

# 1. INTRODUCTION

Mono phase compensation systems are not useful in plants where unbalanced loads exist. In such plants compensation has to be done by measuring all 3 phase parameters individually. Devices, capable of measuring and compensating  $\text{Cos}\phi$  of each phase individually are developed. Such devices are able to correct  $\text{Cos}\phi$  for each phase either with mono phase or 3 phase capacitors.

Tri-Mo series of Reactive Power Controllers are developed in order to obtain maximum efficiency in plants where balanced and unbalanced loads exist. They are manufactured with 8, 13 and 18 steps and either with communication or without communication.

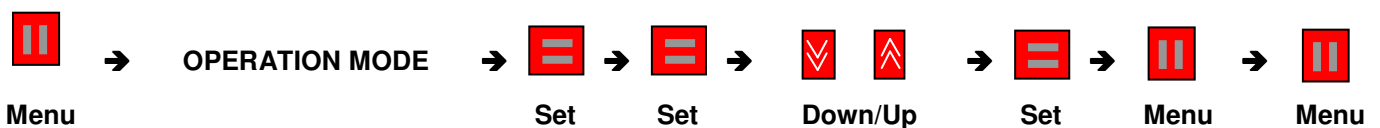
## FEATURES

- 4 lines 20 character LCD display.
- 8-13-18 flexible steps that do not require sequencing.
- Mono phase or 3 phase capacitors connection capability.
- Automatic/Manual Operating Modes.
- Automatic detection and display of capacitor powers. Automatic detection of line to which capacitor is connected.
- Manual entrance capability of capacitor powers.
- Automatic detection of current flow direction.
- Adjustable target  $\text{Cos}\phi$  value (0.8 ind – 0.8 cap).
- Adjustable capacitor switches on/off delay time.
- Adjustable over temperature protection limit and fan output.
- Adjustable overvoltage protection limit.
- Adjustable high harmonic protection limits (VTHD % and ITHD %).
- Measurement and display capability of current and voltage THD values for each phase.
- Measurement and display capability of up to 21th harmonic both for voltages and currents for each phase.
- Measurement and display capability of V, I, PF, F values for each phase.
- Measurement and display capability of kW, kVAR and kVA values for each phase.
- Measurement and display capability of total kW, kVAR and kVA values for each phase.
- 22 alarm sources and one alarm contact output.
- Password protection.

## 2. PROGRAMMING

### 2.1. OPERATION MODE

Device can operate either in automatic or manual modes. While in automatic mode, capacitors are switched on and off according to parameters set and measured values. In manual mode capacitors are defined by user and are also switched on and off by user. Automatic/Manual modes can be selected according to sequence showed below.



#### 2.1.1. Automatic/Manual Mode Selection

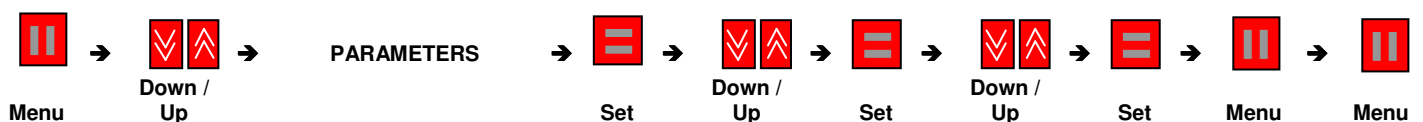
Press “Menu” button and scroll to OPERATION MODE. Press “Set” to display current setting. Press “Set” again to edit value (display is blinking). Scroll between Auto-Manual, press “Set” again to save selected value. Press “Menu” button to exit programming mode.



Manual mode is only useful for testing purposes. If manual mode is leaved active device will switch to Automatic Mode after 30 minutes.

### 2.2. PARAMETERS

This menu includes all the parameters that effect performance of the device. All these parameters have to be adjusted according to the plant and have to be readjusted if any changes occur on the plant. All the changes made in programming mode effect performance of the controller. Parameter settings are done by using 4 front panel buttons in the order listed below.



===== MENU =====				PARAMETERS			
OPERATION MODE			^	→ Cos	:	1 . 0 0 i	^
→ PARAMETERS				ton	:	5 sec	
HARMONICS				toff	:	5 sec	
CAPACITOR POWERS				Uprim	:	2 3 0 V A C	
COMMUNICATION PORT				Usec	:	2 3 0 V A C	
About . . .			v	Kctr	:	5 / 5 A	
				Uov	:	2 6 0 V A C	
				Tov	:	5 5 ° C	
				Acc . Code	:	Off	v

Parameter	Default Value	Range	Description
Cosφ	1.00i	0.80 ind-0.80 cap	Target
ton	5 sec.	1-120 sec.	Capacitor Switch on Time
toff	5 sec.	1-120 sec.	Capacitor Switch off Time
Uprim	230 VAC	100000 VAC	Voltage Transformer Primary Voltage
Usec	230VAC	100000 VAC	Voltage Transformer Secondary Voltage
Kctr	5/5A	5/5 – 5000/5	Current Transformer Ratio
Uov	260 VAC	200-300V	Overvoltage Alarm Limit
Tov	50°C	30°C-80°C	Over temperature Alarm Limit
Acc.Code	OFF	ON – OFF	Menu Input Password Protection Selection

### 2.2.1. Target (Cosφ)

Select Cosφ sub menu from PARAMETERS main menu. Press “Set” button to edit value (current value is blinking). While value is blinking using Down/Up keys adjust the desired target Cosφ value (0.80i-0.80c). Press “Set” button again to save adjusted value. Press “Menu” button to exit menu.

===== MENU =====				PARAMETERS			
OPERATION MODE			^	→ Cos	:	1 . 0 0 i	^
→ PARAMETERS				PARAMETERS			
HARMONICS			v	→ Cos	:	0 . 9 9 i	v

### 2.2.2. Capacitor Switch On Time Delay (ton)

Select ton sub menu from PARAMETERS main menu. Press “Set” button to edit value (current value is blinking). While value is blinking using Down/Up keys adjust the desired ton time (1-120 sec.). Press “Set” button again to save adjusted value. Press “Menu” button to exit menu.

===== MENU =====				PARAMETERS			
OPERATION MODE			^	→ ton	:	5 sec	^
→ PARAMETERS				PARAMETERS			
HARMONICS			v	→ ton	:	4 sec	v

### 2.2.3. Capacitor Switch Off Time Delay (toff)

Select toff sub menu from PARAMETERS main menu. Press “Set” button to edit value (current value is blinking). While value is blinking using Down/Up keys adjust the desired toff time (1-120 sec.). Press “Set” button again to save adjusted value. Press “Menu” button to exit menu.

===== MENU =====				PARAMETERS			
OPERATION MODE			^	→ toff	:	5 sec	^
→ PARAMETERS				PARAMETERS			
HARMONICS			v	→ toff	:	6 sec	v

### 2.2.4. Voltage Transformer Primary Voltage (Uprim)

Select Uprim sub menu from PARAMETERS main menu. Press “Set” button to edit value (current value is blinking). While value is blinking using Down/Up keys adjust the desired Uprim value (20-100000 volts). Press “Set” button again to save adjusted value. Press “Menu” button to exit menu.

===== MENU =====				PARAMETERS			
OPERATION MODE			^	→ Uprim	:	2 3 0 V A C	^
→ PARAMETERS				PARAMETERS			
HARMONICS			v	→ Uprim	:	2 3 1 V A C	v

### 2.2.5. Voltage Transformer Secondary Voltage (Usec)

Select Usec sub menu from PARAMETERS main menu. Press “Set” button to edit value (current value is blinking). While value is blinking using Down/Up keys adjust the desired Usec value (20-100000 volts). Press “Set” button again to save adjusted value. Press “Menu” button to exit menu.

===== MENU =====				PARAMETERS			
OPERATION	MODE		▲	→ Usec	:	230	VAC ▲
→ PARAMETERS				PARAMETERS			
HARMONICS			▼	→ Usec	:	231	VAC ▼

### 2.2.6. Current Transformer Ratio (Kctr)

Select Kctr sub menu from PARAMETERS main menu. Press “Set” button to edit value (current value is blinking). While value is blinking using Down/Up keys adjust the desired Kctr value (5/5-5000/5). Press “Set” button again to save adjusted value. Press “Menu” button to exit menu.

===== MENU =====				PARAMETERS			
OPERATION	MODE		▲	→ Kctr	:	5 / 5 A	▲
→ PARAMETERS				PARAMETERS			
HARMONICS			▼	→ Kctr	:	10 / 5 A	▼

### 2.2.7. Overvoltage Alarm Limit (Uov)

Select Uov sub menu from PARAMETERS main menu. Press “Set” button to edit value (current value is blinking). While value is blinking using Down/Up keys adjust the desired Uov value (200-300 volts). Press “Set” button again to save adjusted value. Press “Menu” button to exit menu.

===== MENU =====				PARAMETERS			
OPERATION	MODE		▲	→ Uov	:	260	VAC ▲
→ PARAMETERS				PARAMETERS			
HARMONICS			▼	→ Uov	:	259	VAC ▼

### 2.2.8. Over Temperature Alarm (Tov)

Select Tov sub menu from PARAMETERS main menu. Press “Set” button to edit value (current value is blinking). While value is blinking using Down/Up keys adjust the desired Tov value (50C-85C). Press “Set” button again to save adjusted value. Press “Menu” button to exit menu.

===== MENU =====				PARAMETERS			
OPERATION	MODE		▲	→ Tov	:	55 °C	▲
→ PARAMETERS				PARAMETERS			
HARMONICS			▼	→ Tov	:	56 °C	▼

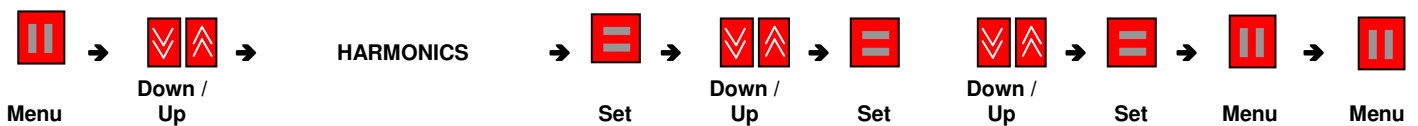
### 2.2.9. Password Protection Enable (Acc.Code)

Select Acc.Code sub menu from PARAMETERS main menu. Press “Set” button to edit value (current value is blinking). While value is blinking using Down/Up keys adjust the desired Acc.Code value (ON/OFF). Press “Set” button again to save adjusted value. Press “Menu” button to exit menu.

===== MENU =====				PARAMETERS			
OPERATION	MODE		▲	→ Acc. Code	:	Off	▲
→ PARAMETERS				PARAMETERS			
HARMONICS			▼	→ Acc. Code	:	On	▼

## 2.3. HARMONICS

Controller is capable of measuring and displaying harmonics of 3 phase for current and voltage. High harmonics may damage system. In order to protect system from harmonics user can set alarm level for harmonics in order to switch off compensation system. Harmonic protection can be set as follows.



Menu -> Up/Down -> HARMONICS -> Set -> Up/Down -> Set -> Up/Down -> Set -> Menu -> Menu

===== MENU =====				HARMONICS			
OPERATION	MODE		▲	→ Alarm	:	Off	▲
PARAMETERS				I t h d			
→ HARMONICS				:			
CAPACITOR POWERS				V t h d			
				:			
				t h d			
				:			
				1 min			
				▼			

Parameter	Default Value	Range	Description
<b>Alarm</b>	Off	Off – On	Enable Harmonic Protection
<b>Ithd</b>	0.0%	0.0% - 50.0%	Current Total Harmonic Distortion Percentage
<b>Vthd</b>	0.0%	0.0% - 50.0%	Voltage Total Harmonic Distortion Percentage
<b>thd</b>	1 min	30 min	Delay Time Before Normal Operation.

### 2.3.1. Harmonic Protection Activation (Alarm)

Select Alarm sub menu from HARMONICS main menu. Press “Set” button to edit value (current value is blinking). While value is blinking using Down/Up keys adjust the desired Alarm value (ON/OFF). Press “Set” button again to save adjusted value. Press “Menu” button to exit menu.

===== MENU =====	H A R M O N I C S
OPERATION MODE	→ A l a r m : O f f
PARAMETERS	H A R M O N I C S
→ H A R M O N I C S	→ A l a r m : O n

### 2.3.2. Current THD Over Limit (Ithd)

Select Ithd sub menu from HARMONICS main menu. Press “Set” button to edit value (current value is blinking). While value is blinking using Down/Up keys adjust the desired Ithd value (0.0%-50.0%). Press “Set” button again to save adjusted value. Press “Menu” button to exit menu.

===== MENU =====	H A R M O N I C S
OPERATION MODE	→ I t h d : 0 . 0 %
PARAMETERS	H A R M O N I C S
→ H A R M O N I C S	→ I t h d : 0 . 1 %

### 2.3.3. Voltage THD Over limit (Vthd)

Select Vthd sub menu from HARMONICS main menu. Press “Set” button to edit value (current value is blinking). While value is blinking using Down/Up keys adjust the desired Vthd value (0.0%-50.0%). Press “Set” button again to save adjusted value. Press “Menu” button to exit menu.

===== MENU =====	H A R M O N I C S
OPERATION MODE	→ V t h d : 0 . 0 %
PARAMETERS	H A R M O N I C S
→ H A R M O N I C S	→ V t h d : 0 . 1 %

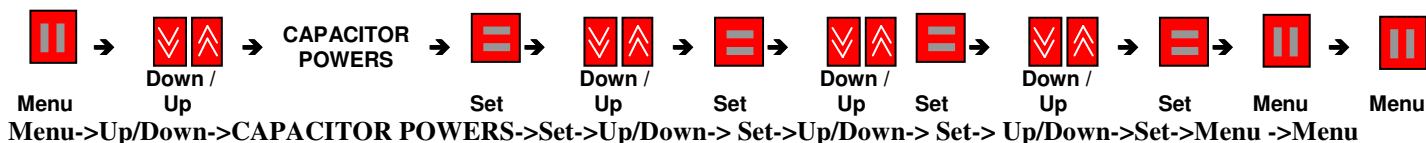
### 2.3.4. Harmonics Alarm Delay Time (thd)

Select thd sub menu from HARMONICS main menu. Press “Set” button to edit value (current value is blinking). While value is blinking using Down/Up keys adjust the desired thd value (1 min – 30 min). Press “Set” button again to save adjusted value. Press “Menu” button to exit menu. When THD value drops below set alarm limit, device waits for adjusted thd value before switches to normal operation mode.

===== MENU =====	H A R M O N I C S
OPERATION MODE	→ t h d : 1 m i n
PARAMETERS	H A R M O N I C S
→ H A R M O N I C S	→ t h d : 2 m i n

## 2.4. CAPACITOR POWERS

Capacitor values connected in the system can be observed or manual entrance can be made within this menu. Connection type (1, 2, 3 phase) and power of each capacitor bank can be done individually. Capacitor values are adjusted inside CAPACITOR POWERS menu as described below via 4 front panel buttons.



===== MENU =====	CAPACITOR POWERS
OPERATION MODE	C 1 : 0 . 0 0 K V a r
PARAMETERS	C 2 : 0 . 0 0 K V a r
HARMONICS	C 3 : 0 . 0 0 K V a r
→ CAPACITOR POWERS	C 4 : 0 . 0 0 K V a r
	C 6 : 0 . 0 0 K V a r
	C 7 : 0 . 0 0 K V a r
	C 8 : 0 . 0 0 K V a r
	C 9 : 0 . 0 0 K V a r
	C 1 0 : 0 . 0 0 K V a r
	C 1 1 : 0 . 0 0 K V a r
	C 1 2 : 0 . 0 0 K V a r
	C 1 3 : 0 . 0 0 K V a r
	C 1 4 : 0 . 0 0 K V a r
	C 1 5 : 0 . 0 0 K V a r
	C 1 6 : 0 . 0 0 K V a r
	C 1 7 : 0 . 0 0 K V a r
	C 1 8 : 0 . 0 0 K V a r

Parameter	Default Value	Range	Connection Type	Description
C1	0 KVar	Kctr<100/5A 0.01-60.0 KVar	*** 3 Phase Cap. * - - 1 Phase Cap. (L1) - * - 1 Phase Cap. (L2)	1. Capacitor Power
C2	0 KVar			2. Capacitor Power
C3	0 KVar			3. Capacitor Power
C4	0 KVar			4. Capacitor Power
C5	0 KVar	Kctr<1000/5A 0.1-600 KVar	- - * 1 Phase Cap. (L3) * * - 2 Phase Cap. (L1-L2) * - * 2 Phase Cap. (L1-L3) - * * 2 Phase Cap. (L2-L3)	5. Capacitor Power
C6	0 KVar			6. Capacitor Power
C7	0 KVar			7. Capacitor Power
C8	0 KVar			8. Capacitor Power
C9	0 KVar	Kctr≥1000/5A 1-6000 KVar	<b>Note:</b> Sequence is from left to right L1-L2-L3. '*' means, capacitor present, '-' means not present. During manual adjustment, first capacitor power then connection type must be entered.	9. Capacitor Power
C10	0 KVar			10. Capacitor Power
C11	0 KVar			11. Capacitor Power
C12	0 KVar			12. Capacitor Power
C13	0 KVar			13. Capacitor Power
C14	0 KVar			14. Capacitor Power
C15	0 KVar			15. Capacitor Power
C16	0 KVar			16. Capacitor Power
C17	0 KVar			17. Capacitor Power
C18	0 KVar			18. Capacitor Power

### 2.4.1 Manual Capacitor Power Entrance (C1 ..... C18)

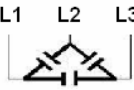
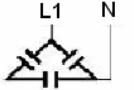
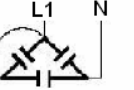
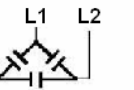
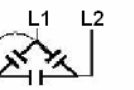
Capacitor stage that is going to be adjusted is selected from CAPACITOR POWERS menu. Press “Set” in order to edit value. While value is blinking, desired capacitor power is adjusted by Down/Up buttons. Press “Set” button to save value, Now display shows blinking “\*” and/or “-“symbols representing connection type of capacitor. Select correct connection type of capacitor by Down/Up buttons and press “Set” button to save value. Press “Menu” button to exit menu. All capacitors (C1...C18) are adjusted as explained above.

Sample1 : C1 = 10 KVar ( 3 Phase Capacitor )	
===== MENU =====	CAPACITOR POWERS
PARAMETERS	→ C1 : 0 . 0 0 K V a r
HARMONICS	CAPACITOR POWERS
→ CAPACITOR POWERS	→ C1 : 1 0 . 0 K V a r * * * V

Sample2 : C2 = 1 KVar – L1 ( 1 Phase Capacitor – L1 Connected )	
===== MENU =====	CAPACITOR POWERS
PARAMETERS	→ C2 : 0 . 0 0 K V a r
HARMONICS	CAPACITOR POWERS
→ CAPACITOR POWERS	→ C2 : 1 0 . 0 K V a r * - - V

Sample3 : C3 = 1 KVar – L2 ( 1 Phase Capacitor – L2 Connected )	
===== MENU =====	CAPACITOR POWERS
PARAMETERS	→ C3 : 0 . 0 0 K V a r
HARMONICS	CAPACITOR POWERS
→ CAPACITOR POWERS	→ C3 : 1 0 . 0 K V a r - * - V

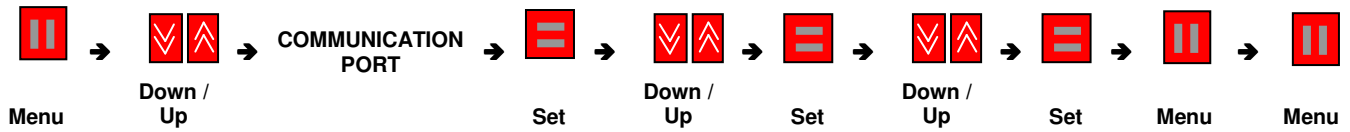
Örnek4 : C4 = 1 KVar – L3 ( 1 Phase Capacitor – L3 Connected )	
===== MENU =====	CAPACITOR POWERS
PARAMETERS	→ C3 : 0 . 0 0 K V a r
HARMONICS	CAPACITOR POWERS
→ CAPACITOR POWERS	→ C1 : 1 . 0 K V a r - - * V

Capacitor Power					
	3 Phase	Phase to Neutral	Phase to Neutral	Phase to Phase	Phase to Phase
<b>0,5 KVAR</b>	0,16 KVAR	0,08 KVAR	0,11 KVAR	0,12 KVAR	0,16 KVAR
<b>1 KVAR</b>	0,33 KVAR	0,16 KVAR	0,22 KVAR	0,25 KVAR	0,33 KVAR
<b>1,5 KVAR</b>	0,5 KVAR	0,25 KVAR	0,33 KVAR	0,37 KVAR	0,5 KVAR
<b>2,5 KVAR</b>	0,83 KVAR	0,41 KVAR	0,55 KVAR	0,62 KVAR	0,83 KVAR
<b>5 KVAR</b>	1,66 KVAR	0,83 KVAR	1,11 KVAR	1,25 KVAR	1,66 KVAR
<b>7,5 KVAR</b>	2,5 KVAR	1,25 KVAR	1,66 KVAR	1,87 KVAR	2,5 KVAR
<b>10 KVAR</b>	3,33 KVAR	1,66 KVAR	2,22 KVAR	2,5 KVAR	3,33 KVAR

Capacitor Table

## 2.5. COMMUNICATION PORT

All the measurements made by device can be monitored by suitable PC software over MODBUS RTU protocol. If necessary, device parameters can be set over communication port. For proper communication PC side and controller side adjustments have to be done. All adjustments are done inside COMMUNICATION PORT menu via four front panel buttons as described below.



===== MENU =====					COMMUNICATION PORT				
HARMONICS					SL . Addr : 1				
CAPACITOR POWERS					Speed : 9 . 6 K b p s				
→ COMMUNICATION PORT ↓					Stop Bits : 1 ↓				

Parameter	Default Value	Range	Description
<b>Sl.Addr</b>	1	1 - 247	Device Address
<b>Speed</b>	9.6 Kbps	4.8 – 38.4 Kbps	Communication Speed
<b>Stop Bits</b>	1	1 - 2	Stop Bits

### 2.5.1. Address Adjustment (Sl.Addr)

Select Sl.Addr sub menu from COMMUNICATION PORT main menu. Press “Set” button to edit value (current value is blinking). While value is blinking using Down/Up keys adjust the desired Sl.Addr value (1-247). Press “Set” button again to save adjusted value. Press “Menu” button to exit menu.

===== MENU =====					COMMUNICATION PORT				
HARMONICS					SL . Addr : 1				
CAPACITOR POWERS					COMMUNICATION PORT				
→ COMMUNICATION PORT ↓					SL . Addr : 2 ↓				

### 2.5.2. Communication Speed Adjustment (Speed)

Select Speed sub menu from COMMUNICATION PORT main menu. Press “Set” button to edit value (current value is blinking). While value is blinking using Down/Up keys adjust the desired Speed value (4.8 Kbps – 38.4 Kbps). Press “Set” button again to save adjusted value. Press “Menu” button to exit menu.

===== MENU =====					COMMUNICATION PORT				
HARMONICS					Speed : 9 . 6 K b p s				
CAPACITOR POWERS					COMMUNICATION PORT				
→ COMMUNICATION PORT ↓					Speed : 19 . 2 K b p s ↓				

### 2.5.3. Stop Bits Adjustment (StopBits)

Select StopBits sub menu from COMMUNICATION PORT main menu. Press “Set” button to edit value (current value is blinking). While value is blinking using Down/Up keys adjust the desired StopBits value (1 –2). Press “Set” button again to save adjusted value. Press “Menu” button to exit menu.

===== MENU =====					COMMUNICATION PORT				
HARMONICS					Stop Bits : 1				
CAPACITOR POWERS					COMMUNICATION PORT				
→ COMMUNICATION PORT ↓					Stop Bits : 1 ↓				

### 3. POWERING CONTROLLER

Install controller according to connection schematic and installation guidance and apply power. Adjust Kctr value first and then Press Down and Up buttons at the same time in order to start "T E S T" procedure. During this procedure current flow directions and capacitor powers are measured and determined. At the end of the "T E S T" device is ready for normal operation.

User should check and adjust required parameters from PARAMETERS menu in order to get optimum performance within specified plant.

While performing "T E S T" procedure user should consider following points.

- Severe changing loads negatively affect TEST procedure; these loads should be kept off during TEST.
- During TEST all 3 phases should supply current and system should be inductive.
- If controller could not detect current flow directions, displays, UNDETERMINED CURRENT DIRECTION for short duration, if this is seen 3 phase load should be increased and TEST should be restarted.
- Installation must be done according to installation schematic.
- If capacitors, fuses, contactors have faults, after correction TEST must be restarted.
- If external CT is not appropriately selected (too high or too low turns ratio) controller may not perform successful TEST procedure.

If there are capacitors that controller cannot determine during TEST procedure, user should enter these capacitors manually by using CAPACITOR POWERS menu.

When device is installed properly user should set password in order to eliminate parameter change by unauthorized staff.. Password protection is activated via PARAMETERS menu. While password protection is activated each time user tries to enter menu or tries to perform TEST controller asks for correct password.

When controller asks for password display shows Access Code XX: YY. Here "XX" is fixed random number in the range of 0 – 99. "YY" is number between 0 – 99 and the value is changeable via Down/Up buttons. **User must adjust YY to the value that completes XX to 99. This is the password.**

Example: Access Code 25:25 → Down/Up Buttons → Access Code 25:74 → Menu (OPERATION MODE)

A c c e s s   C o d e   2 5 :   2 5	A c c e s s   C o d e   2 5 :   7 4
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As can be seen in example here YY value is adjusted to 74 to complete 25 to 99. If different value is entered controller rejects entrance to menu or TEST action.

### 4. OBSERVATION OF MEASURED VALUES

Controller is capable of measuring and display of Voltage, Current, Power Factor, Active Power, Reactive Power, Apparent Power and Frequency of 3 phases and internal temperature of the controller. Controller also displays Alarm Status, Capacitor Status and how they are connected to phases. 4 lines 20 character LCD and 4 buttons make it easy to observe and control information.

When controller is powered main screen displays capacitor status, Cosφ and voltages of 3 phases. Using Down/Up buttons user can scroll between all measured values.

C - █ █ █ █ █ █ █ █ █ █ X X X X X X X X	C - █ █ █ █ █ █ █ █ █ █ X X X X X X X X
L 1 : 1 . 0 0 0      U : 2 2 1 . 3 V	L 1 : 1 . 0 0 0      I :    1 0 . 5 A
L 2 : - . 9 9 9      U : 2 2 0 . 1 V	L 2 : - . 9 9 9      I :    1 0 . 5 A
L 3 : 0 . 9 9 9      U : 2 2 0 . 0 V	L 3 : 0 . 9 9 9      I :    1 0 . 5 A
C - █ █ █ █ █ █ █ █ █ █ X X X X X X X X	C - █ █ █ █ █ █ █ █ █ █ X X X X X X X X
L 1 : 1 . 0 0 0      P F : 1 . 0 0 0	L 1 : 1 . 0 0 0      F : 5 0 . 0 H Z
L 2 : - . 9 9 9      P F : - . 9 9 9	L 2 : - . 9 9 9
L 3 : 0 . 9 9 9      P F : 0 . 9 9 9	L 3 : 0 . 9 9 9      T : 3 0 . 1 ° C

L 1	K W :	3 . 5 4
L 2	K W :	1 . 3 7
L 3	K W :	2 . 2 3
Σ :	K W :	7 . 1 4
L 1	K V a r :	0 . 5 4
L 2	K V a r :	0 . 3 7
L 3	K V a r :	0 . 2 3
Σ :	- 0 . 3 7	0 . 7 7
L 1	K V A :	3 . 9 5
L 2	K V A :	2 . 3 7
L 3	K V A :	2 . 9 3
Σ :	K V A :	9 . 2 6



While controller displays capacitor symbols on uppermost line pressing “SET” button brings table on the screen which shows capacitors on each phase. “Menu” button cancels this screen.

		A U T O M O D E													
L 1	☐ ☐ ☐ ☐	X	X	☐	X	X	X	X	X	X	X	X	X	X	X
L 2	☐ ☐ ☐ X	X	X	☐	X	X	X	X	X	X	X	X	X	X	X
L 3	☐ ☐ ☐ X	X	X	☐	X	X	☐	X	X	X	X	X	X	X	X

While controller displays ITHD% and VTHD% values if “SET” button is pressed controller brings table which shows 3<sup>rd</sup> harmonic values. Using Down/Up buttons user can observe all the harmonics up to 21<sup>st</sup>. User can exit table by pressing “Menu” button.

	% I T H D	% V T H D
L 1 :	% 1 . 0	% 0 . 6
L 2 :	% 1 . 1	% 0 . 7
L 3 :	% 0 . 9	% 0 . 3
	% I 3	% V 3
L 1 :	% 1 . 0	% 0 . 6
L 2 :	% 1 . 1	% 0 . 7
L 3 :	% 0 . 9	% 0 . 3
	% I 2 1	% V 2 1
L 1 :	% 1 . 0	% 0 . 6
L 2 :	% 1 . 1	% 0 . 7
L 3 :	% 2 . 2	% 1 . 8

When alarm condition occurred using Down/Up buttons enters controller to XX ACTIVE ALARMS screen. Active alarms number is observed in this screen. User can observe which alarm is active by pressing “SET” button. If more than one alarm exist user can scroll between alarms via Down/Up buttons. Pressing “Menu” buttons returns to previous screen

0 A C T I V E A L A R M S	
→	O V E R T E M P E R A T U R E
	U N D E R C O M P E N S A T I O N
	O V E R C O M P E N S A T I O N
	C O M P E N S A T I O N E R R .
	L O W F R E Q U E N C Y
	H I G H F R E Q U E N C Y
	C A L I B R A T I O N E R R O R
L 1	U N D E R V O L T A G E
L 2	U N D E R V O L T A G E
L 3	U N D E R V O L T A G E
L 1	O V E R V O L T A G E
L 2	O V E R V O L T A G E
L 3	O V E R V O L T A G E
L 1	O V E R C U R R E N T
L 2	O V E R C U R R E N T
L 3	O V E R C U R R E N T
L 1	V T H D %
L 2	V T H D %
L 3	V T H D %
L 1	I T H D %
L 2	I T H D %
L 3	I T H D %

## 5. MANUAL MODE

If Manual Mode is selected all measurements can be observed as in Automatic Mode except that device never switches on or off capacitor banks. If user needs to switch on or off one of the capacitor banks, while capacitor status are observed on the screen “SET” button is pressed. In this case display shows MANUAL MODE and capacitor table. Using Down/Up buttons capacitor banks is selected. The uppermost line displays moving arrow and bank number to help user select correct capacitor bank. When correct bank is selected pressing “SET” button switches on or off capacitor. Pressing “Menu” button returns to previous screen.

If any function is not used for 30 minutes while in MANUAL MODE, controller switches to AUTOMATIC MODE.

7					*														
L 1	□	□	■	■	X	X	□	X	X	X	X	X	X	X	X	X	X	X	X
L 2	□	□	■	X	■	X	X	□	X	X	X	X	X	X	X	X	X	X	X
L 3	□	□	■	X	X	□	X	X	■	X	X	X	X	X	X	X	X	X	X

## 6. ALARMS

Parameter	Default Value	Range	Tanm
Over Temperature	50°C	50°C-80°C	If internal temperature of controller is over $T_{ov}$ fan output of controller is activated.
Under Compensation	-	-	If target $cos\phi$ value is not reachable with presented capacitor banks Under Compensation Alarm occurs.
Over Compensation	-	-	While all capacitors are switched off if system is still capacitive Over Compensation Alarm occurs.
Compensation Err.	-	-	If target $cos\phi$ value is not reachable with presented capacitor banks Compensation Error occurs.
Low Frequency	F<20Hz	Fixed	If line frequency drops below 20 Hz Low Frequency alarm occurs.
High Frequency	F>62Hz		If line frequency increases over 62 Hz High Frequency alarm occurs.
Calibration Error	-	-	If calibration data is corrupted Calibration Error alarm occurs.
L1-Under Voltage	U1<15V	Fixed	If one of the inputs drop below 15V Under Voltage alarm occurs.
L2-Under Voltage			
L3-Under Voltage			
L1-Over Voltage	260 VAC	200-300VAC	If one of the phase voltages increase above $U_{ov}$ value Over Voltage alarm occurs.
L2-Over Voltage			
L3-Over Voltage			
L1-Over Current	5.5A	Sabit	If current of one of the current inputs increases above 5.5A Over Current alarm occurs.
L2-Over Current			
L3-Over Current			
L1-VTHD Harmonic	0.0%	0.0% - 50.0%	If measured VTHD% or ITHD% values increase above set ITHD% or VTHD% limits, Harmonic alarm occurs.
L2-VTHD Harmonic	0.0%	0.0% - 50.0%	
L3-VTHD Harmonic	0.0%	0.0% - 50.0%	
L1-ITHD Harmonic	0.0%	0.0% - 50.0%	
L2-ITHD Harmonic	0.0%	0.0% - 50.0%	
L3-ITHD Harmonic	0.0%	0.0% - 50.0%	

## 7. TECHNICAL SPECIFICATIONS

Operating Temperature	-25°C... + 65 °C	Current Transformer Direction	Otomatik
Max. Relative Humidity	% 90	Capacitor Bank Stages	8/13/18
Power Consumption	<10VA	Output Contact	250V/3A AC
Supply Voltage(Un)	230VAC ±10%	Alarm Contact	250V/3A AC
Supply Frequency	50 Hz / 60 Hz	Fan Contact	250V/3A AC
Current Inputs	...../5A	Cables	AWG12-16
Current Range	0.02A – 5.5A	Front Panel Dimensions	144mm x 144mm (DIM43 700)
LCD Display	4x20	Dimensions	144x144x70
CTR	5/5A – 5000/5A	Weight	1030 gr.

## 8. USAGE AND SAFETY INSTRUCTIONS

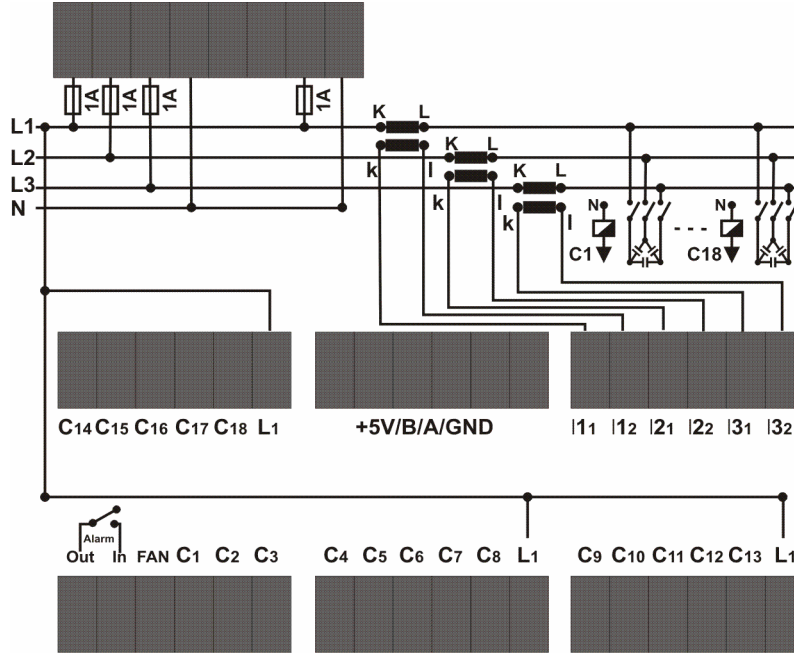
User must consider the following points for safe and correct usage.

- Switch off voltages during installation.
- Do not clean controller with any solvent.
- Please check all the connections according to connection schematic.
- Faulty units must be repaired only by authorized technical staff.

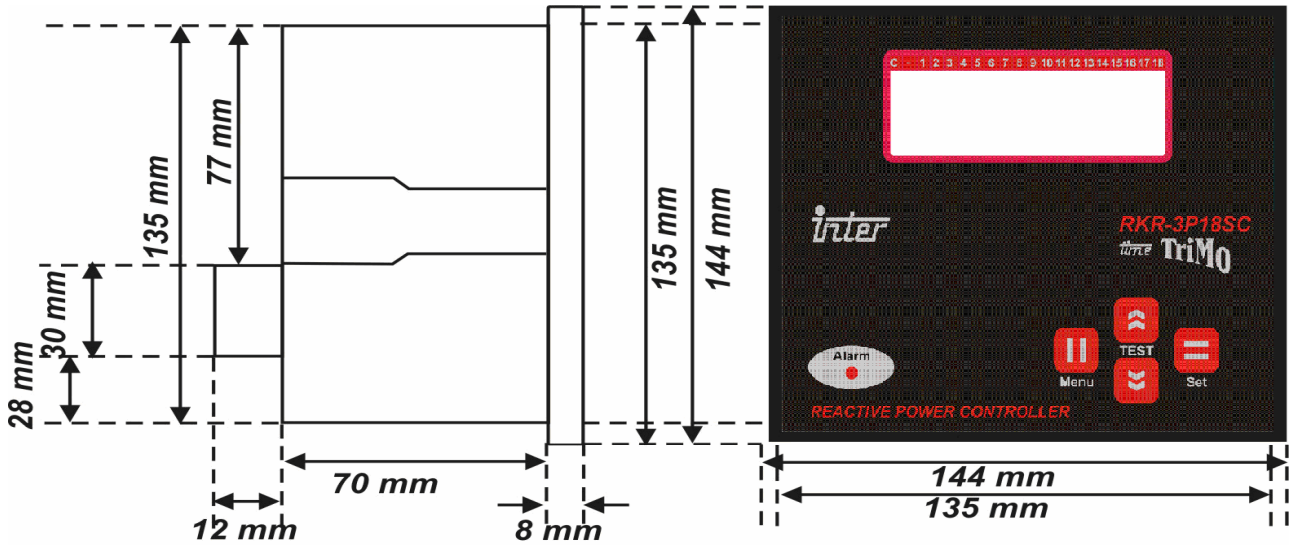
Deviation of above instruction may cause serious injury or death.

Manufacturer or Reseller is not responsible from the results that may occur in the case of deviation of above instructions.

## 9. CONNECTION SCHEMATIC



## 10. DIMENSIONS



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