# USER'S MANUAL

# LL-PFC

LOW LOAD – POWER FACTOR CORRECTOR

This document contains the latest technical information about Low Load Power Factor Corrector panel LL-PFC which is a micro-controller based KVAR controller. The product, LL-PFC is sophisticated electronic equipment and, the user is advised to read this User's Manual carefully before attempting to install or operate the equipment.

***Trinity Energy Systems Pvt. Ltd.***

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# Introduction

The LL-PFC Panel is the `intelligence' which controls the automatic system for correction of the power factor. It senses the power factor by taking the ratio of the true-rms KVA of the system, and the KW. The LL-PFC panel calculates the KVAR requirement of the system (VxIxsin $\phi$). For correct operation of the panel, however, there are some minimum system requirements to be met. Unless the various points in the system which are mentioned below are correctly setup, proper operation of the panel cannot be expected.

### The Main features Available in this Model

- All readings are true RMS measurements
- 16x1 backlit LCD
- Automatic power factor control
- Programmable threshold PF
- Over Voltage Tripping
- Programmable Time Delay from 1 to 5 minutes for step switching
- Meter address selection for RS485 communication

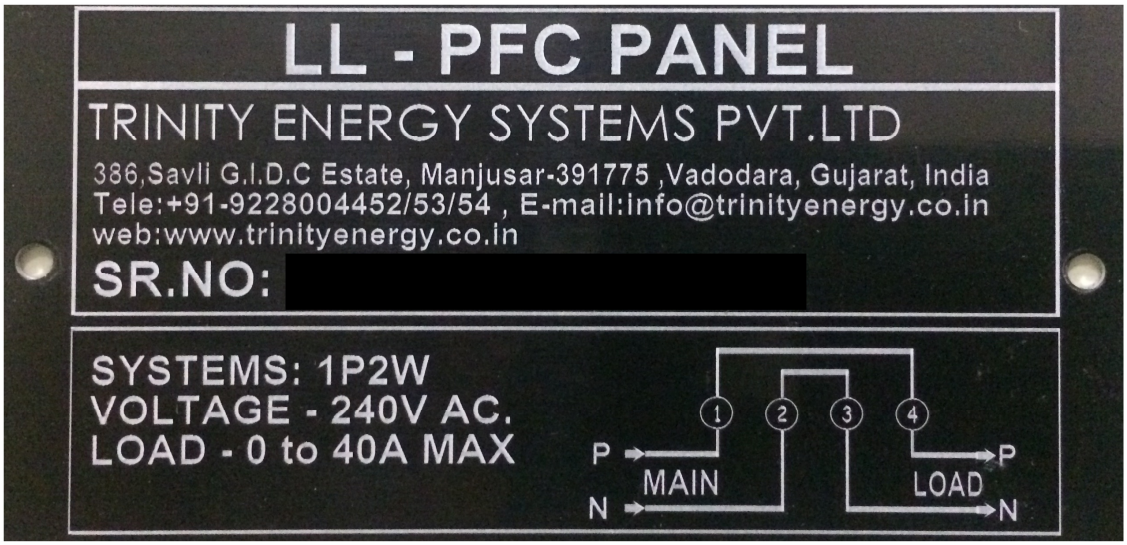
## Technical Specifications

| Parameters | | | |
|---|---|---|---|
| **Type** | | **Name** | **Statistics** |
| **INPUT** | | Supply | One Phase and Neutral |
| | | Voltage | Direct Voltage Input : 160 - 270V L-N<br>Burden : 0.5VA |
| | | Current | Range of Reading : 0.02 – 45A<br>Burden : < 1.0VA |
| | | Power Supply | Self powered from Mains |
| **MEASUREMENT** | True RMS Basic Parameters | Voltage (Volts L-N) | VL-N - Accuracy : 1.0% of Reading |
| | | Current | Accuracy : 1.0% of Reading |
| | | Line Frequency | 45 to 55 Hz, Accuracy : 0.5% of Reading For 50Hz |
| | Power | Reactive Power (Q) | Accuracy : 1.0% of Reading |
| | | Power Factor | Range of Reading : 0.05 - 1.00 Lag/Lead<br>Accuracy : 1.0% of Reading (I*PF*I≥0.5) |
| | Energy | Total Active Energy (KWh) | Range of Reading : 0 to 9999999.9<br>Accuracy : 1.0% of Reading |
| | | Total Apparent Energy (KVAh) | Range of Reading : 0 to 9999999.9<br>Accuracy : 1.0% of Reading |
| **MISCELLANEOUS** | Dimensions | Panel | 300 x 230 x 360 mm |
| | | Display | 16 x1 LCD |
| | | Operating temp | 10°C to 50°C |
| | | Weight | 8.2 Kgs (Approx.) |
| | | Min. Operating Current | 20mA |
| | Comm. | RS485 | Modbus-RTU protocol |
| | | | |

# Installation and Commissioning

The unit supports 1P2W type of electrical installation.

Below image shows terminal connections.




Follow below steps for connections.

1. Connect Phase and Neutral for Input to the terminal marked 1 and 2 respectively shown in below images.
2. Connect Phase and Neutral of Load to the terminal marked 4 and 3 respectively shown in below images.

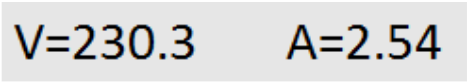
# Operational Details

The KVAR based controller LL-PFC Panel is a versatile unit, with all features needed to implement a robust PF maintenance system.

There are basically two modes of operation in LL-PFC Panel

1. Programming Mode
2. Run Mode.

After supplying power (160 - 270 VAC), the unit will display the power on message, TRINITY ESPL on LCD screen and by default comes into Run mode as shown below.




The unit can now be operated by using the following keys for both the Programming Mode and Run mode:


## Programming Mode

To make the LL-PFC Panel suitable for most field conditions and different types of loads, some parameters have been made programmable. The following parameters can be programmed by the user:

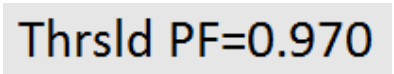
1. Threshold PF
2. Over Voltage tripping value
3. Time Delay
4. Meter Address
5. Auto sense of capacitor Bank

### 1. Setting Threshold PF

Threshold PF can be set from 0.900 to 0.990. Panel will start control action for PF correction only if System PF goes below Threshold PF in LAG or LEAD. For example if Threshold PF is set 0.980 and system PF is 0.985, Panel will not start control action. If System PF goes below 0.980 then only it will start control action for power factor correction.

To set Threshold PF, proceed as follows.

1. In Run Mode, press PROG RUN key for about four seconds continuously. The display will prompt PROG MODE. PRESS^.
2. Press ▲ key to enter into programming mode. The display will now prompt:



3. Press ENTR key again. Immediately 'P' starts blinking which shows that the parameter can now be changed. Set the Threshold PF value by pressing ▲ and ▼ keys according to your desire and then press ENTR key to confirm setting.
4. If other parameters need to be changed, do so using similar method, otherwise press PROG RUN key for about four seconds continuously. The panel will restart and enter into Run Mode.

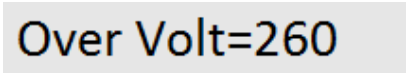
## 2. Setting Over Voltage Value

Over Voltage value can be set from 250 to 270 volts. If System voltage goes above over voltage value for constant 5 seconds, panel will switch OFF all the capacitor banks and over voltage LED (OV) will be ON. Now if system voltage goes below over voltage value minus 10 volts for constant 5 seconds, it will start control action and switch OFF over voltage (OV) LED.

For example if over voltage value is set 260 volts. If system voltage goes above 260 volts for constant 5 seconds, it will switch OFF all the capacitor banks and switch ON over voltage (OV) LED. Now if system voltage goes below 250 volts (260V-10V=250V), it will start control action and switch OFF over voltage (OV) LED.

To set Over Voltage value, proceed as follows.

1. In Run Mode, press PROG RUN key for about four seconds continuously. The display will prompt PROG MODE. PRESS^.
2. Press ▲ key to enter into programming mode. Press ▲ key again till the prompt shows:




3. Press ENTR key again. Immediately 'P' starts blinking which shows that the parameter can now be changed. Set the over volt value by pressing ▲ and ▼ keys according to your desire and then press ENTR key to confirm setting.
4. If other parameters need to be changed, do so using similar method, otherwise press PROG RUN key for about four seconds continuously. The panel will restart and enter into Run Mode.

## 3. Setting Time Delay

Time Delay can be set from 1 to 5 minutes. For the user defined time delay, the panel will not switch ON or OFF any capacitor bank. i.e. Panel will not take control action for PF correction. This is one type of digital dead band.

To set Time Delay, proceed as follows.

1. In Run Mode, press PROG RUN key for about four seconds continuously. The display will prompt PROG MODE. PRESS^.
2. Press ▲ key to enter into programming mode. Press ▲ key again till the prompt shows:


3. Press ENTR key again. Immediately 'P' starts blinking which shows that the parameter can now be changed. Set the Time Delay value by pressing ▲ and ▼ keys according to your desire and then press ENTR key to confirm setting.
4. If other parameters need to be changed, do so using similar method, otherwise press PROG RUN key for about four seconds continuously. The panel will restart and enter into Run Mode.

## 4. Setting Meter Address

Meter address can be set from 1 to 255. The unit also supports RS485 communication port and it should therefore be set the Meter Address from 1 to 255 for communication of it.

To set Meter Address, proceed as follows.

1. In Run Mode, press PROG RUN key for about four seconds continuously. The display will prompt PROG MODE. PRESS^.
2. Press ▲ key to enter into programming mode. Press ▲ key again till the prompt shows:


3. Press ENTR key again. Immediately 'P' starts blinking which shows that the parameter can now be changed. Set the Meter Address value by pressing ▲ and ▼ keys according to your desire and then press ENTR key to confirm setting.
4. If other parameters need to be changed, do so using similar method, otherwise press PROG RUN key for about four seconds continuously. The panel will restart and enter into Run Mode.

## 5. Performing Autosense of Capacitor Bank Sizes

When the Autosense is set to YES, the unit switch ON/OFF all relays one by one. The bank sizes will also display as capacitor banks get sensed one by one and the user therefore must be patient and wait till autosense is in progress. The process is vital for smooth operation of the unit. Once all capacitor banks are sensed, the unit will restart and take control action as per Time Delay.

To get Autosense, proceed as follows.

1. In Run Mode, press PROG RUN key for about four seconds continuously. The display will prompt PROG MODE. PRESS^.
2. Press ▲ key to enter into programming mode. Press ▲ key again till the prompt shows:

   AUTO_SENSE=YES

3. Press ENTR key again. Immediately 'P' starts blinking which shows that the parameter can now be changed. Select the Autosense to YES by pressing ▲ and ▼ keys and then press ENTR key to confirm setting.
4. The unit starts autosensing the capacitor stages one by one. After completing AUTOSENSEING, the unit will restart and enter into Run Mode.

## Run Mode

In the run mode, the various parameters measured by the meter are displayed sequentially on 16x1 backlit LCD.

### 1. Run Mode Display Pages

| Displays | Descriptions |
|---|---|
| V=230.5 A=10.45 | Display shows Voltage and Current. |
| 0.895 LG (0.705) | Display shows system PF with LAG/LEAD indication. Value displayed in bracket is system average PF. |
| KWh=14.89 | Display shows Active Energy. |
| KVAh=15.76 | Display shows Apparent Energy. |
| NEEDKVAR=2.51 | Display shows KVAR value needed to achieve unity PF (1.000). |
| KVAR=2.51 | Display shows System KVAR. |

| | |
|---|---|
| C_AMPS=4.58 | Display shows Capacitor Current. |
| C_KVAR=1.05 | Display shows Capacitor KVAR. |

## 2. Resetting Average PF

The integrated average PF parameter shown in display page can be reset by pressing ▲ key in Run Mode for about 5 seconds continuously. The integrated average PF is basically the ratio of KWh & KVAh energy consumption. After reset its value will go to 1.000.

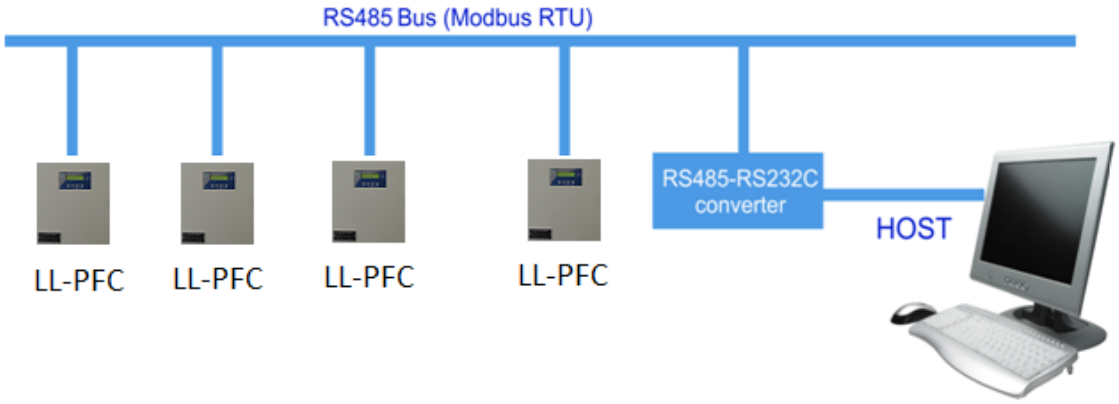
## 3. Freezing and unfreezing the Auto scroll

The Run Mode displays will always auto scroll by default with an interval of about 6 seconds. Each display can be frozen or unfrozen by pressing ENTR key and also moved up and down by pressing ▲ and ▼ keys. When display is frozen, it will blink 'F' at the end of 16x1 LCD.

## 4. LED Indication

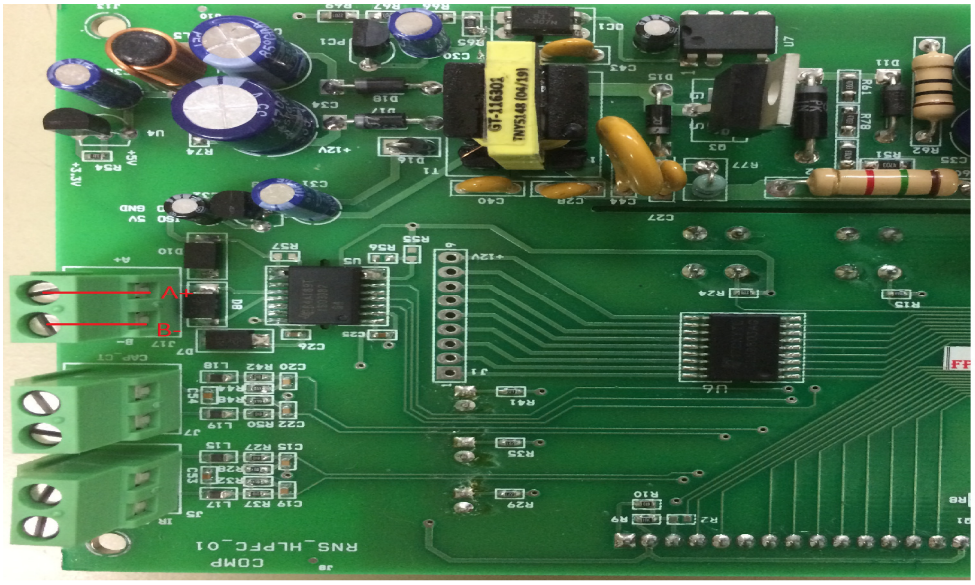

As shown in above image, RL1 to RL4 shows number of capacitors ON/OFF in panel. For example if capacitor 1, 2 and 4 is ON, RL1, RL2 and RL4 LEDs will be ON and RL3 LED will be OFF. Over voltage (OV) LED will be ON if over voltage is detected. RX/TX LED will be ON/OFF while RS485 communication. When panel receives any data GREEN LED will be ON and when panel sends any data, RED LED will be ON.

# Communication




## RS485 Connection to board

Connect A+ and B- of RS485 to RS232 converter to A+ and B- respectively of connector J17 on board as shown on below image.




The industrial standard RS-485 communication port option is also available in LL-PFC. This option makes it possible for a user to select LL-PFC to provide various system information into a variety of existing or new control systems and communication networks such as EMS/PLC/SCADA.

## Modbus RTU on RS485 Port

In order to download live data for the various system parameters, user can use RS485 connecting to SCADA or EMS software. LL-PFC supports an RS485 port with MODBUS-RTU protocol. The station ID for every panel is site selectable. The data which can be read using MODBUS query # 3 (Read Holding Registers) is provided in an address map, with the applicable multiplication factors, vide ***Appendix.***

Communication line parameters: 9600/8/N/1.

The register map is described below. All addresses are in decimal. All parameters are in unsigned long format. If illegal address is sent in the query or the host tries to read more than 40 bytes of data in one query, exception message is generated. The parameters name, address and multiplication factor are mentioned in Appendix.

## Appendix

| ADDRESS | PARAMETER | MF | TYPE |
|---|---|---|---|
| 200 | VOLT | x100 | Unsigned long |
| 202 | MAIN_AMPS | x100 | Unsigned long |
| 204 | KVAR | x100 | Unsigned long |
| 206 | NEEDKVAR | x100 | Unsigned long |
| 208 | CAP_AMPS | x100 | Unsigned long |
| 210 | CAP_KVAR | x100 | Unsigned long |
| 212 | KWH | x100 | Unsigned long |
| 214 | KVAH | x100 | Unsigned long |
| 216 | PF | x1000 | Unsigned long |
| 218 | AVG_PF | x1000 | Unsigned long |

## DEFINING MULTIPLICATION FACTOR

- PF has a multiplication factor of 1000. Thus, a PF value 0.985 LAG will send as 985 for providing resolution. Now if PF value is 0.985 LEAD, it will send 1985. Similarly KWH has a MF of 100. Thus, a KWH value of 148.63 will send as 14863.
- If an attempt is made to read some address other than the valid addresses, the exception response is sent.

## EXCEPTION CODE

In the event that the query from the HOST has no communication error, but there is some error in specifying the address of registers to be read, the meter returns an exception message. The format of the exception message will be as under:

| | | | | |
|---|---|---|---|---|
| Unit Address | 0x83 | Exception code | CRC | CRC |

**Exception Code can have only one value**, 02: if the address is not a valid, start address or host has requested more than 40 bytes of data, this code is returned.

P.O No. : ……

Customer : ……

Sr. No. : ……

Result of Test : ……

Remarks : ……

Test engineer : ……

Date : ……