

USER'S MANUAL

AUTOMATIC POWER FACTOR CORRECTION RELAY (APFCR)

This document contains the latest technical information about Automatic Power Factor Correction Relay (APFCR) which is a micro-controller based KVAR controller. The product, APFCR is sophisticated electronic equipment and, the user is advised to read this User's Manual carefully before attempting to install or operate the equipment.

Published on: (mention the date of publishing)
Document Version: 1.0

Warranty statement

Trinity warrants to the original retail purchaser of the Trinity product enclosed with this limited warranty statement that the product, if purchased new and used in the India conforms to the manufacturer's specifications and will be free from defects in workmanship and materials for a period of one year from the date of original purchase, unless expressly stated otherwise by Trinity, in a written format.

Should your Trinity product prove defective during the warranty period, please bring the product securely packaged in its original container or an equivalent, along with proof of the date of original purchase, to our Trinity Dealer or Factory. You are responsible for all costs (shipping, insurance, travel time) in getting the product to the service location. Trinity will, at its option, repair or replace on an exchange basis the defective unit, without charge for parts or labor. When warranty service involves the exchange of the product or of a part, the item replaced becomes Trinity property. The replacement unit may be new or refurbished to the Trinity standard of quality, and at Trinity's option, the replacement may be another model of like kind and quality. Trinity's liability for replacement of the covered product will not exceed the original retail selling price of the covered product. Exchange or replacement products or parts assume the remaining warranty period of the product covered by this limited warranty.

What This Warranty Does Not Cover:

This warranty does not apply to refurbished or reconditioned products. This warranty covers only normal use in India. This warranty does not cover damage to the Trinity product caused by parts or supplies not manufactured, distributed or certified by Trinity. This warranty is not transferable. This warranty does not cover third party parts, components or peripheral devices added to the Trinity product after its shipment from Trinity. Trinity is not responsible for warranty service should the Trinity label or logo or the rating label or serial number be removed or should the product fail to be properly maintained or fail to function properly as a result of misuse, abuse, improper installation, neglect, improper shipping, damage caused by disasters such as fire, flood, and lightning, improper electrical current, interaction with non-Trinity products, or service other than by an Trinity Authorized Service.

The warranty and remedy provided above are exclusive and in lieu of all other express or implied warranties including, but not limited to, the implied warranties of merchantability or fitness for a particular purpose. In the event, the remedies above fail, Trinity's entire liability shall be limited to a refund of the price paid for the Trinity product covered by this limited warranty. Except as provided in this written warranty, neither Trinity Energy Systems Pvt. Ltd. nor its affiliates shall be liable for any loss, inconvenience, or damage, including direct, special, incidental, or consequential damages, resulting from the use or inability to use the Trinity product, whether resulting from breach of warranty or any other legal theory.

Contents

Introduction 4
 System Consideration 4
 The Main Features Available in This System 5
 Technical Specifications 5

Installation and Commissioning..... 7
 Connection Scheme..... 9
 Capacitor Panel..... 10

Operational Details 11
 Programming Mode 12
 1. Setting the Main CT Ratio..... 12
 2. Selecting the Mode of Control Action 13
 3. Setting the Desired PF 13
 4. Setting the Time Delay in between Stages..... 14
 5. Setting On Delay with Lagging PF 14
 6. Setting OFF Delay with Leading PF 15
 7. Setting Damp Factor for Sensitivity of Control Action 16
 8. Setting Scroll Display in Run Mode 16
 9. Selecting a Capacitor Bank Stages 17
 10. Setting the Capacitor CT Ratio 17
 11. Performing Autosense of Capacitor Bank Sizes..... 18
 Run Mode 19

Control Outputs..... 20
 Trouble Shooting 20
 Trouble Shooting Guide..... 23

Introduction

The relay is meant for flush mounting in a panel for connection to the electrical system.

The relay 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 KW and the true rms KVA of the system, for any one phase of the three phase electrical system. This means that we connect phase and neutral as voltage inputs and the current of the same phase as current input. For correct operation of the relay, 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 relay cannot be expected.

System Consideration

1. If there is an imbalance loads in the three phases, the current transformer (CT) must be mounted on the phase which has maximum load. All the load currents and the capacitor current must pass through the bus on which the main CT is mounted. Ensure that this condition is achieved for proper operation of relay.
2. The actual load current at the time of operation should be more than 5% of the CT primary current rating. If this is not true, the relay will not operate.
3. The relay assumes a uniform loading of the three phase system. In case a capacitor banks are not operating and the relay indicates LEAD power factor, then the main CT, S1 and S2 must be interchanged so as to correct the polarity error.
4. The relay senses the power factor and switches ON or OFF the capacitor banks (through contactors in a panel), to bring power factor closest to the set value. For this the voltage must be within plus/minus 20 % of the rated voltage of the relay. The voltage is to be sensed between any phase and neutral.
5. If need is felt for an external auto/manual control, there is no harm in having one, provided it is implemented properly. An improperly implemented scheme might cause the maloperation of the panel. Make sure this is not the case before putting the blame on the relay.
6. Capacitor CT rating must be calculated for autosense as,

$$\text{CT Primary} \geq \text{Total KVAR} \times 1.6$$

7. Check all these points carefully in the system. If found ok, installation and commissioning of the relay is easy.

The Main Features Available in This System

- Full functional 16 x 1 backlight LCD
- Selectable main CT ratio and capacitor
- Automatic power factor control through PF and VAR modes
- Programmable target PF Setting
- Programmable time-delay for step switching
- Settable Damp factor so as to sensitive the transient jumps into system KVAR values
- Enable to display system KVAR value and KVAR needed for PF correction
- Stage wise LED indication
- Selectable capacitor bank stages and autosense of its bank sizes
- Selectable for Run Mode display scroll and unscroll
- Auto / Manual mode selection through external wiring scheme
- Test mode for checking proper wiring and relay connection in panel.



Technical Specifications

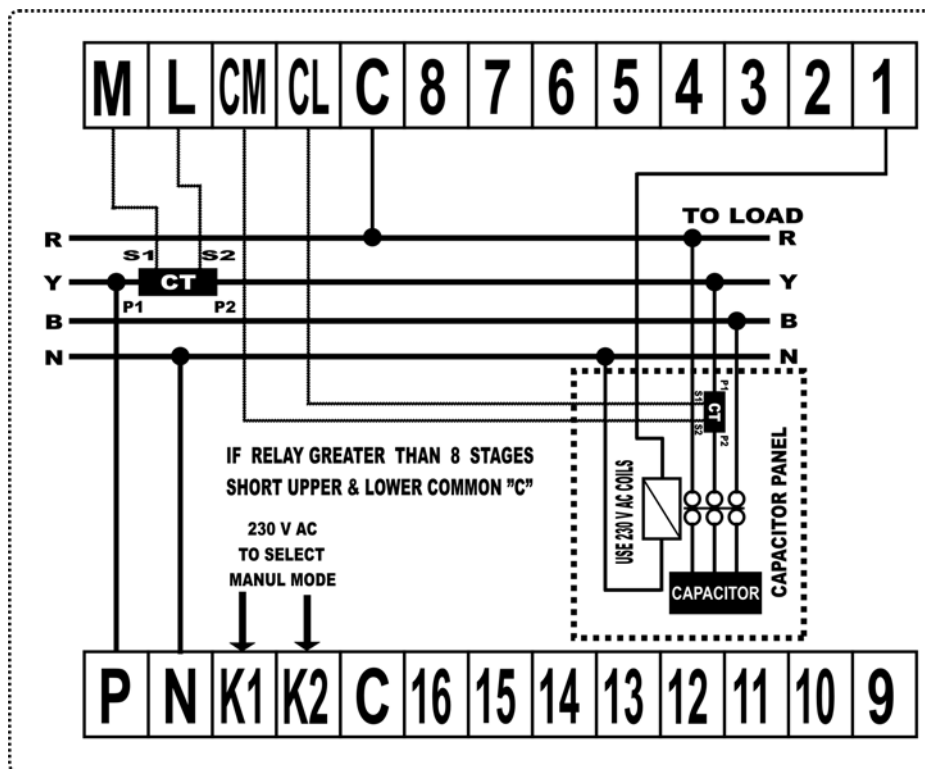
Parameter			
Type	Name	Statistics	
INPUT	Supply	One Phase and Neutral of a 3P4W system	
	Voltage	Direct Voltage Input : Up to 300V L-N Burden : 0.5VA	
	Current	Secondary Current Input : 5A or 1A (To be specified at the time of Ordering) CT Ratio : Site Selectable Range of Reading : 5 – 8000A Burden : < 1.0VA Overload : 5A CT = 6A RMS Continuous 1A CT = 1.2A RMS Continuous	
	Power Supply	Self Powered from mains. Wide operating Voltage SMPS: 80 VAC - 480 VAC, 50-60 Hz.	
OUTPUT	Relay	Switching Voltage : Max. 250 VAC Switching Power : Max. 1000W Expected Mechanical Life: >10 x 10 ⁶ switching operations. Expected Electrical Life : >4 x 10 ⁶ switching operations. @(Load = 200VA, Cosφ = 0.5)	
MEASUREMENT	True RMS Basic Parameters	Voltage (Volts L-N: VRN, VYN, VBN)	Accuracy : 0.5% of Reading
		Current (Amps IR, IY, IB)	Accuracy : 0.25% of Reading
		Capacitor Current	CT Ratio : Site Selectable Accuracy : 1.0% of Reading
		Power Factor	Accuracy : 1.0% of Reading (IPFI≥0.5) Range of Reading : 0.05 to 1.00 Lag/Lead
MISCELLANEOUS	Dimensions	Bezel	144 X 144 mm
		Panel Cutout	138 X 138 mm
		Depth of installation	80 mm
		Operating temp	10°C to 50°C
		Weight	0.730 Kgs (Approx)
		Min. Operating Current	1% of CT primary in VAR mode, 2.5% in PF mode.

Installation and Commissioning

The APFCR is a single phase autosense and the user is supposed to select a phase which has a maximum load with an imbalance and the main CT must be mounted on it. The phase itself must also be connected to supply power from it accordingly. In case of VAR control action, ensure that the capacitor CT must be mounted on its same phase in order to give true PF value and autosense for each capacitor banks. In case of Manual mode, 230 VAC must be supplied to the terminals marked, K1 and K2.

To install and commission the unit, proceed the following instructions:

1. Push the unit into the Panel and mount it by using the clamps provided.



2. In case Y-phase has maximum load with an imbalance load in your system, connect the two wires from the Y-phase main CT to terminals marked M and L such that S1 from CT goes to M and S2 from CT goes to L on the unit. Make sure that the three phases coming to the unit come through control fuses 1.0 Amp rating. This will protect the electronics inside from damage due to severe over voltages or phase faults in the system.
3. Connect the two wires from the Y-phase capacitor CT to terminals marked CM & CL such that S1 from CT goes to CM on the unit. (*The capacitor CT is applicable for operation in VAR mode only. In FIFO mode, the capacitor CT is not applicable*).

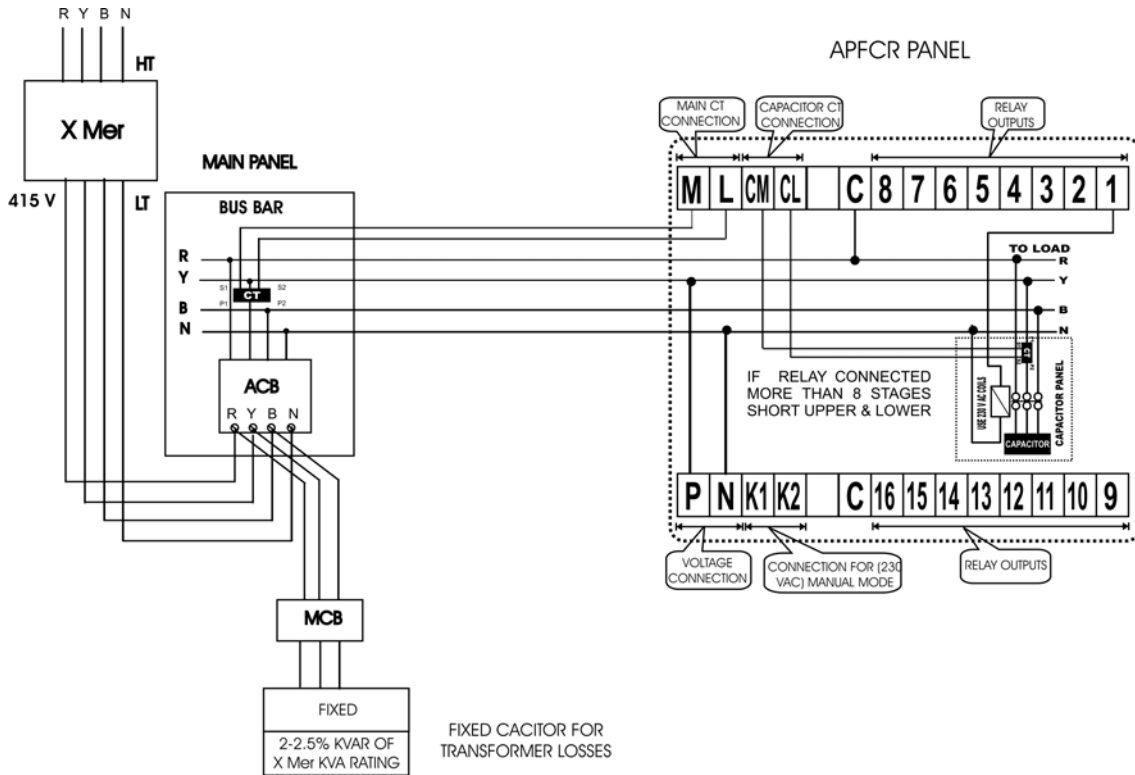
4. Connect the Y-phase and neutral wire to the terminals marked P and N such as shown above.

[Ensure that the phase used for voltage connection is same as the phase on which the main CT is mounted and the current direction must be also proper polarity. This is vital for the correct operation of APFCR].

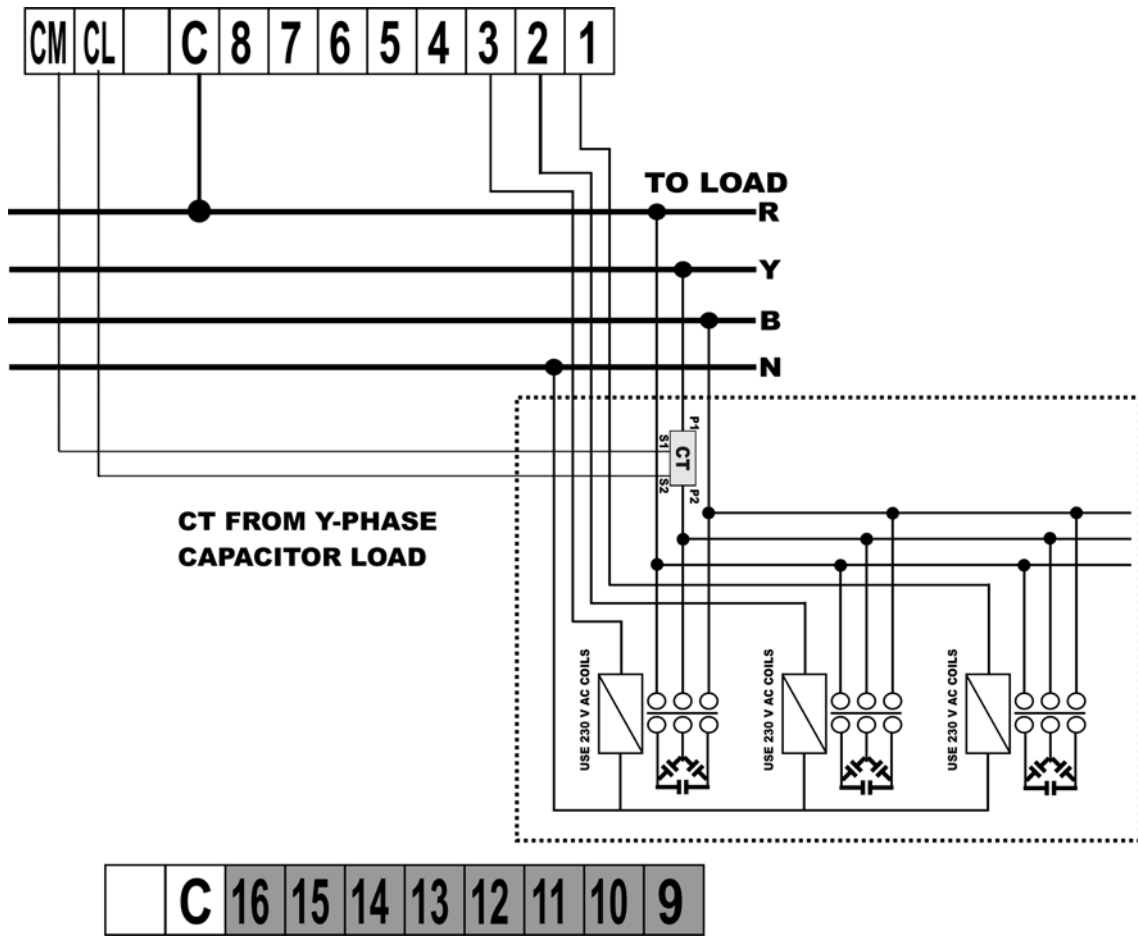
5. Switch on the three phases supply, the unit will then prompt a power receiving information such as TRINITY ESPL for about 2 to 3 seconds.
6. First of all, user should program the following parameters of the unit: such as main CT RATIO, control mode of operation to either PF OR VAR, desire PF, TIME DELAY, ON DELAY, OFF DELAY, DEMP and run mode display SCROLL, number of STAGES, both CT RATIO for CAPACITOR CT and AUTOSENSE only for VAR mode. (Refer *Operational Details* in the next section). *The proper operation of the relay can commence only after these parameters are defined.*

In case of AUTOSENSE, the unit switches on one bank at a time and also, displays the bank size of every stage. After AUTOSENSING is completed, the unit will return to Run Mode, displaying PF.

7. Now, the unit is ready for operation.



Connection Scheme



Capacitor Panel

Operational Details

The KVAR Based Controller APFCR is a versatile meter, with all the features needed to implement a robust electrical load management system. It can be configured to suit most PF correction and communication needs and, is also achieved by making as many parameters field programmable, as possible.

There are basically two modes of operation in APFCR:


1. Programming Mode
2. Run Mode

After supplying power (80 VAC - 480 VAC), the unit displays immediately power receiving information, TRINITY ESPL on LCD screen and by default, the display comes into Run Mode such as shown below.








Now, the unit can be operated by using the following keypad provided for both the Programming Mode and Run Mode such as shown below.



Press  key on Run Mode for about five seconds continuously, the unit will therefore enter into Programming Mode such as shown below.



Programming Mode



In order to operate for all the field programmable parameters, it is easy for user interface by pressing the keys such as , ,  and . Once the display is in Programming Mode, press  key to move into the following programmable parameters:

1. CT ratio for load currents
2. The mode of control action to either VAR or PF
3. Desired PF setting
4. Time delay - delay between two successive switching operations of relay
5. On Delay with Lagging PF
6. Off Delay with leading PF
7. Damp Factor for Sensitivity of Control Action
8. Scroll displays in the Run Mode
9. Capacitor Bank stages
10. CT ratio for current capacitor
11. Autosense of capacitor Bank sizes





1. Setting the Main CT Ratio

In order to give actual current values in your systems, the main CT Ratio between the primary and secondary current should be set accordingly. The CT Ratio can be set from 5 A to 8000 A.

To set the Main CT Ratio, proceed the following instructions:

1. On the Run Mode display, press  for about 5 seconds continuously. The display will prompt such as PROG MODE.PRESS^{♦♦♦♦}.
2. Press  key to enter into Main CT Ratio (CTR_M) and the display will therefore prompt such as shown below.


CTR_M=525

3. Press **ENTR** key. Immediately, 'P' starts blinking for about a one second pulse interval which also indicates that the parameter can now be changed. Set the MAIN CTR by pressing  and  keys until the desired value is received and then, press **ENTR** key so as to confirm the value and proceed into the next programmable parameter, CONTROL mode.
4. If the CONTROL mode is not desired, press  key to go to the desired parameter. Or else, press  key for about five seconds continuously to return into Run Mode.

2. Selecting the Mode of Control Action


For PF correction, there are two types of Control action such as **VAR** and **PF** which are also selectable at site. In case, the CONTROL action is selected to VAR, capacitor CT and AUTOSENSING parameters are applicable at site. However, both the two parameters will not be applicable if PF mode is selected.

To select the Control action, proceed the following instructions:

1. On the Run Mode display, press  for about 5 seconds continuously. The display will prompt such as PROG MODE.PRESS ∇ .
2. Press \blacktriangle key to enter into the CONTROL mode and the display will therefore prompt such as shown below.




CONTROL=VAR

3. Press **ENTR** key. Immediately, 'P' starts blinking for about a one second pulse interval which also indicates that the parameter can now be changed. Select the CONTROL mode to VAR or PF by pressing \blacktriangle and \blacktriangledown keys and then, press **ENTR** key so as to confirm the value and proceed into the next programmable parameter, SET_ PF.
4. If the SET_PF is not desired, press \blacktriangle key to go to the desired parameter. Or else, press  key for about five seconds continuously to return into Run Mode.

3. Setting the Desired PF


The desired PF can be set to either Lead or Lag side according to your requirement. In case of PF control action with lagging PF, the PF should be set in between 0.80 to 1. In case of VAR control action the desired PF should be set in between 0.80 lag to 1 lead. However, for a desired PF to be set for 0.99 with lead side should be set as 1.99 at site.

To set the desired PF, proceed the following instructions:

1. On the Run Mode display, press  for about 5 seconds continuously. The display will prompt such as PROG MODE.PRESS ∇ .
2. Press \blacktriangle key to enter into SET PF and the display will therefore prompt such as shown below.




SET_PF=1.99

3. Press **ENTR** key. Immediately, 'P' starts blinking for about a one second pulse interval which also indicates that the parameter can now be changed. Set the PF to either LEAD or LAG according to your requirement by pressing ▲ and ▼ keys until the desired value is received and then, press **ENTR** key so as to confirm the value and proceed into the next programmable parameter, TIME DELAY.
4. If the TIME DELAY is not desired, press ▲ key to go to the desired parameter. Or else, press  key for about five seconds continuously to return into Run Mode.

4. Setting the Time Delay in between stages


In order to calculate the required KVAR value for each bank stages, the Time Delay should be set from 20 seconds to 180 seconds for a time period. During the time period the unit will calculate and prompt the KVAR value for each switching relays which gives you the number of bank stages to be on. However, the unit stops taking control action and waits for the setting time. This is one type of digital dead band in case of VAR control action.

To set the Time Delay, proceed the following instructions:

1. On the Run Mode display, press  for about 5 seconds continuously. The display will prompt such as PROG MODE.PRESS[▲].
2. Press ▲ key to enter into Time Delay (TIME_D) and the display will therefore prompt such as shown below.



TIME_D=50


3. Press **ENTR** key. Immediately, 'P' starts blinking for about a one second pulse interval which also indicates that the parameter can now be changed. Set the Time Delay by pressing ▲ and ▼ keys until the desired value is received and then, press **ENTR** key so as to confirm the value and proceed into the next programmable parameter, On Delay.
4. If the On Delay is not desired, press ▲ key to go to the desired parameter. Or else, press  key for about five seconds continuously to return into Run Mode.

5. Setting On Delay with Lagging PF

In case of PF control action, On Delay is freely programmable from 10 numbers to 20 numbers countdown. If the system PF falls below the target PF with lagging PF, the unit checks whether the switching capacitor could be persistent or no during which the set On Delay number counts down. If target PF is not achieved during the countdown, the relay switches on the capacitor bank one by one in order to correct


PF.

To set the On Delay, proceed the following instructions:

1. On the Run Mode display, press  for about 5 seconds continuously. The display will prompt such as PROG MODE.PRESS ∇ .
2. Press \blacktriangle key to enter into On Delay and the display will therefore prompt such as shown below.




ON_DELAY=15

3. Press **ENTR** key. Immediately, 'P' starts blinking for about a one second pulse interval which also indicates that the parameter can now be changed. Set the On Delay by pressing \blacktriangle and \blacktriangledown keys until the desired value is received and then, press **ENTR** key so as to confirm the value and proceed into the next programmable parameter, Off Delay.
4. If the Off Delay is not desired, press \blacktriangle key to go to the desired parameter. Or else, press  key for about five seconds continuously to return into Run Mode.

6. Setting OFF Delay with Leading PF

In case of PF control action, On Delay is freely programmable from 10 numbers to 20 numbers countdown. If the system PF falls below the target PF with leading PF, the unit checks whether the switching capacitor could be persistent or no during which the set Off Delay number counts down. If target PF is not achieved during the countdown, the relay switches off the first capacitor bank on in order to correct PF with a FIFO mode of control action.


To set the Off Delay, proceed the following instructions:

1. On the Run Mode display, press  for about 5 seconds continuously. The display will prompt such as PROG MODE.PRESS ∇ .
2. Press \blacktriangle key to enter into Off Delay and the display will therefore prompt such as shown below.



OFF_DELAY=15


3. Press **ENTR** key. Immediately, 'P' starts blinking for about a one second pulse interval which also indicates that the parameter can now be changed. Set the Off Delay by pressing \blacktriangle and \blacktriangledown keys until the desired value is received and then, press **ENTR** key so as to confirm the value and proceed into the next programmable parameter, Damp.

4. If the Damp is not desired, press ▲ key to go to the desired parameter. Or else, press  key for about five seconds continuously to return into Run Mode.


7 Setting Damp Factor for Sensitivity of Control Action

In case of VAR mode of control action, Damp factor should be set from 5 numbers to 20 numbers countdown so as to slow down and sense the transient jumps in response of the control algorithm. Setting a higher value of DAMP will give more slowdown the response of the relay to transient jumps in system KVAR values.

To set the Damp factor, proceed the following instructions:

1. On the Run Mode display, press  for about 5 seconds continuously. The display will prompt such as PROG MODE.PRESS[▲].
2. Press ▲ key to enter into DAMP and the display will therefore prompt such as shown below.


DAMP=20

3. Press **ENTR** key. Immediately, 'P' starts blinking for about a one second pulse interval which also indicates that the parameter can now be changed. Set the Damp by pressing ▲ and ▼ keys until the desired value is received and then, press **ENTR** key so as to confirm the value and proceed into the next programmable parameter, Scroll.
4. If the Scroll is not desired, press ▲ key to go to the desired parameter. Or else, press  key for about five seconds continuously to return into Run Mode.


8. Setting Scroll Display in Run Mode

The Run Mode displays will always autoscroll by default which starts displaying PF and is also freely programmable from 5 to 12 seconds to each parameter on a cyclic basis. If the SCROLL is set to 0, the display will not autoscroll and must be moved up and down by pressing ▲ and ▼ keys.

To set the Scroll, proceed the following instructions:

1. On the Run Mode display, press  for about 5 seconds continuously. The display will prompt such as PROG MODE.PRESS[▲].
2. Press ▲ key to enter into Scroll and the display will therefore prompt such as shown below.


SCROLL=60

3. Press **ENTR** key. Immediately, 'P' starts blinking for about a one second pulse interval which also indicates that the parameter can now be changed. Set the Scroll by pressing ▲ and ▼ keys until the desired value is received and then, press **ENTR** key so as to confirm the value and proceed into the next programmable parameter, Stages.
4. If the Stages are not desired, press ▲ key to go to the desired parameter. Or else, press  key for about five seconds continuously to return into Run Mode.


9. Selecting a Capacitor Bank Stages

APFCR supports upto 16 capacitor bank Stages. For user's system requirement, the number of Stages can be selected from 2 to 16 so as to operate the KVAR control.

To select the Stages, proceed the following instructions:

1. On the Run Mode display, press  for about 5 seconds continuously. The display will prompt such as PROG MODE.PRESS[▲].
2. Press ▲ key to enter into STAGE and the display will therefore prompt such as shown below.


STAGE=8

3. Press **ENTR** key. Immediately, 'P' starts blinking for about a one second pulse interval which also indicates that the parameter can now be changed. Select the Stages by pressing ▲ and ▼ keys and then, press **ENTR** key so as to confirm the value and proceed into the next programmable parameter, capacitor CT Ratio.
4. If the CONTROL mode is not desired, press ▲ key to go to the desired parameter. Or else, press  key for about five seconds continuously to return into Run Mode.


10. Setting the Capacitor CT Ratio

For the application of VAR mode of control action, the capacitor CT Ratio in between the primary and secondary current should be set from 5 A to 5000 A.

To set Capacitor CT Ratio, proceed the following instructions:

1. On the Run Mode display, press  for about 5 seconds continuously. The display will prompt such as PROG MODE.PRESS[▲].
2. Press **▲** key to enter into CAPACITOR CT and the display will therefore prompt such as shown below.


```
CTR_C =220
```

3. Press **ENTR** key. Immediately, 'P' starts blinking for about a one second pulse interval which also indicates that the parameter can now be changed. Set the capacitor CT Ratio by pressing **▲** and **▼** keys until the desired value is received and then, press **ENTR** key so as to confirm the value and proceed into the next programmable parameter, Autosensing.
4. If the AUTOSENSE is not desired, press **▲** key to go to the desired parameter. Or else, press  key for about five seconds continuously to return into Run Mode.


11. Performing Autosense of Capacitor Bank Sizes

In case, the Autosense is set to YES, the unit switches on all relays one by one. The bank sizes will also display as they get sensed one by one and the user therefore must be patient and wait for about 4 to 5 minutes while the autosense is in progress. This process is vital for the smooth operation of the relay. Once all capacitor banks could be sensed, the relay will restart for control action after a while.

To set the Autosense of capacitor, proceed the following instructions:

1. On the Run Mode display, press  for about 5 seconds continuously. The display will prompt such as PROG MODE.PRESS[▲].
2. Press **▲** key to enter into AUTOSENSE and the display will therefore prompt such as shown below.

```
AUTO_SENSE=YES
```

3. Press **ENTR** key. Immediately, 'P' starts blinking for about a one second pulse interval which also indicates that the parameter can now be changed. Select the AUTOSENSE to YES by pressing **▲** and **▼** keys and then, press **ENTR** key so as to confirm the value.
4. If the setting is completed, press  key for about five seconds continuously to return into Run Mode.

Run Mode

In the run mode, the various parameters calculated by the APFCR are displayed on different pages on a 16 X 1 backlit LC Display. There are five displays with the different parameters showing its system values. Those displays can be altered and analyzed one by one in this mode. The displays can also be frozen and unfrozen according to your convenience by programming the settable parameter at site.

1. Screen Displays

Press ▲ or ▼ keys on Run Mode so as to receive the following displays:

Displays	Descriptions
PF=0.99	The first display shows system PF.
VOLTS=242.3	The second display shows system voltage.
AMPS=373.9	The third display shows system current.
NEED KVAR=2.42	The fourth display shows the KVAR needed to achieve the target PF.
SYS KVAR=34.3 LG	The fifth display shows the system KVAR with lagging PF.

Control Outputs

The relays are protected by snubbers against fast voltage transients which occur when inductive loads are switched off and therefore, the following points should be taken care when using these relay contacts:

- Use 230V AC coils only in the contactors. DO NOT use 440V AC coils.
- DO NOT switch small loads like electronic Hooters, small relays with 230V AC coils etc., directly from the relay contact of APFCR. If done so, the small leakage current from the snubbers will not allow these loads to be switched off fully. The electronic hooters thus will give a low hum continuously, and the small relays will switch on but not switch off.
- Use these relay contacts to switch an Auxiliary contactor and put the load on the contactor contacts.

For correct operation, various points in the system need attention and unless these are correctly set up, proper operation cannot be expected.

These points are noted in section (A) and (B) such as subsequent sections deal with operational checks, setting up and trouble shooting.

(A) Trouble Shooting

The **APFCR** is robust electronic equipment and must be handled with all the care merited by it. It is quite rugged and will withstand a few hard knocks, but this cannot make up for the deficiency in system design.

Repairs at site are not recommended because at most this can only be a patch work, and sustained reliability is difficult to achieve with a site repaired Relay. This section on Troubleshooting therefore deals with fault finding in the system and to establish whether the Relay is defective or whether it is a system problem. If the fault is seen to lie entirely with the Relay, it will have to be sent to factory for repairs.

System faults can be classified into three categories:

- Those related to the basic configuration of the system.
- Those related to the errors and mistakes in the implementation of the system design.
- Those related to the faults in the actual equipment.

a. Faults related to the actual system design:

The most common faults are:

External Manual Control not implemented properly

Here many designers provide a 'Starter-relay' configuration for the manual control, and just bring the connection from the relay contact to the contactor.

There are two problems with this:

- i. Timing function is not provided from Manual control.
- ii. The scheme does not work in Auto mode. The remedy is to examine the drawings and make changes at site. The temporary remedy is to change the relay mode to Manual, and use the panel manually. The better alternative is to change the control wiring to incorporate suitable isolating contacts, timers etc. to make a proper system.

CT of the Capacitor Panel itself connected to the Relay

In this case obviously the Relay does not read the power factor of the system. There is no current through the Relay when capacitors are off. If you force one of the capacitors on, it may cause an indication of full Lead (if the current taken by the capacitor is sufficiently high). If the Relay is in Auto mode, it will switch off the capacitor immediately, and nothing further will happen.

The only remedy is to disconnect the CTs (short the secondary!) and bring a six core cable from the CTs of the Main Incomer. Also check that the CT rating is near the actual full load current. Change the CT if it is too large.

Faults related to the external cabling

Only two cables originate in the panel: ***the Power Incomer to the panel*** and ***the CT connections***.

The power flow from the source (such as the main transformer) to the capacitor panel as well as to the entire load must be through the bus on which the CTs are mounted. It is best to provide separate CTs for the Relay to avoid problems.

b. Faults Related to the actual site conditions:

These faults occur when the actual site conditions are different from those assumed by the designer of the system. These faults relate to the location of the load feeders on the busbar, buscouplers, and connections from transformers etc. ***The locations of the CTs are the most important factor as far as the Relay is concerned.***

Another problem frequently encountered is that of insufficient load on the power system. This might occur because the Plant has not been commissioned fully, or because the system allows for future expansion. In either case the actual current through the CT is very low compared to the rating of the CT.

In such conditions, the relay, (specially, if there are no small banks in the capacitor panel) will not take any control action at all. However, the transformer losses will cause the monthly average PF to show up as very poor. The remedy is to connect a small bank directly (independent of the automatic control scheme) for compensating transformer losses.

c. Faults related to the actual equipments:

These relate to the defects in the connected equipments. Again an exhaustive list is beyond the scope of this document. A few are listed below:

Blown fuses, shorted CT, shorted voltage connections, switches that do not make contact, open connections etc. Check everything - before, during and after commissioning and you will be rewarded with a finely tuned system which will give you years of trouble-free service.

(B) Trouble Shooting Guide

(Read carefully section (A). Troubleshooting as before)

1. **Relay is dead.** Check that the specified voltages are available at the voltage terminals of the Relay. Do not check with a neon tester. Use a multi-meter and check physically the voltages available at the R-Y, Y-B and B-R terminals. If the voltages are available and the Relay is dead, the Relay in all probability is defective. Please send it back for repairs.
2. **Relay does not indicate expected power factor.** Your wiring is wrong. Change around the wires leading to the R,Y,B voltage terminals of the Relay. There are six combinations, and only one of them is correct. Try all six. Also check that your expected power factor estimate is reasonably correct.
3. **Relay switches the capacitors on, but the power factor does not improve**

The source of this fault could be:

 - a. The CT is located only on the Load bus, and capacitor current is not passing through the CT. Change the location of the CT to the true main Incomer.
 - b. The capacitors are all defective. This seemingly unlikely fault has occurred at many sites. Measure the current in each lead of each capacitor as it switches on, to check. This would also reveal if all the fuses of all the capacitors have blown.
4. **Relay switches on all the capacitors, the power factor improves, but does not reach the set value.** At the extreme is the possibility that the total installed KVAR is too low. In this case, the Relay switches on all the capacitors but the power factor does not improve to the set value. Check if the capacitors are healthy. Remedy is to add capacitors and add stages. This may need total re-configuration of the panel wiring.
5. **Relay switches on the contactors but does not switch them off, though indication on the Relay is correct.** All contactors switch off simultaneously when the last switch off occurs. Your external Manual Control is not configured correctly. The contactors are latching up through their holding contacts. Extensive rewiring is required to remedy this fault. This is also possible if 440 VAC coils have been used.
6. **Relay is on but PF meter indicates 1.0 always.** The current through the Relay is inadequate.

P.O No. :

Customer :

Sr. No. :

Routine and function tests conducted to relevant standards and our Specifications/Literature/O & M Manual. Traceability: tested against "MTE" Standard Model PRS1.3 having basic accuracy of 0.05% traceable upto International Standards derived using appropriate ratio techniques.

Result of Test :

Remarks :

Test engineer :

Date :
