

GE Power Factor Controller

Installation And Operating Instructions

**GE ENERGY
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1. Read this first

About this instruction manual

- This instruction manual is designed to help you quickly install and operate the PF Controller. Before installation and operation of the PF controller, read this notice carefully.
- Keep it at the disposal of people in charge of installation, maintenance and operation.

Safety

- Installation, maintenance and operation of the PF controller must be performed by qualified electricians.
- Do not work under voltage.
- Do not open the PF controller's housing. There are no user serviceable parts inside.
- The PF controller is connected to a current transformer. Do not unplug the current transformer connections before making sure it is short-circuited or connected to another parallel load of sufficiently low impedance, failure to do so can create dangerous over voltages.
- Do not use this product for any other purpose than its original aim.

Electromagnetic compatibility

This PF controller has been verified for compliance with directives for EMC (Electromagnetic Compatibility) for operation at 50/60 Hz. and bears the UL marking to this effect.

Service conditions

- **Air temperature:** -25C~ 70C
- **Atmospheric conditions:** air moisture must be under 90% at 20C .
- **Environment condition:** No explosion danger of surrounding medium, no enough gas to cause insulation damage and metal corrosion, no conductive dust.

2.Features

- Panel mounting according to DIN 43700 or 35 mm DIN-rail mounting according to EN 50022 12 steps .
- Automatic CT polarity retrieval
- Automatic frequency selection 50/60 Hz.
- THD(U) and THD(I) measurements
- Detection of a step with decreased capacitance
- Hunting detection
- Setting for target power factor ($\cos \phi$) Four-quadrant operation
- Easy-to-use menu-driven user interface
- Setting of reconnection delay
- Back lighted symbol LCD Display
- Plug-in connectors at rear side
- Possibility to operate steps manually and to set steps permanently on/off
- Serial communication option,RS232, MODBUS protocol.
- Protective momentary no-voltage reset function
- State-of-the-art microprocessor technology
- Complies with IEC 61000-6-2 and IEC 61000-6-4 EMC standards

3.Figures

Fig.1. Front view

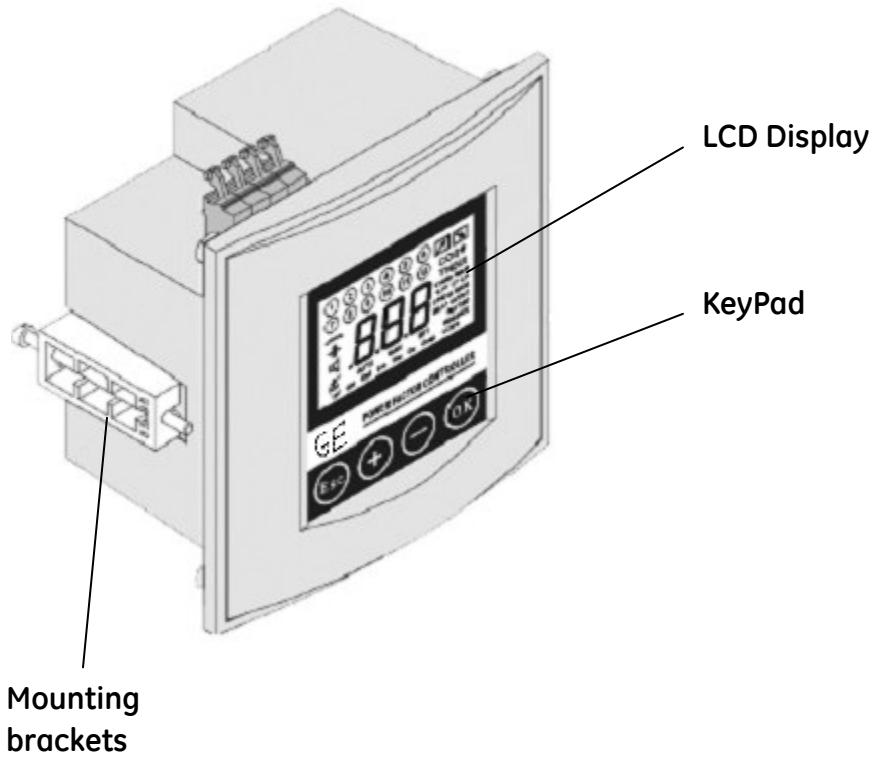
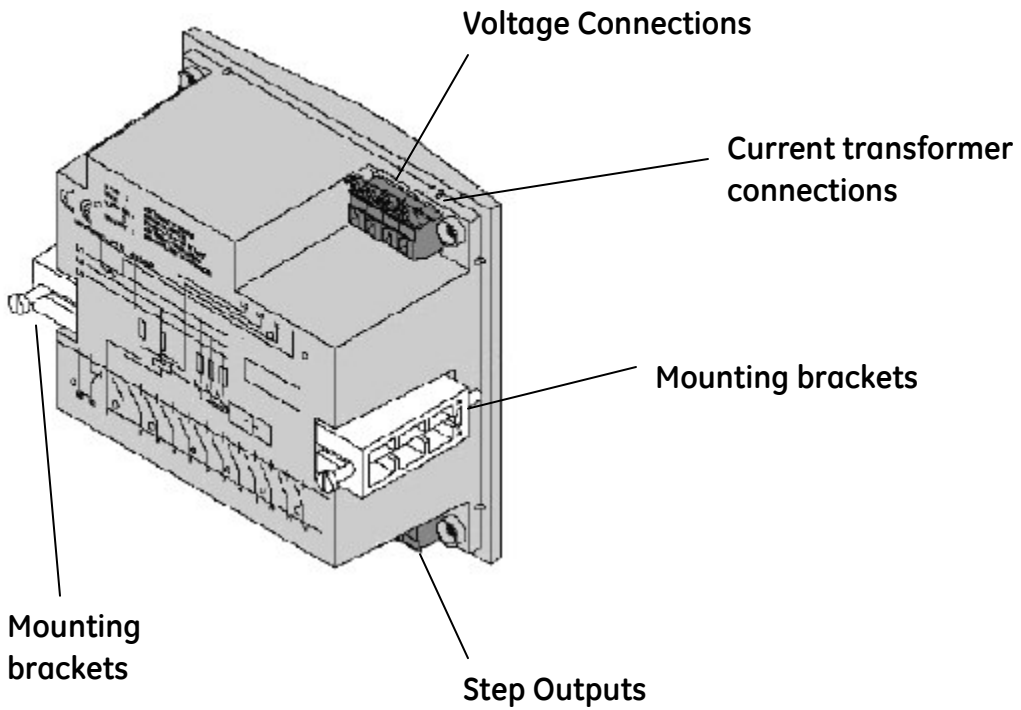
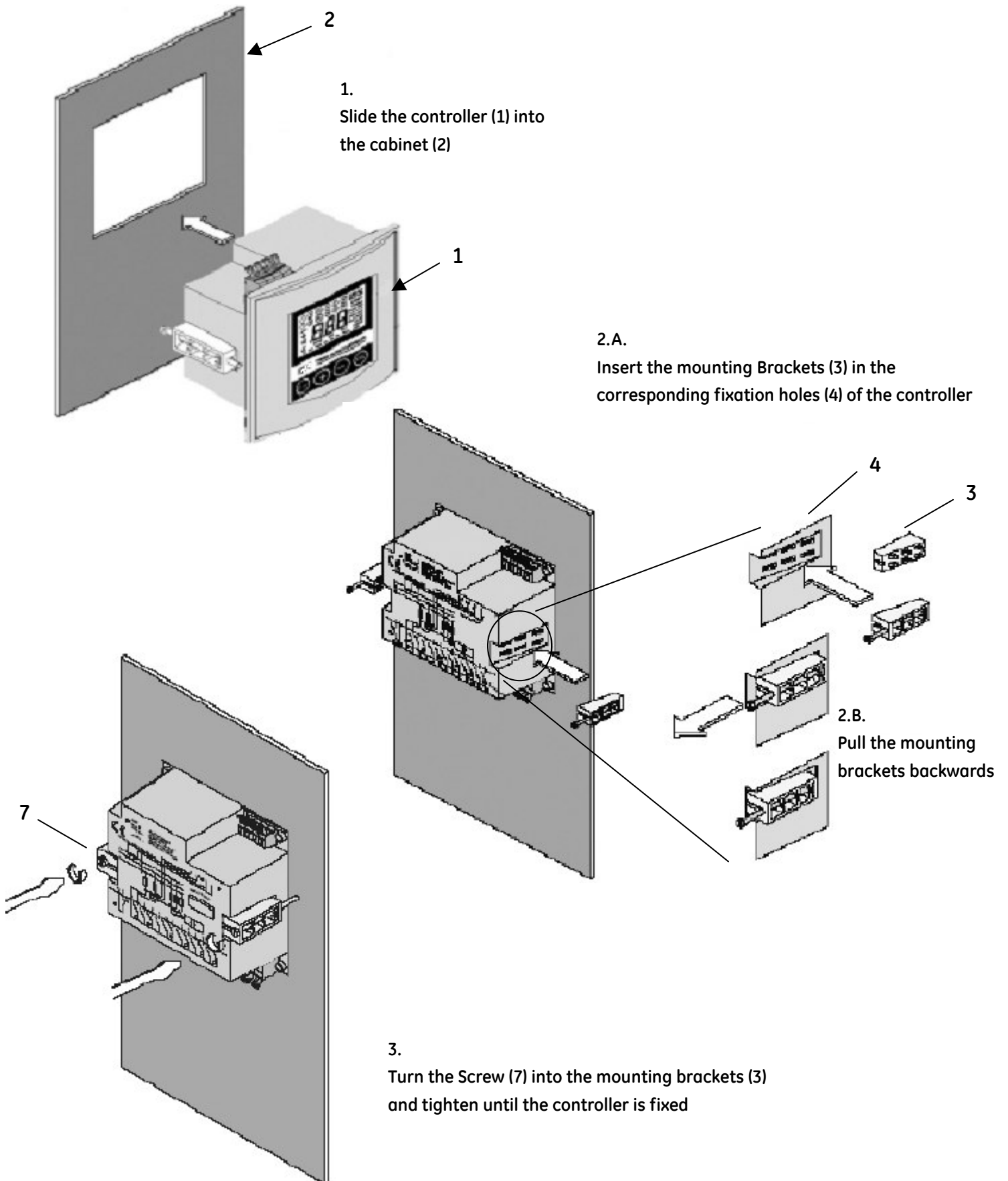


Fig.2. Rear view



4. Mounting

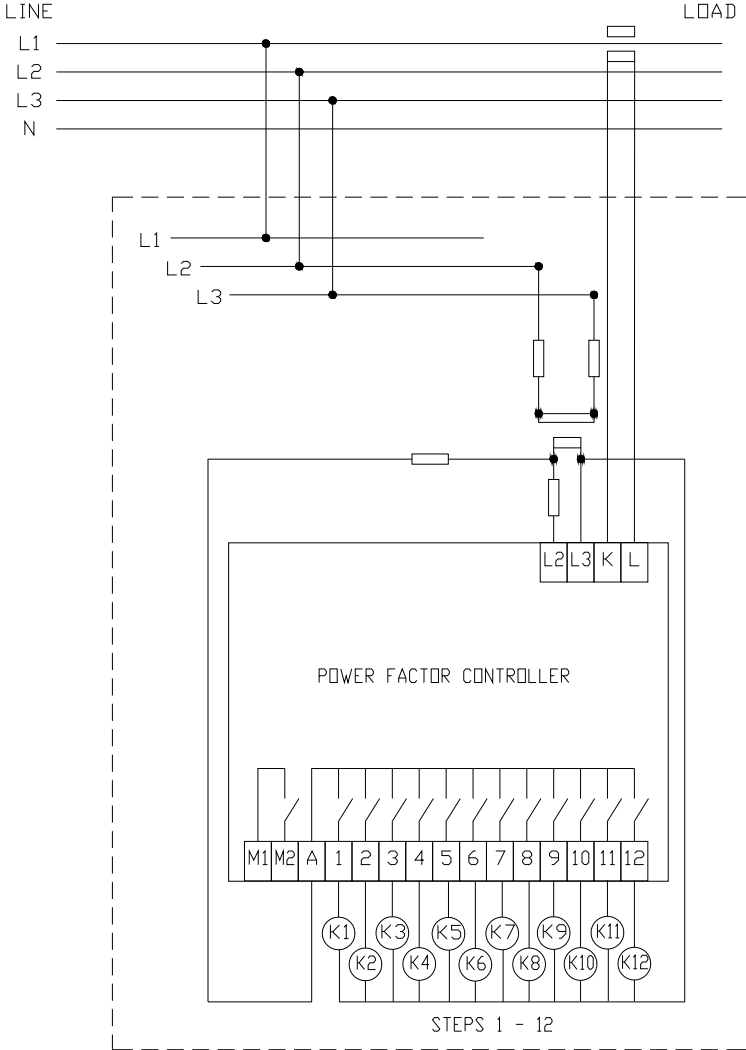


5.Connection arrangement

A.Wiring diagram

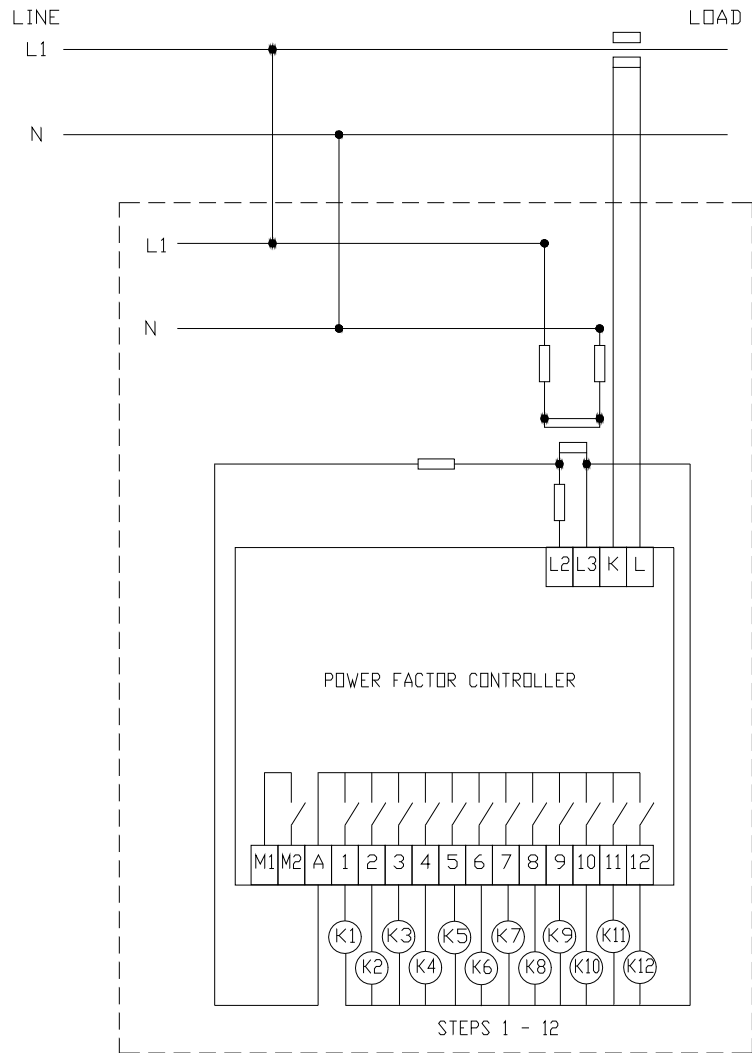
Line TO Line

- K,L; leads of the current transformer
- L2,L3: 2 of the 3 phases(not monitored by the CT)
- A: output relay common source
- 1-12: outputs
- M1,M2: normally open alarm contact

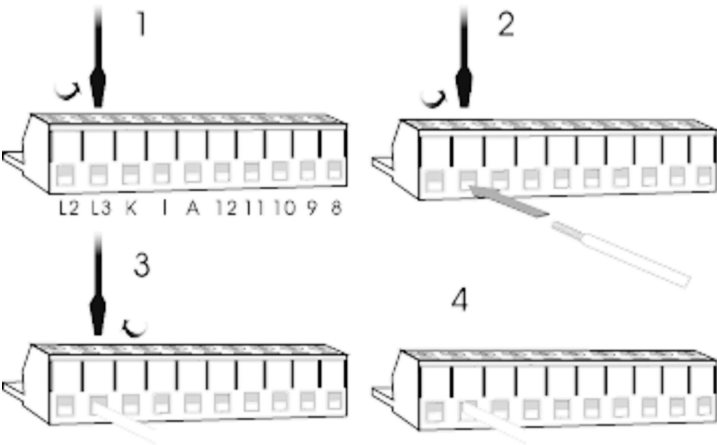


Line TO Neutral

- K,L: leads of the current transformer
- L2: 1 of the 3 phases(monitored by the CT)
- L3: Neutral
- A: output relay common source
- 1-12: outputs
- M1,M2: normally open alarm contact



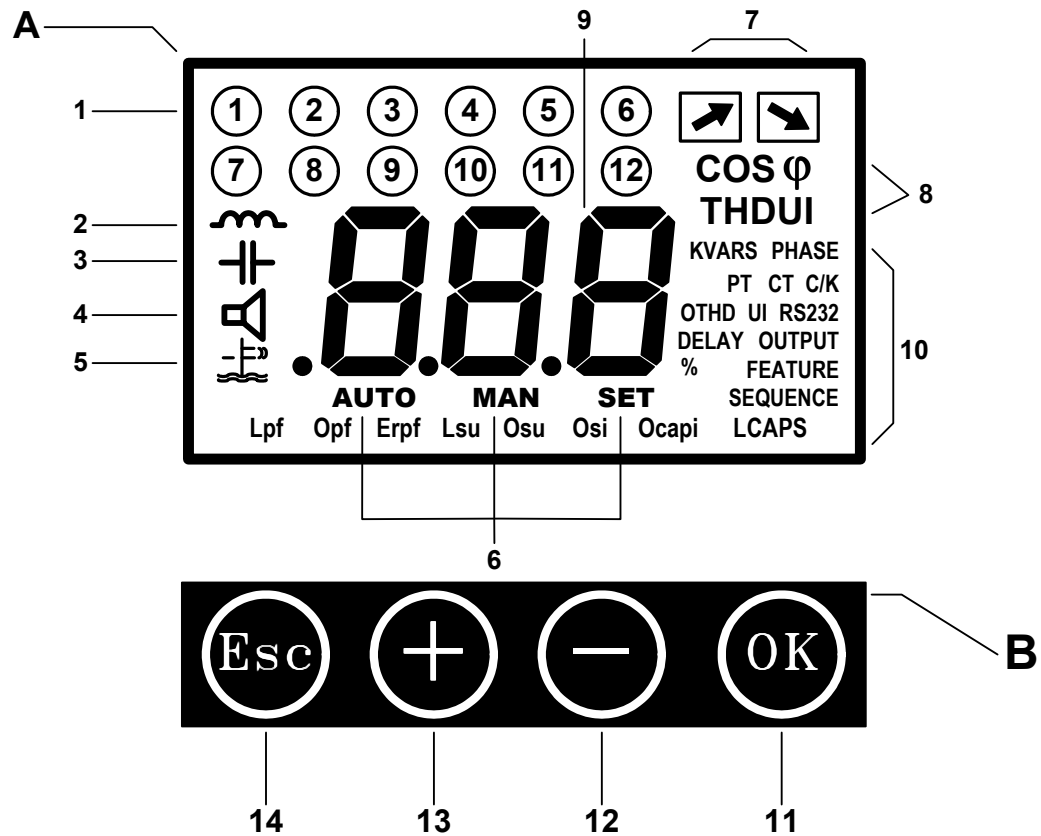
B.Leads connection



6. User interface

A. LCD display

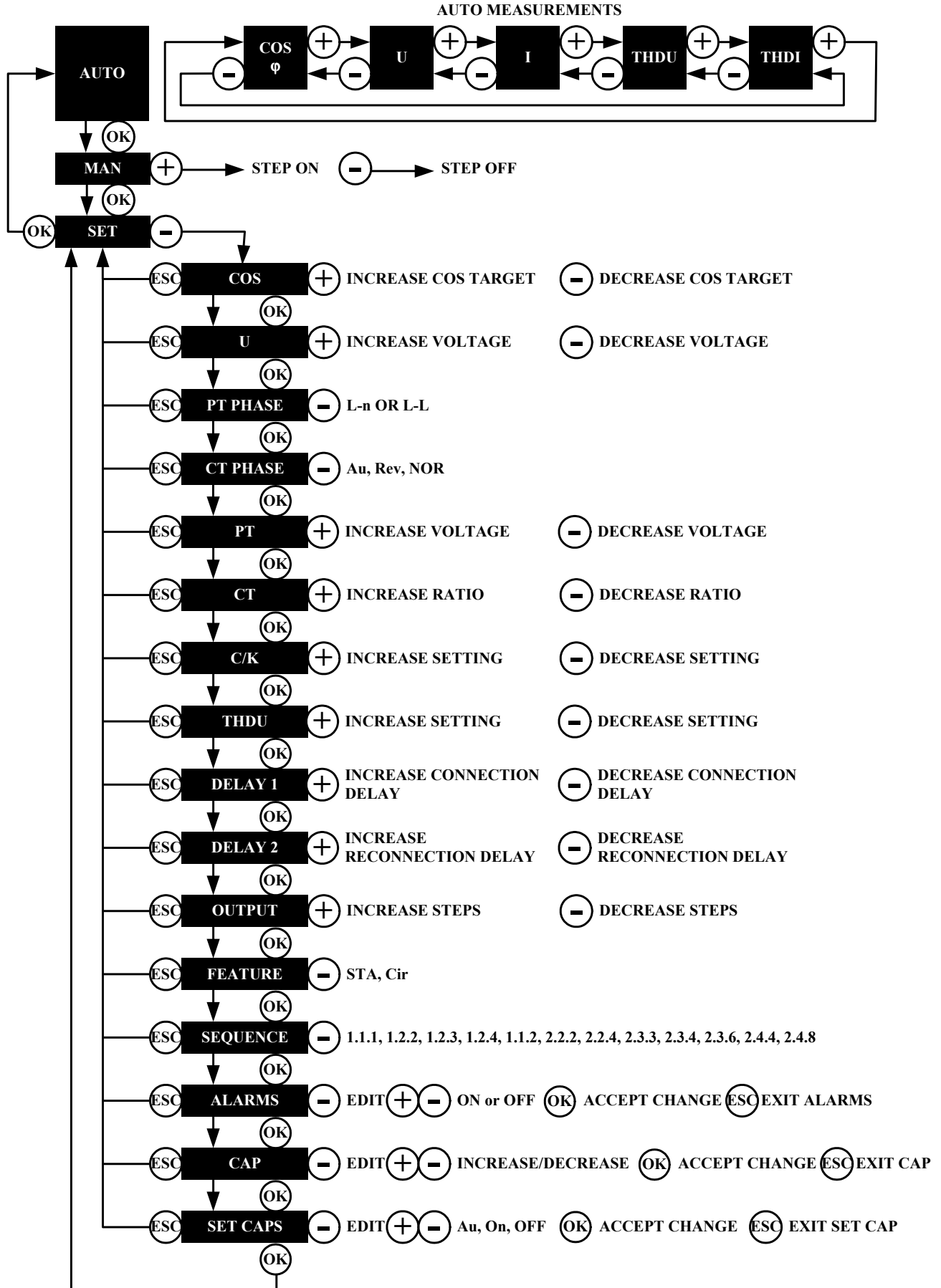
- | | |
|------------------------------|--|
| 1.Active outputs | 6.Modes |
| 2.Inductive PF | 7.Demand for switching on or off capacitor steps |
| 3.Capacitive PF | 8.Measured parameters |
| 4.Alarm | 9.Numerical display |
| 5.Overtemperature indication | 10.programmable parameters and alarm indication |



B. Keypad

- 11. OK button
- 12. - button
- 13. + button
- 14. Esc button

7. Operation of the user interface



8.Commissioning

Step 1: Apply power to the controller

Note: If you have a short-circuit on the CT's secondary winding do not forget to open it after having connected the current input of the PF controller.

After power is applied to the controller, the controller detects the base frequency and changes its operation automatically for 50 Hz. or 60 Hz.

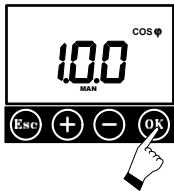


Activate the **AUTO** Mode, the **AUTO** icon and measured $\cos\phi$ value will appear on LCD display. Voltage, current, Total voltage harmonic distortion THD (U) and Total current harmonic distortion THD (I) also can be displayed.

Step 2: Press OK button, activate MAN Mode

MAN icon appears on LCD display.

In the **MAN** Mode, switch On or off one step by pressing + or - buttons.



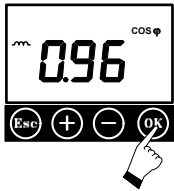
Step 3: Press OK button, activate SETTING Mode

SET icon appears on LCD display.



Step 4: To begin parameter setting by pressing - button.

Programmed parameters and icons of all the parameters will be displayed on LCD one by one by pressing **OK** button , if the controller has never been programmed before, default value appears on LCD Display.



Step 5: To adjust the selected parameters, use + or - buttons.

During this procedure, the parameter which is set last time will appear. All the parameters can be set, confirm your selection by pressing OK.(for more details, see parameter setting)

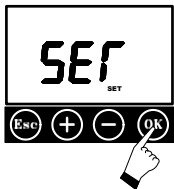


Step 6: Return back by pressing ESC button.



Step 7: To restart AUTO Mode by pressing OK button.

Once in **AUTO** Mode, the PF Controller automatically switches on the necessary steps to reach the programmed target $\cos\phi$.



9.AUTO Mode

After the connections are correct and power is applied to the controller, it will enter to the **AUTO** Mode automatically.

Once in **Auto** Mode, the PF Controller automatically switches on the necessary steps to reach the programmed target $\cos\phi$. The number displayed on LCD indicates this step is switched on.

In **AUTO** mode, the measured parameters can be displayed by pressing + or - buttons.

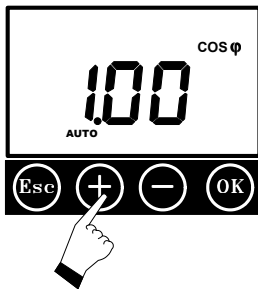
Measurement parameters :

- $\cos\phi$
- Input voltage
- Input current
- Total voltage harmonic distortion THD (U)
- Total current harmonic distortion THD (I)

Example:

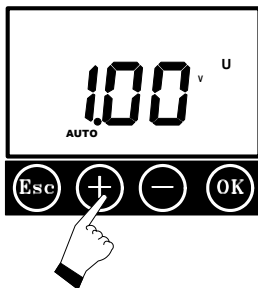
After apply power to the controller and into AUTO Mode.

The measured $\cos\phi$ appears on LCD display, \sim indicates inductive, || indicates capacitive.



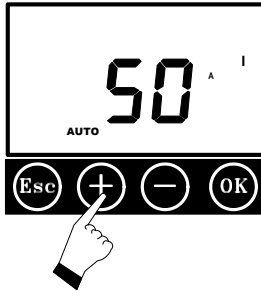
Press + button now

Measured voltage value appears on LCD display. **U** icon indicates voltage, **V** icon indicates unit. If **K** icon appears, it indicates the unit is **KV** now.



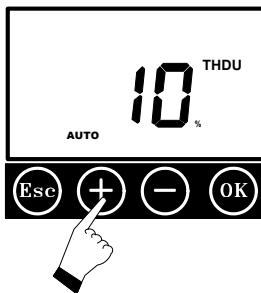
Press + button now

Measured current value appears on LCD display. **I** icon indicates current, **A** icon indicates unit, if **K** icon appears on LCD, indicate the unit is **KA**..



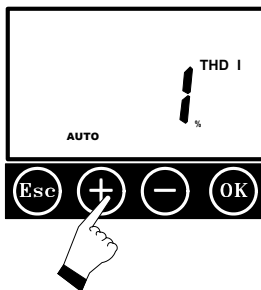
Press + button now

Measured total voltage harmonic distortion THD (U) appears on LCD, **THDU** icon indicates total voltage harmonic distortion, **%** indicates the unit is percent.



Press + button now

Measured total current harmonic distortion **THD(I)** appears on LCD Display, **THDI** icon indicates total current harmonic distortion, **%** indicates unit is percent.





Press + button now

Go back to the display of $\cos\phi$.
The parameters can be displayed in an opposite sequence by using - button.

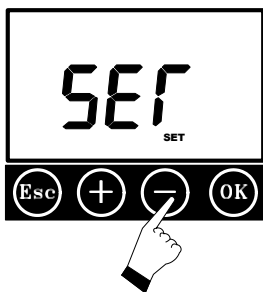
10. Manual operation

In the **AUTO** Mode, press on the **OK** button once to activate the **MAN** Mode .

Switching on or off is done manually by pressing on the + or - button.  and  respectively indicate the demand to switch on or off one step is being processed.



11. Programming

To adjust the selected parameter, use + or - buttons. For more details of how to switch to **SET** Mode and the setting of parameters ,see page 12.

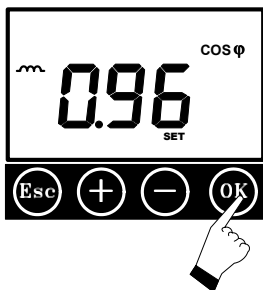


Enter setting Mode

1. Target $\text{COS}\phi$

-  indicates an inductive PF and
-  indicates a capacitive PF.

COS ϕ appears, the programmed target $\text{cos}\phi$ value is displayed .
The value can be adjusted between 0.7 inductive and 0.7 capacitive.

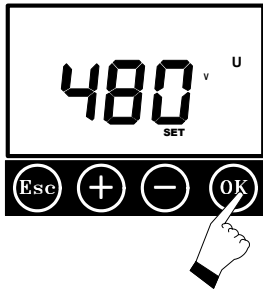


2. Network normal voltage

V indicates the unit

U icon appears, the programmed network normal voltage is displayed.

The value can be adjusted from 120V to 750V.



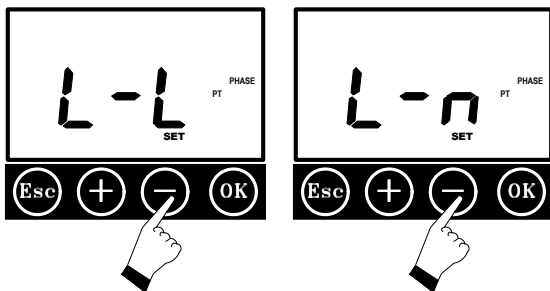
3. PT PHASE

PT and PHASE appear simultaneously indicates the connection of PT .The connection of the voltage measurement inputs.

The alternatives are:

L-L Indicates Line To Line

L-n indicates Line To Neutral



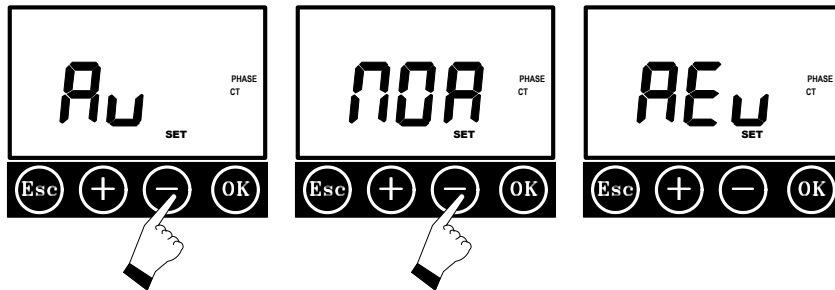
4. CT polarity connection

CT and **PHASE** appear simultaneously indicates **CT** polarity. The controller can retrieve **CT** polarity automatically, **CT** can be connected directly or reversely.

A_U Indicates the controller retrieves CT polarity automatically.

NOA indicates direct CT connection.

AE_U indicates reverse CT connection.



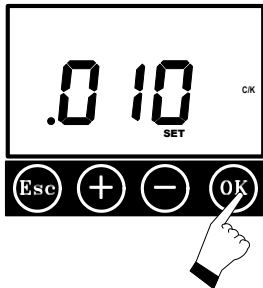
5. PT

PT appears, the programmed voltage is displayed. Normal voltage at the controller. The value can be adjusted from 90V to 120V. **V** indicates the unit.



6. CT

CT icon appears, the programmed CT value is displayed. The value of the CT ratio can be edited from 50/5 up to 8000/5 range. The unit of the value displayed on the LCD is 1:5, if **K** appears, denote the figure is kilobit. For example, 5 is 5000.



7. C/K

C/K icon appears, the programmed c/k value is displayed. The value can be set within the range of 0.01 to 1A..The recommended setting of c/k can be calculated by the following formula.

Three-phase network

$$C / K = 0.62 \times \frac{Q \times 1000}{\sqrt{3} \times U \times K}$$

Q: size of smallest step in Kvars

U: system voltage(V)

K: current transformer ratio

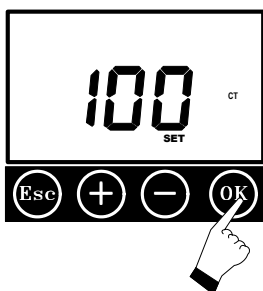
Single-phase network

$$C / K = 0.62 \times \frac{Q \times 1000}{U \times K}$$

Q: size of smallest step in Kvars

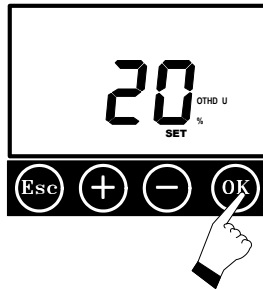
U: system voltage(V)

K: current transformer ratio



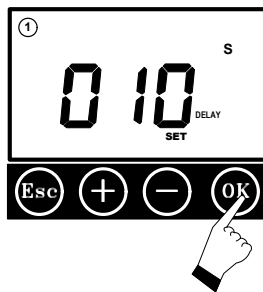
8. Total voltage harmonic distortion setting(OTH DU)

OTH DU icon appears, the programmed alarm level percentages displayed. OTH DU may be programmed from 5% to 40% .



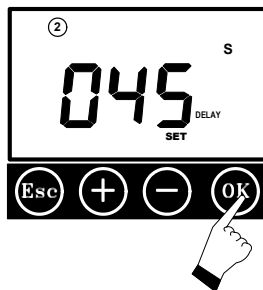
9. Connection delay time

DELAY and ① appear simultaneously. The programmed connection delay time value is displayed. The delay time may be programmed from 1s to 999s. S Indicates the unit in seconds.



10. Reconnection delay time

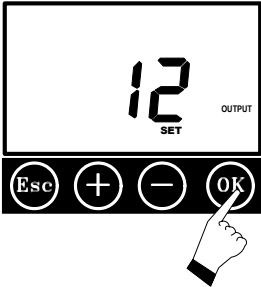
DELAY and ② appear simultaneously. The programmed reconnection delay time value is displayed. The delay time may be programmed from 1s to 999s. S indicates the unit in seconds.



11. OUTPUT

OUTPUT icon appears.

The programmed Output value is displayed. The output value can be programmed from 1 to 12 step as follows:

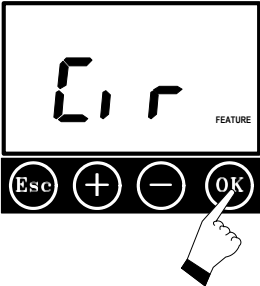
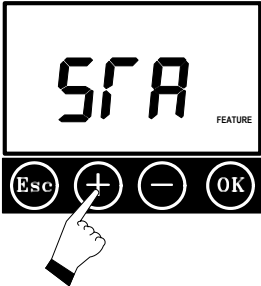


12.Stack/Circular

FEATURE indicates entering stack/circular switching strategy.

SrA indicates the controller choose stack strategy.

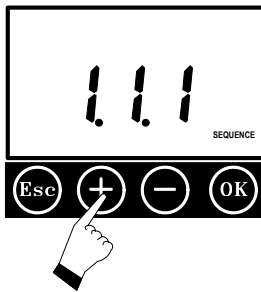
Cir indicates the controller choose circular strategy.



13.Sequence

SEQUENCE icon appears, the programmed sequence type is displayed according to the following table.

Operation sequences	Display
<u>1:1:1:1:....:1</u>	<u>1.1.1</u>
<u>1:1:2:2:2:....:2</u>	<u>1.2.2</u>
<u>1:1:2:3:2:....:2</u>	<u>1.2.3</u>
<u>1:1:2:4:4:....:4</u>	<u>1.2.4</u>
<u>1:1:2:2:4:....:4</u>	<u>1.1.2</u>
<u>1:2:2:2:2:....:2</u>	<u>2.2.2</u>
<u>1:2:2:4:4:....:4</u>	<u>2.2.4</u>
<u>1:2:3:3:3:....:3</u>	<u>2.3.3</u>
<u>1:2:3:4:4:....:4</u>	<u>2.3.4</u>
<u>1:2:3:6:6:....:6</u>	<u>2.3.6</u>
<u>1:2:4:4:4:....:4</u>	<u>2.4.4</u>
<u>1:2:4:8:4:....:4</u>	<u>2.4.8</u>



14. Alarm ON/OFF

🔊 Icon indicates alarm ON/OFF

To activate alarms On or Off by pressing - button Alarm symbol will be displayed on LCD, for more details of alarm symbols, see Alarm Symbols table on Page 30. The No.1 ~No.11 alarms on the table can be enabled/disabled.

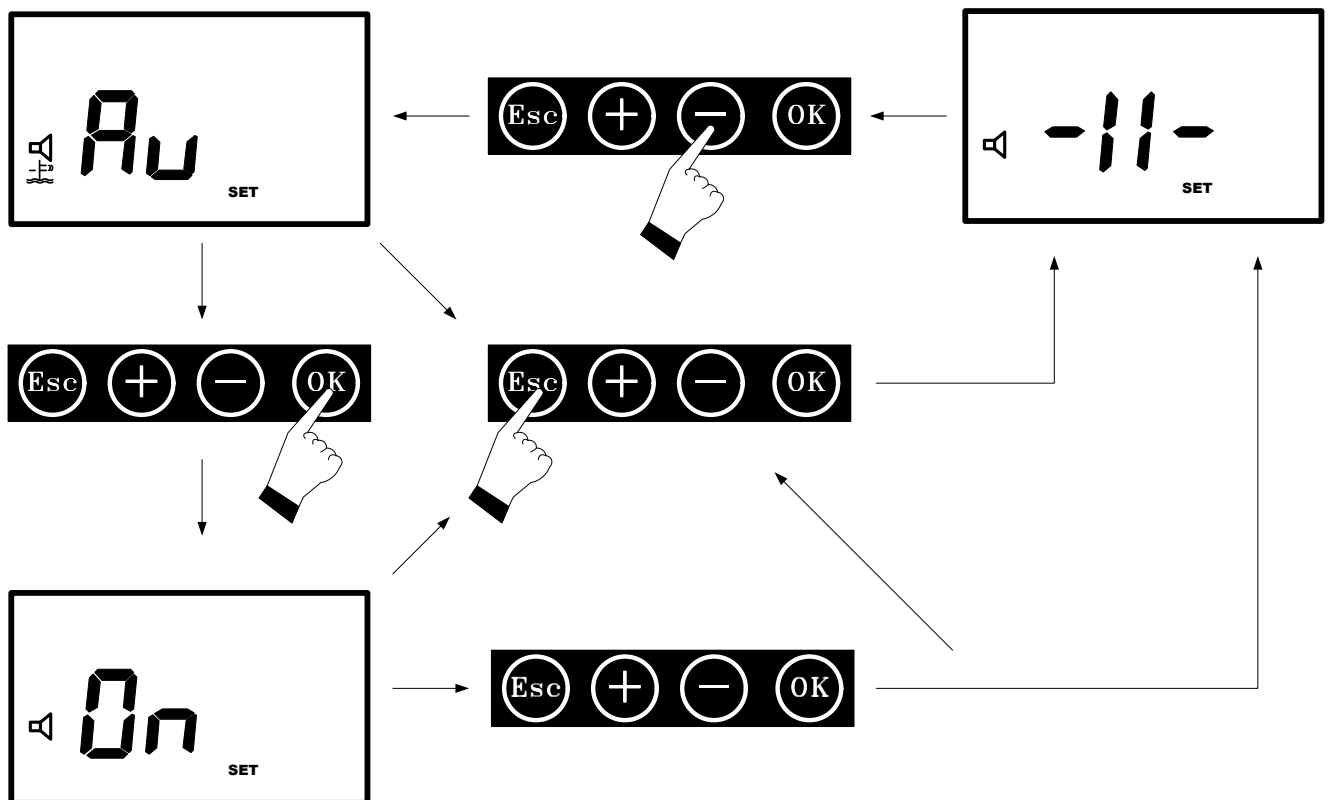
Display alarm state

On icon indicates Alarm is active.

OFF icon indicates Alarm is passive.

To enter next alarm setting by pressing **OK** button.

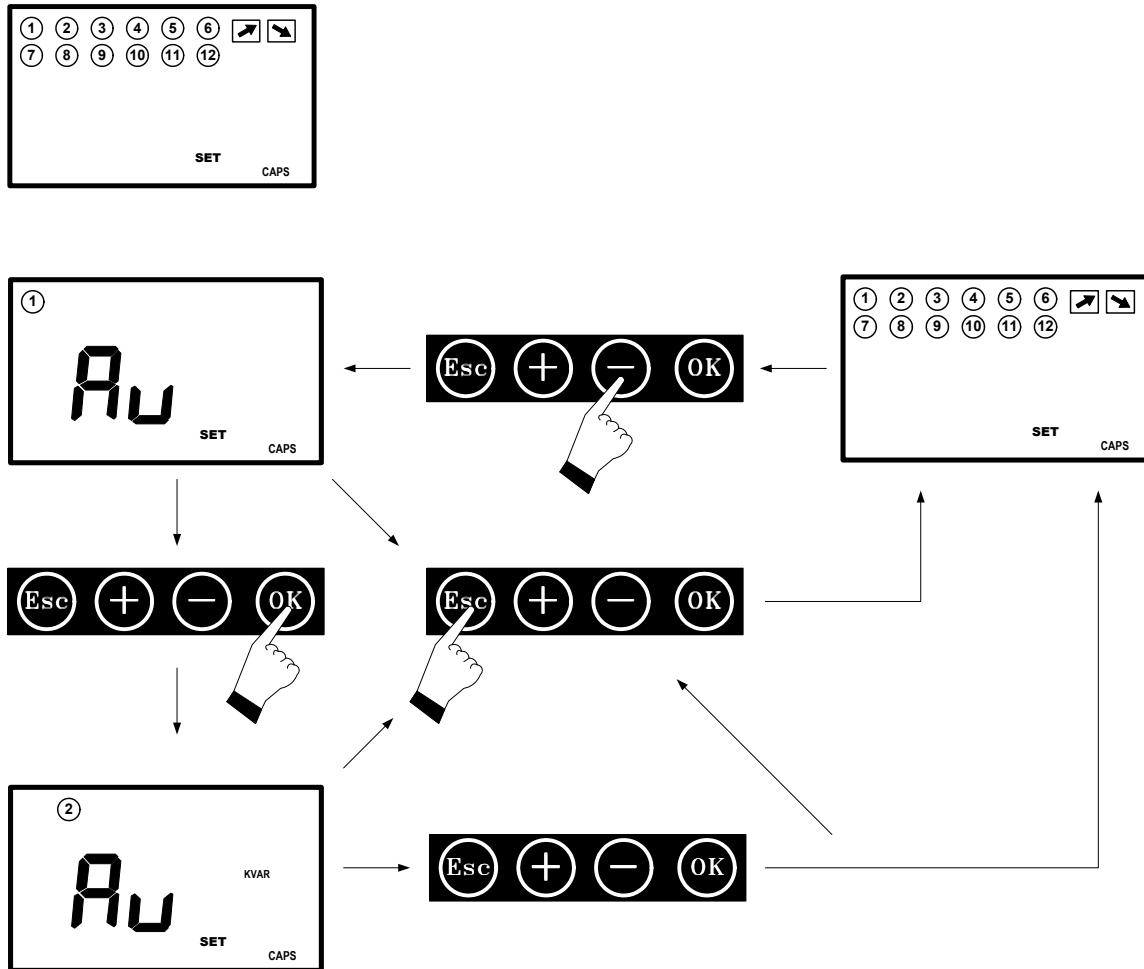
Return back automatically after setting is over or pressing **ESC** button.



15. Stage size in Kvar

Cap icon appears. The programmed stage size is displayed.

To activate stage size setting by pressing - button. **Kvar** indicates unit, The number at the top of LCD Display indicates which capacitor is programmed. The MAX stage size of capacitor is 400Kvar. To enter next editor of stage size by pressing **OK** button. Return back automatically after setting is over or pressing **ESC** button.



16. Auto/ Manual

Caps icon indicates step AUTO/ON/OFF

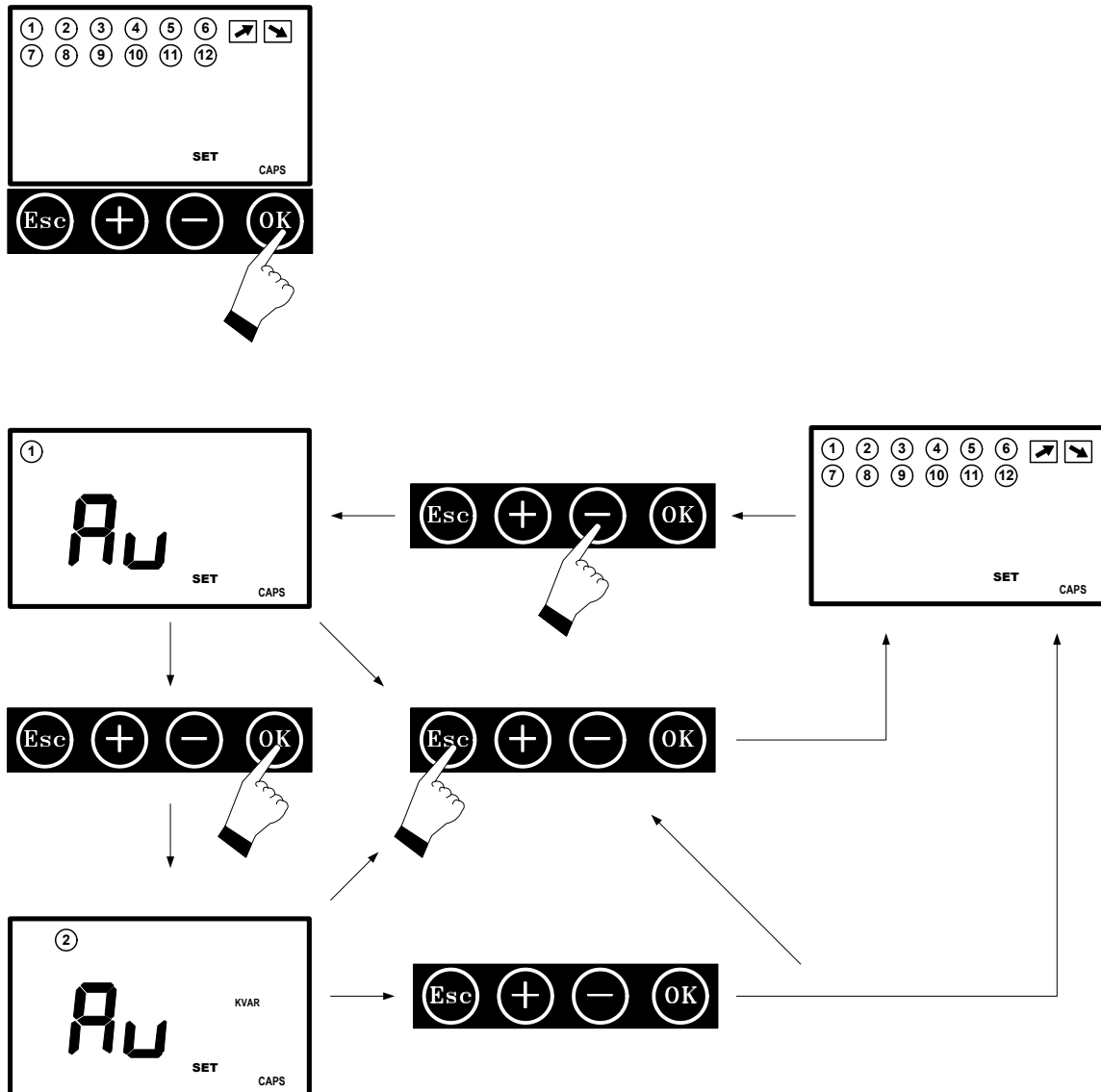
The symbol of 12 steps all appear on LCD display,  and  icons start flashing.

Au indicates capacitor step is AUTO operated state.


On indicates capacitor step is permanently ON state.

OFF indicates capacitor step is permanently OFF state.



To enter next editor, press **OK** button. Return back automatically after setting is over or pressing **ESC** button.



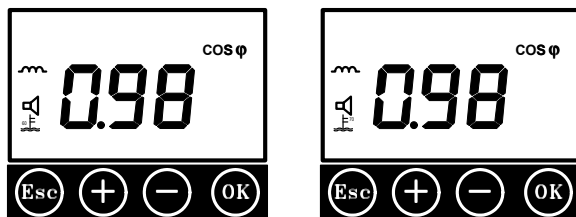
12. Alarm

When alarm is issued, the PF Controller will send alarm message,  icon appears on LCD Display, the PF Controller is also fitted with a normally open alarm contact (M1,M2).It is closed when alarm is issued.

1. Temperature-Alarm

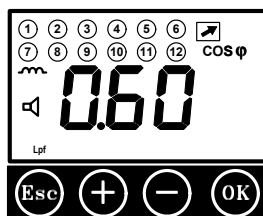
When the internal temperature of PF Controller rises to 60°C,alarm is issued.  starts flashing and connect to the alarm relay. When the internal temperature of PF Controller rises to 70°C,alarm is issued,  appears and connect to the alarm relay.

The controller disconnected all steps and recovers automatically 10 minutes after the temperature has fallen below the alarm level.



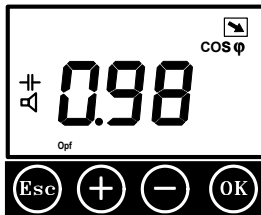
2. Low Power Factor — Alarm

The controller has switched all steps on. Network still stays on inductive and last for 10 minutes, alarm is issued, Lpf icon appears, and connect to alarm relay. If this alarm appears, it means that the capacitor bank is too small to reach target cos φ. To increase the capacitance of capacitor bank or select a lower cos φ.



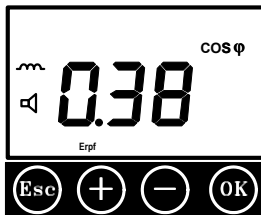
3. Network too capacitive—Alarm

The controller has switched all steps off. Network still stays on capacitive and last for 10 minutes . Alarm is issued, **OPF** icon appears, and connect to the alarm relay. Check the voltage measurement setting and external wiring of the controller and the possible fixed compensation used.



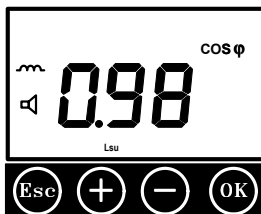
4. Abnormal COSφ -Alarm

When controller detects $\cos\phi < 0.5$, alarm is issued, **Erpf** icon appears, and connect to the alarm relay. The cause of this alarm in most case is that the voltage inputs are connected to wrong phases with respect to the CT. For correct connections, see the setting of CT Phase and PT Phase in Programming. Also a highly varying reactive power load can trigger this alarm.



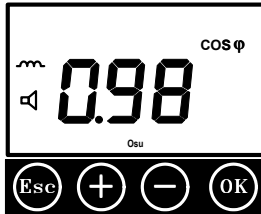
5. Low Voltage—Alarm

Network voltage is below 80% of nominal. The activation time is approximately 1 second. **Lsu** icon appears ,alarm is generated, and connect to the alarm relay, all steps are disconnected simultaneously. The normal regulation continues after 10 minutes period.



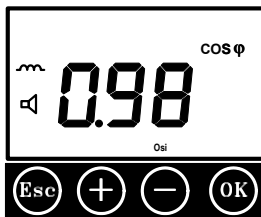
6.Over voltage—Alarm

The network voltage is higher than 110% of nominal. The activation time for 110% over voltage is 30 minutes and for 120% is 30 seconds. Alarm is issued, **Osu** icon appears. As a protection action, the PF Controller disconnects all steps and recovers automatically after a delay of 10 minutes.



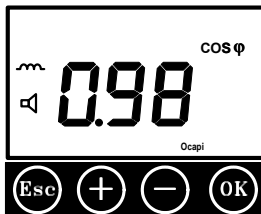
7.Over current—Alarm

The input current is higher than 110% of nominal. **OSI** icon appears, alarm is generated. The controller will recover automatically from this alarm. Check the CT.



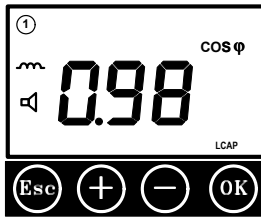
8.Capacitor overload—Alarm

$I_{rms}/I_1 > 1.5$, alarm is generated. **Ocap1** icon appears, the controller disconnects all steps, enters a 10 minute shutdown period and issue alarm. The normal regulation continues after 10 minutes period.



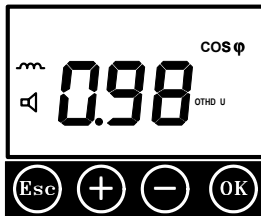
9.Capacitor output low—Alarm

Every time a capacitor step is switched on or off, the difference in reactive power is measured. Using these values as input to a low-pass filter, the condition of each step can be evaluated. If the capacitor output has fallen below 75% of nominal, an alarm is generated. **LCAP** icon appears. The number displayed on the top of LCD indicates the capacitance of this step is low.



10.TH(D)U—Alarm

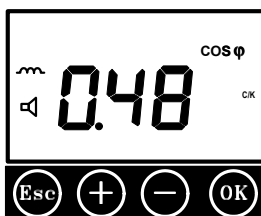
If the voltage harmonic distortion value exceeds alarm level, **OTH(U)** icon appears, an alarm is generated. The controller disconnects all the steps. The normal regulation continues after 10 minutes period.



11.Hunting—Alarm

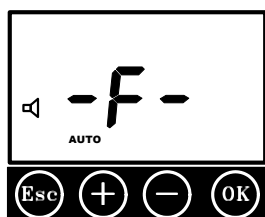
One or more capacitor steps are switched on and off in time intervals of reconnection delay. The C/K setting are too low. Calculate and adjust correct c/k setting or use the Auto C/K feature as described in section the setting of C/K in programming.

The activation time is 30 second response time. **C/K** icon appears, controller stops regulation and the normal regulation continues after 10 minutes period. Calculate and adjust correct c/k settings.



12.Wrong frequency

The controller has not been able to detect a correct network frequency, 50 or 60Hz. at startup, **-F-** icon appears, the controller stops regulation, parameters still can be set. The frequency must be correct within a +/- 2Hz limit.



Alarm symbols

Alarm	Thresholds	Symbol	Action
1.Overtemperature	>60°C		Message and alarm contact
	>70°C		Message and alarm contact, step disconnection
2.Low power factor		Lpf	Message and alarm contact
3.Network too capacitive		Opf	Message and alarm contact
4.Abnormal COS φ	< 0.5	Erpf	Message and alarm contact
5.Low voltage	< 80%	Lsu	Message and alarm contact, steps disconnection within 1s
6.Over voltage	>120%	Osu	Message and alarm contact, steps disconnection
7.Over current	>110%	Osi	Message and alarm contact, steps disconnection
8.Capacitor over load	$I_{rms}/I_1 > 1.5$	Ocap	Message and alarm contact, steps disconnection
9.Capacitor output low	<75%	Lcap	Message and alarm contact
10.Voltage distortion		OTHDU	Message and alarm contact, steps disconnection
11.Hunting		C/K	Message and alarm contact. Stops regulation for 10 minutes
12.Wrong frequency	50/60+/-2Hz	-F-	Stops regulation

13. Troubleshooting

Fault	Solution
The controller does not switch on or off steps although there is a considerable variable inductive load on the CT	<ul style="list-style-type: none">-Check that the controller is in automatic mode-Check setting of phase shift and c/k-Check that the CT shorting switch is opened
The controller does not seem to activate any steps.	Wait for the delay time between switching and/or the power outage delay time.
One of the arrow indicators flashes.	Normal situation when the actual inductive current varies around the set sensitivity (c/k)
The preset power factor is not achieved.	<ul style="list-style-type: none">-At lo or no load, a low power factor can correspond to a very small inductive current.-The corresponding capacitor steps are too large for compensation.-If the average $\cos\phi$ over a period of time is too low, the preset $\cos\phi$ may be increased.
The controller is connected but does not work (nothing on display)	Check the voltage setting.
All capacitors are switched on although the required reactive power is relatively low.	Check setting of phase and c/k setting
The $\cos\phi$ displayed on the LCD is negative and Erpf Alarm is active	Check CT connection and CT polarity connection setting

14. Technical specifications

Measuring system:	Micro-processor system for balanced three-phase networks or single-phase networks.
Operating voltage:	100v to 120v,220v to 240v,380v to 440v depending on type of PF Controller.
Voltage tolerance:	+/- 10% on indicated operating voltages.
Frequency range:	50 or 60 Hz +/- 2Hz(automatic adjustments to network frequency).
Current input:	5A (RMS)
Current input impedance:	< 0.1 Ohm.
Consumption:	15VA max
Output contact rating:	Potential free output contracts: AC:3A/400V,5A/250V,5A/120V DC:0.5A/110V,1.5A/60V,5A/28V
Alarm contact:	Normally closed contact. Max. continuous current: 5A Rated/max. breaking voltage:250Vac/440Vac
Power factor setting:	From 0.7 inductive to 0.7 capacitive.
Starting current setting(C/K):	0.01 to 1A.
Switching time between steps:	Programmed from 1s to 999s(independent of reactive load)
Saving-function:	All programmed parameters and modes are saved in a non-volatile memory.
Power outage release:	Quick automatic disconnection in less than 20ms (50Hz) in case of power outage or voltage drop.
Power outage reset delay time:	40s.
Overtoltage and undervoltage protection.	
Working with generative and regenerative loads.	
LCD contrast automatically compensated with temperature.	
Operating temperature:	-10 °C to 70°C .
Storage temperature:	-30°C to 85°C
mounting position:	vertical panel mounting.
Dimensions:	144x144x80mm(hxwxd).
Weight:	1Kg(unpacked).
Connector:	DEGSON
Front plate protection:	IP 40.
Relative humidity:	maximum 95%: non- condensing.
UL Marked.	

15. Disposal and recycling

The controller casing is made of ABS plastic and can be recycled or disposed in accordance with the local regulation. The controller package is made of corrugated cardboard and thus is an excellent material for recycling. It can also be incinerated.

The printed circuit board contains no recycling parts and must be disposed.