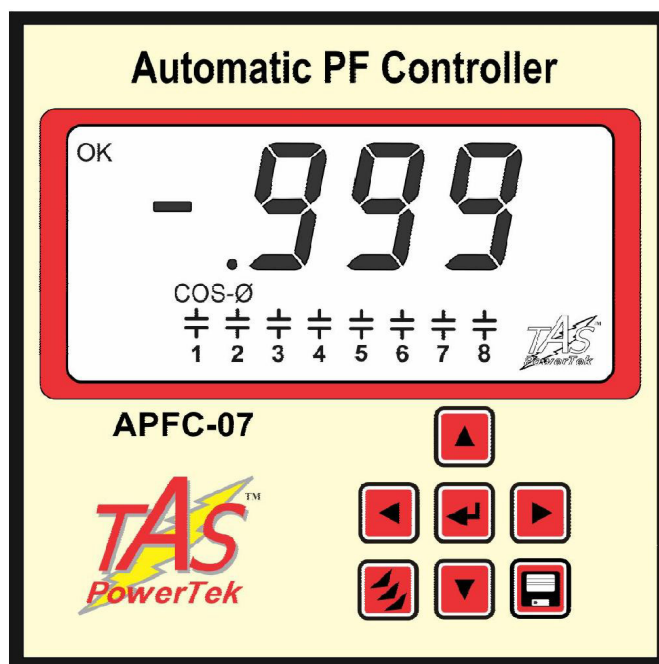


Low-Cost , Single-CT, Automatic Power Factor Controller for Balanced Three-Phase Reactive Power Compensation



User Manual





APFC-07/nn

NOTE

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.

The reproduction, transmission or use of this document or its contents is not permitted without express written authority. Offenders will be liable for damages. All rights are reserved.

Because of continuous improvements efforts by TAS 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:

1. There are High Voltages associated with this Unit, so, take appropriate precautions.
2. This Automatic Power Factor Controller (APFC) is for only in-door use.
3. Make sure that the discharge time set in the controller matches with the capacitor bank discharge time.
4. This User Manual corresponds to the APFC-07 Controller, Firmware Version 2.0 Dated 5th March 2017.

Please always refer to the User Manual supplied to the customer along with the Product, at the time of product dispatch.

One-Page Short-Form Manual is always supplied with the TAS APFC-07 Unit for quick information and settings during field installation by the User. Please refer to full version of the User Manual for more detailed understanding and use of this Power Factor Controller.

Index

• Features	--	4
• Specifications	--	5
• Mechanical dimensions	--	6
• PF correction technique	--	7
• Typical Control wiring diagram	--	9
• Rear View Details	--	11
• Front View Details		
○ LCD Display screen	--	12
○ Key-board	--	13
• Display Parameters List	--	14
• Mode Selection	--	16
• Programming Parameters	--	19
• Fault Indications	--	21
• Programmable Parameter settings at Factory	--	22
• Fixed Parameter settings at Factory	--	23
• TAS PowerTek Contact Details	--	25

Features:

- Advanced, State-of-the-Art, 32-Bit Micro-Controller based Digital Signal processing logic for measurements and control, for Automatic Power Factor Control Operation.
- Voltage, Current 1% Accuracy and Reactive Power Measurement Accuracy is 2%.
- Advanced Power Factor Correction Algorithm.
- Single CT for Supply Current Feedback.
- Relay N.O. Contacts (potential-free) Outputs for Controlling External Capacitor-Duty Contactors, for control for 4, 6 or 8 Capacitor Banks, as per the ordered Model.
- Externally Replaceable Fuse Protection for the Relay Contacts.
- Designed for basically Balanced Three-Phase AC Loads and Balanced Three-Phase Capacitive Reactive Power Compensation, for Power Factor Improvements.
- Large 7 Segments Digits, Custom LCD Display for easy & accurate PF Value indication, Alarm Conditions , Status Indications.
- LED Back-Light for the Custom LCD Display for improved readability in low light.
- Automatic, Timer Controlled, Shut-Off for LED Back-Light for Power Saving.
- Flashing “OK” Indication on the LCD Display for Controller Active Status
- 7-Keys Tactile Keypad for Manual Interactions for user operation & settings , etc.
- Rear Terminals Connections with Plastic Covers, suitable for Fork / “U” Type Lugs.
- DIN Standard 96 x 96 mm Plastic Cabinet for Panel-door flush-mounting.
- Splash Water-proof Front Panel of the Unit.
- Protections provided against:
 - Under Voltage
 - Over Voltage
 - Under Load (Low Load Current)
 - Over Load (High Load Current)
 - Over frequency
 - Under Frequency
 - Over Temperature (Internal to PF Controller)
 - Voltage Harmonic over Load
 - Current Harmonic over Load
 - Out of Capacitor Banks steps, (insufficient Total Capacitor Banks kVAr), only for indication.

All the above protection features are factory settable.

Specifications:

- Operating AC input supply voltage & feed-back voltage range: 100 Vac to 490 Vac, 50 Hz +/- 3Hz OR 60 Hz +/- 3Hz.
- Voltage Input Burdon (Aux. Input Supply & Measurement together): Max. 10 VA
- AC Mains Operating Line Frequency: 50 +/- 3 Hz or 60 +/- 3 Hz, User Settable.
- Measurement Current nominal range 1A or 5A, short term overloads handling capacity of +30% of the nominal rating.
- Minimum Load Current Sensing: 15 mA for 1 Amp range or 75 mA for 5 Amps range.
- Over-Load Current: 20 Amps rms for 1 Second, non-recurring, on 5 Amp Terminals or 4 Amps rms for 1 Second, non-recurring, on 1 Amp Terminals.
- Load Current CT Burdon: Less than 1 VA for Load CT.
- Voltage, Current, Active Power 1% Accuracy and Reactive Power Measurement Accuracy: 2%
- Power Factor Correction time: 10 to 600 Seconds, 60 Seconds, as factory setting.
- Capacitor Bank Discharge Time : 60 to 600 Seconds, 60 Seconds, as factory setting.
- Output Commands: Isolated 'N.O.' Relay contacts suitable for driving Contactor Coil of nominal 250 Vac.
- Operating Ambient Temperature Range: 0 to +65 Deg. Celsius.
- Relative Humidity Range: 10% to 90% (Non-Condensing).

Mechanical Dimensions:

Front Height: 96 mm

Front Width: 96 mm

Rear Depth behind the Panel Door: 65 mm

Recommended Size for Panel Cut-out: 92 x 92 mm

Max. Weight: (with clamps and terminals): Approx. 0.4 Kg (un-packed)



The available Models in APFC-07 Series are as given below:

APFC-07 (4 steps / 6 steps / 8 steps)

For Product Ordering Codes, please refer below.

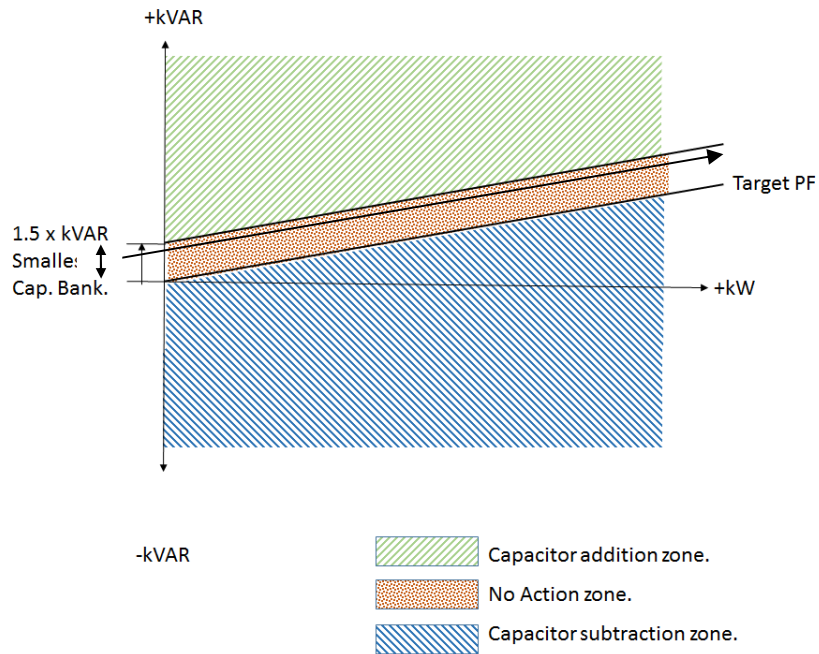
APFC-07/04 - 4 Relay Contact Outputs, for 4 Capacitor Banks.

APFC-07/06 - 6 Relay Contact Outputs, for 4 Capacitor Banks.

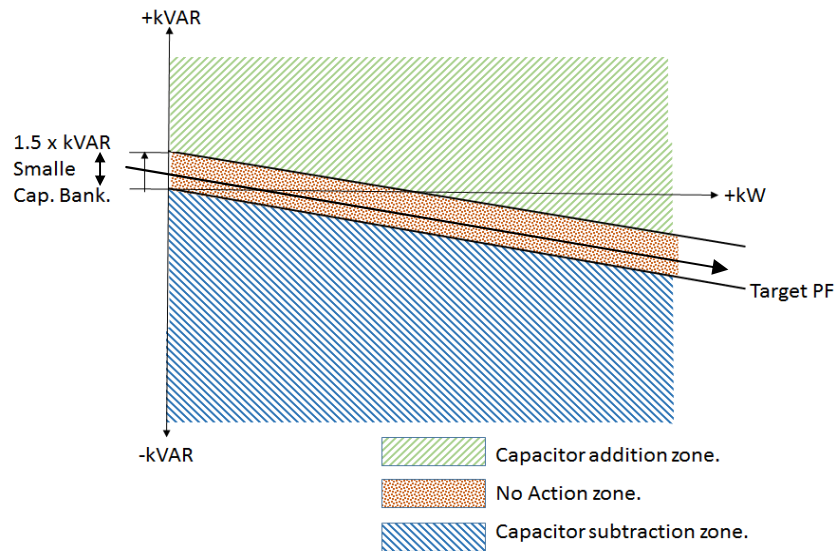
APFC-07/08 - 8 Relay Contact Outputs, for 4 Capacitor Banks.

PF Correction Technique:

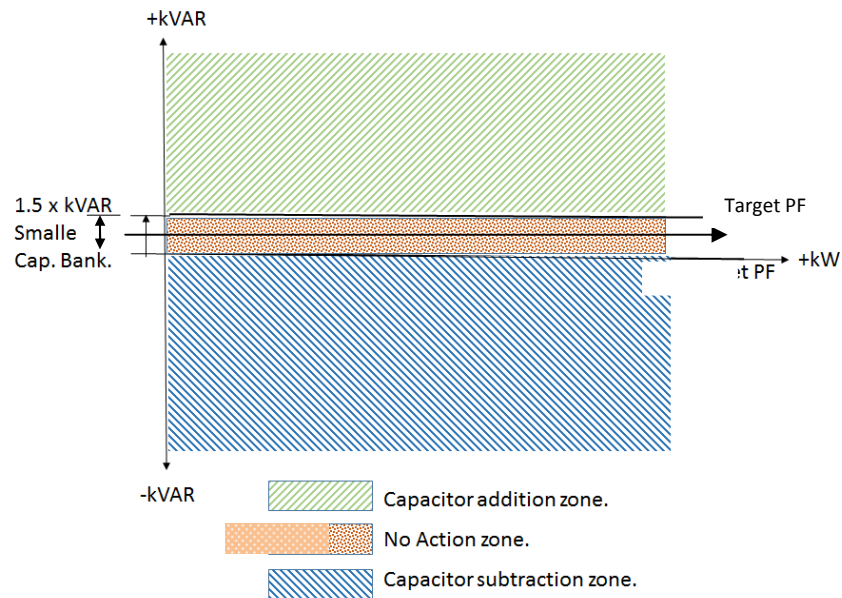
With Lagging (Inductive) Target Power Factor



With Leading (Capacitive) Target Power Factor



With Unity Target Power Factor

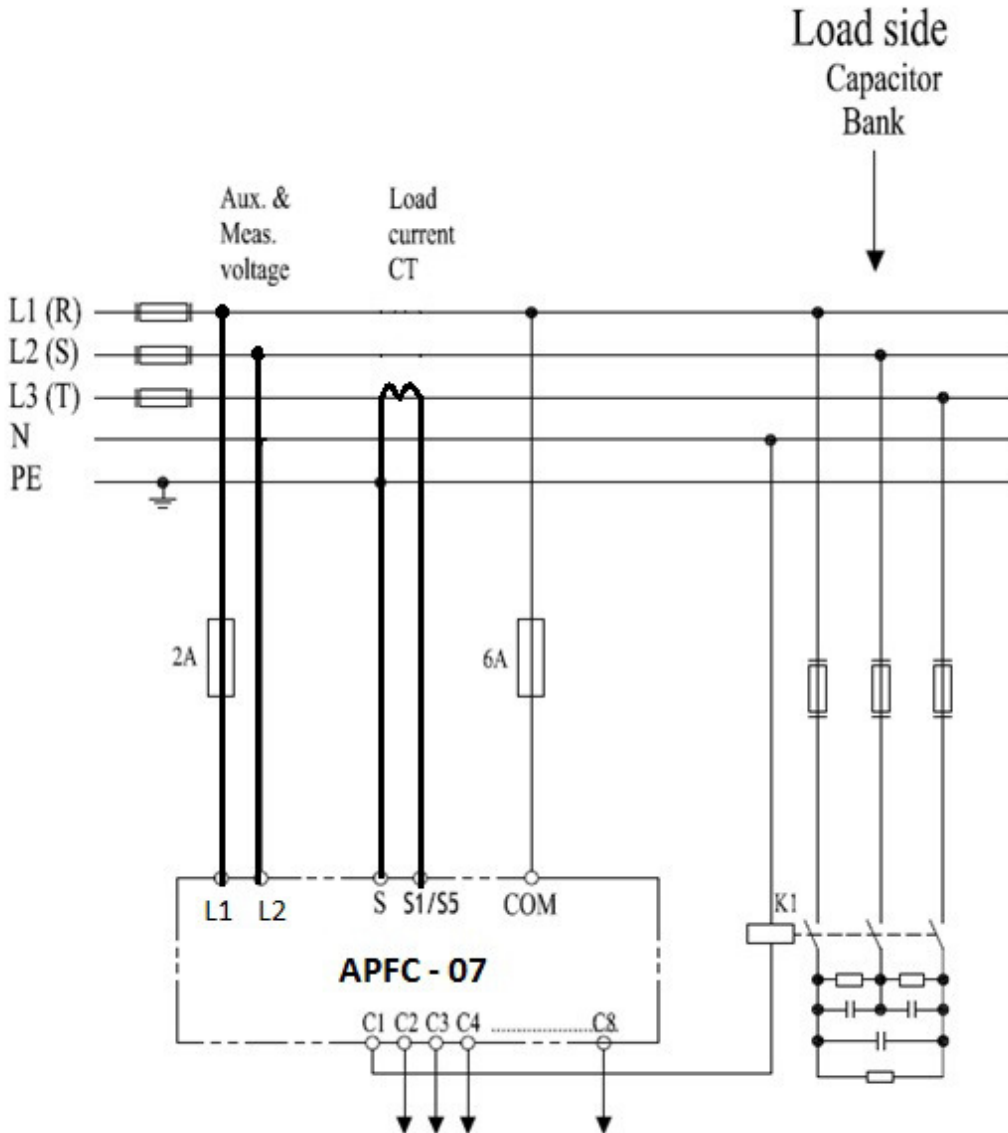


All the three conditions are specified in the diagram. One should take note of “No Action Zone” which is internally created to prevent hunting of the capacitor bank(s), which is, switching ON and OFF every correction cycle.

This PF Controller is designed for a single “TARGET P.F.”

“No Action Zone” is preset to minimum kVAr Capacitor Bank size equal to smallest bank kVAr *1.5. This band is 50%-50% distributed around the Target PF line. This band size normally takes care of all the variations in supply voltage, frequency and harmonics changes, against the hunting of the Capacitor Banks.

Typical wiring diagram for PF correction :



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. The Supply Current feedback is taken from the other phase as that of feedback voltage sensing phases. However, the Power Contactor Coil AC Supply can be taken from any phase, to the "COM" Terminal on the APFC Unit. 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.

Note that the external Contactor used for switching the capacitor bank must be AC6b type, having Nominal Coil Voltage 230 / 240V AC rating only.

Use of a 320 V, +/- 5% Tolerance on Voltage, 20 mm Dia. MOV directly across the Power Contactor 230 Vac Rated Coil, is highly recommended extending the Relay Contact Operational life, as well as avoiding EMI-EMC related issues.

In case, MOVs are NOT immediately available, then, Series Connector Resistor-Capacitor Networks as RC-Snubbers, are to be placed directly across EACH Power Contactor Coil.

This Resistor & Capacitor are to be connected in Series by soldering the leads and to be covered in a Heat-Shrinkable Insulating Tube. No PCB is required for this assembly..

The Specifications for the R-C Components of the Snubbers required are:

- 1] Capacitor: C = 0.1 μ F (100nF)). Voltage Rating = 1000 Volts DC (1 kV DC),
- 2] Resistor: R = 330 Ω , +/- 5%, 1W CFR (Carbon Film Resistor).
- 3] Wires for Connection of RC Snubber to the Contactor: 1 Sq.mm, 7 Centimeter Length.

The loose flying end of the Wires for the Contactor Connection to have a Fork-Type Lug crimped and soldered to the wire.

All Components to be of reputed Makes,

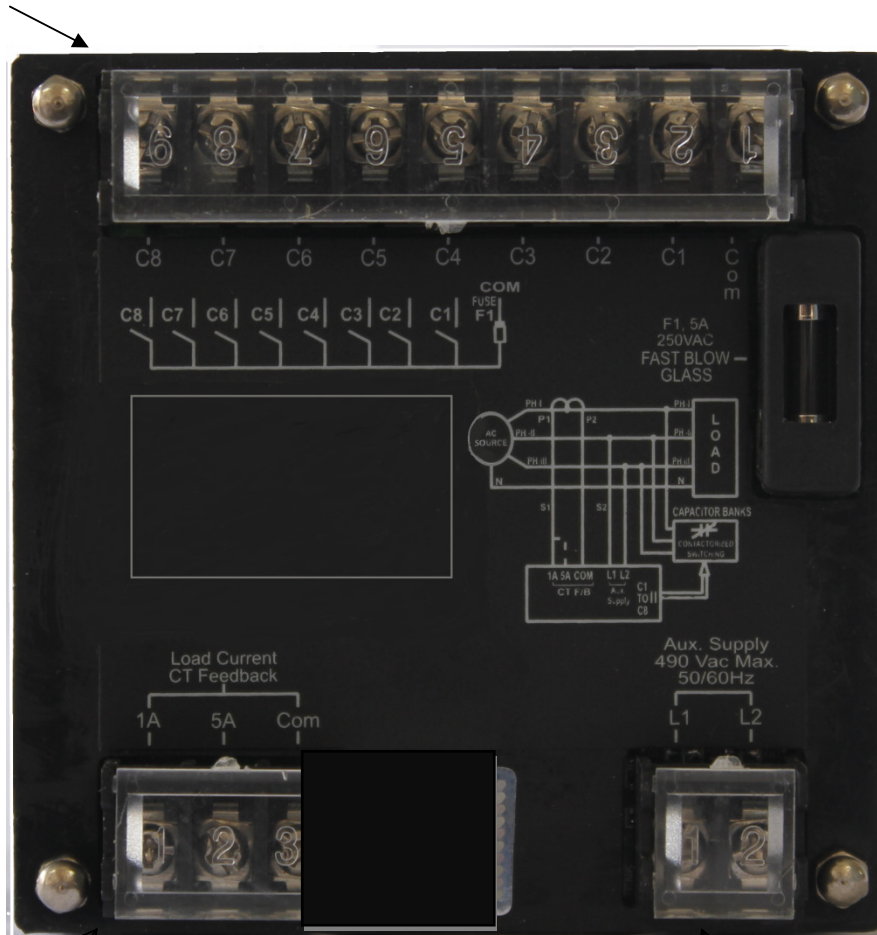
Note: The Resistor-Capacitor Assembly to be covered in appropriate size Heat-Shrinkable Tube and heat-shrunk.

Rear View Details:

Voltage measurement and Current measurement:

Output commands to the AC Coils of the capacitor-duty, three-phase, Power Contactors.
COM = common, for maximum up to 8 Outputs.

C1..... C8 =potential-free Normally-Open relay contacts, 0.5A, 230Vac (Inductive Load).



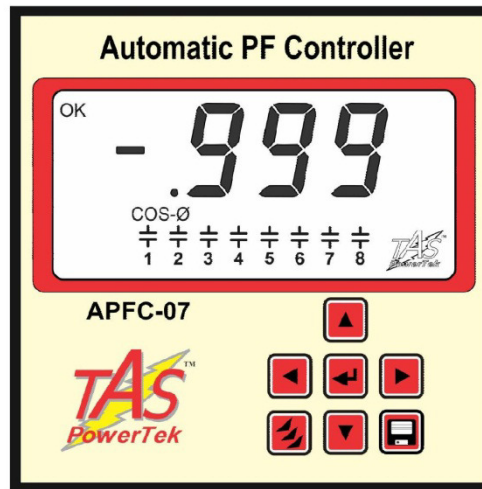
**Load (Supply) Current CT Connection.
User Selectable 1 Amp or 5 Amps**

Auxiliary & Measurement Voltage Phase-to-Phase: Nominal 415 Vac, 50 Hz

Use Correct Size "U" Type, Insulated Fork Lugs for Field Wires Connections, suitable for 2.5 mm-Square wires. Suggested Make: Chetna Engg., F-57, Ambad MIDC, Nashik-422 010, India. Cat. No.: CCFM-937, Serial No.: 835, or Direct Equivalent.

Front View Details:

Custom LCD Display Screen



Custom LCD screen display indicates the PF value, inductive/capacitive PF, and fault(s) / OK status. Large Size, 7-Segments Display indicate the overall PF of the system.

“+” or “-” indicates if this PF is inductive or capacitive respectively.

“OK” (blinking) indicates Healthy Operating Status of the PF Controller.

Last line indicates the status of each capacitor bank by symbols.

Discharging status is indicated by blinking of the capacitor bank symbol.

This Custom LCD has a LED back-light with Auto shut-off timer feature.

User pressing any key on the front panel switches ON the LED back-light automatically.

If no key gets pressed for duration of more than 1 Minute, the LED back-light is automatically turned off to conserve power.

Front View:

Key-board:

Keyboard with soft touch keys are provided on the front fascia of the controller. The various keys are:



UP key: Used to scroll the menu screen up. Increment values in edit mode.



DOWN key: Used to scroll down the menu screen. Decrement values in edit mode.



RIGHT key: Used to shift the cursor to Right. Also used to increase contrast of LCD in default display screen mode.



LEFT key: Used to shift the cursor to Left. Also used to decrease contrast of LCD in default display screen mode.



ENTER key: Used for setting up edited values.

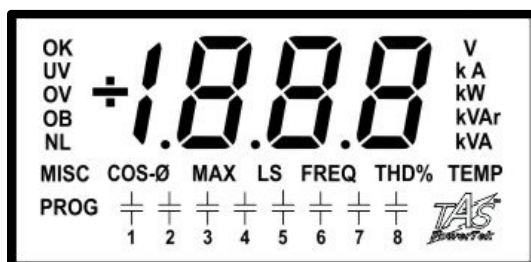


PROGRAM key: Select program modes to edit the parameters.



MEMORY key: Save all changes made in Edit Parameters menu.

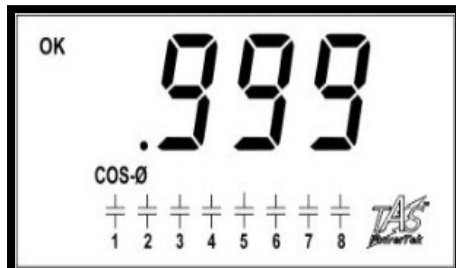
POWER ON Display:



15 Seconds Power-ON stabilizing screen (All LCD Segments are ON for 10 Sec. and OFF for 5 Sec.)

Display Parameters list:

Values of various parameters can be viewed by using UP/DOWN keys in Auto & Misc mode .



Default Screen for PF Value



Measured Phase-Phase Voltage



Measured Phase Current

Up / Down Keys



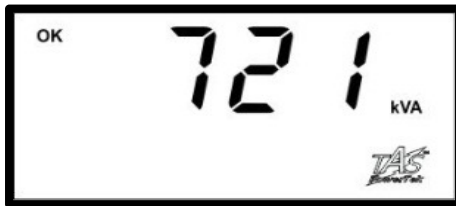
Power Factor in Measured-Phase



kW (Three-Phase)



kVAr (Three-Phase)



kVA (Three-Phase)



LINE FREQUENCY



V-THD% in Measured Phase-Neutral

Up / Down Keys



I-THD% in Measured Phase-Neutral



PF Controller Internal Temperature,
in Degrees Celsius.



This APFC Unit Firmware Version.
This number can change according to
product updates from time-to-time.

MODE Selection :



Press Mode Key on default screen. Two Modes will get displayed on screen.



AUTO OPERATION is a factory default mode of operation.

There are two modes of operation for selection,

- **MISC**
- **PROGRAM PARAMETERS**

By pressing “UP / DOWN” arrow keys, user can choose the MODE of operation.

Press “ENTER” to enter the specific mode.

Auto Mode:

This is the automatic PF correction mode. In this mode, the Capacitor Bank Status indications are: ON, OFF , Discharging or Faulty. The ON state is indicated by keeping Capacitor Symbol and the associated Bank Number, both ON. The OFF state is indicated by keeping the Capacitor Symbol OFF , but the Bank Number ON to indicate that the Bank is available for operation. Discharging Capacitor status is indicated by blinking of the capacitor bank symbol. A faulty Capacitor Bank is indicated as a Flashing Bank Number and the Capacitor Symbol in OFF state.

MISC Mode:

This mode is normally used to perform the operations like:

- Checking the Capacitor banks by turning them ON/OFF.
- To reset the faulty bank status stored in memory.
- Declaring specific bank/s faulty for Masking of the banks so that once auto-mode is selected, these faulty declared banks would not be used for PF correction.

Selecting MISC on the Screen, and pressing “ENTER” button, will put APFC in MISC mode.

In Misc mode various display parameters can also be scrolled & viewed with the help of UP/Down keys. If Controller is in MISC Mode and for 5 minutes no key on the key-pad is pressed, then APFC will automatically switch to Auto Mode, to continue to do the PF Correction function.

In MISC mode, the user can manually turn ON/OFF the Capacitor Bank(s) for testing. But this is not allowable for all the faults. In case of the following faults, turning ON the Capacitor Bank(s) in MISC mode is NOT allowed:

- 1] Under Voltage (UV) – To avoid Chattering of the Three-Phase Power Contactor
- 2] Over Voltage (OV) – To prevent possible damage to the Power Capacitors
- 3] Under Frequency (UF)
- 4] Over Frequency (OF)

Entry in to MISC Mode of operation first turns-off all the Capacitor Banks.

In MISC mode there are two display screens **i) Test (tSt) ii) Fault (FLt)**



i) Select MISC Mode on Mode screen by pressing ENTER key to display Test (tSt) screen.

Pressing 'Enter' key on the Test (tSt) screen will start blinking of the digit Number (Bank No.) . Use ◀ ▶ keys to select the specific bank for turning it ON/OFF. By pressing "UP" or "DOWN" key, user can turn ON or OFF the Bank. After these operations, press ENTER key to stop digit blinking.

ii) In MISC Mode Test (Tst) screen, if no digit No. (Bank no.) is blinking & "DOWN" key is pressed then Fault (FLt) screen is displayed. In Fault (FLt) screen the Faulty Banks can be reset or specific bank can be declared Faulty.

Resetting of Faulty Banks:

a) In Fault (FLt) screen, press ENTER key. The digit No.(Bank No.) will start blinking.

b)The OKAY Banks shall be indicated with ' Capacitor Symbol ' & Faulty Bank status shall be indicated by ' Blank ' location . Use ◀ ▶ keys to select the specific faulty bank indicated by 'Blank' location.

c) By Pressing 'UP' key, the ' Capacitor Symbol ' meaning OKAY status will appear at the specific blank location indicated by blinking digit no.

d)By using ◀ ▶ keys & UP key make all the required faulty bank with Okay status , by display of capacitor symbol.

e) Stop the digit No. (Bank No.) blinking by pressing enter key & Press ' Memory ' key to save the Okay status of capacitor banks to confirm resetting of faulty banks.

Declaring Specific Bank as faulty:

- a)** In Fault (FLt) screen, press ENTER key. The digit No.(Bank No.) will start blinking.
- b)** The OKAY Banks shall be indicated with ' Capacitor Symbol ' & Faulty Bank status shall be indicated by ' Blank ' location . Use ◀ ▶ keys to select the specific capacitor bank to be made faulty.
- c)** By Pressing 'Down' key , a 'Blank Location' (Capacitor symbol will disappear) meaning capacitor bank faulty status will appear at the location indicated by blinking digit no.
- d)** By using ◀ ▶ keys & DOWN key make all the required Capacitor bank with Okay status to faulty status by display of 'Blank Location' (Capacitor symbol will disappear).
- e)** Stop the digit No. (Bank No.) blinking by pressing enter key & Press ' Memory ' key to save the Faulty status of capacitor banks to confirm masking of specific capacitor banks in the auto mode.

By factory default, the APFC Unit is set to operate in AUTO mode.

Note: If the Check Bank Health parameter in the program parameter mode is enabled, then the controller shall monitor the Capacitor Bank kVAR value & if it is outside the internally set reference limit , the Bank shall be declared Faulty.

Sometimes, some Capacitor banks are declared as faulty even if they are checked to be OK. Probable reason for this could be:

- i) Fast varying load condition (kW & kVAR varying rapidly).**
- ii) Load-Side voltage & current THD% is high & continuously fluctuating.**

The continuously fluctuating Load & THD% condition can cause some errors in individual step kVAR measurement & declare the bank faulty, even if they are checked Okay. Under this condition, best is to keep this feature disabled.

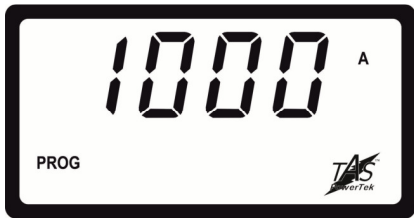
Programing Parameters:



RATED SUPPLY VOLTAGE: User can set rated supply voltage of the panel.



SUPPLY FREQUENCY: User can select the supply frequency as 50 Hz or 60 Hz



CT PRIMARY: User can set the external CT ratio in Amp up to 1999 & after 1999 Amps, it is in kilo-Amp . Maximum up to 5.00 kA (i.e. ,5000 Amp).

Up / Down Keys



TARGET POWER FACTOR: User can set the target power factor form 0.800 to 1.000



POWER FACTOR SIGN: In this menu user can set the target power factor as inductive (+) or capacitive (-).



CORRECTION TIME: Defined in Seconds. This is the Time between two consecutive kVAR compensations. This can be set within the range of 10 Sec to 600 Sec.



DISCHARGE TIME: Time defined in second. Time for discharge the capacitors to a level, so that they can be turned ON again. This can be set within the range of 60 Sec to 600 Sec.



CHECK BANK HEALTH: Here user can ENABLE or DISABLE the bank health monitoring,

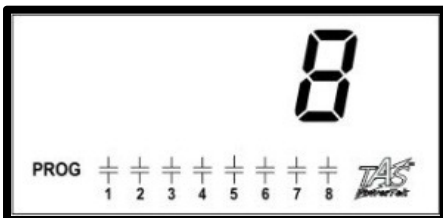


THD% FAULT: Here user can ENABLE or DISABLE the THD% fault (% Limit Exceeded) monitoring and action.

Up / Down Keys



HAMONIC FAULT AUTO RESET TIME: Harmonic fault is declared after every 3 minute averaging of %VTHD or %ITHD parameter. Once the fault gets recorded, APFC will switch off all the capacitor banks. PF correction will start only after the auto reset time defined by user. This time is settable from 180 Sec. to 1800 Sec.



STEP CONNECTED: Defines the number of steps operational. Depending on the APFC Model & Hardware capability, this parameter is set to maximum number of banks that can be connected.



STEP kVAr: These parameters are to be defined for every bank kVAr at defined Capacitor Bank Nominal Rated Voltage.



Fault Indications:

OK: Healthy Condition (No Fault).

UV: Under Voltage.

OV: Over Voltage.

OB: Out of Capacitor Banks. This is during the Total available Capacitive kVAr is not sufficient.

NL: Low (or Zero) AC Supply (Load) Current.

The Errors **Er0**, **Er1** & **Er2** are the APFC Hardware related errors.

Er3 to Er9 Errors are as below:

Er3: Voltage THD% of Measured Phase-Neutral, exceeding limit.

Er4: Current THD% of Measured Phase Current, exceeding limit.

Er5: Measured Phase Under (Low) Current loading sensed.

Er6: Measured Phase Over (High) Current loading sensed.

Er7: Supply system (AC Mains Line) Over Frequency.

Er8: Supply system (AC Mains Line) Under Frequency.

Er9: P.F. Controller Internal Temperature exceeding limit.

Programmable Parameters: Min., Max. Ranges and Factory Default settings:

Programmable Parameters	Min.	Factory Default	Max.
Nominal Supply voltage value across Line to Line terminals.	110 V	415 V	480 V
Primary CT Current in Amps up to 1999 & in kilo-Amp after 1999 .	1	1000	5.00 KA
Target Power Factor.	0.800	0.995	1.000
Target Power Factor Sign +Ve or -Ve. (-Ve value means leading target PF setting and +Ve value means lagging PF)	+Ve	+Ve	-Ve
PF Correction time in Seconds	10	60	600
Capacitor Bank Discharge Time in Seconds	60	60	600
Check Bank health	Disable	Disable	Enable
%Harmonic fault	Disable	Disable	Enable
%Harmonic fault Auto Reset Time in Second	180	180	1800
No. of steps connected, as per the Model Number (Factory Set)	1	Factory Settings	Factory Settings
Capacitor Bank kVAr values at supply nominal rated voltage and nominal rated frequency values.	1 kVAr	25 kVAr	255 kVAr

Fixed Parameter settings at Factory:

Fixed Parameters	Default
Over-Voltage limit (%) of Nominal Supply Voltage	115
Over-Voltage Resume limit (%) of Nominal Supply Voltage	110
Under-Voltage limit (%) of Nominal Supply Voltage	85
Under-Voltage Resume limit (%) of Nominal Supply Voltage	90
Over Current Limit (%) of Nominal Rating.	130
Over Current Resume (%) of Nominal Rating.	125
Under Load Current Limit (%) of Nominal	2
Under Load Current Resume (%) of Nominal	3
For kW loading is above 50% and up to 100% of rated kVA	
V-THD Limit in %	5
I-THD Limit in %	50
For kW loading is above 25% and up to 50% of rated kVA	
V-THD Limit in %	7
I-THD Limit in %	75
For kW loading is between 1% and up to 25% of rated kVA	
V-THD Limit in %	10
I-THD Limit in %	150

Fixed Parameters set at Factory	Default
Under Frequency limit for 50 Hz Supply	47 Hz
Over Frequency limit for 50 Hz Supply	53 Hz
Under Frequency limit for 60 Hz Supply	57 Hz
Over Frequency limit for 60 Hz Supply	63 Hz
Over Temperature Limit in Deg. Celsius	+60
Over Temperature Resume in Deg. Celsius	+55



APFC-07/nn

TAS PowerTek Contact Details:

The Sales & Marketing / The Customer Support & Service Dept. / Design Dept.:

TAS PowerTek Pvt. Ltd.

W-61, C/o. Pawar Industries, Opp. "Machine House",
MIDC Industrial Area, Ambad,
Nashik – 422 010 (via Mumbai), Maharashtra State, India.

Land-Line Phones: +0091-253-6694956 (Sales & Marketing)
+0091-253-6694955 (Customer Support & Service)
+0091-253-6694959 (Design and Developments)

E-mail: sales@taspowertek.com; design@taspowertek.com

Web: www.taspowertek.com

Working Hours: 9:30 AM to 6:30 PM (Normal Weekly Off: Saturdays)

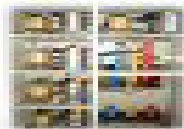
**This Product is completely Designed, Developed, Manufactured,
Assembled, Tested and Calibrated in India by:**

**TAS PowerTek Pvt. Ltd., Nashik – 422 010,
India.**

Would you like to learn in-depth on the subject then, buy e-Book on-line from Amazon.com
Book Title: Reactive Power Compensation on LV Supply.
Author: Mr. Tushar P. Mogre, CEO, Director, TAS PowerTek Pvt. Ltd.
e-Book Published by: Amazon.com

Web link: <http://www.amazon.com/gp/aw/d/B00o7YLLYY>

**Reactive Power
Compensation
on LV Supply.**



Reactive Power Compensation on LV Supply
Reactive Power Compensation on LV Supply
Reactive Power Compensation on LV Supply
Tushar P. Mogre, Inc.