Automatic Power Factor Controller

APFC-05

User Manual
Version 1.0

<u>NOTE</u>

These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connection with installation, operation or maintenance.

Should further information be desired or should particular problems arise which are not covered sufficiently for the purchasers purposes, the matter should be referred to our office.

The contents of this instruction Manual shall not become part of or modify any prior or existing agreement or relationship. Any statements contained herein do not create new warranties or modify the existing warranty.

Because of continuous improvements efforts by TAS PowerTek in their Product's Features and Specifications, the Product as well as the content of the User Manual is likely to get updated. Therefore, please always refer to the User Manual supplied to the customer along with the Product, at the time of product dispatch.

CAUTIONS:
High voltage!
APFC may only be used indoor!
Make sure that the discharge time set in the controller matches the capacitor discharge time!

This User Manual for TAS APFC-05/xx Controller refers to the Firmware Version 1.0.0
Dated: 9th Jan. 2015.

Index

Features

- Totally Micro-processor controlled Digital Signal processing logic for measurements and control.
- Load V, I, odd harmonic coefficients up to 15th harmonic.
- Various modes for switching, viz:
    - Binary
    - Un-equal (user defined)
    - C-Series (preset series)
    - E-Series (user defined)
- Output banks control for either 4 , 6 or 8 Capacitor Banks.
- Standard 96x96 mm Plastic Cabinet for panel door flush mounting.

- Protections provided:
    - Over/Under Voltage
    - Over / Under load current
    - Over Temperature internal to APFC-05 Unit

    All these are user settable

Specifications

- Feed-back Voltage: 1-Phase, 2-Wire, 230Volt Ac, (+/- 10%)
- AC Mains Supply Line Frequency: 50/60 Hz.
- Current input: Selectable 1A or 5A for load.
- Auxiliary Supply: 1-Phase, 230V (+/- 10%).
- Correction time:
  Selectable in Seconds from 1 Sec. to 65530 Sec.
- Output Commands: 4 (APFC-05/4) or 6 (APFC-05/6)
  or 8 (APFC-05/8).
  (Isolated 'NO' contacts of rating Inductive Load 0.5A/250Vac).
- Operating Temperature: 0 to +55oC.
- Storage temperature: 0 to +70oC.
- Relative Humidity: 10% to 95% (Non Condensing).
- AC Mains Supply frequency: 47Hz to 53Hz,or 57Hz to 63Hz.

Mechanical dimensions:
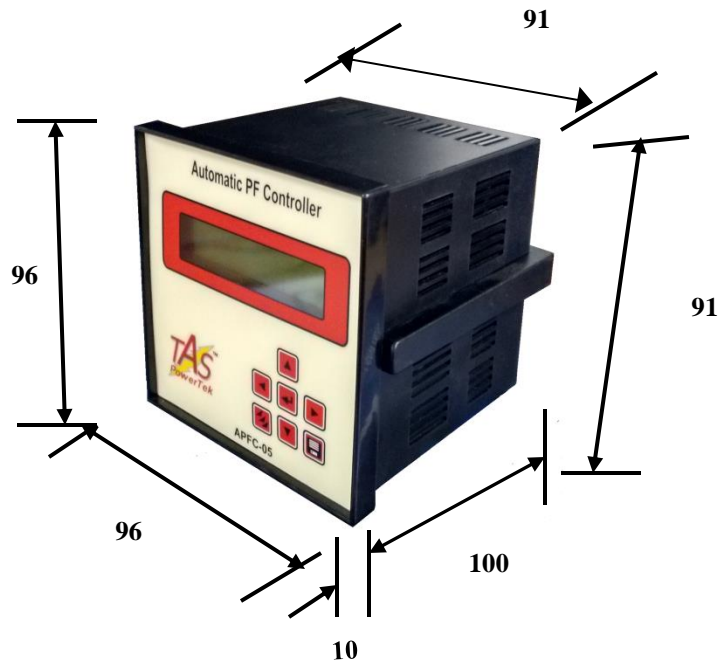
All Dimensions
given are in mm.

Recommended size for cut-out on panel door is 92 x 92 mm.
Max. weight: (with clamps and terminals) = Approx. 0.6 Kgs.
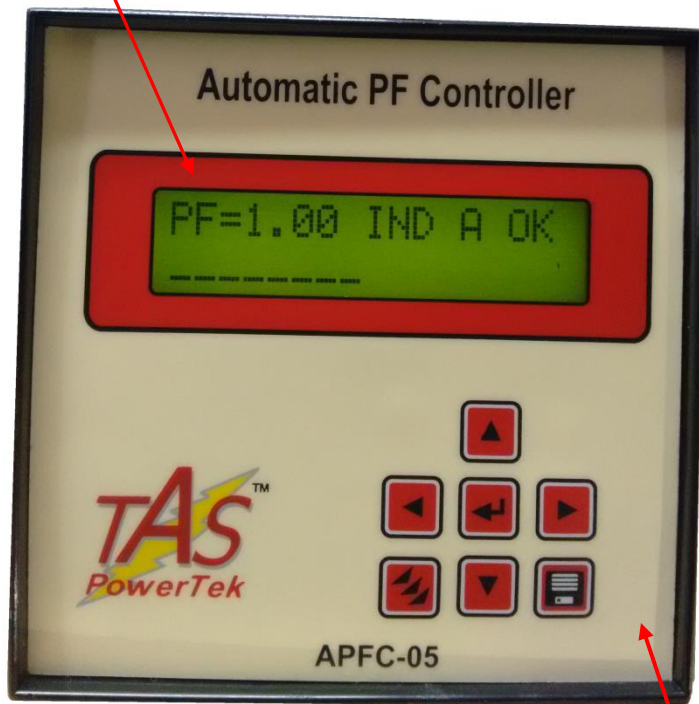
Front fascia

Keyboard, LCD display

LCD Display

LCD Display Contrast Adjustment
Slot for small Allen-Key, at the Top Surface

Key pad

BACK SIDE TERMINALS

•Auxiliary & Measurement Voltage

Load Current CT

Output Terminals

F2 = Relay Contacts Fuse, 5 Amp, Fast-Blow

PF correction technique

Case-1: PF-UPPER & PF-LOWER both set as inductive:

PF_{LOWER.}   kVAr (Ind)   PF_{LOWER.}

smallest Capacitor bank kVAr x 2 width.

PF_{UPPER.}   PF_{UPPER.}

– kW.   kW.

kVAr (Cap)
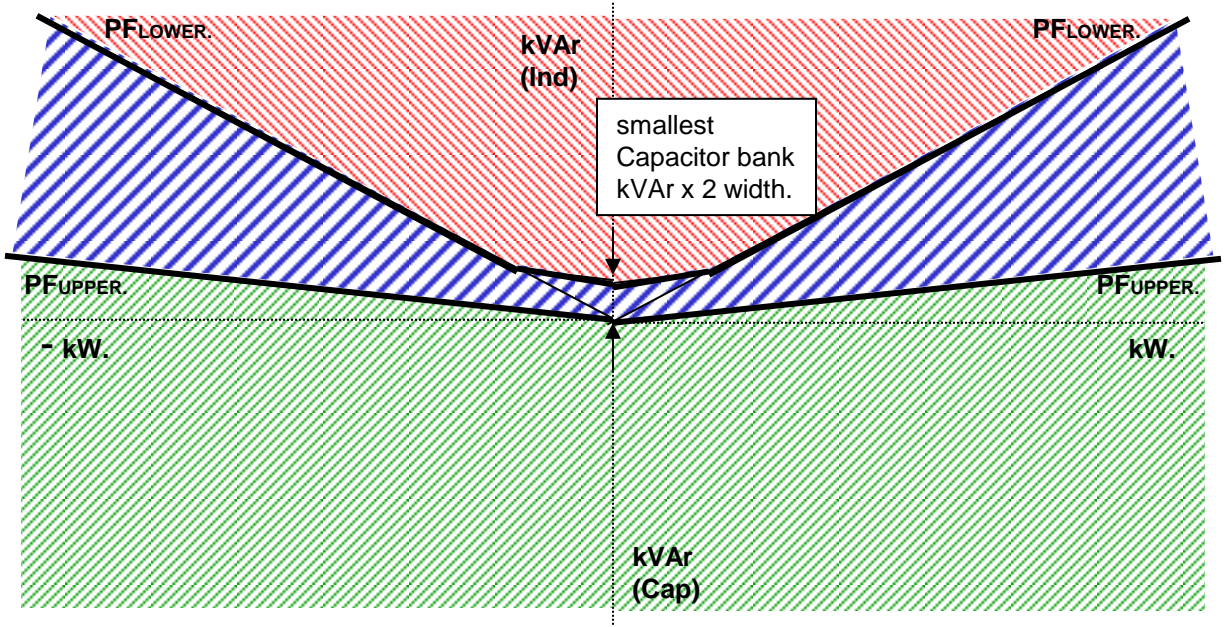
- No change band.
- Capacitor addition band.
- Capacitor removal band.

Case-2: PF-UPPER as Capacitive & PF-LOWER set as Inductive:

kVAr (Ind)

smallest Capacitor bank kVAr x 2 width.

PF_{LOWER.}   PF_{LOWER.}

– kW   kW

PF_{UPPER.}   PF_{UPPER.}

kVAr (Cap)
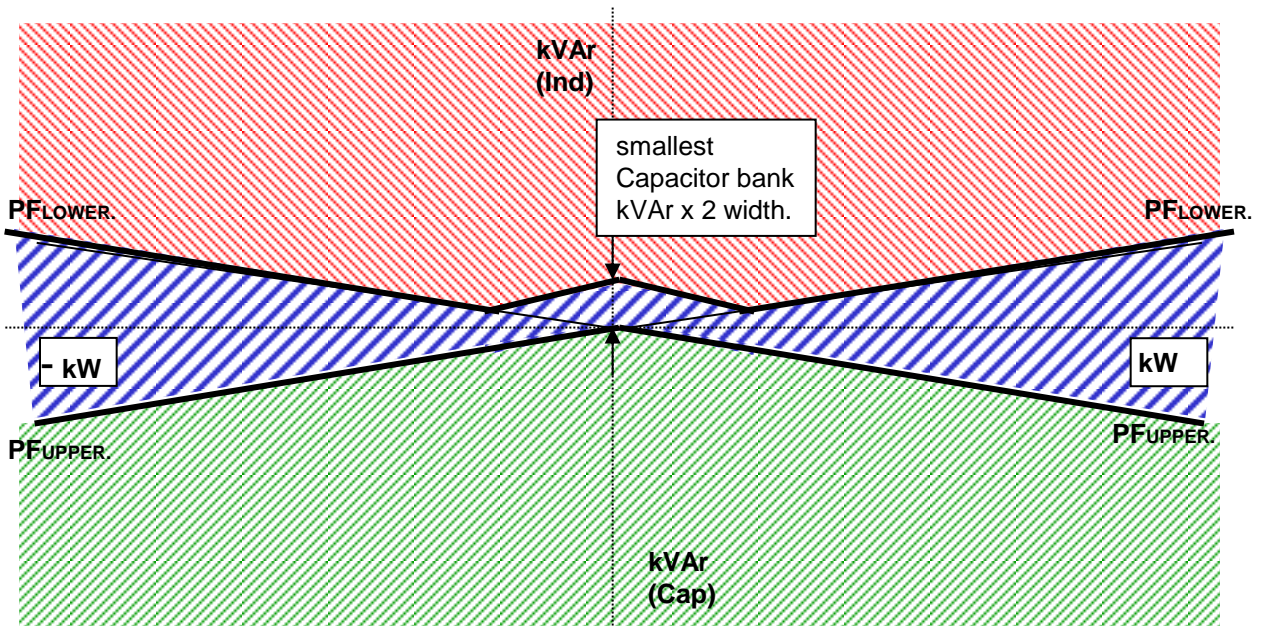
Case-3: PF-UPPER & PF-LOWER both set as Capacitive:
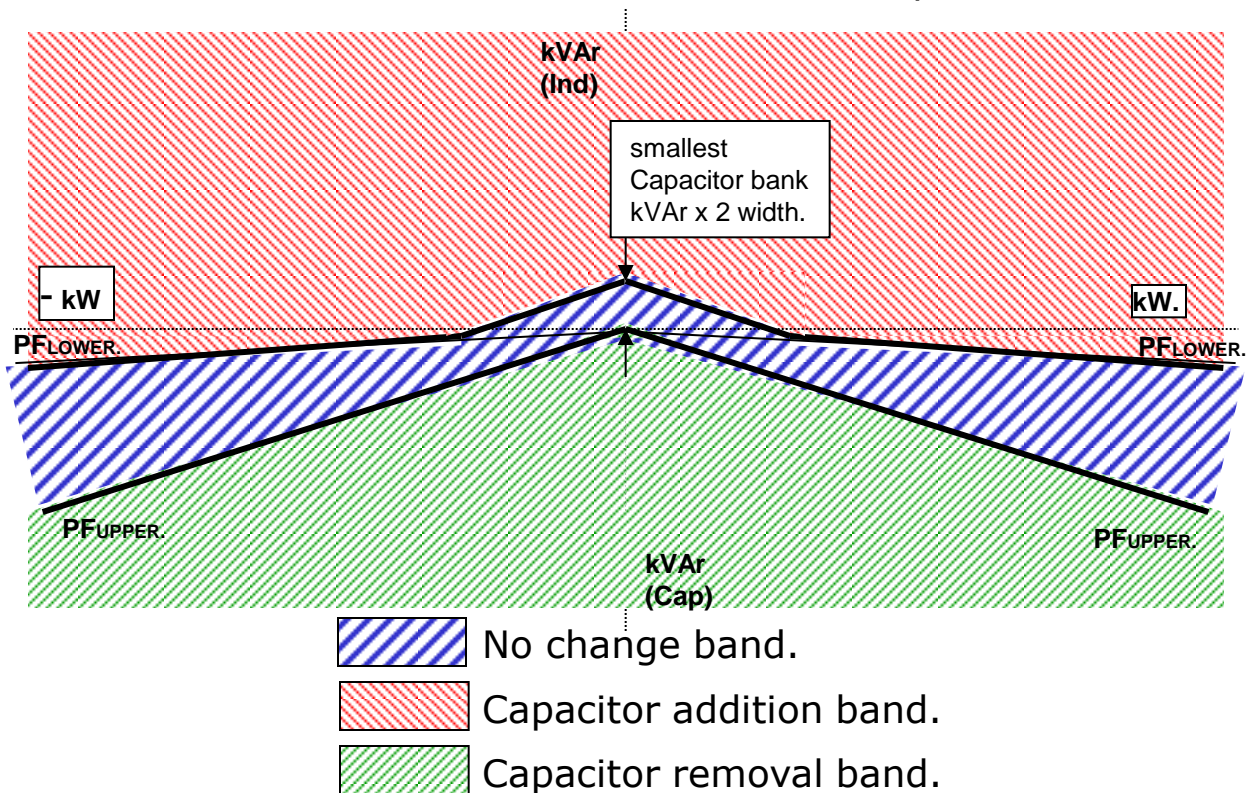
There are two PF set points to be set in APFC-05. The UPPER limit and the LOWER limit. APFC-05 ensures that PF-UPPER is never exceeded. Additionally, "No change band" to minimum kVAr band size equal to smallest bank kVAr * 2 ensures no hunting during the low kW loading.

APFC-05 is normally set for PF settings as per first two diagrams shown where PF LOWER is inductive. This philosophy helps to optimize the system maximum kVAr to be used as well as reduces the number of switching operations during higher loading conditions. This ensures better life expectancies of the switched capacitors as well as the switching devices.

This methodology of kVAr compensation reduces the complex settings that are used by conventional PF relays. The settings like C/K ratio and kVAr offsets/shifts are eliminated which makes APFC-05 user friendly and thus easy to commission.

Typical wiring diagram for PF correction

Scheme - 1

Load CT

HT side   LT side

Conventional LT side PF improvement system schematic

L
O
A
D
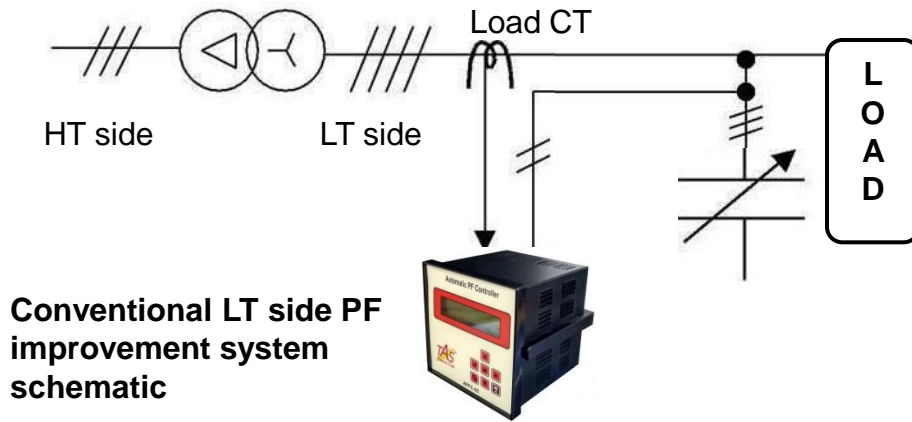
As per this scheme, the load sensing CT is put between the source and the PF correction capacitor banks. This is as per diagram shown above. The voltage feedback is taken from the LT bus system itself.

This type of scheme is used when user is interested in maintaining the healthy Power factor on secondary side of the transformer.

This scheme is preferred with LT consumers of electricity, where the metering is carried out on LT side.

Typical wiring diagram for PF correction

Scheme - 2

CT/PT on HT side
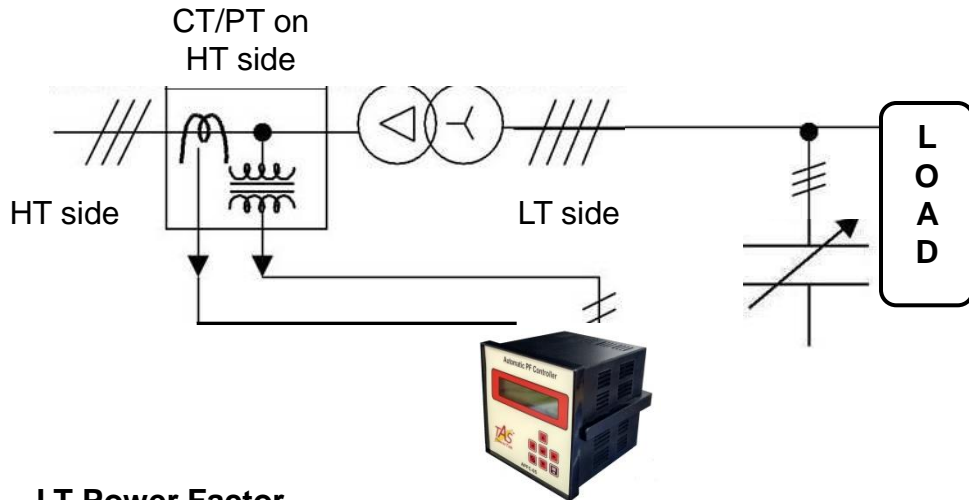
HT side

LT side

LT Power Factor compensation with HT side feedback

L O A D

As per this scheme, the load sensing CT is put at the input of the transformer on HT side.

This scheme is preferred with LT consumers of electricity, where the metering is carried out on HT side.

This scheme gives the compensation against magnetizing current of the transformer. Thus, for HT metering able to give more accurate results.

Control wiring diagram
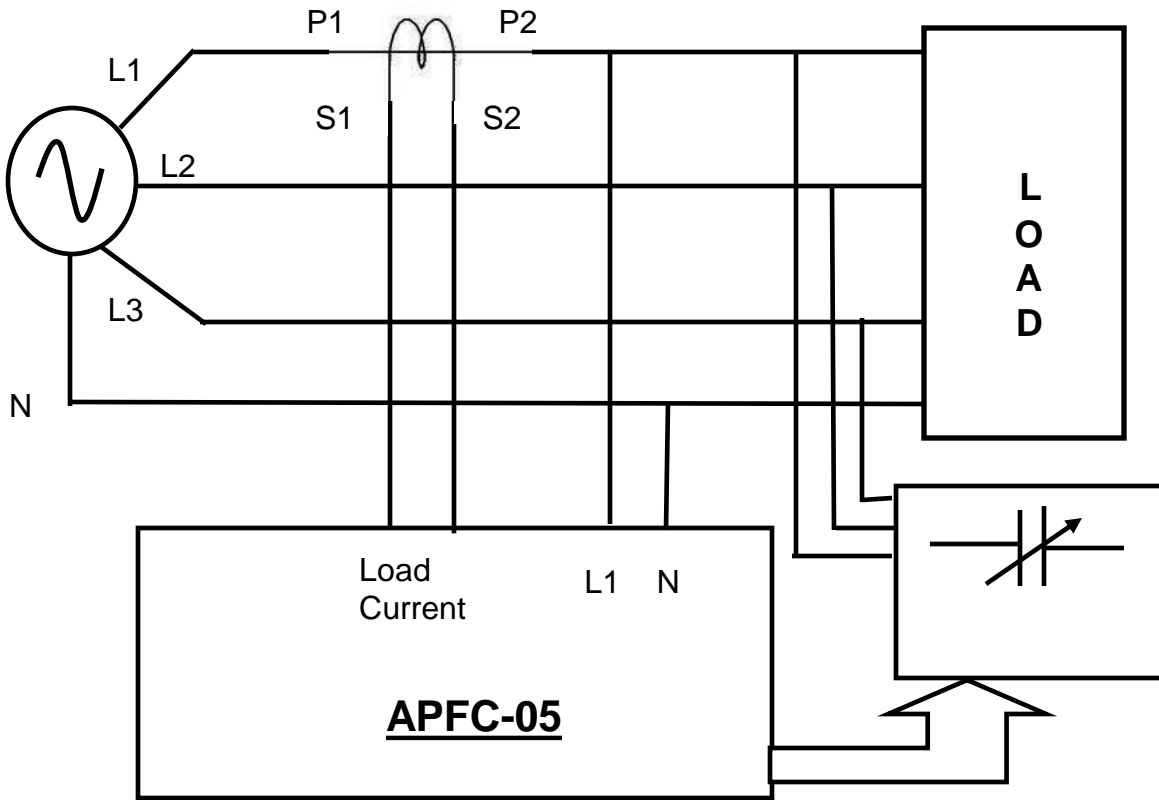
Either of the above specified schemes can be selected by the user based on the system requirement.

Rear side terminals – measurement

voltage, measurement current

Auxiliary & Measurement
voltage Connection
230 V, 1Phase, 2Wire

Load CT Connection
Selectable 1A or 5A
Example: Select either
S1 (1A) or S5 (5A)
along with S (common)

N	L1		S1	S5	S

C8	C7	C6	C5	C4	C3	C2	C1	COM
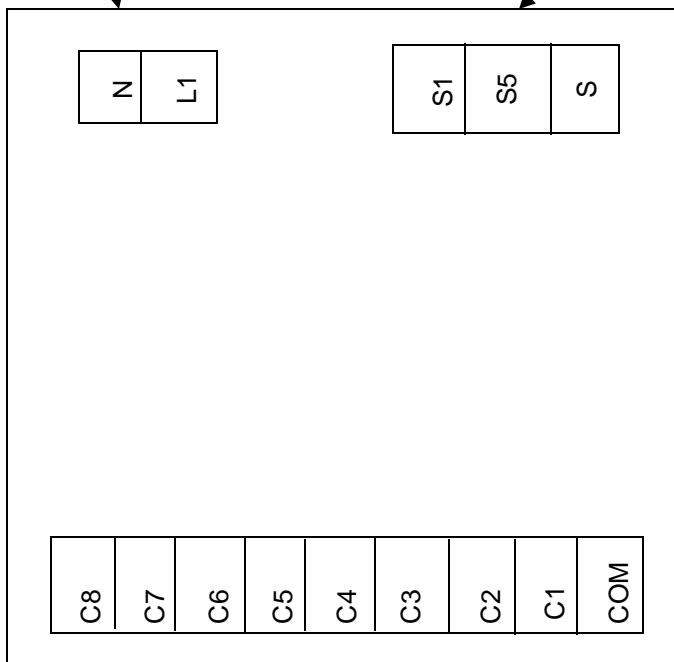
Output commands to capacitor contactors.
APFC 05

COM = common,

C1…… C8 = potential free relays, maximum of up to 8 Stages,
0.5A, 230Vac, Inductive Load. F2 Fast-Blow Fuse Protected.

Front fascia –
LCD screen, LED indications

> **PF=1.00 IND A OK**
> _ _ _

First line of display indicates the PF value, inductive / capacitive PF, mode of operation and fault / OK status:

"PF = 1.00" indicates the overall PF of the system.
"IND" or "CAP" indicates if this PF is inductive or capacitive respectively.
"A" or "M" indicates the Auto and Manual mode of operation respectively.
"OK" (blinking) indicates status of the system, healthy or faulty.

Last two characters represent one of the following status:
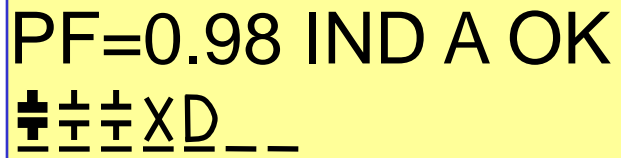
OK	Controller status is okay	OV	Over voltage
VA	Measurement voltage is absent	UV	Under voltage
OD	Outputs are disabled	UT	Over internal temperature
OF	Over frequency	UF	Under frequency

Second line indicates the status of each capacitor bank by symbols. The status is also shown by LEDs provided on the front fascia. Following table gives the description of symbols & LEDs.

Symbol	Description
⊥⊤	bank is in ON state.
—	bank is in OFF state.
⊥⊤	bank is declared as FIXED & is in ON state.
X	bank is declared FAULTY & not available for use
	output stage is not used in the system.
D	bank is in DISCHARGE mode (blinking red LED)

Front fascia –
LCD screen

Example of a typical LCD display screen is show below:

PF=0.98 IND A OK

$\boxed{\mp\pm\pm}$XD _ _

Meaning of this screen contents:
Total no. of banks connected is seven.
Power Factor at Load sensing CT is 0.98 'IND' Inductive.
('CAP' defines Capacitive).
Unit is operating in 'A' Auto mode. ('M' defines Manual mode)
Total number of banks that are operational are eight.
Bank no. 1 is declared as fixed and is in ON condition.
Bank nos. 2 and 3 are in ON condition.
Bank no. 4 is declared as faulty.
Bank no. 5 is in discharging state.
Bank nos.6 and 7 are in off state. Ready to be switched on.
Bank (output) no. 8 is not used / not connected.

Front fascia –
Keyboard

Keyboard with soft touch keys are provided on the front facia of the controller. The various keys are:
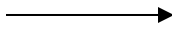
UP key. Used to scroll up the menu screen; increment values when entering numbers. Also used for changing the status of banks.
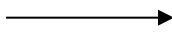
DOWN key. Used to scroll down the menu screen; decrement values when entering numbers. Also use to change status of bank.
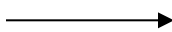
RIGHT key. Used to shift the cursor to right; also used to increase the contrast of LCD in default display screen mode.
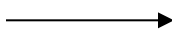
LEFT key. Used to shift the cursor to left; also used to decrease the contrast of LCD in default display screen mode.
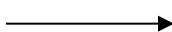
ENTER key. Used for entering a submenu or for setting up values.

PROGRAM key. Used for selecting modes of operation and editing of parameters
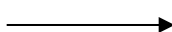
MEMORY key. Used to save all changes made in Edit Parameters menu.

Display of various parameters

Values of various parameters can be viewed by using UP / DN keys & then pressing ENT key. To exit a sub-menu press MODE.

Display	Description
PF=0.98 IND A OK ⬓‡‡x<u>D</u>_ _	This is factory set default display screen giving information on PF, mode, bank & controller status.
Display Overall Values	Overall values gives the average values of system parameters – V, I, kW, kVAr, kVA. Load side PF, kVAr, kVA & frequency.
Display Power	Displays values of PF, kW, kVA, kVAr.
Display Harmonics	Displays average values of THD for V, I, harmonics up-to 15th.
Display Step kVAr	Displays the measured kVAr value of each connected output step.
Display Aux-Function	Displays the internal (cabined) temperature.
TAS PowerTek India APFC 05	Displays the version of software.

Sub menu for display of parameters

Overall Values

Mains Voltage 00240.6V(L-N)
Mains Current 0002.5A
Active Power 000440.0KW
Reactive Power 000440.0KVAr
Apparent Power 000442.0KVA
Frequency 50 Hz

Power

PF 1.000 IND
KW 000250.0
KVAR 000005.7
KVA 000254.0

Harmonics

V- THD -(R/F) 000.0%
I - THD -(R/F) 000.0%

Step KVAR

Step[1] KVAr 0010.0
Step[2] KVAr 0010.0
Step[3] KVAr 0010.0
Step[4] KVAr 0010.0
Step[5] KVAr 0010.0
Step[6] KVAr 0020.0
Step[7] KVAr 0020.0
Step[8] KVAr 0020.0

Aux-Function

INT- Temperature 41 Deg

Method for keyboard / display usage

Flowchart for entering into different modes:

PRESS

If Password Option is Enable/Disable.

Enable — Disable

PF=0.98 IND A OK

Default Display mode

Enter Password:

****

PRESS

Enter the 4 digit Password by using ◀ ▶ ▲ & ▼ keys.

PRESS

IF PASSWORD Correct?

NO — YES

✱

Continued on next page

✱

PF=0.98 IND A OK
±±±XD__

Default Display mode

Select
1. Edit Parameter

Select
2. Auto Operation

Select
3. Manual Operation

#

Continued on next page

# #

Select 1. Edit Parameter	Select 2. Auto Operation	Select 3. Manual Operation

PF=0.98 IND A OK
♣‡‡XD _ _

Operation in Auto Mode.

PF=0.87 IND M OK
♣‡‡XD _ _

Operation in Manual Mode.

Edit Parameters
General and IO → General parameters

Edit Parameters
System → Grid / transformer / APFC system related parameters

Edit Parameters
Fault → Fault trip settings

Edit Parameters
Step → Capacitor bank step settings

Edit Parameters
Utilization Cntr → Banks utilization counter

Keyboard / Display operations

Mode Selection

There are two modes of operation (Manual and Auto) and one mode for data entry (Edit Parameters).

Press the PROGRAM key. Enter password (if enabled) by using ◂ ▸ ▴ ▾ keys. Press ENTER Now using ▴ ▾ keys, select the Mode of operation:

- **AUTO OPERATION**
- **MANUAL OPERATION**
- **EDIT PARAMETERS**

Then press ENTER to enter the specific mode.

Auto Operation:

For functioning in automatic compensation.

Manual Operation:

Pressing ENTER button on this screen will put APFC-05 in Manual mode. This mode would continue to run till it is purposefully changed or power down occurs.

This mode is normally used to perform the operations like:
- Resetting of faulty banks to healthy status.
- Checking the Capacitor banks by turning them ON/OFF.
- Declaring specific bank/s faulty. Masking of the banks so that once auto mode is selected, these faulty declared banks would not be used for PF correction.

For Declaring banks faulty or Resetting faulty banks:
In manual mode default screen press ENTER key.
The cursor above bank 1 will start blinking. Use ◂ ▸ keys to select the specific bank. Then use ▾ key to declare it faulty. To reset the faulty bank, bring the blinking cursor to that bank and use ▾ key again to declare that bank as healthy.
After any of these operations press ENTER key so that cursor stops blinking. To save the status on permanent basis (so that even after Power down, the status is unchanged), press MEMORY key. After saving the settings, the unit will jump back to default mode. (Default as Auto or Manual is set in Edit Parameters).

…continued.

For Testing banks with manual ON / OFF commands:
Press ENTER key, the cursor will start blinking. Use ◄ ► keys
to select the specific bank/s that are healthy and use ▲ key to
turn ON and use ▼ key to turn OFF that capacitor banks.
To come out of Manual ON/OFF edit mode, press ENTER key so
that cursor stops blinking.

Edit Parameters:
This mode is used to carry out system settings. In this mode
various system settings can be carried out. To do the same,
use the ▲ ▼ keys and select the type of parameters to be
edited. The types of parameters that can be edited are:

General & IO   : For general settings.
System   : For mains/generator system settings.
Fault   : Fault settings.
Step   : Capacitor bank step settings.
Utilization counter: Bank operations utilization counters.

After selecting the type, press ENTER to enter the sub-menu of
that specific type.
The details of these sub-menus for every type is given further.
You can edit all these sub-menu settings by using the ENTER,
▲ , ▼ , ◄ , and ► keys
To come out of the sub-menu press PROGRAM key once.
To store the edited parameters permanently, press SAVE when
you are either in the Edit Parameters or any sub-menu area.
To come out of Edit Parameters without saving the changes
press PROGRAM key again.

Note: In the Edit Parameters area, if no keys are pressed for
more than a minute, the default display screen comes on and
the changes done till that time are discarded.

General & IO

PASSWORD
Enable : 1
CHANGE PASSWORD
: 0001
LOAD DEFAULT
No : 0
THD TO DISPLAY R/F
F-THD : 1
UNIT ID
0000

<u>Password:</u> Enable or disable password.
Value: 0=Disable, 1=Enable.
<u>Change Password:</u> Set new value of password (4 digit). Factory default password is "0000"
<u>Load Default:</u> Loads factory set default parameters. 0=No, 1=Yes.
<u>THD to Display:</u> Type of THD to be displayed for V, I.

<u>Unit ID:</u> Allows Users to assign a Unique, 4-Digit Identification Number to this APFC Unit.

System

Meas. Voltage
: 240
EXT-PT Ratio
0001.0:1
CUR CT Primary
Mains : 1000
PF Up Lim : Mains
[Ind :1] 0.980
PF Up Lim: Mains
Ind : 1 [0.980]
PF Low Lim: Mains
[Ind :1] 0.970
PF Low Lim: Mains
Ind :1 [0.970]
Auto kW Polr Chk
Disable: 0

<u>Measured Voltage:</u> Factory set parameter dependent on hardware. For viewing only.
<u>Ext-PT ratio:</u> By default set to 0001.0:1, but in case external PT is used, this ratio can be set. Limits: Lower: 0000.1   Upper: 6000.0
<u>Cur CT Primary: (Mains):</u> Feedback source current for mains (if used with summation CTs). Limits: Lower: 0001 Upper: 9999.

<u>Power Factor Limits:</u> APFC-05 has one set point for Mains. upper & lower limits can be defined as Upper PF and Lower PF. PF limits can be set as inductive or capacitive.

<u>Auto kW Polr Chk:</u> Allows user to correct the kW Reading to a Positive Value to indicate Energy "Import" without reversing the CT Polarity in case the kW reading is a –Ve value.

Fault

Over voltage flt
Disable : 0

Over voltage
Limit :115%

Over voltage
Resume :110%

Under voltage flt
Disable : 0

Under voltage
Limit :085%

Under voltage
Resume :090%

Over load flt
Disable : 0

Over load
Limit :130%

Over load
Resume :125%

Under load flt
Disable : 0

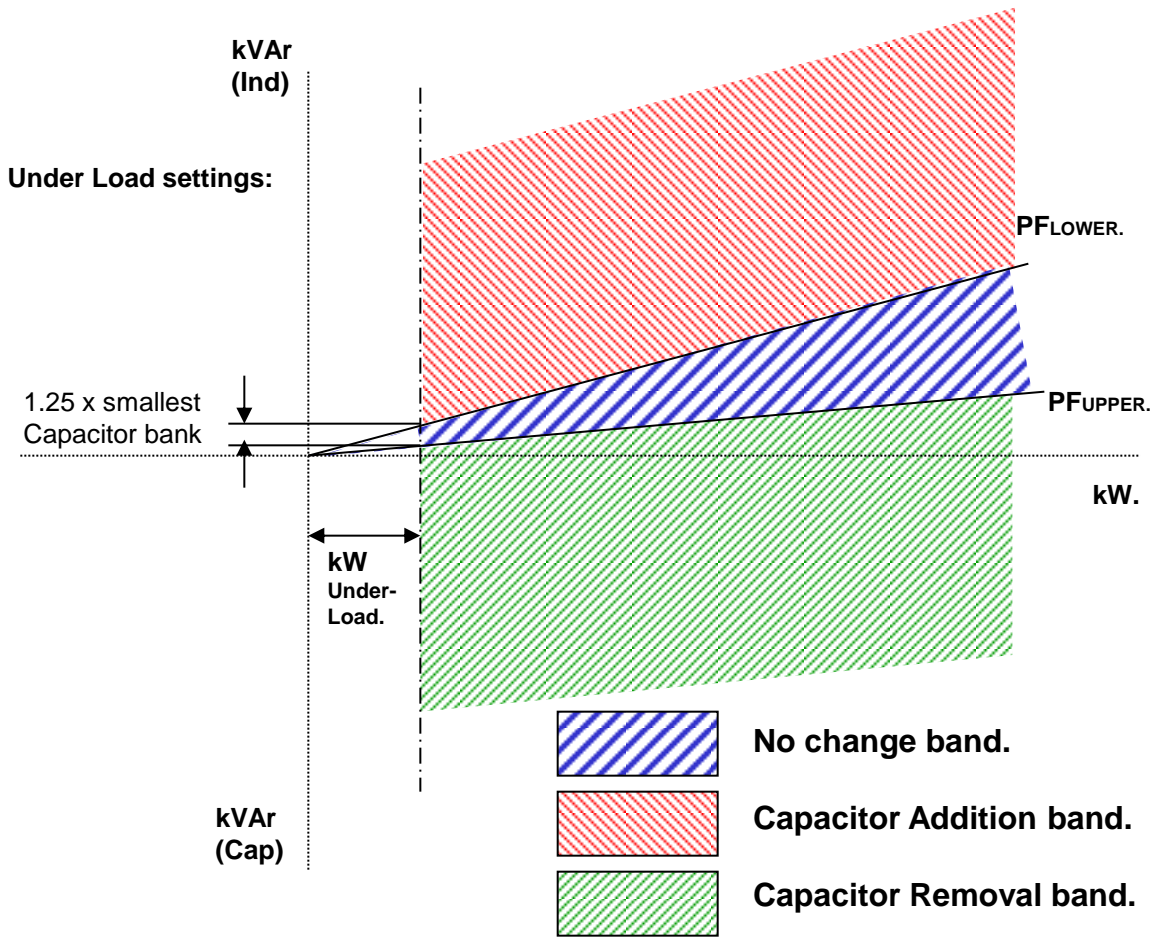| Under load |
|:---:|
| Limit :020% |

Under load
Resume :025%

For most of the types of faults defined here, the options available are as hereunder:
0=Disable
1=Indicate (Display a Fault Message & or store in Flash)
2=Off Step (Switch off Non Fixed Steps one by one)
3=Off Fixed Step Also (Switch off All Steps one by one)
4=Fast Off Step (Switch off all Steps in one shot)

For all the faults, normally two limits are defined. One is Detection Limit and another Resume Limit. Detection Limit if exceeded by the parameter would mean the action as defined by parameter in type of fault (as given here-above). Resume Limit defines the parameter value below which the fault is deactivated.

• Over Voltage: As name suggests, its for Over-Voltage conditions.
• Under Voltage: For Under-Voltage conditions.
• Over Load: If APFC-05 detects the supply system is overloaded, then it is sometimes recommended to remove the capacitors out of circuit to reduce the fault current levels. Under such circumstances this parameter is set. Alternately, it can be set to Indicative.
• Under Load fault: The values here are set as % of Maximum rated KW. This is useful in case of banks are put in circuit to take care of no load compensation. Value for this Under-Load KW can be calculated as shown here.

For PF$_{\text{UPPER}}$ Inductive and PF$_{\text{LOWER}}$ Inductive :

Under-Load kW value setting =
$$\frac{1.25 \times \text{Smallest bank kVAr.}}{[\tan\{\cos^{-1}(\text{PF}_{\text{LOWER}})\} - \tan\{\cos^{-1}(\text{PF}_{\text{UPPER}})\}]}$$

For PF$_{\text{UPPER}}$ Capacitive and PF$_{\text{LOWER}}$ Inductive :

Under-Load kW value setting =
$$\frac{1.25 \times \text{Smallest bank kVAr.}}{[\tan\{\cos^{-1}(\text{PF}_{\text{UPPER}})\} + \tan\{\cos^{-1}(\text{PF}_{\text{LOWER}})\}]}$$

For PF$_{\text{UPPER}}$ Capacitive and PF$_{\text{LOWER}}$ Capacitive:

Under-Load kW value setting =
$$\frac{1.25 \times \text{Smallest bank kVAr.}}{[\tan\{\cos^{-1}(\text{PF}_{\text{UPPER}})\} - \tan\{\cos^{-1}(\text{PF}_{\text{LOWER}})\}]}$$

…continued.

Int Temperature Flt
Disable :0
Temperature
Resume : 55 Deg C
Temperature
Limit : 65 Deg C
Step Health Chk
Disable : 0
Bank KVAR Fault
Tolerance :10
Bank KW Fault
Tolerance :10

▪Internal Temperature Fault: Unit monitors the temperature inside the APFC 05 housing. This temperature can go up either due to ambient temperature in the APFC panel has gone up beyond limit or if some component failure in APFC-05 hardware itself. Upper limit is for tripping and lower limit is for normal operation (resume).

• Step Health Check : APFC 05 carries out on line monitoring of the kVAr values of every step. This is when the step is put in the tolerance limit defined here is exceeded, that specific bank is declared faulty.

Step

Steps connected : 08
Default mode Auto   :0
Compensation kVAr Mean   :1
Cap Bank Voltage 0415 V
Correction Time Seconds   :00010
Discharge Time Seconds   :00060
Step Response Time Cycles   : 00045
Fix-Bank Setting – – – – – – – –
Bin/C / E Series Bank kVAr : 200
Ext Fix Bank KVAr : 000
Correction Type C Series   : 2
C – Series : 00 11111111111111
E - Series 1488888888888888
Unequal Bank [1] KVAr = 050
Unequal Bank [2] KVAr = 050
Unequal Bank [3] KVAr = 050
Unequal Bank [4] KVAr = 050
Unequal Bank [5] KVAr = 050
Unequal Bank [6] KVAr = 050
Unequal Bank [7] KVAr] = 050
Unequal Bank [8] KVar = 050

Steps Connected: Defines the number of steps operational. Depending on PF system banks, this parameter is set.

• Default Mode: 0: Auto and 1: Manual. This parameter defines the mode during Power up. (Default is 0: Auto)

• Compensation kVAr: 0:Instantaneous & 1:Mean. Defines the method for kVAr compensation. If it should be instant at which the compensation is made or it is mean of kVAr that is required from previous   compensation to present compensation.

• Capacitor Bank Voltage: Capacitor bank voltage line to line value is defined here. i.e. it defines the Voltage value at the defined kVAr.

• Correction Time: Defined in seconds. This is the Time between two consecutive kVAr compensations.

• Discharge Time: Time defined here is the time for discharge of the capacitors to a level, so that they can be turned ON again.

• Step Response Time: Defines the time after which the kVAr of any step should be measured when the step turns on .

• Fix-Bank Setting: Defines the banks that are to be declared as fixed. These banks even in spite of overcompensation cannot be turned OFF. The banks can only be turned OFF under fault conditions. (if settings in fault are defined).

• Correction Type: APFC-05 can have bank configurations that are defined by four various methods. 0=Binary, 1=Unequal, 2=C Series, 3=E Series.

   Binary is in ratio of 1:2:4:8:16---.

   Un-equal is used with banks not having definite ratio.

   C series is predefined Control Series. The standard ratios are preloaded in APFC-05 that can be selected here. E series is User defined Control Series. The bank ratios that are not defined in C series can be defined here. Digits can be 1,2,-- 9,

…continued.

• <u>C Series:</u> Various control series (C Series) can be selected
00: 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1.
01: 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2.
02: 1 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3.
03: 1 2 3 4 4 4 4 4 4 4 4 4 4 4 4 4.
04: 1 2 4 4 4 4 4 4 4 4 4 4 4 4 4 4.
05: 1 2 3 6 6 6 6 6 6 6 6 6 6 6 6 6.
06: 1 2 4 8 8 8 8 8 8 8 8 8 8 8 8 8.
07: 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2.
08: 1 1 1 1 1 6 6 6 6 6 6 6 6 6 6 6.
09: 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2.

• <u>E-Series:</u> As explained earlier, this series is the user defined series. Digits can be adjusted from 1 to F i.e. 1 to 15.

• <u>C/E/Bin Series Bank kVAr:</u> The kVAr defined here is the capacitor bank KVAR of the smallest bank i.e. the value defined by digit '1' in C series, E series or Binary.

• <u>Unequal Bank kVAr [1….8]:</u> If unequal kVAr bank configuration is used, these parameters are to be defined for every bank kVAr (at defined Capacitor Bank Voltage). APFC-05 has a in built intelligent algorithm to select the best possible combination to suit the exact kVAr requirement for compensation.

Step Utilization

Utilization cntr Bank [1] : 000026
Utilization cntr Bank [2] : 000026
Utilization cntr Bank [3] : 000026
Utilization cntr Bank [4] : 000026
- - - -
Utilization cntr Bank [8] : 000026
Clr Bank [1] cntr NO : 0
Clr Bank [2] cntr NO : 0
Clr Bank [3] cntr NO : 0
- - - -
Clr Bank [8] cntr NO : 0

Utilization cntr: Bank n: This gives the number of ON/OFF operations of the "n"th bank.

• Reset Utilization Counter: Bank n: Options are "Yes" and "No". Declaring specific bank number with Yes and pressing save command will reset the specific bank utilization counter to zero. This is normally done in case the specific bank is replaced with the new one.

Commissioning Instructions

Before panel is powered up for the first time

1. Panel Wiring Check

Ensure that all connections in the panel is tightened properly and there are no loose connections. Also ensure that the wiring is done as per the wiring diagram.

2. Power Wiring Check

Ensure that the power cables are connected properly from the Panel I/C to the feeder I/C or the transformer bushings. The connection has to be after the Load Feed back CT looking from the Transformer side.

Ensure that the Bus Bars and/or Lugs are clean and free of Dust, Corrosion or Oxidation on the contact sides so that good electrical connection is maintained. The surface area should be flat so as to get maximum contact area.

If required Clean the Bus Bars and/ or Lugs by rubbing it with Polish Paper to remove the oxidation layer. Provide contact paste in between the contacts surfaces.
Not performing this, can result in to a weaker source point for Capacitor charging during Step on and this can generate undesirable Noise which can hamper the performance of equipments installed in the capacitor panel.

3. Load Feed Back CT connection

Ensure that the load feed back CT connections are done properly. Confirm that correct phase CT is connected with the correct phase input terminals.

CT connections to be done carefully so as to ensure that the wire does not get open and there is no loose connection.

Loose connection or open CT secondary can result in very high voltages getting developed in the circuit which can damage the CT and also produce high levels of noise in the system.

After panel is powered up

- Remove the fuses/switch off MCBs/MCCBs which are in series with every capacitor bank. Connect supply to the APFC-05. Keep the load feedback current feedback in shorted condition.

- Turn ON the supply to the panel and set the various parameters as per the panel configuration. It is important to understand the meaning of every parameter from the instructions given before and then put the appropriate values in them. Wrong values entered can give the wrong performance of the panel.

- Once the parameterization is complete, put the APFC-05 in Manual mode to check every bank command is transmitted to the switch. This can be observed by turning ON the contactor coil supply MCB on. The corresponding output should be checked for physical turn ON / OFF of the contactor.

- Once all the contactors are seen to be getting the correct commands, switch off the supply to the panel and replace all the fuses (or turn on MCBs/MCCBs if they are provided instead of fuses). Turn on the panel.

5. Put APFC-05 back in Manual mode and turn ON/OFF the individual steps. Use Tong tester (ac current measurement) to check that current in all three phase of the corresponding bank are OK. In case any bank is not giving the desired current, check for capacitor bank healthiness or power circuits.

6. Keep all the banks in off mode. Remove the short of Load feedback CT. In case kW value is seen as –ve , CT is with wrong polarity.

7. Now turn ON the capacitor banks one by one and observe that capacitor current increases as per the rating of the steps on capacitor Current display. Turn ON all the banks to see that almost full rated current flows through the capacitors.

8. Switch OFF all the banks manually and put the APFC-05 in Automatic mode. Switch Off the supply to panel and put it ON. APFC-05 will first turn ON all the capacitor banks and turn them off.

   Observe panel performance for about 2 Hours after commissioning.

Troubleshooting procedure

Nature of Fault	Probable Reason	Action to be taken
Unit does not turn ON.	•Input auxiliary supply not coming. •Input side fuses blown	•Check the input supply & restore. •Check fuses in the unit are OK.
Unit does not turn ON any capacitors even if PF is below Lower PF limit.	The load kW is too low. • Control connections from RLY module to contactor coils are not proper.	•This is expected condition. •Check control supply and connections from RLY to contactors.
Some Capacitor banks are declared as faulty even if they are checked to be OK.	•Individual step health monitoring is enabled and tolerance limits set are too stringent. • Capacitor current THD factor is continuously fluctuating.	•Set the tolerance limits for individual steps monitoring appropriately. • With continuously fluctuating THD of Capacitor current and higher level of THD can cause some errors in individual step kVAr measurement. Under this condition, best is to keep this feature disabled.

Troubleshooting procedure ... continued

Nature of Fault	Probable Reason	Action to be taken
APFC-05 resets occasionally on turning OFF of any contactor.	• The contactor supply phase may be the same as used for **APFC-05** auxiliary supply. • R-C Snubbers or MOVs for AC Circuits or free-wheeling diodes for DC Circuits are not put with contactor coils.	• Use the different phase for control supply of contactors and for **APFC-05** supply • Usage of R-C Snubbers or MOVs / free-wheeling diodes, across the Contactor Coils is mandatory.

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This Product is completely Designed, Developed, Manufactured,Assembled, Tested, and Calibrated in India by

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