CIRCUTOR

LV CAPACITOR BANKS WITH DETUNED FILTERS AND STATIC SWITCHING

FRE / FRES

INSTRUCTION MANUAL

(M98247101-03-12A)

CE

SYMBOLS AND WARNINGS

Pay attention to the danger and warning indications in this manual, which are shown with the following symbols.

DANGER: Warns of a risk, which could result in personal injury or material damage.

WARNING: Indicates that special attention should be paid to a specific point.

If you must handle the equipment for its installation, start-up or maintenance, the following points should be taken into consideration:

Incorrect handling or installation of the unit may result in injury to personnel as well as damage to equipment. In particular, handling with power applied may result in electric shock, which may cause death or serious injury to personnel. Defective installation or maintenance may also lead to the risk of fire.

Carefully read the manual prior to connecting the equipment. Follow all the installation and maintenance instructions for the equipment throughout its working life. In particular, follow the installation standards indicated in the Low Voltage regulations and additional technical instructions.

The installation, operation and maintenance of LV equipment must only be carried out by authorised installers. See the National Code Instructions specifically defining the requirements that authorised installers must meet in each country.

If in order to install the equipment, you must work in areas that have high-voltage (HV) equipment installed, then the personnel handling equipment in this area must be authorised to work in HV installations. Refer to the National Code Instructions, in each country, which specifically regulate the requirements for personnel and maintenance companies autorised to handle high-voltage installations.

TABLE OF CONTENTS

1 INTRODUCTION

The purpose of this manual is to assist during the installation, start-up and maintenance of **FRE** and **FRES** series equipment. **FRE** and **FRES** are PF correction equipment with detuned filters and static switching.
Carefully read the manual to achieve the best equipment performance.

2 SAFETY HAZARDS AND WARNINGS

2.1 Hazards encountered during the installation and start-up of electrical equipment.

The installation, operation and maintenance of LV equipment must only be carried out by authorised installers. See the National Code Instructions specifically defining the requirements that authorised installers must meet in each country.

Do not access the active elements of a detuned filter with static switching that has been previously powered, since it might have residual voltages at the capacitors. Wait at least 5 minutes after the power supply has been disconnected.

Do not touch the terminals or active parts of the unit until you have verified that there is no residual voltage at the capacitors. If you have to handle or touch the terminals or other control panel components while the equipment is connected to the supply, use adequately insulated personal protection equipment and tools.

After maintenance and before re-applying the power supply to the unit, check that its enclosure is properly closed and that no items or tools were left inside that could cause a short-circuit.

Do not open the secondary circuit of current transformer without short-circuiting it first. The operation of a current transformer with an open secondary will cause an overvoltage that can damage it and electrocute the person handling it.

2.2 Safety warnings

Apart from the general standards listed above, the standards and applicable laws of the country where the capacitor bank is installed or operated should be strictly followed.

Installation or maintenance personnel should read and understand this manual before operating the equipment.

A copy of this manual should always be available to maintenance personnel for reference purposes.

Connecting the equipment to the public grid will be carried out in compliance with standard EN-IEC60204-1, on the safety of LV electrical installations.

It is recommended that several personnel are present when handling the equipment for either installation or maintenance.

If damage or faults are detected during equipment operation, or in circumstances that compromise safety, immediately stop work in that area and disconnect the equipment in order to check it once it is de-energized.

Modifying, upgrading or rebuilding the equipment without written authorization from the manufacturer is strictly prohibited.

2.3 Application warnings

Capacitor banks with detuned filters can attenuate the remote control signals transmitted through the network which are used in some countries to connect or disconnect certain loads or lines. When remote control frequencies close to the tuning frequency of **FRE** or **FRES** filters are used, blocking filters must be placed in the supply line, or the tuning frequency of the **FRE** /or **FRES** filters must be changed.

3 RECEPTION, TRANSPORT, HANDLING AND STORAGE

3.1 Reception protocol

- Make sure that the equipment has not been damaged during transport.
- Check that the equipment received matches with the order and that its electrical characteristics are suitable for the grid where it is to be connected.
- Check the shipping documentation. The dispatch note number must coincide with the number marked on the outer part of the unit package.
- Unload and transport the equipment in accordance with the instructions in section 3.2
- Perform an external and internal visual inspection of the equipment prior to connecting it.
- Check that all items on the packing list are present and match with the delivered documentation.

If any discrepancy is detected upon reception, immediately contact the transport company or CIRCUTOR's after-sales services.

3.2 Transport, loading and unloading, handling and storage

The transport, loading and unloading and handling of the equipment must be carried out with proper precautions and using the proper manual or mechanical tools to prevent damaging the equipment.

If the equipment is not to be immediately installed, it must be stored at a location with a firm and level floor and satifying the storage conditions listed in the technical characteristics section. It is recommended that the equipment be stored with its original protective packaging.

To move the equipment a short distance, the unit's floor support profiles facilitate handling with a pallet jack or forklift.

The centre of gravity of some units may be at a considerable height. Therefore, when handling with a forklift, it is recommended that the equipment be securely fastened and that no abrupt operations are made. The equipment should not be lifted more than 20 cm over the ground.

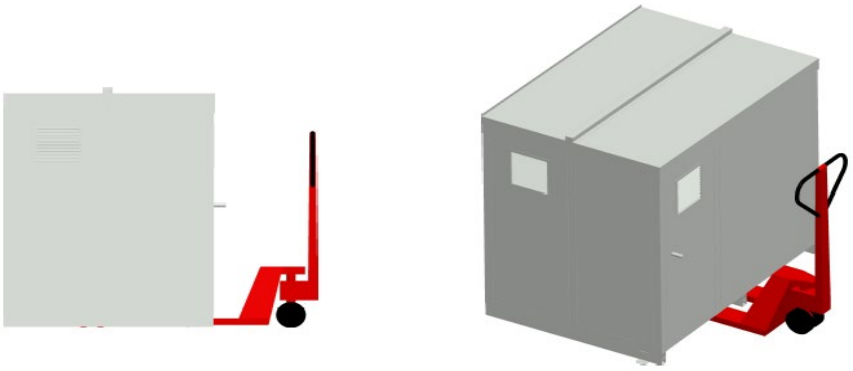


Fig. 3-1 .-Transport with pallet jack

When unloading and moving the equipment, use a forklift with forks long enough to support the entire length of the base. In the limit, the forks should be long enough to support at least ¾ of the depth. The

forks must be flat and laid firmly on the base. The cabinet must be raised by placing the forks underneath the profile that supports the equipment. (Fig. 3-2).

There might be an offset in the centre of gravity from the centre of the cabinet, as a result of the uneven distribution of loads in equipment. The necessary precautions must be taken to prevent the equipment from tipping over during abrupt operations.

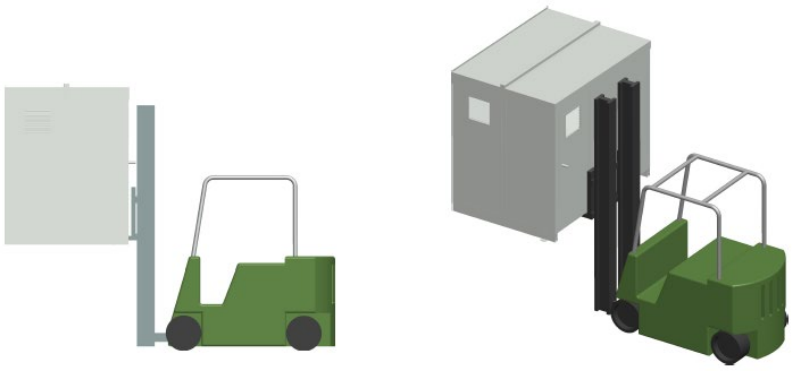


Fig. 3-2 .-Unloading with a Forklift

3.3 Storage

The following storage recommendations should be followed for static capacitor banks with detuned filters:

- Avoid placing it on uneven surfaces.
- Do not store in outdoor or humid areas or areas exposed to the splashing of water.
- Avoid hot zones for storage (maximum environmental temperature: 45 ºC)
- Avoid saline and corrosive environments.
- Avoid storing the equipment in areas where dust is generated or where the risk of chemical or other types of contamination is present.
- Do not place heavy parcels or other equipment on top of the FRE or FRES cabinets.

4 TECHNICAL CHARACTERISTICS

4.1 Label with the equipment's characteristics

The label with the equipment's characteristics is located inside it, generally next to the PF regulator (refer to Fig. 4-1). A capacitor bank with filters includes always the p% information, which states the filter's tuning factor. This information is important to establish the filter's resonance frequency.

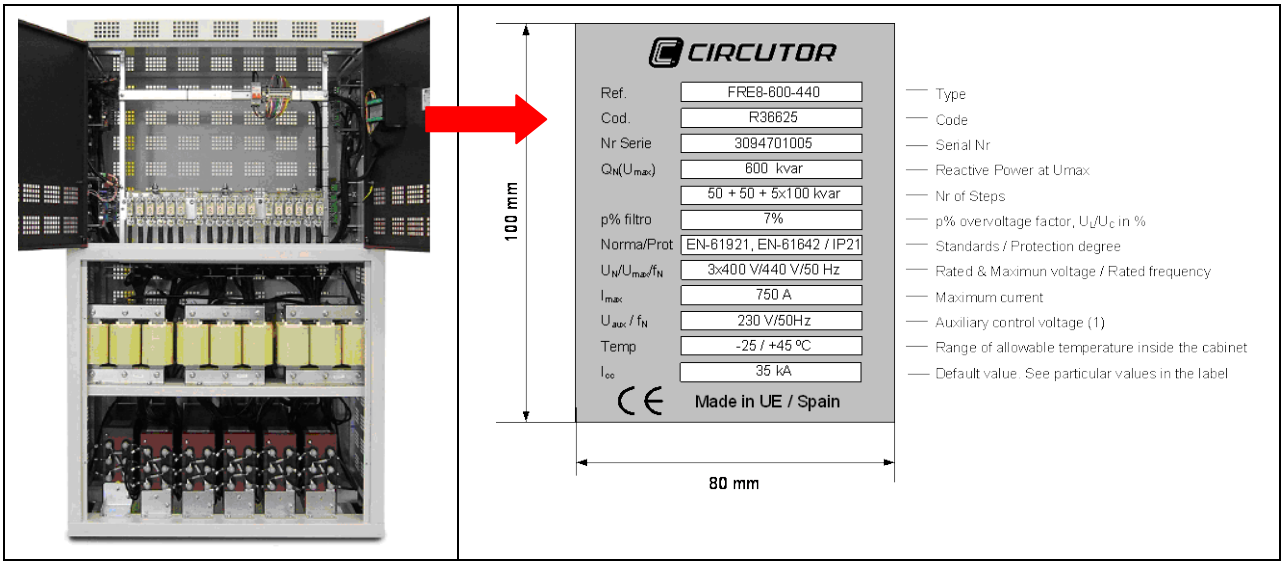


Fig. 4-1.- Label of characteristics

4.2 Electrical characteristics

- Operating voltage and nominal frequency: U_n / f , listed on the label
- Design voltage: U_{Nn}+ 10% (440 V for 400 V equipment)
- Nominal power and distribution of steps: Q_n and composition, (see label)
- Overvoltage factor, p% Standard 7% , Others 14%, 8.2% and 5.67% (see label)
- Total loss: Standard 3.5 at 4 W/kvar
- Residual discharge voltage: 75 V after 3 minutes
- Overload capacity: 1.3 . I_n in all items
- Contact operating voltage: U_{aux} , listed on the label.
  NOTE: In general, use a 1.5 mm2 cable to supply external power.
  If the label indicates "**Internal**" , means that this the auxiliary circuit does not require external power.
- Current Transformer Input: 5 A , (Transformer I_n /5 A)
  NOTE: Minimum cable section 2.5mm2.
- Compliance with Standards EN-61642 and UNE EN 61921
- Protection elements:
  - Fuses Type gL, NH gauge (minimum 1.5 x I_n)
  - Reactor thermostat: 90 ºC ±5 ºC
    Insulation 3 kV /50 Hz
    Breaking capacity 10 A / 250 V_{ac}, resistive load
- Capacitor characteristics:
  - Capacity tolerance: ± 5%
  - Insulation level from earth: 3 kV /50 Hz
  - Impulse test: 15 kV , ray type wave 1.2/50 µs
  - Protection elements: Internal fuses and over-pressure system
  - Compliance with Standards EN 60831
- Reactor characteristics:
  - Inductor tolerance: ± 5%
  - Rated voltage standard 500 V (RMS value)
  - Saturation current Standard at 1.4 I_n, L=5% (Others for **RBX**)
  - Level of insulation phases to earth 3 kV /50 Hz; 15kV shockwave 1.2/50 µs
  - Max. overload $\Sigma(n.I_n)^2$ Permanent 20% ; Transient (1 min) 2 I_n

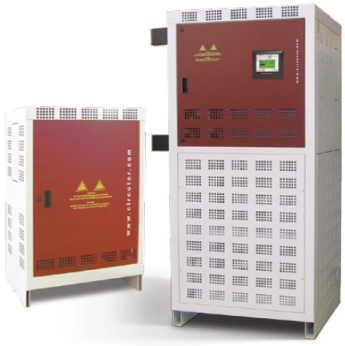
4.3 Environmental Characteristics

- Capacitor max. temperature Category C in accordance with EN 60831-1
  - Maximum for 1h 50 ºC
  - 24h average 40 ºC
  - Annual average 30 ºC
- Max. temperature of reactors In accordance with IEC 60076-6
  - Maximum environmental temperature 60 ºC
  - Indoor temperature at In <110 ºC
  - Protection thermostat 90 ºC
  - Cabinet ventilation For Tout > 30 ºC, forced ventilation must be used for the cabinet
- Maximum relative humidity: 80%
- Altitude: 1000 m (For higher altitudes, always maintain forced ventilation)

4.4 Mechanical characteristics:

- Protection degree: Marked on the label:
- Paint Oven dried epoxy type
- Standard colours RAL 7035 Grey ; RAL 3005 Maroon

4.5 External dimensions and weights



Type	Length (mm)	Height(mm)	Width (mm)	Weight (kg)
FRES	700	1000	380	215
FRE4	930	1900	650	460
FRE6	1360	1900	650	685
FRE8	1760	1900	650	1000
FRE12	2720	1900	650	1389

Fig. 4-2. - Dimensions (*) Maximum dimensions

4.6 Capacitor bank components

Fig. 4-3 shows the different models of capacitor banks with filters and their essential components. Some protection elements are optional.

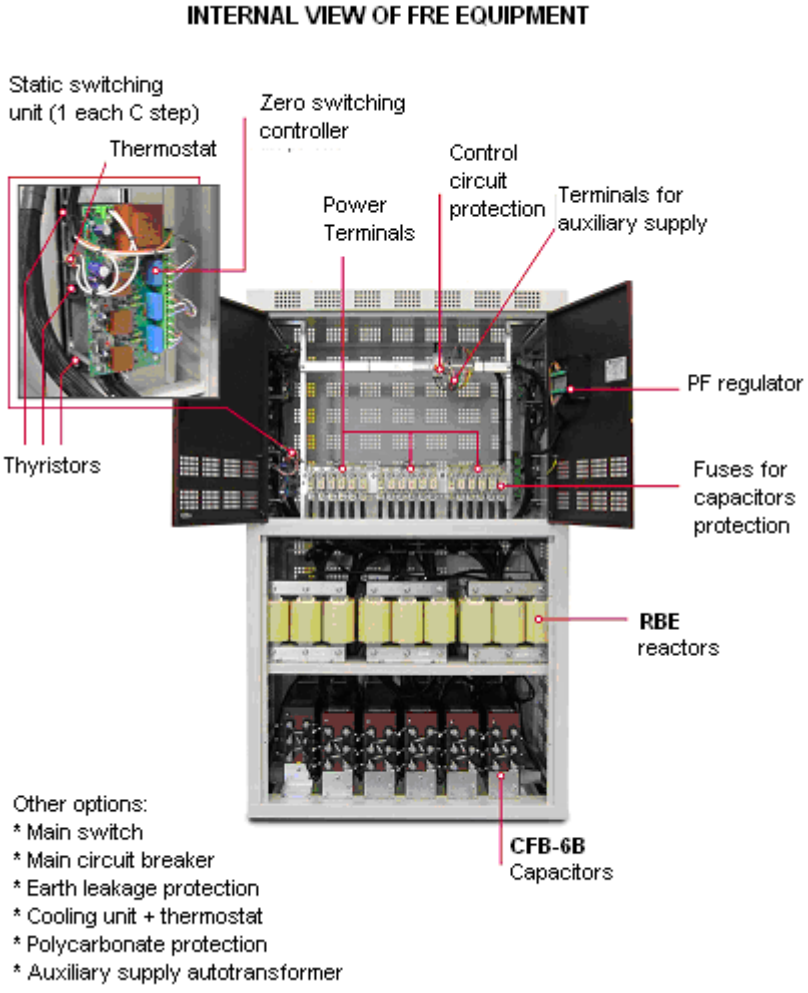


Fig. 4-3 .- **FRE** Capacitor bank components

NOTES:
• Some elements of protection shown in Fig. 4-3 are optional and may not be present in your equipment
• In FRES equipment, capacitors are cylindrical type and static switches cut only two phases

Static switching equipment have a series of characteristic elements, which are very different from those in equipment using contactors. Namely the main blocs are:

4.6.1 Fast regulator

Static capacitor banks are equipped with **computer Max f**, **computer Smart f** or **computer Plus TF** fast regulators. The outputs of these regulators are static; that is to say, instead of an output via relay contact they have a semiconductor-based switch which allows them to perform operations in rapid succession, practically every network cycle. This type of output is prepared to drive COM and ACT inputs on **CPCxx** zero switching controller

Fast regulators enable regulation with minimum delay, generally between 20 and 100 ms (see manual for the specific regulator being used)

4.6.2 CPC, zero switching controller

Static capacitor banks are equipped with CPCxx controllers (xx means that there are different types according to the network voltage, control voltage and control type).

The role of the CPCxx is to control the switching of the thyristors at zero voltage during the turn ON operation, thus avoiding current transients. The typical connection diagram of a single step is shown in Fig. 4-4 and in more detail in the simplified wire diagram in section 10.

CPC controllers are powered with an auxiliary voltage U_{aux}. The standard CPCs are mainly used for networks with U_{max} = 440 V, nevertheless they have a dual-voltage supply circuit able to be supplied at a rated voltage of 230 V or 400 V (±10%) . There are special controllers, type CPC3i, which are designed to operate on networks up to 690 V. Notice that even for the latter case, the auxiliary control voltage, U_{aux} must be 400 V or 230 V. The CPC3i controllers allow three-phase or individual phase-phase control, thanks to an RS-485 bus. However, the standard control is through a voltage-free static contact (semiconductor-based), which opens or closes the circuit between the controller's COM and ACT terminals.

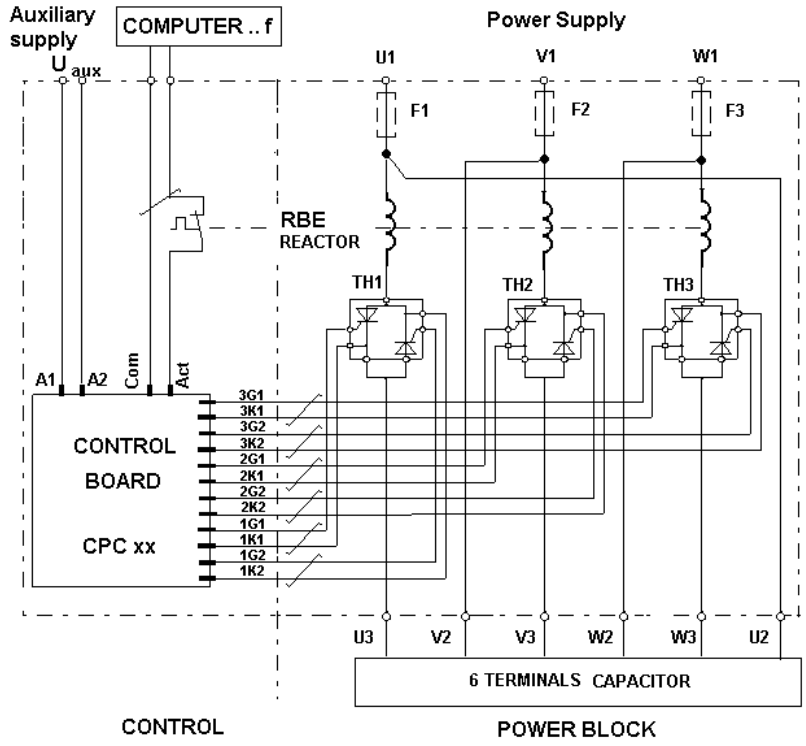


Fig. 4-4 .- Basic connection diagram of the **CPCxx** to the power block

4.6.3 Power block:

The power block of **FRE or FRES** units is made up of 3 to 12 thyristors + capacitor groups, depending on the type. Each group consists of a 6-terminal capacitor (three single-phase capacitors), three (*) thyristor modules attached to a cooling heatsink, one **RBE** reactor for each step and the suitable protection elements addapted to the module's rated power.

(*) On some models the three thyristor modules are integrated into a single encapsulated package

5 INSTALLATION

5.1 Preparation

FRE and **FRES** CIRCUTOR's static filters are prepared for an easy installation and start-up.

Remove the equipment's packaging and verify that the unit's electrical characteristics are suitable for connection to the available grid. For this, check the characteristics label located inside the cabinet, next to the regulator, refer to Fig. 4-1 as an example. Key data to be checked:

- Grid voltage and mains frequency, U_n / f.
- Nominal power of the capacitor bank, Q_n (kvar) and composition
- Type of filter, identified by the p% factor (7%, 14%, ..., etc.)
- Current consumption, I_{max} (See label). This current must be considered to select the proper size of the equipment's power supply cable and ultimately the main switch or the external circuit breaker to protect the equipment.
- Auxiliary control voltage, U_{aux} (See section 5.3.3)
- Environmental conditions. (See section 4.3)

5.2 Installation location

For static switching equipment it is specially important to maintain a minimum distance around the equipment to facilitate cooling. In self-supporting cabinets, the back and front sides of the cabinet must be kept at least 50 cm away from walls and other equipment. Regarding the sides, it is recommended that a separation of 10 cm to be maintained between adjacent equipment. On wall mounted cabinets, it is recommended that at least 20 cm of separation be maintained between the sides of adjacent equipment.

	NOTE: Static units have one or more aluminium heatsinks for cooling the thyristors. Periodically clean these heatsinks with a brush or with compressed air and ensure that they have maximum ventilation.

Make sure the equipment can be accessed easily.

The environmental conditions of the location where the equipment is installed must not surpass the limits established in the technical characteristics (See section -❑)

To ensure proper ventilation, the unit must be installed in a vertical position.

In accordance with most National Electric Codes and LVD, once the unit is installed, it must be protected against electric shock hazard due to direct or indirect contacts; therefore, a circuit breaker and an earth leakage protection relay should be provided for the capacitor bank's supply line.

5.3 Connection of the capacitor bank with filters to the grid

	Check that the nominal voltage of the capacitor bank with filters matches the voltage between phases of the grid where it is being connected. Also check the auxiliary circuit voltage (CPC controllers). For this, refer to section 5.3.3 For feeding cables into the capacitor bank cabinet, always use the entry points available for this purpose. Do not drill holes into the cabinet for feeding cables through them or for installing support brackets. Drilling produces metal shavings that may enter the contacts or other devices and cause short-circuits.

5.3.1 Power circuit.

- Connect input terminals L1, L2 and L3 (power circuit) to the grid using proper sized cable in accordance with the LVR. Generally, the cables of the phases follow the following colour code: L1 (black), L2 (brown), L3 (grey). If an auxiliary voltage is required to supply some auxiliary elements, the supply is obtained from a suitable transformer or auto-transformer.
- To determine the size of the phase cables, the maximum nominal current I_{max} shown on the equipment's label and a transient overload of up to 1.5 times I_{max} must be taken into account.

5.3.2 External isolation and protection elements

- In case the capacitor bank with filters does not have an internal switch or circuit breaker, it must be connected to a line with an external switch or circuit breaker.

The protection elements, isolation switches and/or switches that are added externally to the capacitor bank must be of a minimum size to withstand a current 1.5 times greater than what is indicated on the label

If an earth leakage protection for the capacitor bank is installed, its sensitivity and trip delay must be adjustable.

- For static capacitor banks with filters equipped with a standard regulator that measures the current in one single phase, we advise installing the current transformer (CT) in the phase connected to L1 (black cable). The CT secondary outputs, S1 and S2, must be connected to the terminals with the same name on the main cabinet. For more details about the connection of the CT, see 5.3.5

5.3.3 Auxiliary control voltage.

- The auxiliary control circuits include those related to the power supply of the CPCxx controllers and other control or protection devices and ventilation units. The CPC controllers, up to 400 V_{ac}, usually are supplied at 400 V_{ac} from phase to phase voltage. In other applications using a voltage above 440 V_{ac} and up to 690 V_{ac}, the CPC must be supplied from an auxiliary source, usually obtained from a suitable transformer or auto-transformer. In such case the label will indicate U_{aux}/f … internal.
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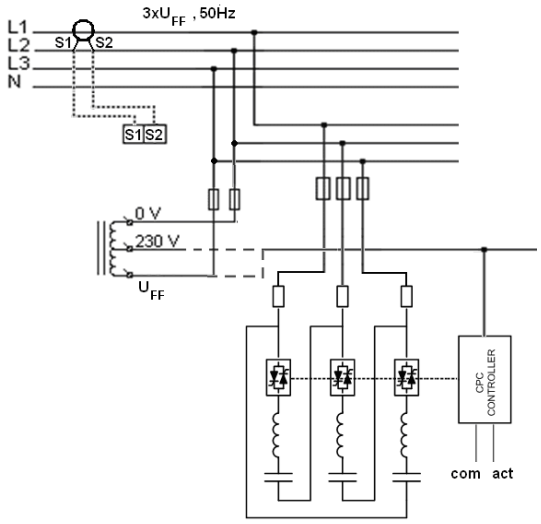

Fig. 5-1.- Auxiliary supply by means of autotransformer

5.3.4 Earth cable connection

Connect the earth terminal of the FRE or FRES equipment, located inside the equipment cabinet(see Fig. 4-3) to the exterior earth connection. The earth cable section will be selected in accordance with the admissible current limits established in the Low Voltage Directive or in the National code of the country where the filter is installed.

5.3.5 Connecting the current transformer (CT)

	**An external current transformer (CT) must be installed to measure the total load current plus that of the filter (see Fig. 5-2).** The standard transformer must have a nominal secondary output of 5A. We recommend connecting the CT to phase L1. The primary indications P1 - P2 must be placed in the direction grid to load (see Fig. 5-2). Terminals S1-S2, must be connected to terminals with the same name on cabinet terminal strip (see Fig. 5-2). Avoid the flow of current through the CT primary before closing the secondary to terminals S1 and S2 in the cabinet. If the CT must be installed while the installation is working, make a short-circuit between S1 and S2 while they are not connected to the capacitor bank terminals.

- The current rating of the CT primary winding must be equal to or slightly greater than the size of the installation's mains switch. Therefore, the CT must be able to measure the maximum expected current of the loads being compensated.

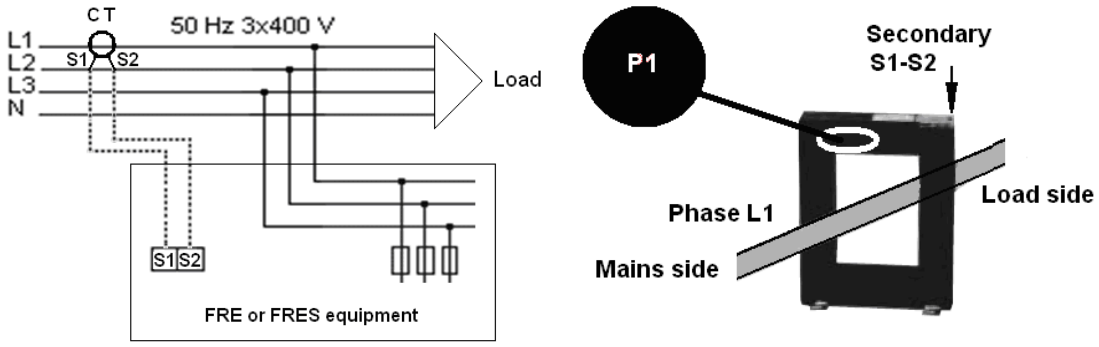

Fig. 5-2 .- Installation of the current transformer (CT) (external)

- The connection point of the CT for a capacitor bank that compensates an entire installation is after the installation's mains switch.
- To prevent excessive attenuation of the signal, the minimum cross section of secondary cables (terminals S1, S2) should be 2.5 mm2.

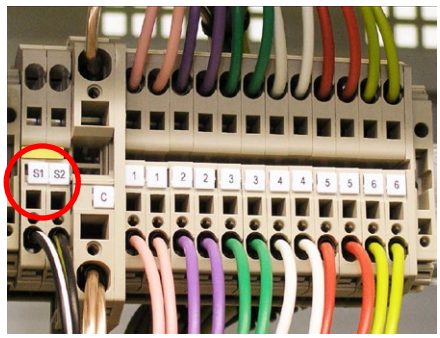

Fig. 5-3 .- CT connection terminals

- Once the cables are installed, disconnect the jumper connecting terminals S1 and S2 inside the capacitor bank (see Fig. 5-4)

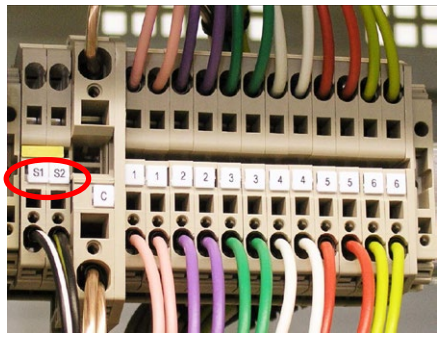

Fig. 5-4 .- Jumper for short-circuiting the secondary winding of the current transformer (CT).

⚠	Any time you wish to change or disconnect a current transformer from the filter cabinet. it is important to install a jumper connecting S1 and S2.

6 START-UP OF A STATIC CAPACITOR BANK WITH DETUNED FILTER (FRE or FRES)

6.1 Before start-up

FRE and **FRES** filters have a built-in power factor regulator. Prior to start-up, the operation of such regulator device must be known. For this reason, all capacitor banks and filters **come with the specific instructions manual of the PF regulator used. Ensure you have this manual available before the start-up process**. In case of static banks the PF regulator must be MOS static output type (**computer Max f**, **computer Smart f** , **computer PlusTF** or equivalent)

⚠	The set-up of the PF regulator controlling the filter and its optimum adjustment during start-up requires the installation to have at least a 30 to 40% of rated load. If the load during the start-up process is low , only a few steps will connect. In such case, manually force the connection of all the steps in order to check them all. During low load periods, manually connecting the full power of the filter bank is not recommended, as in some cases resonance with the installation power transformer could occur.

6.2 Start-up

⚠	**SAFETY** Apply the safety regulations listed in section 2 of this manual before operating the equipment. The standards and applicable national laws of the country where the static filter bank is installed or operated should be strictly followed.

- Ensure that the inner circuit breaker that starts the regulator, shown as the control circuit protection in Fig. 4-3 is connected
- Connect the **FRE** or **FRES** equipment to power supply and check that the PF regulator display illuminates immediately. If not, stop and check the previous step.
- Check the cosφ indication of PF regulator display. If the indication is out of range 0.5 to 1, the current transformer and / or the power supply to the regulator may be improperly connected. Most of the regulators use only one current transformer. In this case, connect as per Fig. 6-2 (place the current transformer in phase L1 and take the power voltage from phases L2 and L3)

Fig. 6-1 .- Computer Max f Regulator
(Picture provided as an example. It may not coincide with the model used on your unit).

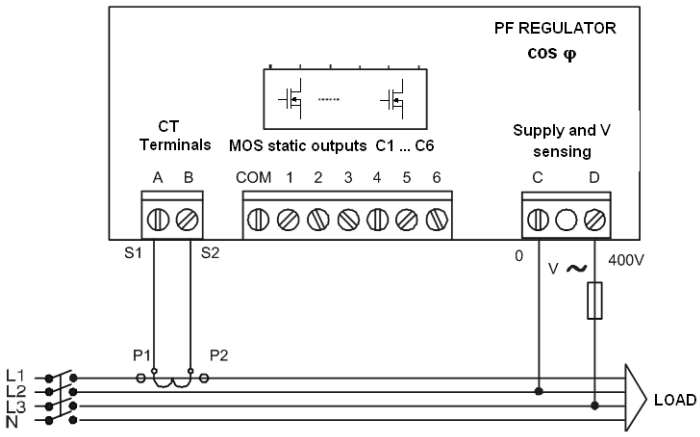

Fig. 6-2 .- Standard connection of a regulator with a single CT (3 current transformers will be used when Computer + is used. See the specific manual of the Computer + regulator)

- Once ensured that the regulator is properly connected, set-up the regulator parameters according to the installation you are attempting to compensate. For this, follow the regulator's instructions manual included in the static filter documentation.

6.3 Tests once the capacitor bank is connected and the PF regulator has been adjusted

- After start-up, make sure that the equipment is operating correctly. A sign of proper operation after the regulator's reaction time has passed is a cosφ indication close to 1. In addition, the reactive energy meter must stop.
- Check that the power supply voltage does not exceed the nominal value +10% (IEC 60831-1)
- Check the current absorbed by each LC group of the filter. Under normal working conditions, it must be close to the nominal values (see Table7-4) and never more than 1.3 times this value continuously. Continuous consumption over the nominal value may be caused by the presence of harmonics in the grid or an excessively high power supply voltage. Both circumstances are harmful for capacitors and the filter reactors.
- In accordance with the IEC 60831-1 Standard, the capacitor is prepared to operate at the permanent voltage assigned and with an overvoltage of up to 10% during 8 hours every 24 hours.
- NOTE: For capacitor banks with filters, the capacitor's voltage exceeds the grid voltage by a % that is approximately equal to the filter's overvoltage factor (p%). In fact, the capacitor's real overvoltage is $\frac{\Delta V_C}{V_{RED}}\% = \frac{100.p\%}{(100 - p\%)}$
- To check the filter's correct tuning, make sure that the voltage on the terminals of each winding of the reactor is $V_L = V_{MAINS} \cdot \frac{100.p\%}{(100 - p\%)}$

⚠	Check the working temperature of the capacitors and reactors after they have been operating for 24 hours. The capacitor case must be under 40 ºC. The housing of reactors can reach temperatures of about 60 ºC

7 MAINTENANCE

7.1 Safety regulation

SAFETY
Apply the safety regulations listed in section 2 of this manual before operating the equipment.
The standards and applicable national laws of the country where the capacitor bank with **FRE** filters is installed or operated should be strictly followed.

7.2 Maintenance with the filter bank disconnected

7.2.1 Basic maintenance protocol

Monthly

- Visually inspect the capacitors
- Check the protection fuses
- Control the environment temperature (average must be about 30 ºC. in accordance with IEC 60831).
- Control the supply voltage (especially during moments of low load, it must not exceed the nominal value +10%).
- Check the temperature of thyristor's heat sinks. It must be less than 80ºC

Every six-month

- Keep the capacitor terminals and reactors clean.
- Force all steps off (push down key at PF regulator front plate). Once all disconnected, check that the current drawn by the three phases is practically zero. If significative current is detected in any phase indicates that there is a shorted thyristor.
- Check that the current at each step and each phase is not less than 25% neither greater than 120% of the nominal value. Unbalance between phases must be less than 15%.

Annually

- Perform isolation tests on the different elements of the power circuit, applying 2.5 kV during 1s between passive components (basically L and C) and ground terminal.

NOTE: To carry out isolation tests, thyristors must be short-cutted.

- Check the capacity of the different steps. An indirect verification can be performed by checking that the consumption matches the value stated in Table7-4, with a maximum deviation of ± 10%.
- Check the tightness of all terminal connections on the different power elements.
- Inspection of the fuses.
  - Power circuit: NH fuses. Check continuity and temperature.
  - Control Circuit: Neozed fuses or circuit breaker. Check continuity and temperature.

7.2.2 Tightening the electrical connections.

- The connections must be tight. The tightening torques for different elements of the filter banc are listed in Table 7-1, Table 7-2 and Table 7-3

Table 7-1.- Tightening torques of cables fuses and to thyristors

Device	TORQUE (Nm)
NH-00 fUSES	15,2
Power circuit of thyristors	3,25
Thyristor to heatsink clamping	5

7.2.3 Key points for inspecting static switches.

- Check that the plastic parts are not blackened and do not show signs of burning or hardening.
- Check the tightness of cables and terminals, as shown in Table 7-1
- The terminals must be clean.

- In dirty environments (dust, sawdust, metal trimmings, etc.). Vacuum the dust and solid remains regularly. There is no estimated time frame for cleaning, it depends on the amount of dirt that penetrates the capacitor bank cabinet.

Table 7-2.- Tightening torques of the cables to reactor terminals.

Reactor	Connection	Terminal (Nm)
RE-5-400	Terminal	1.83
RE-10-400	Terminal	1.83
RE-15-400	Terminal	1.83
RE-20-400	Terminal	6.2
RE-25-400	Terminal	6.2
RE-30-400	Terminal	15.2
RE-40-400	Terminal	15.2
RBE-50-400	Flat strip	30
RBE-60-400	Flat strip	30
RBE-80-400	Flat strip	30

7.2.4 Key points for inspecting capacitors.

- Inspect the cables and terminals. They should not be overheated or blackened.
- The terminals must be clean
- The slow discharge resistors must be in good condition (they should not be open or show signs of burns)
- Check the tightness of capacitor terminals, as shown in Table 7-3

Table 7-3 .- Tightening torques of the cables on the capacitor bank terminals

Capacitor	Power terminal (Nm)	Earth terminal (Nm)
CFB, CSB	21	6.2
Tubular		

7.2.5 Key points for testing the PF regulator

- Check that the regulator does not show signs of deterioration and the display is lit as normal.
- Inspect the cables and terminals. They must be clean, not hardened or overheated.
- Check the connections and the insertion of removable terminal strips, if used:
  - The terminal strips must be well fastened on removable regulators.
  - Check that the terminals are tightened properly. The recommended torque is 0.6 Nm.

7.2.6 Cleaning the cabinet

- Remove possible metallic and other debris.
- Clean the inside of the cabinet
- Clean ventilation grills

7.3 Maintenance with the capacitor bank connected

- Check that the main switch turns on and off, without having to force the mechanism
- If there is an individual earth leakage protection for the capacitor bank, check its proper operation by pressing the test button
- Check that the auxiliary control voltage is within the tolerance limits. If the capacitor bank has an autotransformer, check that it is in good condition and does not show signs of deterioration
- Force the connection and disconnection of the different steps in manual mode. (refer to the regulator manual before carrying out this operation) and perform the following tests:

- Check that the steps connect and disconnect properly
- Check that there is no consumption in any phase with the step disconnected. If there is consumption this means that some of the thyristors are defective.
- Check the consumption of the different steps, in each phase. The normal values are shown in Table7-4

Table 7-4.- Nominal consumption of the LC steps of an FRE or FRES filter

POWER	CURRENT	
	230V	400V
	I_n	I_n
2.5 kvar	6.28 A	3.6 A
5 kvar	12.56 A	7.2 A
7.5 kvar	18.85 A	10.8 A
10 kvar	25.12 A	14.4 A
12.5 kvar	31.41 A	18 A
15 kvar	37.7 A	21.6 A
20 kvar	50.24 A	28.8 A
25 kvar	62.82 A	36 A
30 kvar	75.4 A	43.2 A
40 kvar	100.48 A	57.6 A
50 kvar	125.64 A	72 A
60 kvar	150.8 A	86.4 A
70 kvar	175.92 A	101.1 A
80 kvar	200.96 A	115 A

- Check the voltage on all of the reactor's windings (input - output of the same winding, not between phases). The voltage depends on the filter's *p%* factor (see label on the equipment), in accordance with the following formula: $V_L = V_{MAINS(\ phase-phase\ )} \dfrac{0{,}577.p\%}{(100-p\%)}$

  For example, in the case of the 400V grid and *p%*=7, V_L=17.38V. For the 400V grid and *p%*=14, V_L=37.57V. For other line voltages, the V_L value is proportional to the line voltage.

NOTES:

- When the consumption of the steps is 25% less than that stated in Table7-4 and the voltage is within the tolerance limits, this is a sign of degradation in the capacitors. These must be replaced with a suitable spare part if these symptoms are detected in a step.
- When the consumption of the steps is 10% more than the values stated in Table7-4, this can be caused by the presence of resonances. If this is detected, measure the grid's voltage THD (it must be under 5%) or check the filter's tuning frequency.
- If the voltage drop in a reactor deviates from the values stated in this section, check the reactor. This phenomenon can be caused by the presence of a resonance.

7.3.3 PF regulator checkings.

Refer to the manual of the specific regulator used in the capacitor bank. This manual is always supplied with the capacitor bank.

- Make sure that there are no damaged segments on the display (abnormal brightness).
- Make sure that regulator's keyboard is working properly:
  - Enter Setup and check the adjusted values
  - Force the manual connection and disconnection of a step.

7.4 Environmental Conditions:

- Check that the maximum environmental conditions listed in section 4.3 are observed

8 WARRANTY

CIRCUTOR guarantees its products against any manufacturing defect for two years after equipment delivery. CIRCUTOR will repair or replace any defective factory product returned during the guarantee period.

No returns will be accepted and no unit will be repaired or replaced if it is not accompanied by a report indicating the defect detected or the reason for the return.

The guarantee will be void if the equipment has been improperly used or the storage, installation and maintenance instructions listed in this manual have not been followed. "Improper usage" is defined as any operating or storage condition contrary to LV Regulations or that surpasses the limits indicated in the technical and environmental characteristics of this manual.

In particular, capacitor units are very sensitive to adverse environmental conditions, to temperatures above the established limits and overloads produced by the absorption of harmonic currents. Therefore, special care must be taken to not surpass these usage conditions.

CIRCUTOR accepts no liability for possible damage to equipment or other parts of the installation, nor will it cover any possible penalties resulting from possible failure, improper installation or "improper usage" of the equipment.

Consequently, this guarantee does not apply to failures occurring in the following cases:

1. Overvoltages and/or electrical disturbances in the supply;
2. Water, if the product does not have the appropriate IP classification;
3. Poor ventilation and/or excessive temperatures;
4. Improper installation and/or lack of maintenance;
5. Buyer repairs or modifications without the manufacturer's authorisation.

9 TECHNICAL ASSISTANCE AND DECLARATION OF CONFORMITY

CIRCUTOR provides advice and technical assistance services throughout Spain for the planning and installation of capacitors, automatic power factor correction equipment and harmonics filters.

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9.1 Conformity declaration

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DECLARACION DE CONFORMIDAD CE
CE DECLARATION OF CONFORMITY
DECLARATION DE CONFORMITE CE

Por la presente CIRCUTOR, S.A.
We hereby
Par le présent

Con dirección en: Vial Sant Jordi, s/n
With address in: 08232 VILADECAVALLS (Barcelona)
Avec adresse à: ESPAÑA

Declaramos bajo nuestra responsabilidad que el producto:
We declare under our responsibility that the product:
Nous déclarons sous notre responsabilité que le produit:

Equipos de compensación de reactiva **Serie:** FRE4, FRE6, FRE8, FRE12, FRES

Marca CIRCUTOR

Siempre que sea instalado, mantenido y usado en la aplicación para la que ha sido fabricado, de acuerdo con las normas de instalación aplicables y las instrucciones del fabricante,
Provided that it is installed, maintained and used in application for which it was made, in accordance with relevant installation standards and manufacturer's instructions,
Toujours qu'il soit installé, maintenu et utilisé pour l'application par laquelle il a été fabriqué, d'accord avec les normes d'installation applicables et suivant les instructions du fabricant,

Cumple con las prescripciones de la(s) Directiva(s):
Complies with the provisions of Directive(s):
Accomplie avec les prescriptions de la (les) Directive(s):

2006/95/CE
2004/108/CE
98/37/CE

Está en conformidad con la(s) siguiente(s) norma(s) u otro(s) documento(s) normativo(s) :
It is in conformity with the following standard(s) or other normative document(s) :
Il est en conformité avec la (les) norme(s) suivante(s) ou autre(s) document(s) normatif (ves) :

IEC 60439-1 :1999
IEC 60831-1 :1996
IEC 60831-2 :1995
IEC 61000-6-4 :2006
IEC 61000-6-3 :2006
IEC 61000-6-1 :2005
IEC 61000-4-2 :2008
IEC 61000-4-3 : 2006
IEC 61000-4-4 :2004
IEC 61010-1 :2001
IEC 60832 :1998
BS 1650
VDE 560

Año de colocación del marcado "CE": 1996
Year of affixing "CE" marking:
An de mise en application du marquage "CE":

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