply with the Electrical Safety Standard EN 61010, in accordance with the requirements of the Low Voltage Directive (LVD) 73/23/EC and EMC Directive (2004/108/EC) and, therefore, they are certified to carry the CE mark.



This user manual describes the operation of the **Computer plus TF** series regulators and shows the user the procedures required to install, commission and operate the units.

SAFETY

CAUTION!	The installation and maintenance of the unit must be performed by duly trained and authorised staff, in accordance with the national and international standards.
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DANGER!	Before performing any maintenance operation on the $\cos \phi$ regulation units, be sure to disconnect the main switch. After disconnecting it, wait at least 5 minutes to ensure that the capacitors are totally discharged.
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During the installation, maintenance or commissioning of the units regulated by a **Computer plus** unit, the following safety precautions must be observed:

- ✓ Before connecting the units make sure the earth terminals have been connected correctly. A defective earthing connection may cause the unit to work incorrectly and represent a danger of electric shock to the user the person operating it.

- ✓ Maintenance must be performed taking the necessary precautions to avoid electrocution and electric shock. Before any intervention, we recommend you ensure the unit has been disconnected and wait during the time necessary for the capacitors to be totally discharged. We recommend the use of safety goggles and gloves when necessary.
- ✓ If the PF compensation units are connected without load, resonance may occur, so that the voltage harmonics may be amplified and may damage the compensation unit and other equipment connected to the network.
- ✓ The start-up and interruption procedures indicated in the manual must be followed to avoid damaging the unit and/or adjacent units.
- ✓ The adjustment or replacement of components or parts of the unit must be made with original replacement parts and in accordance with the procedures described in the corresponding instruction manual.

1 COMPUTER PLUS TF POWER FACTOR REGULATORS

The regulators in the **Computer plus** series are power factor regulators that incorporate the latest advances in technology regarding power factor compensation and harmonic filtering, both in systems with contacts and in fast systems. The core of the controller is a state-of-the-art DSP processor that allows the quick and efficient execution of advanced control algorithms.

The **Computer plus TF** regulators described in this manual are static switching regulators to be used with contactor-driven capacitor banks. For information about the **Computer plus T8 and T14** types for contactors, see manual M98223001-01-AAx. (AAx: AA are the last two digits of the year of revision and x is an alphabetical character, A...Z, used to indicate the version).

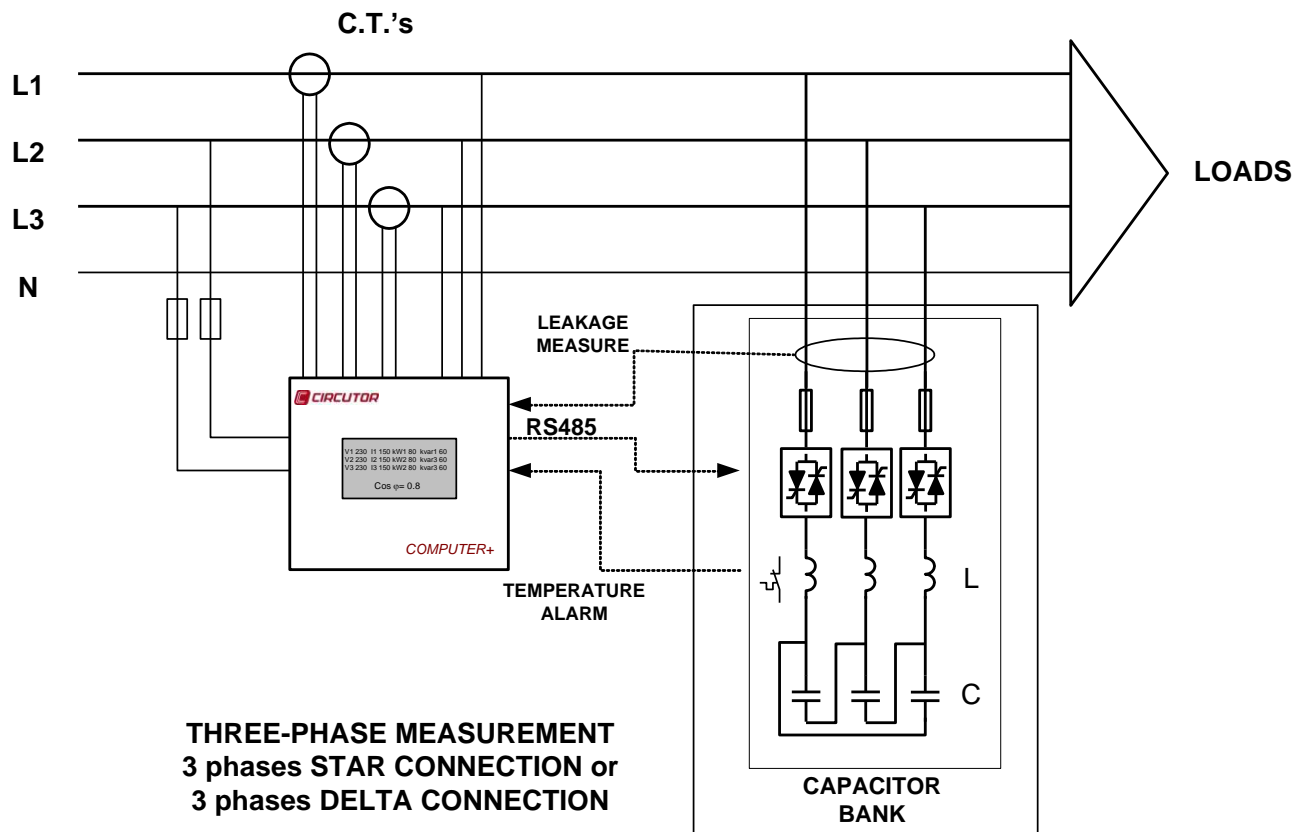


Fig. 1 .- Schematic diagram of connections

Types and basic functions:

TYPE	VOLTAGE (Vac)	OUTPUT	MEASURE MENT	OTHER FUNCTIONS
Computer plusTF-C	110-480	16 static outputs	Three- phase	Basic type for static capacitor banks (Includes Communications)
Computer plusTF-CDI	110-480	16 static outputs	Three- phase	Basic type of static capacitor banks + Leakage measurement + Measurement of I capacitors

2 TECHNICAL SPECIFICATIONS

Auxiliary power supply:	110 to 480 Vac (50...60 Hz) ($\pm 10\%$) Consumption of the unit: • 6.6 VA / 230 V ÷ 19 VA / 400 V ÷ 24.9 VA / 480 V
Voltage circuit: Measurement margin Maximum consumption Frequency	5% to 120 % for $U_n = 300$ Vac (phase-neutral) 5% to 120 % for $U_n = 520$ Vac (phase-phase) < 0.6 VA 45 ... 65 Hz
Intensity circuit: Nominal current Admissible overload Consumption (.../5 A and .../ 1 A)	Transformers $I_n / 5 A_{ac}$ or $I_n / 1 A_{ac}$ 6 A permanent, 100 A $t < 1$ s < 0.45 VA
Integrated control system	FCP or Linear / 4 quadrants
Integrated control algorithms	Three-phase and Phase-Phase (Star or Delta)
Communications of Computer plus with CPC3i (Non-configurable): Bauds Parity No. Bits \ Stop Frame	38400 bps NO 8 / 1 See Section 13
Environment: Operating temperature Storage temperature Maximum relative humidity Maximum operating altitude Installation category Contamination level Protection degree	-10° to +50 °C -20° to +65 °C 95 % non-condensing 2000 m (over sea level) Installation category III, in accordance with IEC 61010 2, in accordance with IEC 61010 IP 51 front panel - IP 20 rear panel
Safety: Installation category Protection to electric shock	Installation category III, in accordance with IEC 61010 Double insulation class II Designed and identified with the CE mark

Construction features:	
Connection	Direct connection terminals for rigid 2.5 mm wire (4,5 mm ²) or flexible (AWG 11)
Box material	V0 self-extinguishing plastic
Dimensions	In accordance with Fig. 2
Weight	0.511 kg
Regulations:	
EMC	IEC 61000-4-2, IEC 61000-4-3, IEC 61000-4-4, IEC 61000-4-5, IEC 61000-4-11

2.1 Dimensions and fixings

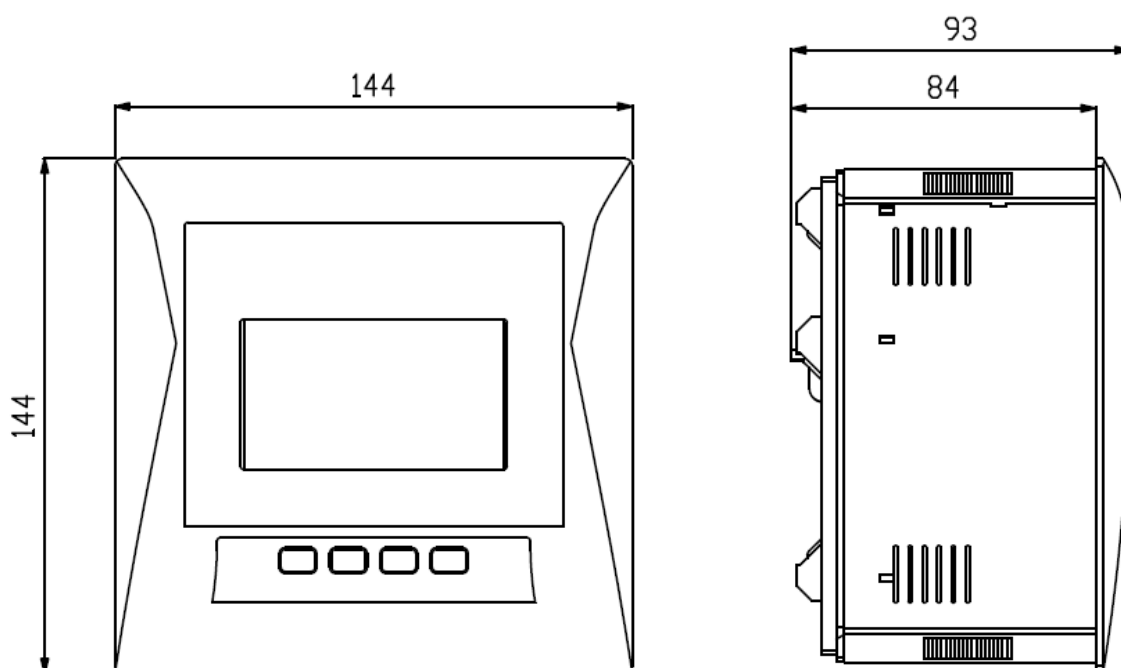


Fig. 2 .- External dimensions

The unit is intended to be installed in the panel door (138⁺¹ x 138⁺¹ mm in accordance with DIN 43 700).

3 STANDARD CONNECTION DIAGRAMS

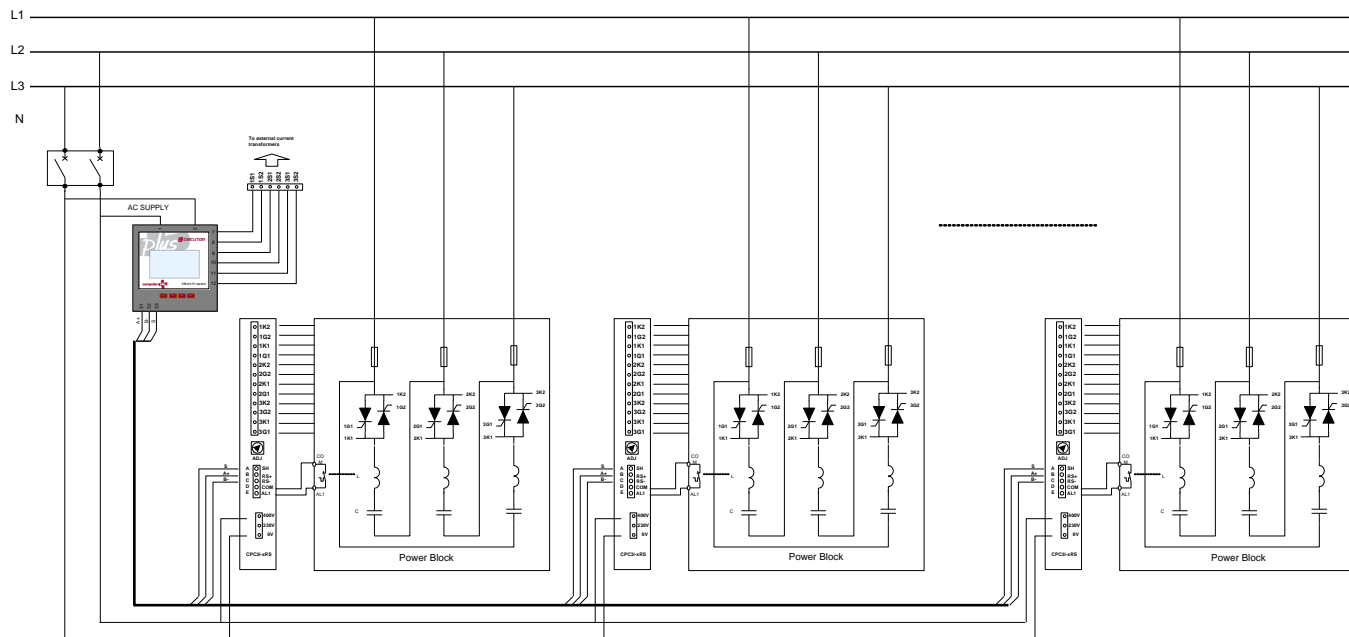
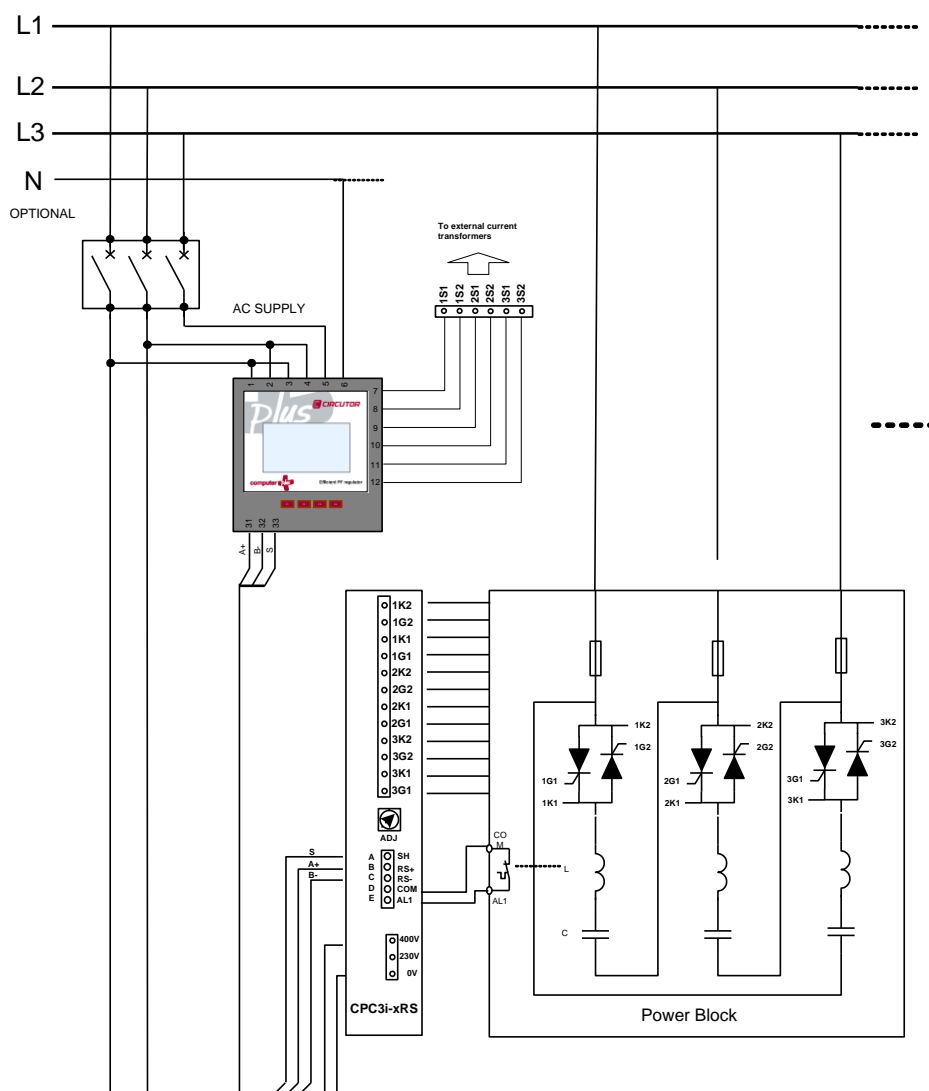


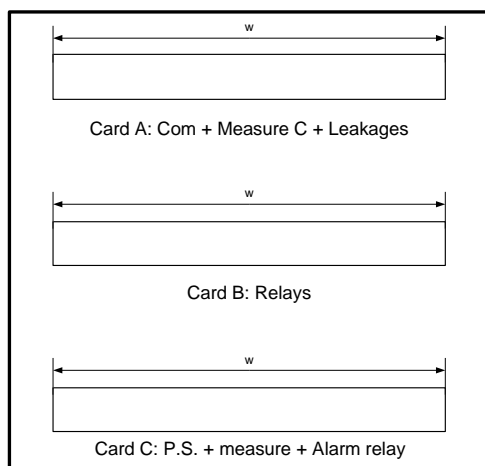
Fig. 3 .- Connection of Computer plus with various CPC3i-RS cards



IMPORTANT: Computer plus TF-C and TF-CDI always use static capacitor banks with the CPC3i-xRS card and both are connected through an RS-485 channel. The peripheral number must be configured on each CPC3i-xRS card (see Section 13).

Fig. 4 .- Details of the connection of a step to CPC3i-RS

3.1 Cards and Functions



Computer plus TF includes two printed circuit boards or cards.

Card A: Communications. Capacitor Current Measurement and Leakage Measurement

Card C: Power supply and measurement of line voltages and currents

3.2 Allocation of terminals

3.2.1 Card C: Power supply and measurement

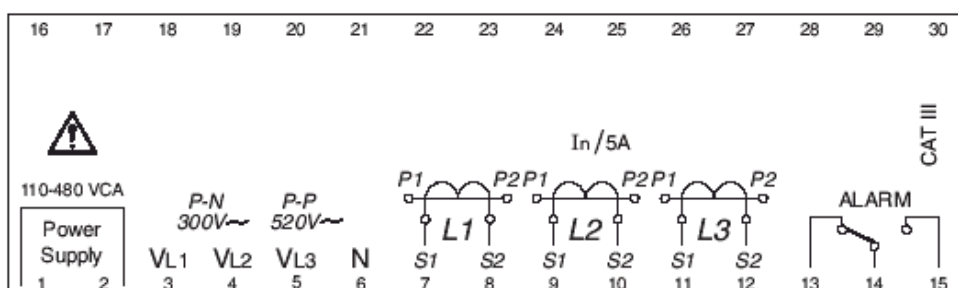


Fig. 5.- Power supply and measurement terminals

CARD C TERMINALS	FUNCTION
1	Power supply
2	Power supply
3	Voltage 1
4	Voltage 2

5	Voltage 3
6	Neutral
7	Secondary 1 Current IA
8	Secondary 2 Current IA
9	Secondary 1 Current IB
10	Secondary 2 Current IB
11	Secondary 1 Current IC
12	Secondary 2 Current IC
13	Alarm Relay NC Contact
14	Alarm Relay Common
15	Alarm Relay NO Contact

3.2.2 Card A: Communications, measurement of I in capacitors and measurement of I in leakages

31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
A+	B-	S	RS485	A+	B-	S													
CPC NET				COM1															

Fig. 6.- Card A Terminals for Computer plus TF-C

31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
A+	B-	S	A+	B-	S	COM	D1	D2	D3	D4	D5	S1	S2	S1	S2	S1	S2	S1	S2
CPC-NET			COM1									IF		IC1		IC2		IC3	

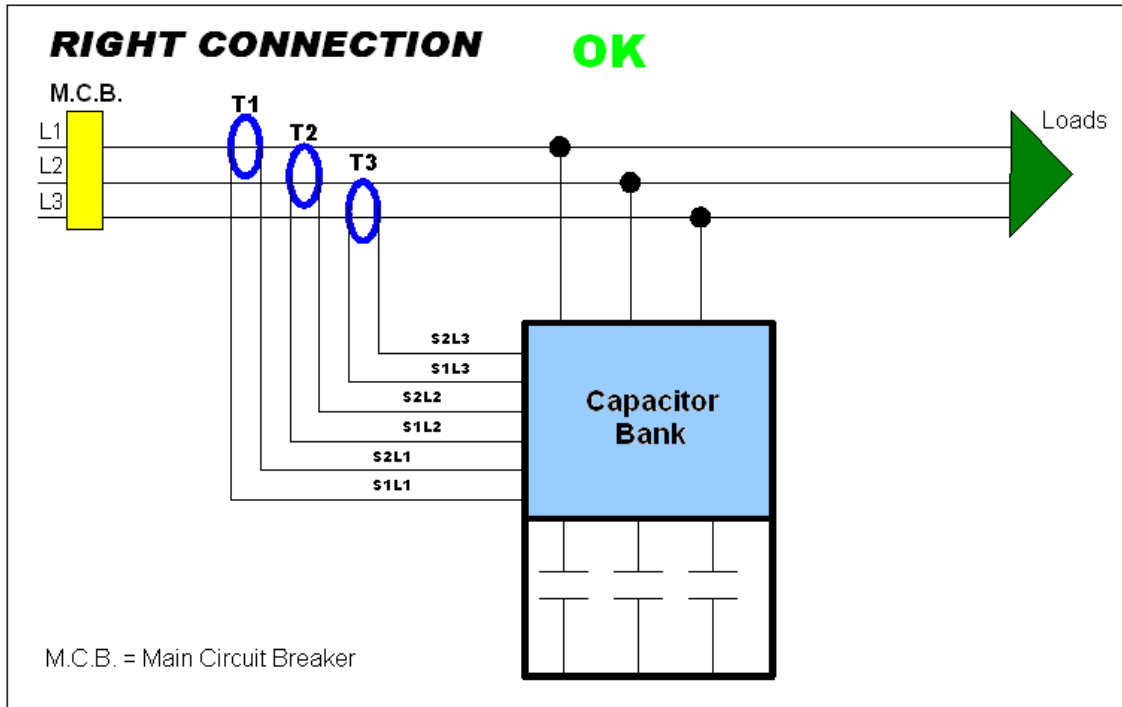
Fig. 7.- Card A Terminals for Computer plus TF-CDI

CARD A TERMINALS	ALLOCATION	FUNCTION
31	A+	Terminal A+ RS-485 (control of capacitors Only TF versions)
32	B-	Terminal B- RS-485 (control of capacitors Only TF versions)
33	S	Terminal S- RS-485 (control of capacitors Only TF versions)
34	A+	Terminal A+ Communications RS-485
35	B-	Terminal B+ Communications RS-485
36	S	Terminal S Communications RS-485
37	COM (1)	Common Digital Inputs
38	D1 (1)	Digital Input 1
39	D2 (1)	Digital Input 2
40	D3 (1)	Digital Input 3
41	D4 (1)	Digital Input 4
42	D5 (1)	Digital Input 5
43	IF - S1 (1)	Earth leakage transformer, I leakages Secondary 1
44	IF - S2 (1)	Earth leakage transformer, I leakages Secondary 2
45	IC1 - S1 (1)	Metering transformer, I capacitors, phase 1. Secondary 1
46	IC1 - S2 (1)	Metering transformer, I capacitors, phase 1. Secondary 2
47	IC2 - S1 (1)	Metering transformer, I capacitors, phase 2. Secondary 1
48	IC2 - S2 (1)	Metering transformer, I capacitors, phase 2. Secondary 2
49	IC2 - S1 (1)	Metering transformer, I capacitors, phase 3. Secondary 1
50	IC1 - S2 (1)	Metering transformer, I capacitors, phase 3. Secondary 2

(*) The grey boxes are only available in Computer plus TF-CDI

3.3 Connection of current transformers

The unit measures the current of the three input phases with three current transformers. The PF equipment requires current transformers, which must be installed at the mains supply line, so that the total current of the installation can flow through them (load current + current of the capacitors).



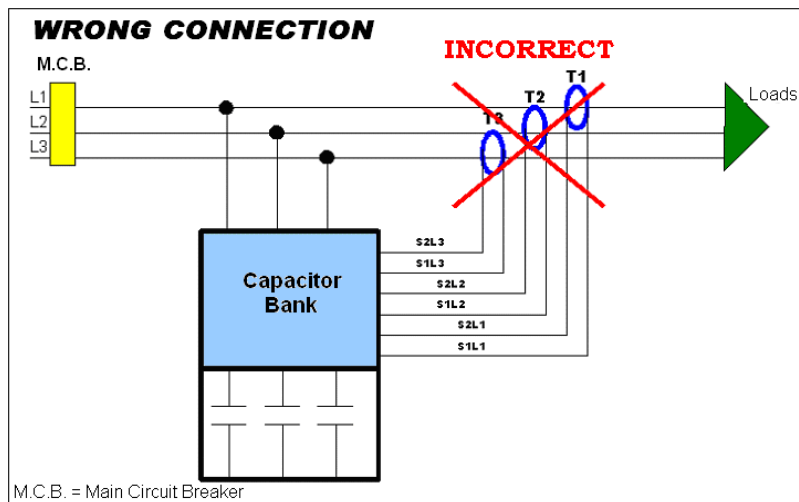
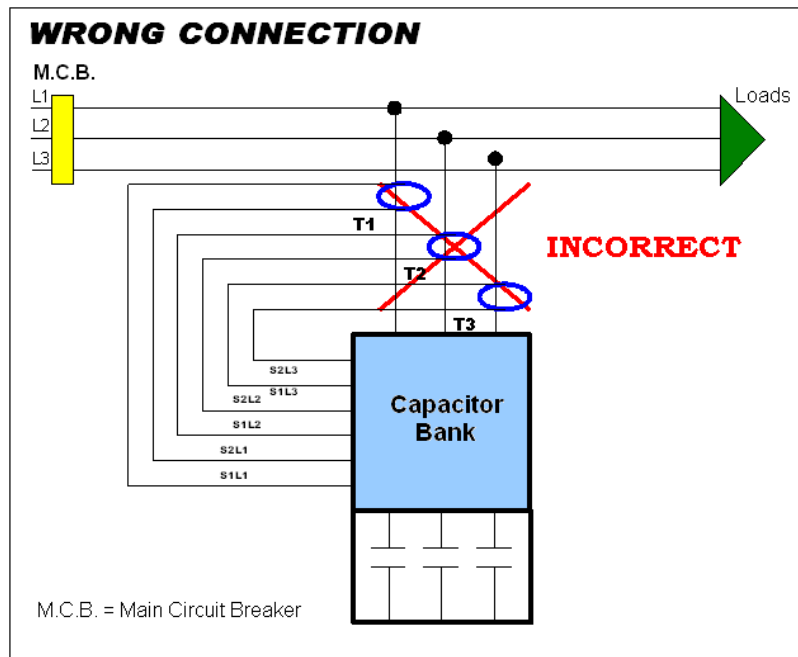


Fig. 8 .- Connection of the line current transformers

4 SETTINGS AND START-UP

Read the safety instructions in the introduction of this manual. You must respect these conditions to guarantee the safe operation of the unit and keep it in good condition regarding safety. The unit must not be used and programmed until it has been installed in its final position in the electrical panel with the adequate protection elements.

If you use the unit in a way that is not specified by the manufacturer, the protection of the unit may be compromised.

If the unit has been damaged, burnt or hit by any element, the internal circuits might have been damaged and the safety protection elements might not be in full working order. In this case, disconnect the power supply and contact the authorised Technical Service to request a replacement.

4.1 Verifications that must be carried out before powering the unit:

Before powering the unit, check the following points:

a.- Auxiliary power supply:

- Voltage: 110 - 480 Vac ($\pm 10\%$)
- Frequency: 50 ... 60 Hz

b.- Nominal voltage in the voltage measurement circuit:

- Maximum nominal voltage: U_{p-N} : 300 Vac / U_{p-p} : 520 Vac
- Frequency: 45 ... 65 Hz

c.- Nominal current in the current measurement circuit:

- Secondary ... / 5 A: 5 Aac
- Secondary ... / 1 A: 1 Aac

d.- Operating conditions:

- Operating temperature: -10° to $+50^{\circ}$ °C
- Relative humidity: $< 95\%$ non-condensing

e.- Safety:

- Designed for CAT III 300/520 Vac installations, in accordance with EN61010.
- Double-insulated electric shock protection class II.

The unit is intended to be installed in the panel door (drill panel, in accordance with DIN 43 700):

- Drill panel $138^{+1} \times 138^{+1}$ mm



All connections are inside electric panel.

Remember that with the unit connected, the terminals may be hazardous to the touch, and opening the covers or removing elements may provide access to parts that are dangerous to the touch. The unit must not be used until it is fully installed.



The regulator should be connected to a power supply circuit protected by gl type (IEC 269) or M type fuses (IEC 127), rated between 0.5 and 2 A. It should be provided with a MCB or equivalent device to switch off the system from the power supply circuit. Both power supply and voltage measuring circuits as well as connections to different relays will be wired with cables of a minimum cross-section of 1 mm² (AWG 17). The current transformer secondary side connection line should have a minimum cross section of 2 mm² (AWG 14) and with a minimum temperature rating of 60 °C.

To connect a **Computer plus** regulator to a power factor compensation unit, follow these steps:

- Connect the power supply terminals (1 and 2 in Card C) to the control panel's voltage source.
- Connect terminals VL1, VL2, VL3 and the neutral N (if available) to the network's phases and neutral.
- **VERY IMPORTANT!**

The device considers that phase 1 is the phase connected to the VL1; phase 2 will be that connected to VL2 and phase 3 that connected to the regulator's VL3. (Cables L1, L2 and L3 of the power supply connection).

- Connect current transformers T1, T2 and T3 to phases 1, 2 and 3, respectively. If you do not connect each transformer to the corresponding phase, the "Plug and Play" setting can be used to detect them automatically. In addition, they can be configured manually with the *Connection of Transformers V-I* option in the *Setup* menu folder.
- Make sure that the cables (S1-S2) coming from the secondary connections of the current transformers are connected to terminals S1-S2 of the **Computer plus** unit. If you do not connect each transformer to the corresponding phase, the "Plug and Play" setting can be used to detect them automatically. In addition, they can be configured manually with the *Connection of Transformers V-I* option in the *Setup* menu folder.

4.2 Energising the regulator.

- The device can be energised once the power supply and measuring cables have been connected.
- After energising the **Computer plus** unit and waiting for a start-up time of 10 seconds, the device will start to display the values measured. Some information might not be coherent ($\cos \varphi$ out of reasonable margins, active power values with a negative sign, etc.). This is usually the result of incorrect connections (current transformers connected to the incorrect phase or inverting S1-S2).

Any of these errors can be solved without changing the cables; simply enter the setup menu of the device, select option *Connection of Transformers V-I* (see section 7.3), or execute the “Plug and Play” option (see section 7.2).

NOTE: If you connect the unit and it does not operate, remember that it must be put in the RUN mode (section 7.3.9). In particular, this is essential when working with static capacitor banks, given their fast operation, in order to avoid the connection of all capacitors when they are powered, causing an accident due to an overcompensation.

4.3 Regulator settings.

ATTENTION:

The Computer plus TF-C and TF-CDI regulator is delivered with the outputs disabled as the default factory settings. Therefore, when you connect the voltage and before adjusting the setup, do not connect any capacitor step. If any capacitor is connected, set the Computer plus in the STOP status (See Section 7.3.9) and adjust it in accordance with the instructions in Section 7.

When the regulator is installed on a CIRCUTOR capacitor bank, it has already been set-up and its final location will only need you to select the “Plug & Play” option (see section 7.2).

If you are sure that the regulator has not been set-up and a capacitor connects, this indicates that something is working incorrectly. In this case, check the settings in accordance with the instructions in section 7.

Follow these steps to adjust the unit:

- Apply voltage to the unit and follow the set-up instructions in section 7.
- Configure the alarms according to your needs by following the instructions in section 8.
- If you have a communications network and you wish to integrate the PF compensation unit into the **SCADA Power Studio**, follow the instructions in section 11.

5 BASIC INSTRUCTIONS TO BROWSE THE MENUS

5.1 Browsing the menus: Functions of the keys

The **Computer plus** system has four **dynamic** keys, marked **F1** **F2** **F3** and **F4**. **Dynamic** means that the functions of these keys is not always the same, because it changes on each screen. The function of each key is shown on the lower line of the corresponding screen. For example, on the screens on Fig. 10 and 11, the functions of the keys correspond to the indications on the boxes on the lower part of the screen.

In general, you can return to the main menu from any screen, by pressing the **F1** key until the screen shown on Fig. 12 is displayed.

5.2 Main menu and default menu

Normally, when you power the device it performs an initial test and during this time it shows the start screen (Fig. 9). After 5 seconds, it will show an information screen (Fig. 10) with the model, software version, language, date and time and serial number.

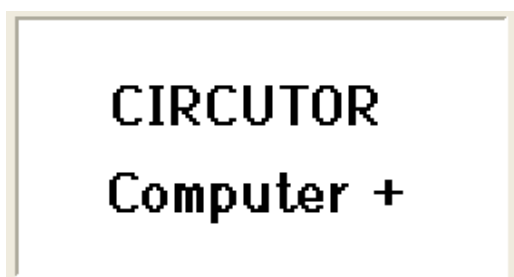


Fig. 9.- Start screen

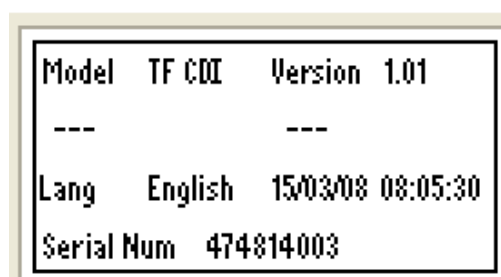


Fig. 10.- Information screen

After 5 seconds showing the information screen, the unit will display the **default screen by default in the STOP mode** (Fig. 11). If the unit is in the **RUN MODE**, the Fig.12 displayed on screen will be displayed, indicating the kvar connected in each phase.

ATTENTION: If the unit has not been set-up, and the screen shown on Fig. 12, is displayed **set the unit in the STOP mode** (press the **Stop**) key and return to the screen shown on Fig.10. **Next, check the settings, following some of the procedures described in Section 7.**

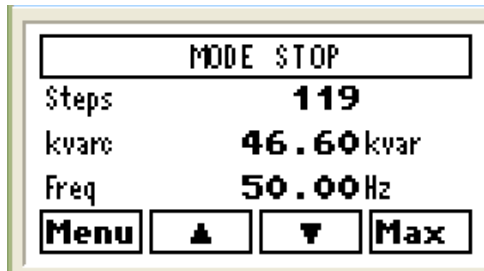


Fig. 11.- Default screen in the STOP mode

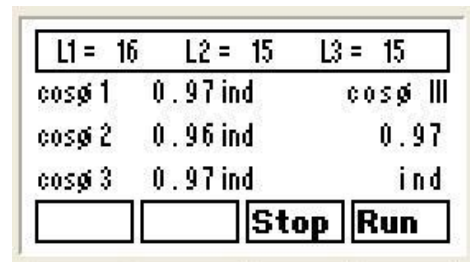


Fig. 12.- Default screen in the RUN mode

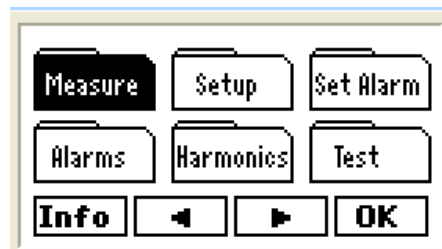


Fig. 13.- Main Menu Screen

All screens will display the menu browsing options on the lower part of the screen, which must be selected by pressing the **F1** **F2** **F3** or **F4** keys, depending on the option selected. Therefore, to move from the default screen (Fig. 11) to the main menu (Fig. 13), press **F1**.

Computer plus will jump directly to the default screen (Fig. 11 or Fig. 12) when no key has been pressed during a period of two minutes.

5.3 Basic options of the Main Menu

After powering the **Computer plus** and completing the start-up process, simply press the **F1** key various times to access the main menu (Fig.13).

6 folders will be displayed on the main menu, which correspond to the **basic functions** that can be executed by **Computer Plus**. Said functions are:

- **Measure:** Displays the parameters measured (Voltages and currents) and other parameters calculated (Power, power factor, etc.)
- **Setup:** Used to adjust the unit and adapt it to the application conditions.

- **Set Alarm:** (Alarm Setup). Used to adjust the maximum and minimum trip, delay, etc. values.
- **Alarms:** Shows the state of alarms
- **Harmonics:** Shows the voltage and current harmonics.
- **Test:** Manual connection and disconnection of steps and test of the system

On the bottom of the main menu there are a series of menu options that can be selected with the **F1** **F2** **F3** and **F4** keys. The different menu options are:

Info Access a screen that indicates the name of the unit, and the model, version and serial number (Fig. 10).

◀ ▶ Used to browse through the main menu and select the desired option.

OK To select an option and access the desired menu.

5.4 Editing numerical or literal fields

- Many menus show the option to edit numerical or literal fields. Editing is usually done as follows:
- Press the **Edit** key and the following menu will be displayed: **Esc** **▲▼** **Edit** **OK**
- **▲▼** Select the field you wish to edit and press **OK**
- The menu will be displayed **Esc** **▲** **▶** **OK**
- When editing numbers, press the **▶** key to change the number being edited, which will appear underlined and with **▲** you can change the numerical value in cycles (0 to 9). When you reach the value desired, move onto the following character and press **OK** when you are finished.
- If the value edited is incorrect or out of the limits, then when you press **OK** the previous value will be kept.
- When you wish to edit fields with different options, menu **Esc** **▲** **□** **OK** will be displayed, and you can change the option with the **▲** key. When you reach the desired value, press **OK**

6 SUBMENU LAYOUT

Each of the **basic functions** described in the main menu (folders) has a series of options or submenus that allow the configuration of the device or check the status of the different values controlled by the **Computer Plus**. The layout of the different submenu options is shown next. A detailed description can be found in section 7.

6.1 Measure menu

The measure menu allows the display of all the parameters measured or calculated by the device. The layout is shown on Fig.14

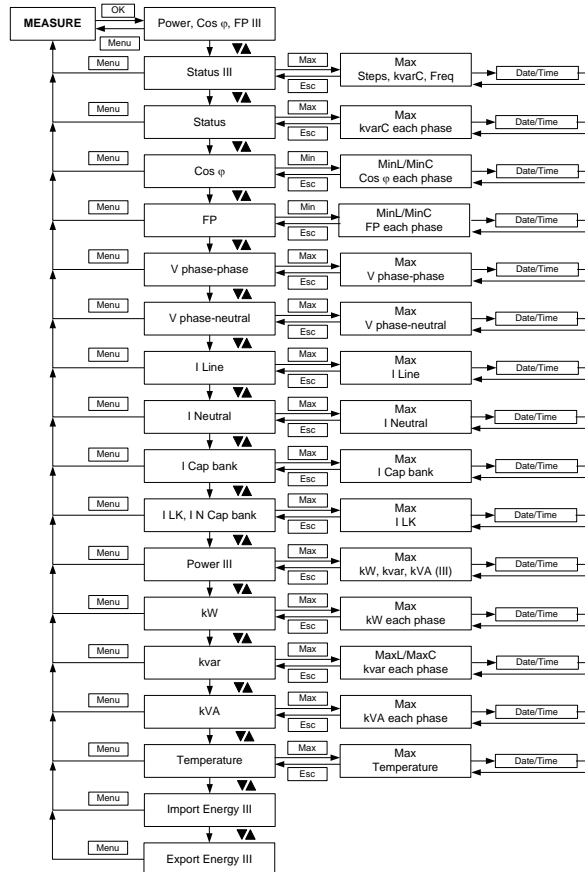


Fig.14.- Measure menu tree

6.2 Device setup menu

In the setup menu you can configure the different options of **Computer Plus**. This menu is protected by a password. You can browse the menus and see how the parameters are configured, but you must choose the **Edit** option to edit them on any screen. A password will be asked before a modification is permitted. The standard password is the sequence of **F1 F3 F2 F4** keys. The menu layout is shown on Fig.15 (for more details, see section 7).

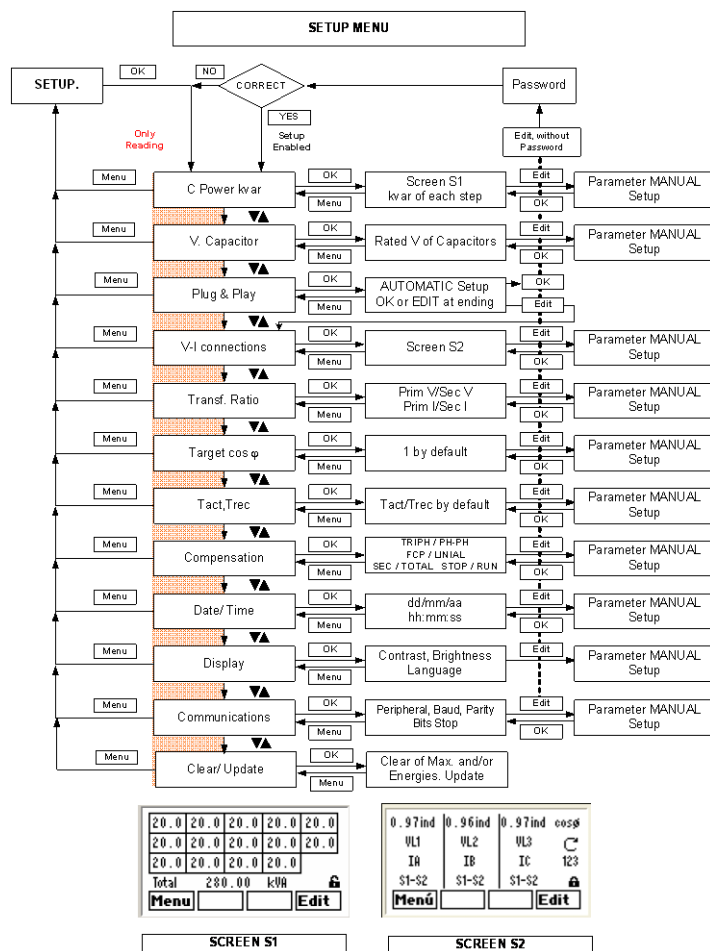
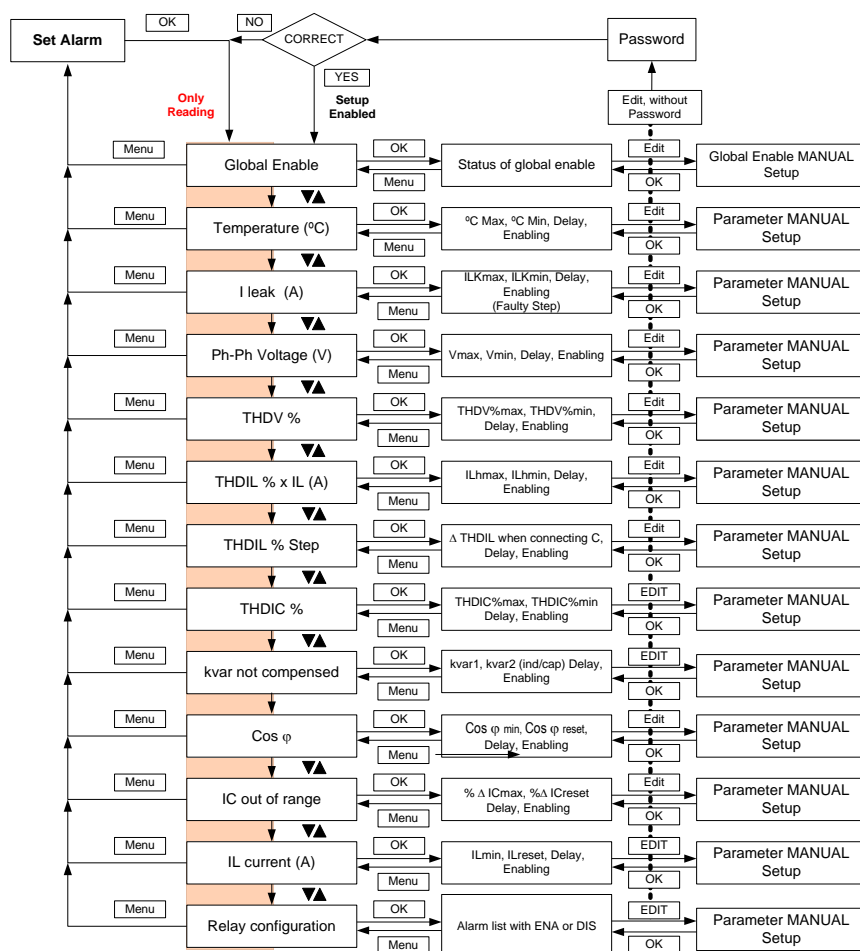


Fig.15.- Configure device menu tree

6.3 Alarm setup menu

The alarm setup menu displays and allows the programming of the alarms of **Computer Plus**. This menu is protected by a password. You can browse the menus and see how the alarms are configured, but you must choose the **Edit** option to edit them. The password will be asked before a modification is permitted. A standard password is the sequence of **F1 F3 F2 F4** keys. The menu layout is shown on Fig. 16

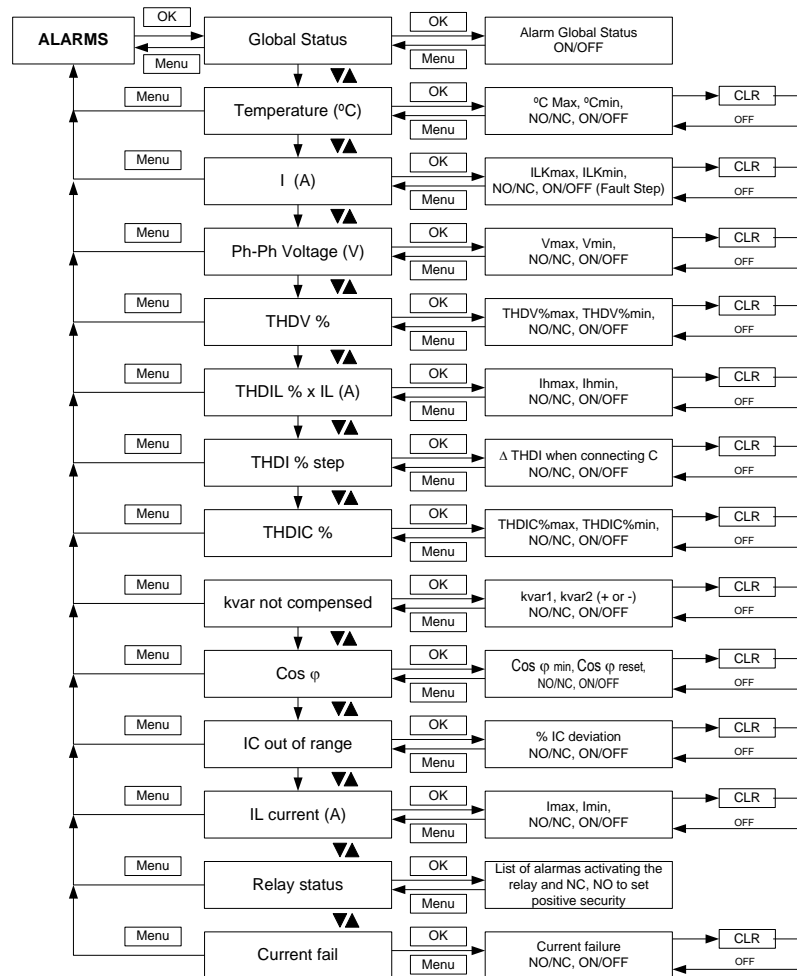


NOTE: The I leak, THDIC and Ic parameters are only available for the TF-CDI versions of **Computer plus**

Fig.16.- Alarm setup menu tree

6.4 Alarm status menu

This menu displays and allows resetting of alarms that have tripped, but it can not be used to change the limits or activation status. The menu layout is shown on Fig.17.

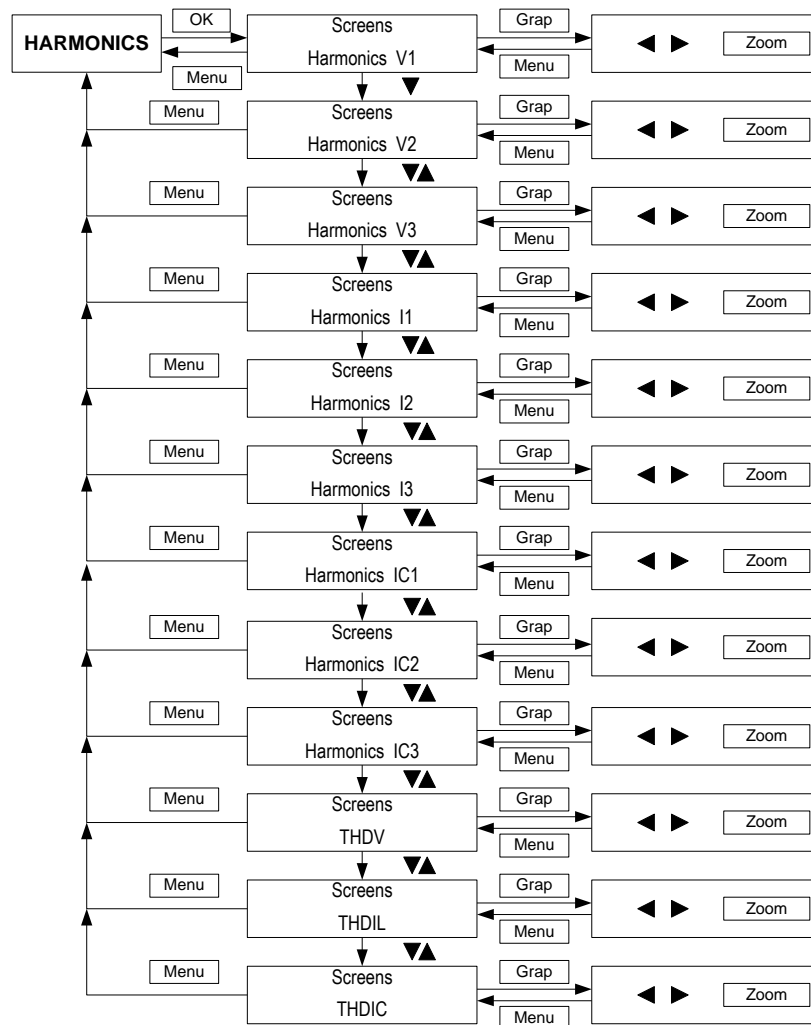


NOTE: The I leak, THDIC and Ic parameters are only available for the F-CDI versions of **Computer plus**

Fig.17.- Alarms menu tree

6.5 Harmonics menu

This menu displays 32 harmonics from the different voltages and currents measured by **Computer plus**.



NOTE: The IC1, IC2, IC3 and THDIC parameters are only available for the F-CDI **Computer plus**

Fig.18.- Harmonics menu

6.6 Test menu

The Test menu can be used to enter the device's manual mode. The options in this menu have been designed to carry out different tests of the compensation system, including harmonics prediction tests. When you enter this menu the unit runs manually and, therefore, stops carrying out its regulation functions.

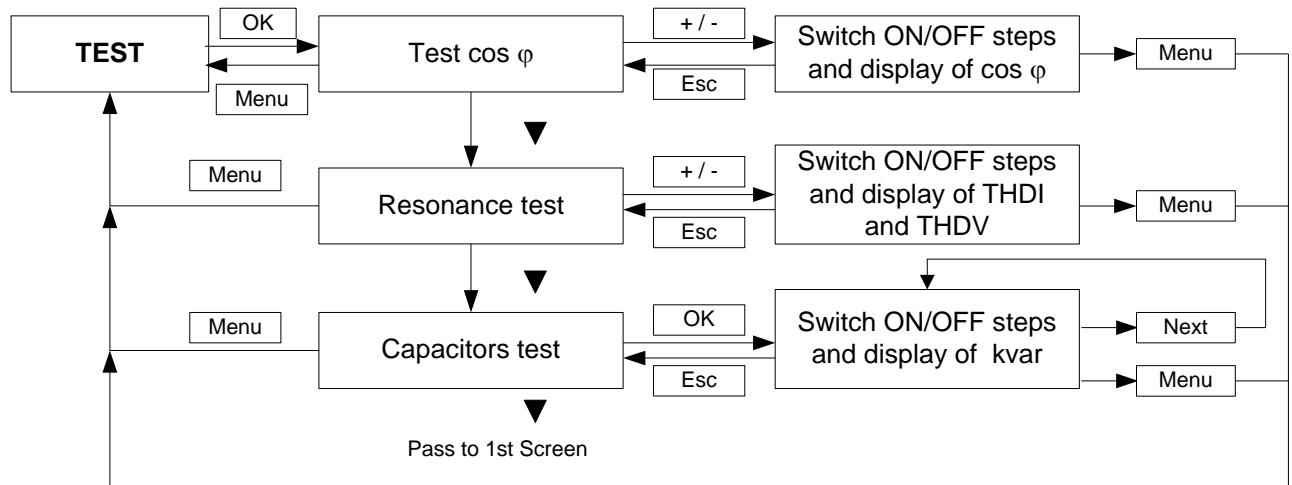


Fig.19.- Test menu tree

7 DEVICE SETUP: SETUP MENU

Computer plus must be programmed to adapt itself to the installation being compensated. Such adaptation process requires the selection of a series of parameters, such as No. of capacitor steps, power of each step, current transformers (CT) ratio, etc. All of these parameters can be adjusted as follows:

- Automatic adjustment with the **Plug & Play** option
- **Manual** Adjustment

Please check the **menu tree of the setting described in section 6.2.** before entering the setting

7.1 Password

- The screen shown on Fig. 20 will always be displayed when you wish to change the setup and it will ask for the password. Enter the **F1 F3 F2 F4** key sequence to activate the programming option. The unit will disconnect any connected capacitor steps and then display the setup screen. The right lock-shaped icon indicates whether the unit is locked or not for the edition of adjustable parameters.

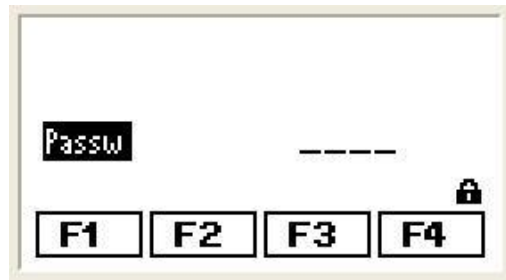


Fig.20.- Password request

7.2 "Plug & Play" Setting

One of the most important features of **Computer plus** when compared to other cheaper regulators is its configuration advantages. **Computer plus** is a very sophisticated regulator and it has a **Plug & Play** option in the setup menu. The following data must be entered in this option:

- **Power of each capacitor step**
- **Voltage and connection of capacitors (star or delta).**

ATTENTION: The Plug & Play setting is always in the three-phase mode, even when you have selected the phase-phase control option.

- 1) During the Plug&Play setup, the device will connect a capacitor step to measure the ratio of the current transformers (CT)
- 2) The kvar data of each capacitor step at nominal voltage is labelled on each capacitor.

With this information, the device can configure all other parameters by simply pressing a key, thus saving time and preventing any errors. After calculating the installation's setup and before starting the automatic regulation mode, the device will display a report of the setup of the different parameters and request for confirmation.

The steps that must be followed to configure the device in the **Plug & Play** mode are as follows:

7.2.1 Plug&Play Step 1





- Go to the main menu (Fig. 21)
- Use the arrows to   select the folder  and press  . Fig.22 will be displayed on the screen.



Fig. 21.- Main menu



Fig.22.- Setup menu

- Select the option **C Power kvar** and press **OK**. The screen shown on Fig. 23 will be displayed.
- Press **Edit** and the password screen will be displayed if the edition is locked. Follow the steps described in section 7.1. After entering the password the screen shown on Fig.24 will be displayed.

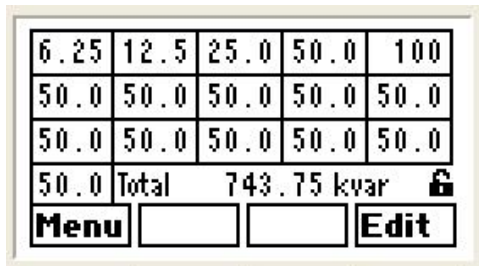


Fig.23.- Programming capacitor power

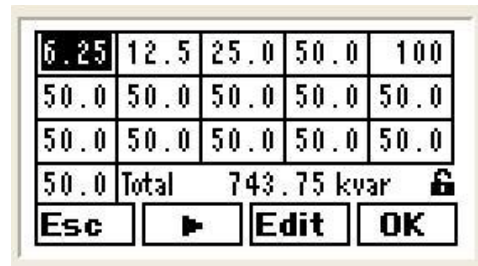



Fig.24.- Programming capacitor power

- On the screen shown on Fig.24, each box represents a capacitor step and the number inside it states the nominal kvar of the capacitor. Use the arrow  to change the step being adjusted. To adjust the first one, press **Edit** when it is highlighted in reverse video and the screen shown on Fig. 25 will be displayed, where you can change the kvar of the highlighted step.

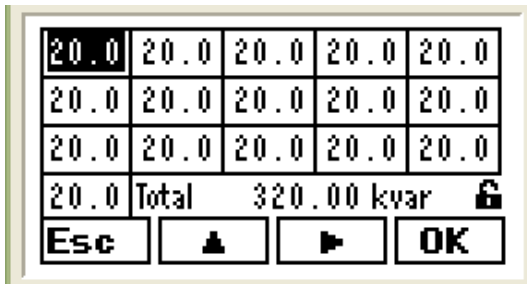


Fig.25.- Programming capacitor power

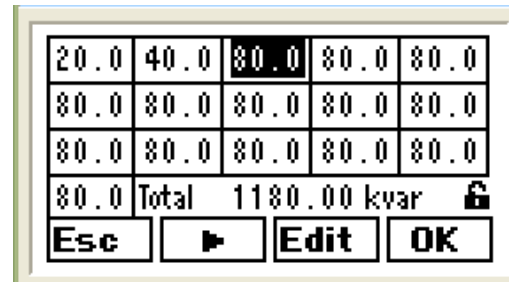


Fig.26.- Programming capacitor power

- On the screen shown on Fig.25, use the arrow to change the digit and use the arrow to change the value. The kvar value will be programmed for each step and it will be confirmed by pressing **OK**.

NOTE: After programming the first step, all other steps will change their values, using the value of the first one (20 kvar in the case shown on Fig.25). The screen on Fig.24 will be displayed and we can then program the next step. Assume that the second step is 40 kvar. Select the second step with and repeat the operation to program value 40. When this operation is complete, press **OK**. If we assume that the third step is 80 kvar, follow the same procedure. The screen shown on Fig. 26 will be displayed, where all steps after the last step programmed also have the value 80.

- **Number of steps:** The previous screens show 16 boxes. This means that Computer plus TF-C and TF-CDI can govern up to 16 capacitor steps with a static capacitor bank. When the unit has fewer steps, for example, 11 steps in a Computer plus T8, program step N+1 as zero (in the example on Fig. 28, step 12) and the regulator will then know the number of steps used (in our example, 11 steps).

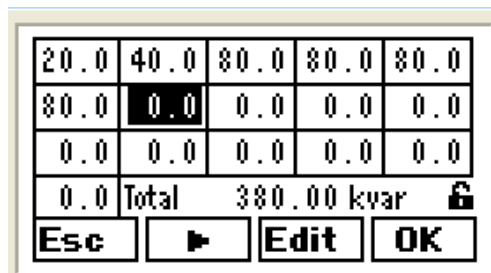


Fig.27.- Programming for a 6-step unit (step 7 = 0 kvar)

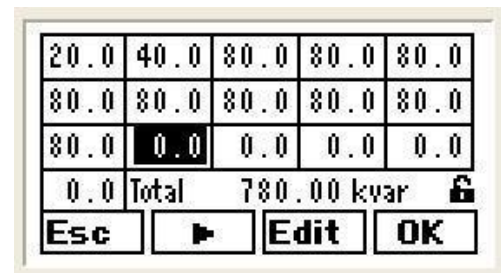


Fig.28.- Programming for a 11-step unit (step 12 = 0 kvar)

7.2.2 Plug&Play Step 2

- **Nominal voltage of capacitors and steps configuration:** The second Plug&Play step involves the selection of the nominal voltage of capacitors and a star or delta connection. This information is usually shown on the label of the capacitors with the nominal power rating. In general, the connection is delta,

unless otherwise stated. To enter this information in the regulator, open folder **Setup**, press **OK** and the screen shown on Fig.29 will be displayed. Select the **Capacitor** option and press **OK**. The screen shown on Fig. 30 will be displayed. Press **Edit** and the screen shown on Fig.31 will be displayed. Select the field edited with **▲▼** and press **Edit** again to display the screen shown on Fig.32. Edit the numbers with arrow **▶◀** to change the digit and use the arrow **▲▼** to change the value. Confirm with **OK**. Use the **Unit** section to select **V** or **kV** and **Connec** to select Δ or **Y**



Fig.29.- Programming the capacitor setup



Fig.30.- Programming the capacitor setup



Fig.31.- Programming the capacitor setup



Fig.32.- Programming the capacitor setup

7.2.3 Plug & Play Step 3

- After configuring the power and capacitor steps configuration, the automatic setting can be launched. To do so, select the Plug&Play option from the main menu (Fig.33) and press **OK**. The screen shown on Fig. 34 will be displayed. Confirm the setting by pressing **Do**. Any steps connected will be shown on the screen shown on Fig. 35 or, in case of the first setting, the screen on Fig.36 will be displayed.



Fig.33.- Launch the automatic Plug&Play setting



Fig.34.- To start Plug&Play, press **Do**

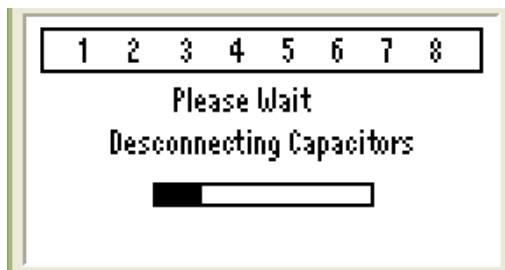


Fig.35.- Plug&Play in case there are steps connected

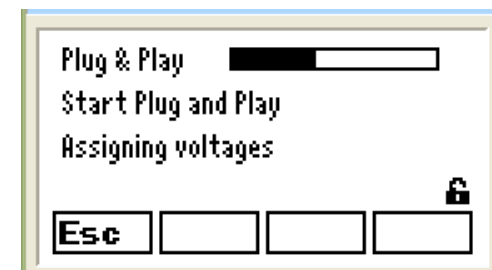


Fig.36.- Start of Plug&Play

- From this point, the Plug&Play automatic setting will continue allocating the phases and the direction of current transformers, allocating each transformer to its phase, while calculating the transformer ratio, always assuming that In/5A transformers are used. The results of automatic adjustments are shown on different screens, as shown on Fig.37 to 40.

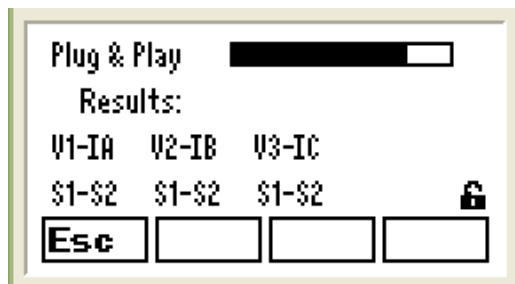


Fig.37.- Plug&Play. Phase allocation information

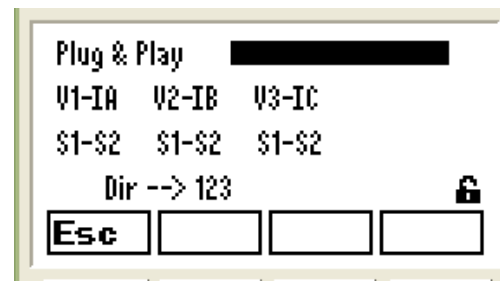


Fig.38.- Plug&Play. Phase allocation information

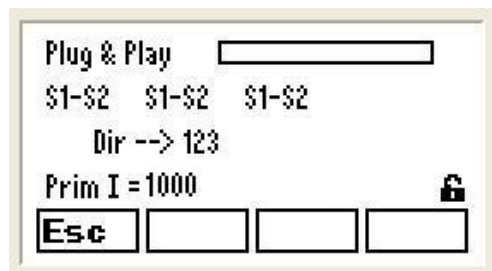


Fig.39.- Plug&Play. Secondary sense phase sequence and primary current transformers information



Fig.40.- End of Plug&Play

7.2.4 Interpretation of the settings made by Plug & Play

- The screen shown on Fig.37 shows information about the phase to which the current transformers have been connected (CT). If IA, IB and IC are shown together with V1, V2, V3 and all are in the S1-S2 order, each CT is connected to the correct phase and in the correct direction. However, if you have the example shown on Fig. 38, this would mean that the current in phase C has been connected instead of B and vice versa, and phase 3 secondary terminals of the CT have been inverted.

NOTE: This information is usually correct if the load is inductive or slightly capacitive during the Plug&Play setting (cos fi between 0.65 inductive and 0.98 capacitive). In any case, if you consider that the connections are correct, you can repeat the Plug&Play setting and if the results are the same, there is a high probability that the connections are as detected by the automatic setting unit.

- The screen on Fig. 39 shows information about the phase sequence connected to V1, V2 and V3 and about the current transformer ratio, both detected by the Plug & Play automatic setting system.
- The final automatic setting is shown on the screen displayed on Fig. 40, indicating the end of the Plug&Play.

- If there is an error message at the end of the automatic adjustment process, carry out the process again and if the error persists, the system must be adjusted manually, as described in section 7.3.
- If the error message is not displayed at the end of the automatic setting, press the **Run** key to assess whether the cosine values of ϕ and the value of kvarC connected are logical or not (see Fig. 41). If they are correct, press the **Run** key again and the regulator will start to operate.

7.2.5 Default Plug&Play Values

Some parameters affect the compensation process and they are configured by the Plug & Play by default.

The default values of the parameters are shown on table 7.1.

Parameter	Meaning	Default values
cos ϕ objective	Desired cos value ϕ	1
Default connection of capacitors	Steps configuration	Delta
Tact	Connection/Disconnection time between steps	10 s
Trec	Reclosing time of the same step	50 s
V1/V2 voltage transformer ratio	Transformer ratio of voltage measurement transformers (generally 1, except in the case of MV or HV)	1/1
Current transformer secondary	Nominal value of I2	/5
Menu language		Spanish
Parameters of the communications channel	Parameters of the communications channel	Peripheral...1 Baud rate... 19200 Parity... No Leng. Data... 8 bits Bits Stop... 1

Table 7.1.- Parameters configured by default

7.3 MANUAL Setup

Even though the easiest way of configuring **Computer plus** is with the **Plug & Play** option, all of the unit's parameters can also be configured manually.

7.3.1 General information about the Setup menu

- To edit a field, follow the procedure described in section 5.4.
- The screen displayed on Fig. 41 will be displayed at the end of the adjustment procedure on any setup screen, after the final validation of the settings with **OK**, indicating the $\cos \varphi$ in each phase and three-phase, as well as the kvar entered in each of the L1, L2 and L3 phases in case it is started. The menu bar shows the options to continue editing values when you press **Edit**. The unit will start-up when you press **Run**. At the end of the setup process, when the values displayed on the screen seem logical, both in terms of $\cos \varphi$ values and capacitor steps that will be connected, press **Run**. Otherwise, press **Edit** to return to the setup menu and check for any errors.

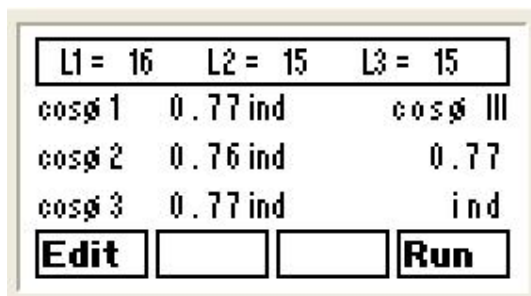


Fig.41.- Exit any setup screen

7.3.2 Entering the setup menu




- To enter the setup menu, open the main menu (Fig.42). Use the arrows   to select the folder  and press **OK**. The list of options shown on Fig.43 will be displayed.



Fig. 42.- Main menu



Fig.43.- Setup menu

- You can browse any parameter to see how it is programmed. However, when you attempt to edit a field, a screen will ask for the password (Fig.44). Follow the instructions described in section 7.1 to enter the password.
- If the unit is in operation, the screen shown on Fig. 45 will appear before the setup process is carried out and the regulator will disconnect any steps connected.



Fig.44.- Password request



Fig. 45.- Setup with connected steps.

- The indispensable parameters that must be configured to start-up the **Computer plus** are:
 - **C Power kvar**
 - **Capacitor**
 - **V-I Connections**
 - **Transf. Ratio**
 - **Compensation**
 - **Target Cos ϕ**
 - **tact, trec**
- Apart from the indispensable parameters shown on the previous list, **Computer plus** has a series of optional parameters that do not have a direct impact on the compensation process. These parameters are:
 - **Date/Time**
 - **Display**
 - **Communications**
 - **Clear/Update**

7.3.3 Adjusting Capacitor Power

This unit can be used to adjust the power of each capacitor step in the compensation unit.

The adjustment method is described in section 7.2.1 for the Plug&Play settings.

NOTE: Any power rating can be used on each step. However, these are usually established in ascending order, respecting the 1:1:1:1; 1:2:2:2 or 1:2:4:4 ratios. In any case, many other different ratios can be used, such as 1:1:2:2:3:3:5:8.

7.3.4 Adjusting and configuring the nominal voltage of capacitors

The second Plug&Play step involves the selection of the nominal voltage of capacitors and a star or delta connection. This information is usually shown on the label of the capacitors with the nominal power rating.

The adjustment method is as described in section 7.2.2 for the Plug&Play settings.

7.3.5 Adjusting the connections of current transformers (CT)

- Open the setup menu by following the process described in section 7.3.2
- Select the **V-I connections** option and press **OK**. The screen on Fig.47 will be displayed. (The screen on Fig.45 will be displayed if there are steps connected).
- In this case, the phases connected to the VL1, VL2 and VL3 correspond to the phases where the A, B and C current transformers are connected. Therefore, the default connection is VL1 with IA, VL2 with IB and VL3 with IC. The unit assumes the default connections and measures the **cos φ** . The values are shown on the top part of the screen and the phase sequence on the right (123 or 132). The sequence is measured on the voltage signals. If 132 is displayed, change the VL2 and VL3 voltage cables to correct the situation. When they are in the correct place, the system will show 123.



Fig. 46.- Connection of transformers

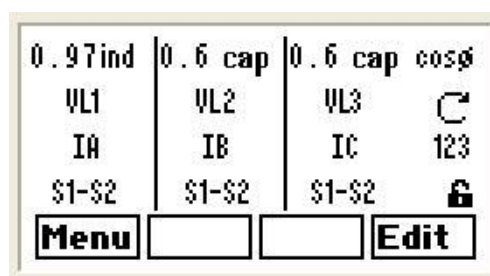


Fig.47.- Transformer connection menu

- The screen displayed on Fig.47 shows that the VL1, VL2 and VL3 cables might not match the corresponding current transformers. The cos φ values are not coherent with the expected results (it is not normal to have an inductive phase and two capacitive phases). Therefore, we must edit the values on the screen, for example, changing IB by IC and inverting S1-S2 until we obtain a set of coherent cos φ values.

- To edit the information on the screen shown on Fig.47, press the **Edit** option and the screen shown on Fig.48 will be displayed. Use the arrow to change the field being edited. Pressing **Edit** again we may change IB by IC, for example, or S1-S2 by S2-S1.
- If you do not know how the cables of the current transformers (CTs) are connected, try various combinations until you obtain a coherent $\cos \varphi$ reading. Imagine this can be achieved with the setup shown on Fig. 49. This would mean that the CT of phases 2 and 3 are changed and that the secondary of phase 3 has S1-S2 inverted.

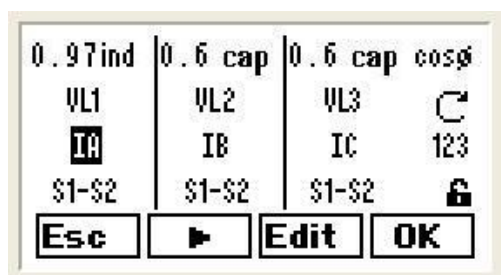


Fig. 48.- Menu to change CT connections



Fig. 49.- Menu to change CT connections

- When the setup is producing a coherent set of $\cos \varphi$ values, press **OK** and adjust the transformer connections.

7.3.6 Adjusting the transformer ratios

In this menu, the voltage transformer and the current transformer ratios can be adjusted. In general, there will only be voltage transformers in the medium or high voltage systems (MV or HV). In the case of low voltage installations, the voltage transformer ratio is 1:1.

To adjust the transformer ratios, proceed as follows:

- Open the setup menu by following the process described in section 7.3.2
- From the list of options, select **Transf. Ratio** (screen on Fig.50) and press **OK** to display the screen shown on Fig.51



Fig. 50.- Transformer Ratio

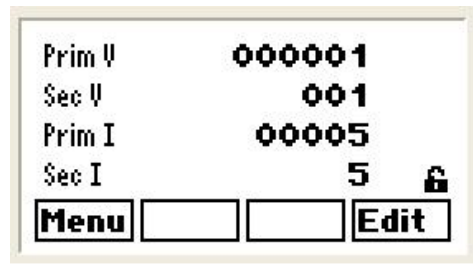


Fig. 51.- Edit Transformer Ratio

- Press **Edit** and the screen shown on Fig.52 will be displayed. To edit a field, follow the procedure described in section 5.4.



Fig. 52.- Transformer Ratio Menu

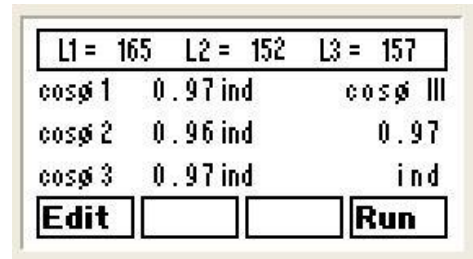


Fig. 53.- Edit Transformer Ratio Menu

- When the adjustment is complete, press **OK** to display the screen shown on Fig.53, indicating the $\cos \phi$ of each phase and in the header, the kvar introduced in each phase in case it is started. The menu bar shows the options to continue editing values when you press **Edit**. The unit will start-up when you press **Run**. If the values measured seem correct, press **Run**. Otherwise, check for errors.

7.3.7 Adjusting the $\cos \phi$ objective

The $\cos \phi$ objective can be adjusted. To do so, follow this procedure:

- Open the setup menu by following the process described in section 7.3.2
- From the options menu, select **Target $\cos \phi$** (screen on Fig.54) and press **OK**. The screen shown on Fig.55 will be displayed



Fig. 54.- Transformer Ratio Menu

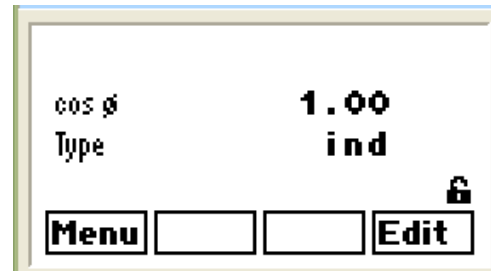


Fig. 55.- Edit Transformer Ratio Menu

- Press **Edit** to adjust the desired value. To edit a field, follow the procedure described in section 5.4.

7.3.8 Adjusting the Tact and Trec times

The connection, disconnection and reclosing times between steps can be adjusted (reclosing means connecting a previously connected step). To do so, follow this procedure:

- Open the setup menu by following the procedure described in section 7.3.2.
- Select the **Tact, Trec** option and press **OK**. The screen on Fig.57 will be displayed. In the quick operation Computer plus units (TF-C and TF-CDI), the network cycle is the operating time adjustment unit. 3 cycles have been adjusted in Fig.57).
- Press **Edit** to adjust the desired value, following an identical procedure to that described in section 5.4.



Fig. 56.- Tact, Trec Menu



Fig. 57.- Edit Tact, Trec Menu

7.3.9 Adjusting the compensation mode

Various parameters related to the compensation mode can be adjusted. To do so, follow this procedure:

- Open the setup menu by following the procedure described in section 7.3.2.

- Select the **Compensation** (Fig.58) option and press **OK**. The screen on Fig.59 will be displayed.
- Press **Edit** to adjust the desired parameter values.



Fig. 58.- Tact, Trec Menu



Fig. 59.- Edit Tact, Trec Menu

- The options available are:

In **Comp** ... you can select three options **TRIPH** or **PH-PH** which means three-phase or Phase-Phase compensation, respectively.

In **Man** ... you can select the following options: **FCP** or **LINIAL**. These options are related to the steps sequence in FIFO (FCP) or LIFO (LINIAL) mode. The FIFO mode means first in - first out (disconnected) and the LINIAL mode means that the last one in is the first one disconnected.

In **Contrl** ... you can select the following options: **SEC** or **TOTAL**. **SEC** means that there is a sequential step input (one by one, respecting Tact). **TOTAL** means that all steps required to reach the desired $\cos\phi$ will be connected at once.

In **Mode**... you can choose between **RUN** or **STOP**, to start or stop **Computer plus**.

- To edit a field, follow the procedure described in section 5.4.

7.3.10 Adjusting the Date and Time

- Open the setup menu by following the procedure described in section 7.3.2.
- Select the **Date / Time** (Fig.60) option and press **OK**. The screen on Fig.61 will be displayed.
- Press **Edit** to adjust the desired **day/month/year** and **hour:minute:second** values.
- To edit a field, follow the procedure described in section 5.4.

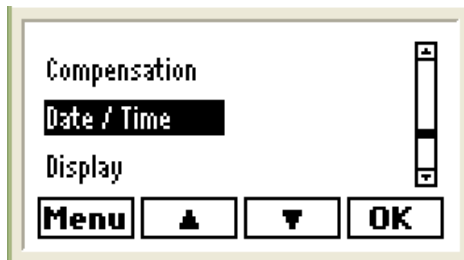


Fig. 60.- Date and Time Adjustment Menu



Fig. 61.- Edit Date and Time Adjustment Menu

7.3.11 Adjusting the Display

- Open the setup menu by following the procedure described in section 7.3.2.
- Select the **Display** (Fig.62) option and press **OK**. The screen on Fig.63 will be displayed.
- Press **Edit** to adjust the desired parameter values.



Fig. 62.- Display Adjustment Menu



Fig. 63.- Edit Display Adjustment Menu

- The following parameters can be configured:
 - Cont** Adjust the screen contrast. Adjustable between 00 and 99
 - BLight**... This option adjusts the display's back light. The settings are:
 - ON**... Always on
 - OFF**... Always off
 - 10 , 90 or 180**...Seconds during which the back light of the display is on after the last key has been pressed.
 - Lang**... Choose **Spanish** or **English**
- To edit a field, follow the procedure described in section 5.4.

7.3.12 Adjusting Communication Settings

This option is used to **adjust the communications parameters of channel COM1**, in order to integrate **Computer plus** in a network with "Power Studio Scada". The **CPC NET** channel controls the capacitors through the CPC3i-xRS card and **it can not be configured**.

To adjust channel COM 1 proceed as follows:

- Open the setup menu by following the procedure described in section 7.3.2.
- Select the **Communications** (Fig.64) option and press **OK**. The screen on Fig.65 will be displayed.
- Press **Edit** to adjust the desired parameter values.



Fig. 64.- Communications Adjustment Menu

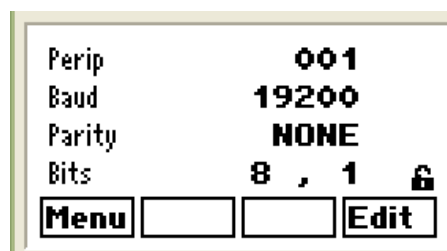


Fig. 65.- Edit Communications Adjustment Menu

- The following parameters can be configured:
 - Perip** ... Adjustment of the peripheral number when **Computer plus** is in a network of instruments connected to "Power Studio Scada". Adjustable between 001 and 255
 - Baud**...This option adjusts the communication speed (Baud rate). The options are: 9600, 19200, 38400 and 57600
 - Parity** Adjusts the parity. The options are: None, Even, Odd
 - Bits**... Adjusts the number of bits and Stop bits. The options are: 8bits , 1stop or 8bits , 2stop
- To edit a field, follow the procedure described in section 5.4.

7.3.13 Adjusting Clear / Update

This option can be used to delete the maximum or minimum records and enter the device's reprogramming system.

- Open the setup menu by following the procedure described in section 7.3.2.
- Select the **Clear / Update** (Fig.66) option and press **OK**. The screen on Fig.67 will be displayed.
- Press **Edit** to adjust the desired parameter values.



Fig. 66.- Clear / Update Menu

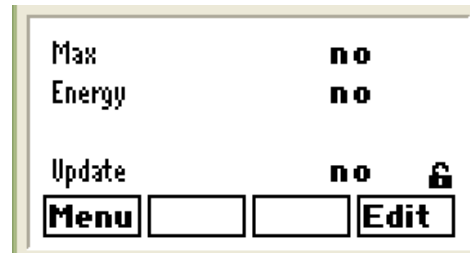


Fig. 67.- Edit Clear / Update Menu

- The following parameters can be configured:

Max... Deletes the maximum and minimum values recorded

Energy... Resets energy meters

Update... This option updates the unit's software when the adequate software is used. This option is only available to the technical service of CIRCUTOR.

8 DISPLAY OF VARIABLES: MEASUREMENT MENU

Computer plus has a menu with a series of options that can be used to display the measurements of the most important variables of the installation where the power factor is regulated.

See the menu tree in section 6.1 for a general outline of the measurement options available.

8.1 Opening the measurement menu



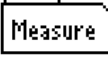

- To open the measurement menu, go to the main menu (Fig.68). Use the arrows   to select the folder  and press . The list of options will be displayed, as shown on Fig.69.



Fig. 68.- Main menu

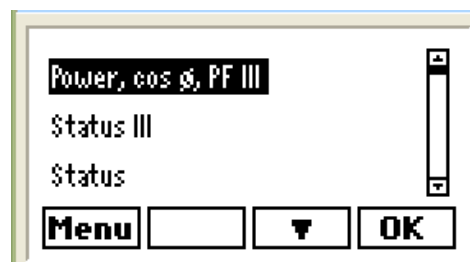


Fig.69.- Setup menu

8.2 Measurable parameters

- The options available and measurable parameters are summarised on table 8.1.
- Each option can be selected with two different ways:
 - A) Search the specific parameter and press **OK**
 - B) Moving onto the next or previous screen with the browsing arrows.

Options	Display	Parameters displayed on the screen
Power, $\cos \varphi$, FPIII	Fig. 70	Displays the three-phase active, power factor and apparent power and the $\cos \varphi$ and three-phase PF
Status III	Fig. 71	Shows the number of steps connected, kvarC III connected and the frequency of supply
Status	Fig. 72	Shows the kvarC connected to each phase
$\cos \varphi$	Fig. 73	Shows the $\cos \varphi$ of each phase and the $\cos \varphi$ III
PF	Fig. 74	Shows the PF of each phase and PF III
V phase-phase	Fig. 75	Shows the phase - phase voltages of the installation
V phase-neutral	Fig. 76	Shows the phase - neutral voltages of the installation
I line	Fig. 77	Shows the line current of each phase
I neutral	Fig. 78	Shows the installation's neutral current (parameter calculated, not measured)
I Cond	Fig. 79	Shows the current of each phase of the capacitor bank
I leak, I N Cond	Fig. 80	Shows the leakage current (measured) and the neutral current (calculated) of the capacitor bank.
Power III	Fig. 81	Shows the three-phase active, reactive and apparent power
kW	Fig. 82	Shows the active power of each phase
kvar	Fig. 83	Shows the power factor of each phase
kVA	Fig. 84	Shows the apparent power of each phase
Temperature	Fig. 85	Shows the temperature inside the Computer. This temperature is usually 10°C above the temperature in the cabinet's environment.
Imported Energy III	Fig. 86	Shows the energies in kWh, kvarL and kvarCh, imported since the last meter reset.
Exported Energy III	Fig. 87	Shows the energies in kWh, kvarL and kvarCh, exported since the last meter reset.

(*) Only in Computer plus TF-CDI

Table 8.1.- Options of the measurement menu and data measured

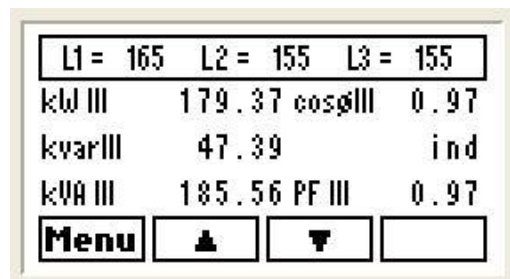


Fig. 70.-Power, cos φ, FPIII

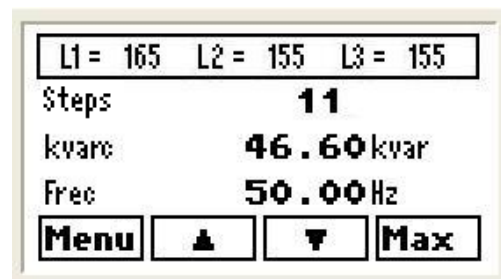


Fig.71.- Status III

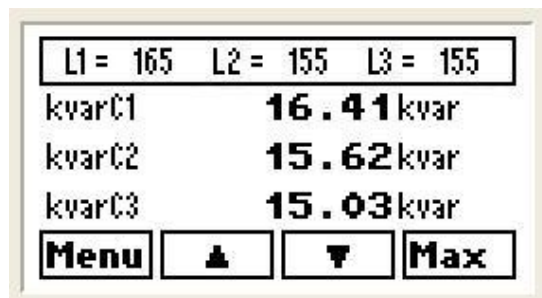


Fig. 72.- Status

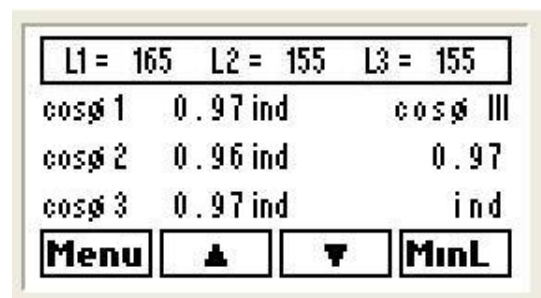


Fig.73.- cos φ

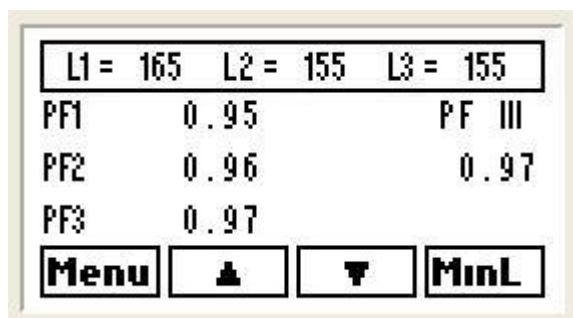


Fig. 74.- PF

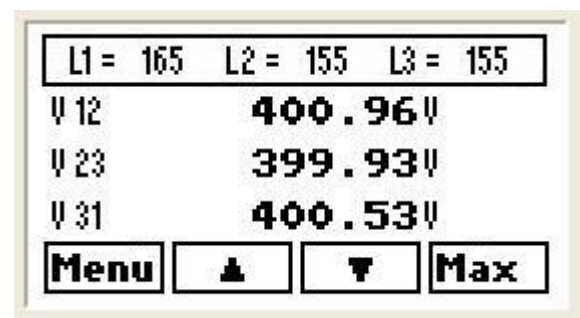


Fig.75.- V phase-phase

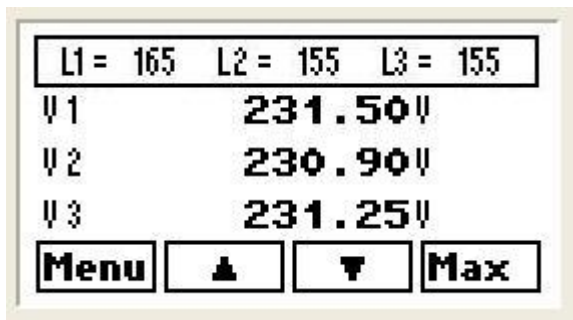


Fig. 76.- V phase-neutral

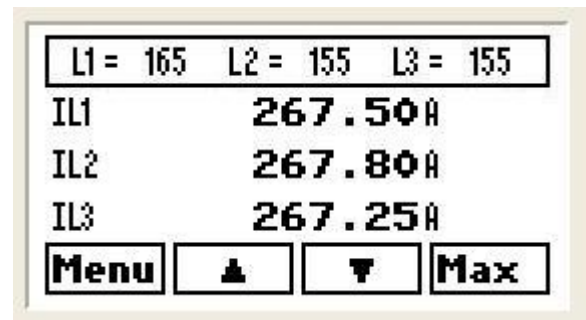


Fig.77.- I Line

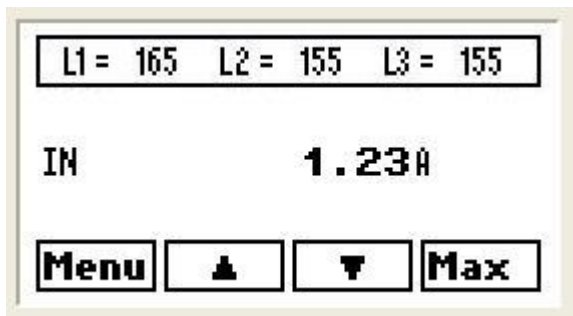


Fig. 78.- I Neutral

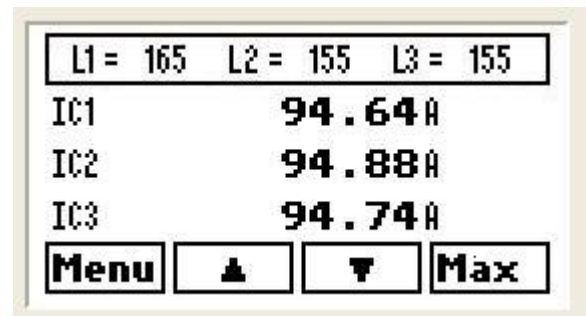


Fig.79.- I Cond (Only in TF-CDI)



Fig. 80.- I leak, I N Cond

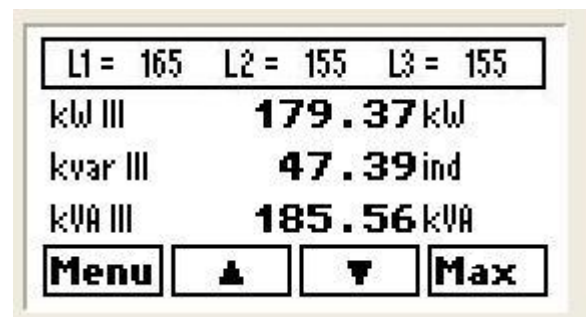


Fig.81.- Power III

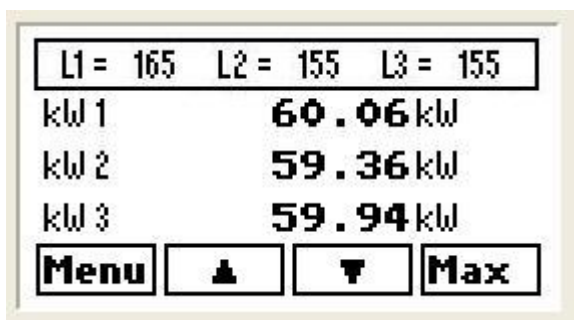


Fig. 82.- kW

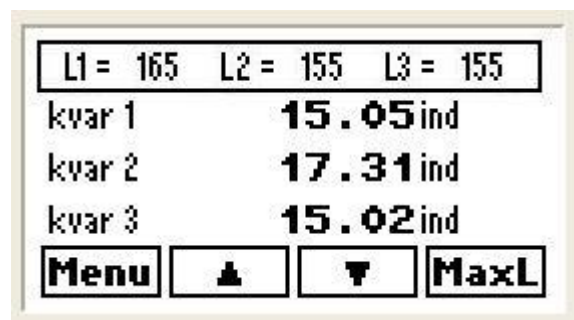


Fig.83.- kvar

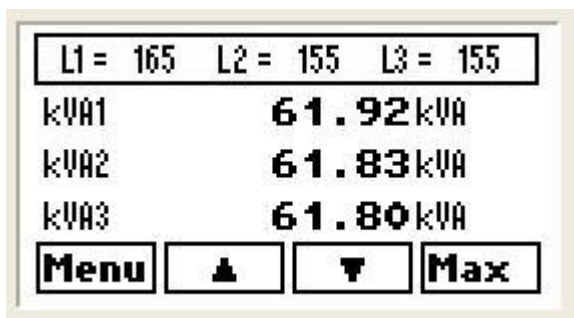


Fig. 84.- kVA

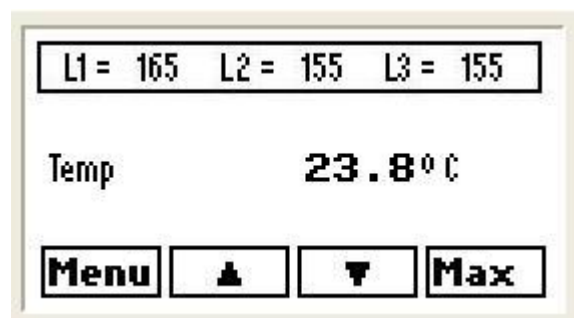


Fig.85.- Temperature

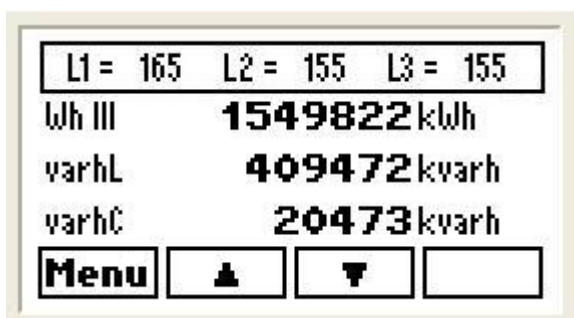


Fig. 86.- Imported Energy III



Fig.87.- Exported Energy III

- Some parameters record the maximum or minimum values and indicate the date and time when they occur. The parameter screens show the **Max** or **Min** option (see Figs. 71 to 85). Select **Max** or **Min** to display the values recorded on the screen (Fig. 88) with the possibility of displaying the date and time when they occur (see Fig. 89). To exit these submenus, press **Esc**.

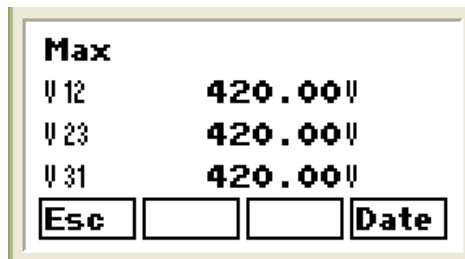


Fig. 88.- Maximum value screen

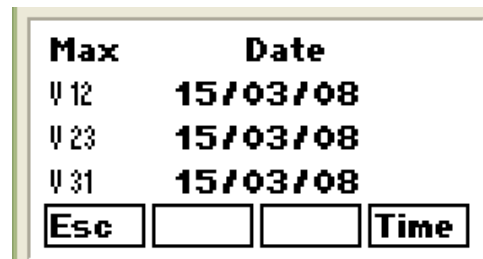


Fig.89.- Maximum value screen: Date and time

9 ALARM SETUP

Computer plus has a series of alarms that can be configured in accordance with the protection needs. See the abridged menu tree in section 6.3 for a general outline of the alarm options available

9.1 Opening the alarm configuration menu



- To open the alarm setup menu, go to the main menu (Fig.90). Use the arrows   to select the folder **Set Alarm** and press **OK**. The list of options will be displayed, as shown on Fig.91.



Fig. 90.- Main menu



Fig.91.- Set alarm menu

- You can browse each alarm to see how they are programmed. However, when you wish to edit a field, a screen will ask for the password (Fig.20). Follow the instructions described in section 7.1 to enter the password.

9.2 Alarm setup options

- Table 9.1 shows a summary of each alarm option that can be configured and table 9.2 defines each option available.

Options	Programmable alarm parameters
Enable Global	Global activation of all alarms
Temperature (°C)	Alarm limits of temperature (HI-LO), delay time (DelayT) and trip mode(NO, NC, DIS)
I leakage (A) ⁽¹⁾ ⁽²⁾ (See 9.4.1)	Alarm limits of I leakage (HI-LO), delay time (DelayT) and trip mode (NO, NC, DIS) The alarm is only available in Computer plus TF-CDI . The LO value must always be set to zero.
Voltage P-P (V)	Alarm limits of phase-phase voltage (HI-LO), delay time (DelayT) and trip mode (NO, NC, DIS)
THDV % ⁽²⁾	Alarm limits of THDV (HI-LO), delay time (DelayT) and trip mode (NO, NC, DIS) The LO value must always be set to zero.
THDIL x IL (A) ⁽²⁾	Alarm limits of total harmonic current (HI-LO), delay time (DelayT) and trip mode (NO, NC, DIS). The LO value must always be set to zero.
THDIC% ⁽¹⁾ ⁽²⁾	Alarm limits of THDIC (HI-LO), delay time (DelayT) and trip mode (NO, NC, DIS) The alarm is only available in Computer plus TF-CDI . The LO value must always be set to zero.
uncompensated kvar	The LO value indicates the alarm level when there are no steps entered and the HI level indicates the alarm level when steps have been entered. The delay time (DelayT) and trip mode (NO, NC, DIS) can be programmed
cos φ	The values are ordered from -1 to +1. – are capacitive values and + are inductive values. The delay time (DelayT) and trip mode (NO, NC, DIS) can be programmed
IC out of the margin ⁽¹⁾ (See 9.4.2)	The alarm limits by IC (HI-LO) are programmed in %. In this case, instead of the delay, the number of times that the anomaly must be detected before the alarm is tripped (N Rep) and the trip mode (NO, NC, DIS) can be programmed. The alarm is only available in Computer plus TF-CDI .
IL current (A)	Alarm limits of IL (HI-LO), delay and trip mode (NO, NC, DIS)
Relay setup	It can be used to assign the alarms that switch the relay. The relay switches when any of the alarms assigned is activated and when these are enabled and the global enabling is also activated ("OR" function of all alarms assigned to a relay)
Current Fault Alarm (See 9.4.3)	Not programmable. Not displayed on the menus. It detects if current in any of the three phases is below 1% of the nominal value (CT primary). When there is a failure in all three phases, Computer plus disconnects all capacitors and stops the regulation function.
Notes	
(1) These parameters are only available in Computer plus TF-CDI .	
(2) In these parameters it does not make sense to have a minimum alarm, so that LO must always be set to zero.	
(3) All alarms, except I leak, have a minimum delay of 1 s and those related with THD(I) and THD(V) a minimum delay of 2 s.	

Table 9.1.- Options of the alarm setup menu and description

Common alarm legends	
HI	High alarm limit value
LO	Low alarm limit value
DelayT ...	Delay time before the activation of the alarm (in seconds, except for the alarm of I leak, which is in tenths of a second)
NO	Normally open. The alarm is activated out of the HI, LO limits, i.e., above HI and below LO
NC	Normally closed. The alarm is activated within the HI, LO interval, i.e., above LO and below HI
NO+Desc ...	As in the case of NO, but in this case the capacitors are disconnected when there is an alarm, respecting the Tact time.
NC+Desc ...	As in the case of NC, but in this case the capacitors are disconnected when there is an alarm, respecting the Tact time.
DIS	Alarm disabled.

Table 9.2.- Definition of legends in the alarm menu

9.3 Configuring each alarm

Select one of the options displayed on the alarm list (Fig.92). The selected option will be displayed in reverse video.


- Once the option has been selected, press **OK**.
- Fig. 93 to 95 show the standard alarm edition and setup screens. The fields can be edited in accordance with the procedure described in section 5.4. Press **Edit** to open the screen and edit the HI, LO, DelayT and Enable fields.
- In general, the  key is used to browse the options, the **Edit** key to edit the selected field and **OK** to confirm the selection.
- The different menu options are stated on table 9.2.



Fig.92.- General alarm menu

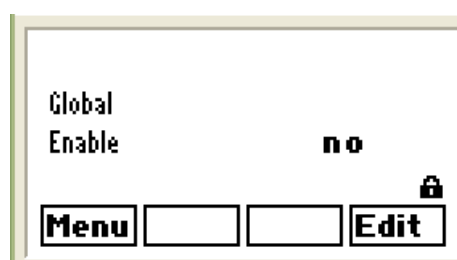


Fig.93.- Global setup

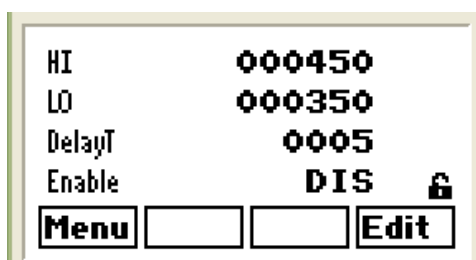


Fig.94.- Configuring standard alarm screens



Fig.95.- Editing standard alarm screens

9.4 Special Alarm scenarios

Some alarms have certain peculiarities. In particular, this section describes the three alarms that have a special behaviour

9.4.1 Alarm I leak (A) I leak

This alarm can be used to disconnect a faulty capacitor when it is the reason for the leakage. To do so, when the **Computer plus** detects a leakage after connecting a capacitor step, it stops the regulation process and starts disconnecting capacitors until it reaches the faulty capacitor. When the fault capacitor is detected, it is isolated and it does not participate in the regulation process until the alarm is RESET.

9.4.2 IC Alarm out of the margin

This alarm can be used to detect the faulty capacitor when the reactive current exceeds the top or the lower limits by far, in accordance with its nominal power programmed in the Setup Menu. In particular, the HI and LO values are programmed in this case in % and HI should exceed 100%, while LO must be lower than 100% (for example, HI should be programmed at 120% and LO at 80% for a 20% deviation).

Note: When the TF-C and TF-CDI types are programmed in the TOTAL regulation mode (all power is introduced at the same time), the deviation is counted as a % of the total.

9.4.3 Current Failure Alarm

This alarm can not be programmed. **Computer plus** is configured by default so that when a current under 50 mA (1% of the nominal current, in the case of an Ip/5 current transformer) is detected in any of the phases, the alarm will trip. If the currents in the three phases are below 1%, **Computer plus** will disconnect all steps and stop the regulation process.

9.4.4 Earth Leakage Transformer Fault Alarm (only in TF-CDI)

This alarm can not be programmed. **Computer plus** is configured by default so that when it detects that the secondary circuit of the WG earth leakage transformer is open and the I leak alarm is enabled, the alarm will trip. The status of the alarm is displayed on Fig. 104.

9.5 Programming the alarm relay

There is only one alarm relay and it can be used with any "OR" combination of the available alarms.

- To open the relay setup menu in the Set Alarm list, select the **Relay configuration** option and press **OK** see Fig.95.
- The list of alarms will be displayed (Fig.96) and you can assign the alarms that will make the relay switch (ON) and which will not make it perform the switching action (OFF). The relay is switched when any of the alarms assigned trips, provided that these are enabled and that the global enabling option is also activated.

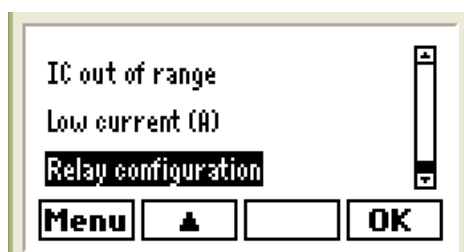


Fig.96.- Configuring standard alarm screens

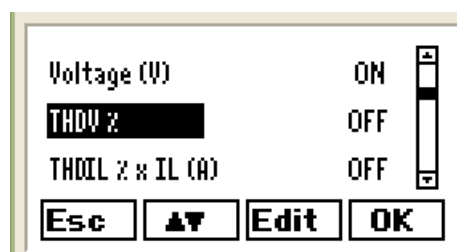



Fig.97.- Editing standard alarm screens

10 VIEWING THE STATE OF THE ALARMS

Computer plus has a menu to display the status of alarms.

ATTENTION:

- When an alarm has tripped and the global alarm has been activated, the back light of the display will start flashing to warn of this situation.
- Alarms can not be displayed on the display menu. To program them, enter the menu .
- See the abridged menu tree in section 6.4 for a general outline of the measurement options available on the display menu.

10.1 Opening the alarm display menu





- To open the alarm display menu, go to the main menu (Fig.98). Use the arrows   to select the folder  and press . The list of options will be displayed, as shown on Fig.99





Fig. 98.- Main menu



Fig.99.- Alarm display options

10.2 Alarm display options

- The options available and their meaning are summarised on table 10.1.
- Each option can be selected with two different ways:
 - A) Searching for the specific alarm and press 
 - B) Moving onto the next or previous screen with the browsing arrows. 

Options	Comments	Meaning
Global Enable		Shows the global alarm enable status. The following can be displayed: ON... Global enable activated and some alarm tripped OFF... Global enable activated and no alarm tripped DIS... Global enable deactivated (All alarms disabled)
Temperature (°C)		<p>The general operation mode of the display menu is as follows: When one of the alarms in the list on the screen on Fig. 98 is selected, the computer shows if the selected alarm is tripped or disabled.</p> <p>ON... Enabled and tripped OFF... Enabled and not tripped DIS... Alarm disabled.</p> <p>If the alarm is ON, press Date , Time to display when the alarm was tripped and press Data to display the maximum and/or minimum value that the variable reached to trip the alarm. Press the CLR dynamic key to reset the alarm, although this can be tripped again if the anomaly is not corrected. To exit the display of a specific alarm, press Esc and press Menu to return to the main menu.</p> <p><i>The I leak and IC out of margin alarms have a special behaviour, as described in sections 10.2.2 and 10.2.3</i></p>
I leak (A)	The alarm is only available in Computer plus TF-CDI .	
Ph-Ph Voltage (V)	Voltage phase-phase	
THDV %		
THDIL x IL (A)		
THDIC%	The alarm is only available in Computer plus TF-CDI .	
kvar not compensated		
Cos φ		
IC out of range		
IL current (A)		
Relay status	Relay with switched contact	It can be used to view the alarms that switch the relay. The relay is switched when any of the alarms assigned is tripped (" OR " function of all alarms) and the alarm's relay is configured as ON.
Current Failure	This alarm can not be programmed, since it is a default system alarm.	The alarm is tripped when the measured current in one of the phases is under the device's detection threshold <i>See section 10.2.4</i> In TF-CDI , the alarm will also be tripped when the secondary of the earth leakage transformer is open and the I leak alarm enabled.

Table 10-1.- Options of the alarm display menu.

10.2.1 Parameters displayed on the alarm status screens.

A screen like the one shown in Fig.99 or Fig.100 when the status of alarms is browsed. The different screens show the variable, "trip mode" (NO, NC or DIS), HI and LO values programmed and the status ON, OFF, DIS, etc. When the alarm is ON, the date **Date**, time **Time** and value that tripped the alarm can be checked. With the **Data** option, the HI and LO fields show the trip values.

The texts on the screen and their meaning are described on table 10.2.

HI	High value that triggered the alarm. No value will be displayed when the alarm has not been triggered due to the HI limit.
LO	Low value that triggered the alarm. No value will be displayed when the alarm has not been triggered due to the LO limit.
Status	ON: Alarm enabled and tripped
	OFF: Alarm enabled but untripped
	DIS: Alarm disabled

Table 10-2.- Description of the legends on Fig. 100 and 101



Fig. 100.- Alarm status screen (DIS or OFF)



Fig.101.- Alarm status screen for an alarm tripped by HI (ON)



Fig. 102.- Status screen with the day of the last trip



Fig.103.- Status screen with the day of the last trip

10.2.2 I leak alarm

As mentioned in section 9.4.1, **Computer plus** will treat this alarm as a special case. This alarm can be used to disconnect a faulty capacitor when it is the causing the leakage. To do so, it will trip the alarm when a leakage is detected. It will then stop the regulation operations and disconnect each capacitor connected one by one until the cause of the leakage is found. When it has been located (the leakage disappears), **Computer plus** will disconnect the suspicious capacitor and it will not be connected until the alarm has been RESET.

I leak (A)					
Cap 1	OFF	OFF	OFF	OFF	OFF
Cap 6	OFF	OFF	OFF		
<div>Esc ▲▼ CLR</div>					

Fig. 104.- I leak alarm **Data** screen

IC out of range					
Cap 1	OFF	OFF	OFF	OFF	OFF
Cap 6	OFF	ON	OFF	OFF	OFF
Cap 11	OFF	OFF	OFF	OFF	
<div>Esc ▲▼ CLR</div>					

Fig. 105.- IC out of margin alarm **Data** screen

In the case of the I leak alarm, the **Data** option of the alarm display menu will open a screen as that shown on Fig.104. The screen displays all capacitor steps and, in case there is a faulty capacitor, it will be shown as ON. The **CLR** option can be used to reset the system when the capacitor has been replaced (it will be tripped again if the fault remains).

10.2.3 IC out of the margin Alarm.

The IC out of margin alarm is shown when a capacitor is taking an abnormal current. The screen shown on Fig.105 will be displayed when the capacitor current deviates by a certain % from the nominal value and the display will show ON in a box above the faulty capacitor. The case on Fig.105 shows that C7 has the alarm triggered (ON).

10.2.4 Current Fault Alarm.

The screen shown on Fig. 106 will be displayed when the current in the three phases does not reach 1% of the nominal values, showing the I line ON.

In TF-CDI, this screen also shows a fault in the earth leakage transformer. If this transformer has the secondary open, it will show ON in the I leak line.



Fig. 106.- Current fault alarm screen

11 HARMONICS DISPLAY

Computer plus also includes an option to display voltage and current harmonics. It can be used to view the numerical values or a bar graph for each measured voltage or current.

NOTE: the measured harmonics are refreshed each second

11.1 Opening the harmonics display menu



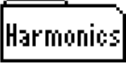

- To open the harmonics display menu, go to the main menu (Fig.107). Use the arrows   to select the folder  and press . The list of options will be displayed, as shown on Fig.108.



Fig. 107.- Main menu

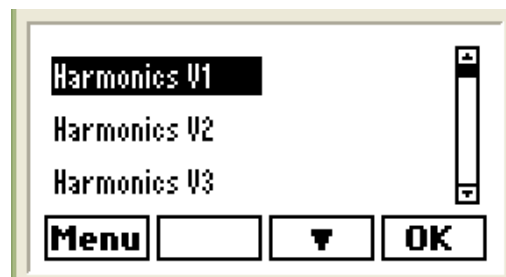


Fig. 108.- Harmonics display options

11.2 Harmonics display options

- The options available and their meaning are summarised on table 11.1.

- The options will be selected from the list shown on Fig. 108 with the dynamic keys  . Press **OK** when the option selected appears on the reverse video.

Options	Comments	Measurable parameters
Harmonics V1		Shows the voltage harmonics of phase 1
Harmonics V2		Shows the voltage harmonics of phase 2
Harmonics V3		Shows the voltage harmonics of phase 3
Harmonics I1		Shows the current harmonics of phase 1
Harmonics I2		Shows the current harmonics of phase 2
Harmonics I3		Shows the current harmonics of phase 3
Harmonics IC1	Available only in Computer plus TF-CDI .	Shows the current harmonics of phase 1 of the capacitor bank
Harmonics IC2		Shows the current harmonics of phase 2 of the capacitor bank
Harmonics IC3		Shows the current harmonics of phase 3 of the capacitor bank
THDV		Shows the THD voltage of each phase-neutral voltage: V1, V2, V3
THDI		Shows the THD current of each phase-neutral voltage: I1, I2, I3
THDIC	Only available in Computer plus TF-CDI .	Shows the THD current of each current in the compensation unit: IC1, IC2, IC3

Table 11-1.- Options of the harmonics display menu.

- Numerical values or bar graphs can be displayed for each variable (see Fig. 109 and 110).

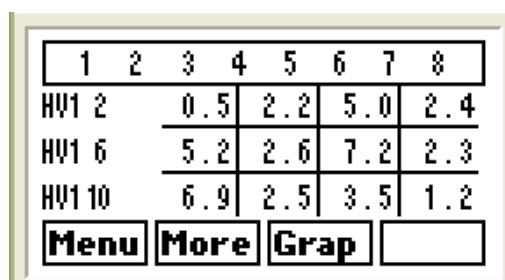


Fig. 109.- Numerical display of harmonics

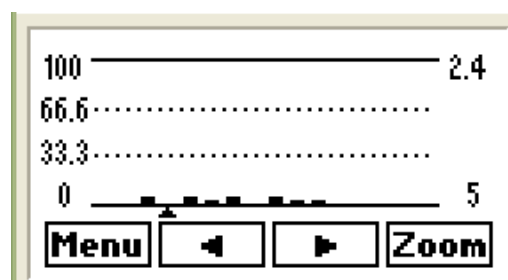


Fig. 110.- Graphical display of harmonics

- Each numerical harmonics display screen shows a table with the value of 12 harmonics (example on Fig.109, row HV1 2 shows the voltage harmonic values of phase 1, of the order of 2 to 5. The next row shows the order from 6 to 9, etc.). Press **More** to see up to the harmonics order 33.

- The numerical display screens show the **Grap** dynamic key. Press the key to display the harmonics in a bar graph (Fig.110) and use the keys **◀** **▶** to change the harmonics cursor. The harmonics order (lower part) and % value (top part) will be displayed on the right of the screen.
- Use the **Zoom** key to expand the vertical scale. (Fig.111).

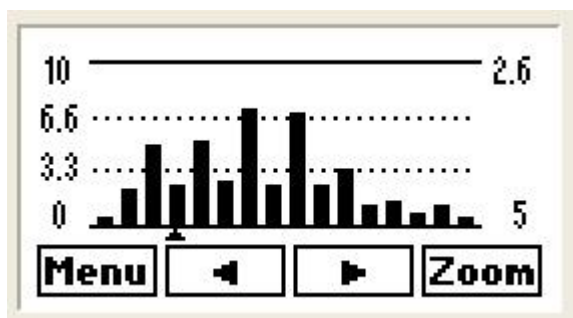


Fig. 111.- Graphical display of harmonics with zoom

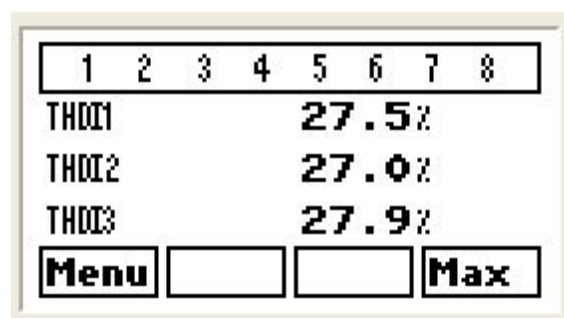


Fig. 112.- Display of THDV or THDI

- The screens that display the current and voltage THD (Fig.112) show the **Max** option, which can be used to display the maximum THD values recorded. The date and time when the maximum value was produced can also be displayed with the **Date** and **Time** dynamic keys
- To go back to any of the harmonics display submenus press **Esc** or **Menu**

12 TEST

Computer plus has a powerful Test menu that allows you to check the power factor compensation unit and check whether it is adapted to the installation being compensated or not. This menu has been designed to check the status of components in the bank after start-up and the potential resonances between the equipment and certain loads in the installation. The Test menu offers three options:

- **cos ϕ Test**
- **Resonance Test**
- **Capacitor Test**

12.1 Opening the Test menu




- To open the test menu, go to the main menu (Fig.113). Use the arrows    to select the folder and press **OK**. A list with the three options available will be displayed (Fig.114).



Fig. 113.- Main menu

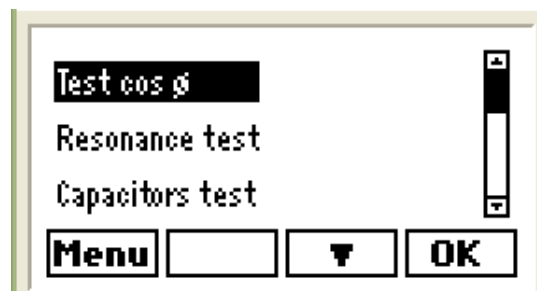


Fig. 114.- Options of the Test menu

- The options can be selected with the  and  dynamic keys; then press **OK**.

12.2 Test cos ϕ and resonance test

These two options must be used at the same time. The purpose is to execute the manual connection and disconnection of capacitors while displaying the cos ϕ or THDV and THDI of each phase. This allows you to check that the compensation unit is working correctly and whether the connection of a certain number of capacitors is causing resonances in the installation or not. Each test is carried out as follows:

- The **Test cos ϕ** option of **Computer Plus** shows the cos ϕ of all phases and the type (inductive or capacitive), as well as the cos ϕ III (total) and its type (Fig.115).


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16															
cos ϕ 1				0.97 ind				cos ϕ III							
cos ϕ 2				0.96 ind				0.97							
cos ϕ 3				0.97 ind				ind							
Esc								+				-			

Fig. 115.- cos ϕ Test


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16															
THDV1				7.3				THDI1				27.5			
THDV2				7.5				THDI2				27.0			
THDV3				7.9				THDI3				27.9			
Esc								+				-			

Fig. 116.- Resonance Test

- Use the keys to connect or disconnect the capacitor steps sequentially. While doing so, check how the $\cos \phi$ is changed when entering or removing steps. This can detect current transformers that are not connected correctly or check whether the compensation is as expected or not.

NOTE: The connection and disconnection time in the fast mode TF-C and TF-CDI is 2 seconds, in order to avoid extremely fast connections or disconnections.

- The display of **Test cos ϕ** can be changed to the **Resonance Test** screen with the and dynamic keys.
- The **Resonance Test** option can be used to check the connection of a certain number of steps in the installation. **Computer plus** shows the values of THDV and THDI for each phase in these menus and the keys can be used to connect and disconnect steps sequentially (Fig. 116).
- If there is a huge increase in the THDI when the installation is overcompensated or for a certain combination of capacitors connected, this might mean that there is resonance in the system. If the unit does not have filters, this would indicate that it would be advisable to install them.

12.3 Capacitors Test

- The last option in the Test menu is the **Capacitors Test**. This test menu has been designed to test the power of each individual capacitor.
- When you open the **Capacitor Test** menu, after pressing on the option, as shown on Fig. 117), **Computer plus** will show the screen on Fig. 118. In case there are some capacitors connected, only the button will be active. Keep this button pressed to disconnect the capacitors sequentially. The computer will ask the user to enter the password before starting the disconnection (see section 7.1)

NOTE: The connection and disconnection time in the fast mode TF-C and TF-CDI is 2 seconds, in order to avoid extremely fast connections or disconnections.

- Once all the capacitors are disconnected, two more buttons appear (Fig.119)

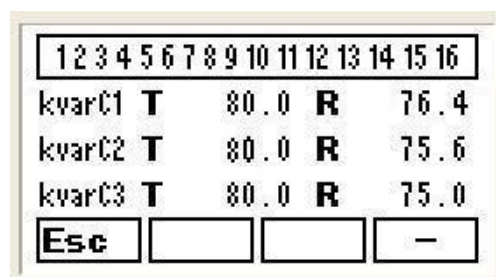
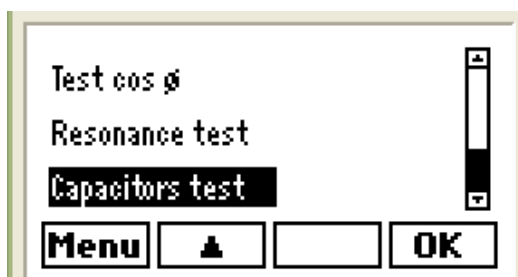


Fig. 117.- Capacitor Test Selection

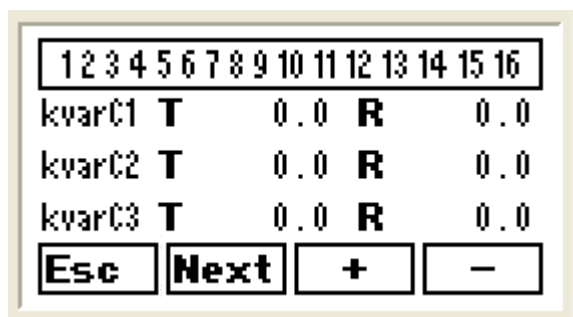


Fig. 119.- Capacitor Test Menu

Fig. 118.- Disconnection of capacitors

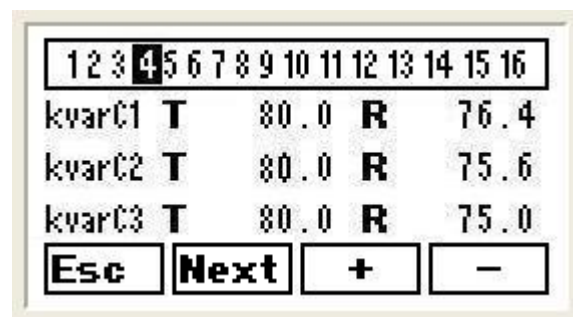


Fig. 120.- Capacitor Test Menu

- Press the **Next** button so that **Computer Plus** will highlight the capacitor which can be connected by pressing button **+** or which can be disconnected with button **-** (Fig. 120 shows step 4 as connected and step 4 as selected), showing the theoretical kvar (**kvarC1 T**) and real kvar (**kvarC1 R**) on two columns. Each capacitor can be checked individually to see if the expected capacity is met. The connection and disconnection of steps is carried out within 2 seconds.
- To exit this menu, press press **Esc**.
- To return to the main menu from the Test menu, press **Menu**.

13 CONNECTION OF COMPUTER PLUS WITH CPC3I CARDS

- The regulators of the Computer plus TF-C and TF-CDI series have been designed to control static capacitor banks, in conjunction with the operation of CPC3i-xRS cards.
- The connection of Computer plus TF to the card is carried out through channel RS-485, in accordance with the 13-1 connection table. See the terminal connection diagrams on Fig. 121 and 122.

CPC3i-xRS		Computer plus (CPC NET)		Function
Name	Terminal	Name	Terminal	
SH	A	S	33	Communication cable screen
RS+	B	A+	31	Transmitter / Receiver +
RS-	C	B-	32	Transmitter / Receiver -

Table 13-1.- Connection of CPC3i to Computer plus

- The connection diagrams of the complete unit are shown on Fig. 2 and 3.
- Each CPC3i card of a static capacitor bank must be configured with a different address (1 to 16) for each step, using a rotating ADJ switch with the CPC3i card.

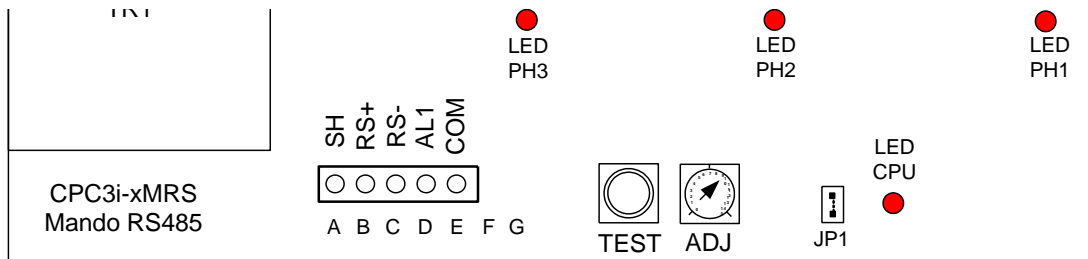


Fig. 121.- Terminals of the CPC3i-xRS card

31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
A+	B-	S	A+	B-	S	COM	D1	D2	D3	D4	D5	S1	S2	S1	S2	S1	S2	S1	S2
CPC NET			RS485			COM1						IF		IC1		IC2		IC3	

Fig. 122.- Terminals of card A of Computer plus

13.1 MODBUS Control frame

Computer plus controls the **CPC3i** cards with the MODBUS protocol. In particular, it sends a frame every 20 ms, using the 15 function (N bits write). The message is a "broadcast" message, i.e., it will be read by all cards, in any address. The format of the frame is as shown on Fig. 123.

The message is composed of a frame sent to the slave address 00H (broadcast, i.e., all CPC3i cards receive all frames). The 1r bit address on the CPC3i card is 00H – 64H and the frame has 64 bits (00H – 40H), grouped in 8 octets.

Slave Nr. 1 byte	Function 1 byte	1st bit addr. 2 bytes	Nr of bits 2 bytes	Nr Oct 1 byte	Data	CRC 2 bytes
00	0F	00 - 64	00 - 40	08	DD0 A DD7	XX - XX
Broad. to all	Function 15	address	64 bits	8 octets	Data 8 bytes	CRC 2 bytes

Fig. 123.- Control frame of the CPC3i card (MODBUS, function 15)

The meaning of 8 octets DD0 to DD7 is described in table 13-2.

Byte	7 bits	6 bits	5 bits	4 bits	3 bits	2 bits	1 bits	0 bits
DD ₀	-	thy3_np2	thy2_np2	thy1_np2	-	thy3_np1	thy2_np1	thy1_np1
DD ₁	-	thy3_np4	thy2_np4	thy1_np4	-	thy3_np3	thy2_np3	thy1_np3
DD ₂	-	thy3_np6	thy2_np6	thy1_np6	-	thy3_np5	thy2_np5	thy1_np5
DD ₃	-	thy3_np8	thy2_np8	thy1_np8	-	thy3_np7	thy2_np7	thy1_np7
DD ₄	-	thy3_np10	thy2_np10	thy1_np10	-	thy3_np9	thy2_np9	thy1_np9
DD ₅	-	thy3_np12	thy2_np12	thy1_np12	-	thy3_np11	thy2_np11	thy1_np11
DD ₆	-	thy3_np14	thy2_np14	thy1_np14	-	thy3_np13	thy2_np13	thy1_np13
DD ₇	-	thy3_np16	thy2_np16	thy1_np16	-	thy3_np15	thy2_np15	thy1_np15

Table 13-2.- Meaning of the 8 control bytes

where:

thyn_npx	<p>Thyristor n of the block or peripheral x (This number of peripheral, x, is the one programmed in the rotating selector for each card).</p> <p>The frame asks for the transmission of data to thyristors in up to 16 different steps, phase by phase</p>
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14 INTEGRATION OF COMPUTER PLUS IN THE SCADA POWER STUDIO PROGRAM

Computer plus types **TF-C** and **TF-CDI** have an additional COM1 communications channel, apart from the CPC NET thyristor control channel. Channel COM1 is of the RS-485 type and can be used to integrate **Computer plus** as an additional peripheral in CIRCUTOR's **SCADA "Power Studio"** software.

The connection can be made directly with an RS-485 bus or with the integration in an Ethernet network with a converter from RS-485 to Ethernet / Modbus (CIRCUTOR TCP2RS-TCP)

The communication features are defined in the Communications option in the Setup menu. In this sub-menu the peripheral number (identification number of the unit in the Power Studio Scada network unit), the transmission speed and the characteristics of the communication frame to send (parity, stop bits) are selected.

For more details about the SCADA software, see the Power Studio software manual.

15 SAFETY INFORMATION

The installation standards described in the previous SETTINGS AND START-UP, CONNECTION DIAGRAMS and TECHNICAL FEATURES chapters of the unit must be taken into account.

With the unit connected, it is dangerous to touch the terminals. Opening the covers or removing elements may provide access to parts that are also dangerous to the touch. This unit is supplied in good working order.

16 MAINTENANCE

The **Computer plus TF** regulator does not require special maintenance. It is necessary to avoid as far as possible all adjustments, maintenance or repairs with the unit open. If they must be carried out, they must be performed by qualified staff who is well informed of the procedure to follow.

Before performing any connection modification, replacement, maintenance or repair operation, disconnect the unit from its power supply. If you suspect an operational fault in the unit or in its protection system, remove the unit from service, ensuring it is not possible to connect it by accident. The design of the unit makes it easy to replace parts in case of a fault.

17 TECHNICAL SERVICE

If you have any doubts about the operation of the unit or any faults, contact our technical service at CIRCUTOR S.A.

CIRCUTOR S.A. - After-sales service

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