ACCUVAR
KVAR BASED CONTROLLER FOR LT CAPACITOR BANKS

USER’S MANUAL

TRINITY
MAKING ENERGY MATTER
This document contains the latest technical information about ACCUVAR which is a microcontroller based KVAR controller for LT capacitor bank. The product, ACCUVAR is sophisticated electronic equipment and, the user is advised to read this User’s Manual carefully before attempting to install or operate the equipment.
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ACCUVAR - Operational Manual

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Introduction

Every Power distribution system requires reliable metering of various electrical parameters. From the electricity user’s point of view, this is important for saving of electrical energy, where-ever possible. Not only should his distribution transformer be loaded optimally, but it should also operate at near unity power factor. The load imbalance on the three phases should be within reasonable limits. Thus, information like amount of loading imbalance, power factors at different times of the day, peak loading hour etc. can be of great help in planning usage of power and also implementing automatic switched capacitor systems to maintain power factor near unity.

This is where ACCUVAR comes in. ACCUVAR is a KVAR based controller which controls capacitor banks optimally to achieve near unity power factor and also which measures/calculates various electrical parameters.

ACCUVAR is meant for use in three phase four wire L.T. electrical system. It uses the three watt-meter method to calculate KVA, KW & KVAR.

ACCUVAR is based on a powerful micro-controller operating at 4 MHz. The controller receives voltage & current signals and performs high speed measurement and calculations, typically finishing one complete measurement cycle in less than a second.

The unit displays all parameters locally on a 16X1 STN LCD. The userfriendly keypad on the front makes programming the unit (for C.T. ratios etc.) very easy.

ACCUVAR is thus a very versatile controller and accurate information interface for the user.
The Main Features Available in this Model

1. 3P4W LT electrical system
2. Three powers: KW, KVA and KVAR
3. Three phase voltages (Vr, Vy & Vb) and currents (Ir, Iy, Ib)
4. Active energy (KWh) and apparent energy (KVArh)
5. CT ratio for both load current and capacitor current selectable
6. Capacitor current (I cap)
7. Phase-Wise PF, System PF and Average integrated PF
8. Autosense/Manual types of KVAr control and the capacitor bank size of every stage display.
9. Eight/twelve/fifteen stage relays controller with a one alarm selectable.
10. Total Harmonics Distortion (THD) for each Voltages and Currents.
## Technical Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Name</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supply</strong></td>
<td></td>
<td>Three Phase and Neutral of a 3P4W system</td>
<td></td>
</tr>
<tr>
<td><strong>Voltage</strong></td>
<td></td>
<td>Direct Voltage Input</td>
<td>Up to 300V L-N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Burden</td>
<td>0.5VA</td>
</tr>
<tr>
<td><strong>Input</strong></td>
<td>Current</td>
<td>Secondary Current Input: 5A or 1A</td>
<td>Up to 5000A from mains. Site Selectable</td>
</tr>
<tr>
<td></td>
<td>CT Ratio</td>
<td>: Site Selectable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Range of Reading</td>
<td>: 0 – 5000A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Burden</td>
<td>: &lt; 1.0VA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Overload</td>
<td>: 5A CT = 6A RMS Continuous</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>: 1A CT = 1.2A RMS Continuous</td>
<td></td>
</tr>
<tr>
<td><strong>Power Supply</strong></td>
<td></td>
<td>Self Powered from mains. Wide operating</td>
<td>80 VAC - 480 VAC, 50-60 Hz.</td>
</tr>
<tr>
<td><strong>Output</strong></td>
<td>Relay</td>
<td>Switching Voltage</td>
<td>Max. 250 VAC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Switching Power</td>
<td>Max. 1000W</td>
</tr>
<tr>
<td></td>
<td>Expected Mechanical Life &gt;10 x 10^6</td>
<td>&gt;10 x 10^6 switching operations.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Expected Electrical Life</td>
<td>&gt;4 x 10^6 switching operations.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>@ (Load = 200VA, Cos φ = 0.5)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Measurement

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage (Volts L-N: VRN, VYN, VBN)</td>
<td>Accuracy</td>
<td>0.5% of Reading</td>
</tr>
<tr>
<td>Current (Amps IR, IY, IB)</td>
<td>Accuracy</td>
<td>0.25% of Reading</td>
</tr>
<tr>
<td>Capacitor Current</td>
<td>CT Ratio</td>
<td>Site Selectable</td>
</tr>
<tr>
<td></td>
<td>Accuracy</td>
<td>1.0% of Reading</td>
</tr>
<tr>
<td>Line Frequency</td>
<td>45 to 55 Hz, Accuracy</td>
<td>0.3% of Reading</td>
</tr>
<tr>
<td>Active Power (P)</td>
<td>Accuracy</td>
<td>1.0% of Reading (For IPF&gt;0.9)</td>
</tr>
<tr>
<td>Reactive Power (Q)</td>
<td>Accuracy</td>
<td>1.5% of Reading (Between 0.5 Lag to 0.8 Lead)</td>
</tr>
<tr>
<td>Apparent Power (S)</td>
<td>Accuracy</td>
<td>1.0% of Reading</td>
</tr>
<tr>
<td>Power Factor</td>
<td>Accuracy</td>
<td>1.0% of Reading (IPF≥0.5)</td>
</tr>
<tr>
<td></td>
<td>Range of Reading</td>
<td>0.05 to 1.00 Lag/Lead</td>
</tr>
<tr>
<td>Total Active Energy (KWh)</td>
<td>Range of Reading</td>
<td>0 to 9999999.0 KWh</td>
</tr>
<tr>
<td></td>
<td>Accuracy</td>
<td>1.0S as per IS13779.</td>
</tr>
<tr>
<td>Total Apparent Energy (KVAh)</td>
<td>Range of Reading</td>
<td>0 to 9999999.0 KVAh</td>
</tr>
<tr>
<td></td>
<td>Accuracy</td>
<td>1.0% of Reading</td>
</tr>
<tr>
<td>Misc.</td>
<td>Cap. Bank KVAR</td>
<td></td>
</tr>
</tbody>
</table>
## Miscellaneous

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td></td>
</tr>
<tr>
<td>Dimensions</td>
<td></td>
</tr>
<tr>
<td>Bezel</td>
<td>144 X 144 mm</td>
</tr>
<tr>
<td>Panel Cutout</td>
<td>138 X 138 mm</td>
</tr>
<tr>
<td>Depth of installation</td>
<td>76 mm</td>
</tr>
<tr>
<td>Operating temp</td>
<td>10°C to 50°C</td>
</tr>
<tr>
<td>Weight</td>
<td>0.82 Kgs (Approx.)</td>
</tr>
<tr>
<td>Min. Operating Current</td>
<td>5% of CT primary for FIFO/SFIFO Mode</td>
</tr>
</tbody>
</table>
Installation and Commissioning

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

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

Back View (Connection Scheme) of the Unit
2. Connect the three phases with the phase sequence being R-Y-B to the terminals marked R, Y and B accordingly such as shown above Connection Scheme. 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 neutral wire to the terminal marked N.

4. Connect the two wires from the R-phase main CT to terminals marked M1 & L1 such that S1 from CT goes to M1 on the unit. Connect the two wires from the Y-phase main CT to terminals marked M2 & L2 such that S1 from CT goes to M2 on the unit. Connect the two wires from the B-phase main CT to terminals marked M3 & L3 such that S1 from CT goes to M3 on the unit.

5. 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.

6. Switch on the three phases supply. Unit will power on from these three phases supply and prompt such as --TRINITY ESPL-- for about 2 to 3 seconds.

7. First of all, user should program the following parameters of the unit: CT RATIO FOR MAIN CTs, CT RATIO FOR CAPACITOR CTs, ALARM MODE. Refer Operational Details in the next section. The proper operation of the relay can commence only after these three parameters are defined.

8. Ensure that all capacitors are in the circuit i.e. all fuses link pushed in. Give Autosense (Refer Operational Details in the next section). ACCUVAR will first
display 'AUTOSENSING' and as it switches on one bank at a time and also, displays the bank size of every stage. After AUTOSENSING is completed, the unit will Reset.

9. Now, the unit is ready for the control action after a 1 minutes delay.
Operational Details

The KVAR Based Controller for LT Capacitor Banks, ACCUVAR 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 control needs and this is achieved by making as many parameters field programmable as possible.

There are basically two modes of operation in ACCUVAR:

1. Programming Mode
2. Run Mode

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

\[ KVAH = 0.00 \]

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

![Keypad Image]

Press \( \text{PROG RUN} \) key for about five seconds continuously, to go from Run mode to Programming Mode. The first screen in this mode is:

\[ \text{PROG MODE PRESS } \wedge \wedge \]
Programming Mode

In order to set all the field programmable parameters, the user has to press the keys such as , , ▲ , ▼ and . Once the display is in Programming Mode, press key to set the values for the following parameters:

1. CT primary for load currents
2. CT primary for capacitor currents
3. Desired PF Setting
4. PF Controlling Mode
5. Unit Addr (Station ID)
6. Baud Rate
7. LCD Backlight
8. Switching
9. Alarm Mode
10. Alarm Limit - PF setting below which alarm will operate
11. Alarm Delay - Delay after which alarm should operate
12. Switching Delay - Delay between two successive switching operation of Relay
13. Damp Factor for settling the sensitivity level for control action
14. Min Bank
15. Auto Sense for Capacitors
1. Setting CT Primary for Load Current

In order to get actual current values in the system, the CT Primary value should be set. The CT Primary value can be set from 5 A to 5000 A.

To set CT Primary value for Load Current, proceed as follows:

Once in Programming mode,

1. Press ▲ key to go to first programmable parameter i.e. CT Primary for load current. The display will show :

   MAIN CTR=525

2. Press ENT key. Immediately, character “P” will blink at the end of the LCD at one second interval which indicates that the parameter value can now be set. Set the MAIN CTR by pressing ▲ and ▼ keys until the desired value is reached and then, press ENT key to confirm the value. After that, unit will restart.

2. Setting CT Primary for Capacitor Current

In order to get the actual current values for capacitors in the system, the capacitor CT Primary should be set.

To set CT Primary for Capacitor Current, proceed as follows:

Once in Programming mode,

1. Press ▲ key till the following prompt appears :

   CAP.CTR=525
2. Press key. Immediately, character “P” will blink at the end of the LCD at one second interval, which indicates that the parameter value can now be set. Set the CAP CTR by pressing ▲ and ▼ keys until the desired value is reached and then, press key to confirm the value. After that, the unit will restart.

3. Setting the Desired PF

The desired PF can be set to either Lead or Lag side according to the requirement. In case, the desired PF is 0.994 on lead side, the PF value must be set to 1.994. In case the desired PF is 0.998 on lag side, the PF value must be set to 0.998.

To set the desired PF value, proceed as follows:

Once in Programming mode,

1. Press ▲ key till the following prompt appears:

   SET PF=0.998

2. Press key. Immediately, character “P” will be blink at the end of the LCD at a one second interval, which indicates the parameter can now be set. Set the SET PF by pressing ▲ and ▼ keys until the desired value is reached and then, press key to confirm the value. After that, unit will restart.
4. Setting the Mode of Control Action

For PF correction, there are four types of Modes of Control Action such as FIFO, VAR, PID and straight FIFO (SFIFO) which are also settable at site.

The Relay has the provision to operate in multiple control action modes, each of which optimized for different industrial load types. The modes are as follows: 1. VAR 2. FIFO 3. PID 4. Straight FIFO (SFIFO).

In VAR mode, the relay will take control action, based on the instantaneous KVAR requirement of the system. The control action is intelligent and the switching follows no set sequence. This sequence is suitable where there are unequal banks and the load fluctuations are not too fast or too large and are a limited percentage of the total prevailing load.

In MANUAL mode, the control action is disabled, and the relay becomes just an indicator. Manual Mode can be achieved by applying 230V at K1 and K2.

In FIFO mode, the relay will take a control action, based on the Instantaneous PF of the system. The control action is PF based and the switching follows the older FIFO sequence. This sequence is suitable where the banks are equal sized.

In PID mode, the relay will take control action, based on the instantaneous as well as the integrated KVAR requirement of the system. The integration is over the switching delay programmed. The control action is again intelligent and the switching follows no set sequence. This sequence is suitable where there are unequal banks and the load fluctuations are fast/large.

In Straight FIFO (SFIFO) Mode, the relay will take control action, based on the instantaneous PF of the system. The control action is PF based and the switching follows from the first bank. This Sequence is suitable where the banks are equal sized.
To set the Mode of Control Action, proceed the following instructions:

Once in the programming mode,

1. Press ▲ key till the following prompt is seen:

   MODE=VAR

2. Press ▼ key. Immediately, character "P" will be blink at the end of the LCD at one second interval which indicates that the parameter can now be set. Set the Mode by pressing ▲ and ▼ keys until the desired mode of action is set and then, press ▼ key to confirm the control action. The unit will then restart.

5. Unit Addr : (Station Id) :

   The Relay has RS485 port for external communication as an optional feature. ACCUVAR supports MODBUS-RTU protocol on RS485 port. Each device on RS485 bus should have unique address for proper functionality. Unit Address value is programmable from 1 to 255. To change the unit address follow the procedure as described below:

   Once in the programming mode,

   1. Press ▲ key till the following prompt is seen:

   UNIT ADDR=255
2. Press ENTER key. Immediately, character “P” will be blink at the end of the LCD at one second interval which indicates that the parameter can now be set. Set the unit address by pressing ▲ and ▼ keys until the desired unit address value is set and then, press ENTER key to confirm the control action. The unit will then restart.

6. Baud Rate:

The baud rate for communication is programmable between 9600 or 19200.

To Change the Baud Rate follow the procedure as described below:

Once in the programming mode,

1. Press ▲ key till the following prompt is seen:

   BAUD RATE=9600

2. Press ENTER key. Immediately, character “P” will be blink at the end of the LCD at one second interval which indicates that the parameter can now be set. Set the baud rate by pressing ▲ and ▼ keys until the desired baud rate value is set and then, press ENTER key to confirm the control action. The unit will then restart.

7. LCD Backlight

   If Cont. backlight is set to ON, backlight will be always ON with full brightness and if it set to OFF, backlight will be dimmed after 5 minutes. On any key press event LCD will have full brightness.
8. Switching

Normal (Contactor) OR Fast (Thyristor) is site selectable. Once you change any switching state, system will restart.

9. Setting Alarm Mode

The relay has an inbuilt alarm mode. In case, the relay ordered is of 8 stage, selecting the alarm mode as NO will keep it as 8 Stage relay. The Control action will cover 8 Relays. If however, you have selected alarm mode other than NO, the relay will effectively become 8+1ALARM stage relay and the 16th stage will be used as an alarm Contact. Thus, in a fifteen stage relay, alarm mode NO means a 15 stage Relay, while alarm mode other than NO will make it as 15 stage Relay, with 16th stage used as an alarm contact. There are two additional parameters which need to programmed. i.e. Alarm Limit and Alarm Delay. These s how up in Programming Sequence only when Alarm mode is selected other than NO. In Alarm mode, if the selected parameter remains below/above the Alarm Limit, continuously for Alarm Delay time, the alarm relay will come ON. The hooter connected to this stage can be silenced by pressing any key. Alarm Mode can be set on PF, I_THD, V_THD or NO. Alarm mode PF will cause alarm when PF remains below the limit. For alarm mode I_THD or V_THD, alarm will occur when the THD values for current/voltage are above the programmed ALARM LIMIT.

To Change the alarm mode follow the procedure described below:

Once in the programming mode,

1. Press ▲ key till the following prompt is seen:

   ALRM MODE=I_THD
2. Press \textcolor{red}{\textbf{ENTR}} key. Immediately, character “P” will be blink at the end of the LCD at one second interval which indicates that the parameter can now be set. Set the alarm mode by pressing \textcolor{red}{\textbf{\uparrow}} and \textcolor{red}{\textbf{\downarrow}} keys until the desired alarm mode is set and then, press \textcolor{red}{\textbf{ENTR}} key to confirm the control action. The unit will then restart.

10. Setting Alarm Limit

The Alarm Limit is programmable from 0.800 to 0.999 for PF Mode. same can be set between 10 to 80\% of V\_THD & ITHD. The sign of PF is not considered.

To Change the alarm limit follow the procedure described below:

Once in the programming mode,

1. Press \textcolor{red}{\textbf{\uparrow}} key till the following prompt is seen:

\begin{center}
ALRM LMT=10
\end{center}

2. Press \textcolor{red}{\textbf{ENTR}} key. Immediately, character “P” will be blink at the end of the LCD at one second interval which indicates that the parameter can now be set. Set the alarm limit by pressing \textcolor{red}{\textbf{\uparrow}} and \textcolor{red}{\textbf{\downarrow}} keys until the desired alarm limit value is set and then, press \textcolor{red}{\textbf{ENTR}} key to confirm the control action.
11. Setting Alarm Delay

Alarm Delay value can be set from 20 to 180 seconds.

To Change the Alarm Limit follow the procedure described below:
Once in the programming mode,

1. Press \[ \text{key} \] till the following prompt is seen:
   
   \[ \text{ALRM DLY}=20 \]

2. Press \[ \text{key} \]. Immediately, character "P" will be blink at the end of the LCD at one second interval which indicates that the parameter can now be set. Set the alarm delay by pressing \[ \text{and } \] keys until the desired alarm delay value is set and then, press \[ \text{key} \] to confirm the control action.

12. Setting the Switch Delay

This is one type of digital dead band. In fast switching mode Value can be set from 1 to 10 and In normal switching mode value can be set from 40 to 180

To change the switch delay follow the procedure described below:
Once in the programming mode,

1. Press \[ \text{key} \] till the following prompt is seen:
2. Press \( \text{ENTR} \) key. Immediately, character "P" will be blink at the end of the LCD at one second interval which indicates that the parameter can now be set. Set the switch delay by pressing \( \uparrow \) and \( \downarrow \) keys until the desired switch delay value is set and then, press \( \text{ENTR} \) key to confirm the control action. The unit will then restart.

13. Setting Damp Factor for Sensitivity of Control Action

The Damp value should be set from 2 to 10 so as to slow down the response of the control algorithm. Setting a higher value of DAMP will slow down the response of the relay to transient jumps in system KVAR values. To change the damp factor value follow the procedure described below: Once in the programming mode,

1. Press \( \uparrow \) key till the following prompt is seen:

\[
\text{DAMP}=10
\]

2. Press \( \text{ENTR} \) key. Immediately, character "P" will be blink at the end of the LCD at one second interval which indicates that the parameter can now be set. Set the damp by pressing \( \uparrow \) and \( \downarrow \) keys until the desired damp value is set and then, press \( \text{ENTR} \) key to confirm the control action. The unit will then restart.
14. MIN. BANK

Min. Bank (Minimum Bank) value can be set either to 100% or 75%. In VAR and PID mode, Accuvar will take control action if it finds that the needed KVAR is larger than the smallest bank connected. e.g. if it finds that in order to achieve the desired PF, the system needs to add/remove 8 KVAR, but the smallest bank connected to the system is 10 KVAR, it will not switch, if the MIN BANK is set to 100%. If however it is set to 75%, it will take switching action. (because 75% of 10KVAR is 7.5KVAR). To change the this value, follow the procedure described below: Once in the programming mode,

1. Press ▲ key till the following prompt is seen:

   MIN. BANK=75%

2. Press ENTER key. Immediately, character “P” will be blink at the end of the LCD at one second interval which indicates that the parameter can now be set. Set the MIN BANK by pressing ▲ and ▼ keys until the desired MIN BANK value is set and then, press ENTER key to confirm the action.
15. Performing Auto Sense of Capacitor Bank Sizes

When the Auto Sense 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 have been sensed, the relay will restart for control action and also display the parameters one by one. To start the Auto Sense follow the same procedure as described below:

1. Press ▲ key till the following prompt is seen:

   AUTO SENSE=NO

2. Press ▼ key. Immediately, character "P" will be blink at the end of the LCD at one second interval which indicates that the parameter can now be set. Set the auto sense by pressing ▲ and ▼ keys until the desired auto sense is set and then, press ▼ key and after sensing all the banks, the unit will restart.
Run Mode

In the run mode, the various parameters calculated by the ACCUVAR are displayed on different pages on a 16 X 1 backlit LC Display.

1. **Screen Displays**

Press ⅆ️ or ⅄️ keys on Run Mode so as to receive the following displays:

<table>
<thead>
<tr>
<th>Displays</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>KVAH=125</td>
<td>The first display shows Apparent energy.</td>
</tr>
<tr>
<td>VR=241.2</td>
<td>The second display shows voltage in R-phase.</td>
</tr>
<tr>
<td>VY=238.2</td>
<td>The third display shows voltage in Y-phase.</td>
</tr>
<tr>
<td>VB=240.6</td>
<td>The fourth display shows voltage in B-phase.</td>
</tr>
<tr>
<td>IR=360.4</td>
<td>The fifth display shows current in R-phase.</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>IY=376.4</td>
<td>The sixth display shows current in Y-phase.</td>
</tr>
<tr>
<td>IB=384.3</td>
<td>The seventh display shows current in B-phase.</td>
</tr>
<tr>
<td>Icap=34.4</td>
<td>The eight display shows current passing through capacitor.</td>
</tr>
<tr>
<td>KWH=21.4</td>
<td>The ninth display shows Active energy.</td>
</tr>
<tr>
<td>0.942 LG (0.944)</td>
<td>The tenth display shows System PF as well as integrated average PF within the bracket.</td>
</tr>
<tr>
<td>PF 1.00 1.00 1.00</td>
<td>The eleventh display shows Individual Phase’s PF.</td>
</tr>
</tbody>
</table>
KVA=243.3

The twelveth display shows Apparent power.

KW=229.0

The thirteenth display shows Active power.

KVAR=81.9  

The fourteenth display shows Reactive power with lagging PF.

Vr  THD=3.7

The fifteenth display shows R Phase Voltage Total Harmonic Distortion in %.

Vy  THD=5.5

The sixteenth display shows Y Phase Voltage Total Harmonic Distortion in %.

Vb  THD=3.7

The seventeenth display shows B Phase Voltage, Total Harmonic Distortion in %.
The eighteenth display shows R Phase Current Total Harmonic Distortion in %.

The nineteenth display shows Y Phase Current Total Harmonic Distortion in %.

The twentieth display shows B Phase Current Total Harmonic Distortion in %.

2. **Resetting Average PF**

The integrated average PF parameter shown in 10th display page can be reset by pressing key in Run Mode for about 5 seconds continuously. This integrated average PF is basically the ratio of KWh & KVAh energy consumption. After reset the value will go to 1.00.

3. **Freezing and unfreezing the AutoScroll**

The Run Mode displays will always autoscroll by default with an interval of about 5 to 6 seconds. Each display can be frozen or unfrozen by pressing key and also be moved up and down by pressing ▲and ▼keys. When the display is frozen at one page, the display will show a ‘F’ in the 16th position.
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 ACCUVAR. 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.
System Considerations:

The Relay senses the total resultant power factor of the system and switches the Capacitors through the appropriate control gear in the panel so as to correct the power factor to the required level.

To enable the Relay to measure the power factor correctly:

a. The R, Y, B voltage connections must be correct.

b. The voltage must be nearest (10% plus or minus) to the specified voltage for the Relay.

c. The control circuits of the panel, on which the Relay is mounted, are equally important. Using the built in Manual control is the easiest way to implement the system. It is also the most economical and trouble free. If user wishes to use external Manual Control, pay careful attention to signal flow. Push-buttons must be used for the contactors to enable automatic cutoff in the event of a power failure. Do provide isolating contacts for each contactor, otherwise the control can lock out in Auto, by feedback over the Manual Bus.

(A). Troubleshooting

The ACCUVAR 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.
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). Troubleshooting 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:
The CTs are located only on the Load bus, and capacitor current is not passing through the CTs. Change the location of the CTs to the true main Incomer.

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 reconfiguration 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.
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.