

LogiCon

PFC24 TCR

POWER FACTOR CONTROLLER

USER MANUAL



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1. ABOUT THE DOCUMENT

1.1. Introduction

This document is designed for easy installing, commissioning and maintenance of PFC24 TCR power factor control relay.

Carefully read and follow the “Safety Precautions” (Section 1.2) and “Installation” (Section 3) sections before mounting and doing the terminal connections of your device.

“Description” (Section 2) gives brief introduction of the device. “Easy Commissioning” (Section 4) step by step guides the commissioning of the device while “Main Menu” (Section 5) and “Settings Menu” (Section 6) describes the user interface and functions of the device in detail. Measurement and parameter ranges table and dimensions are included in Appendices part.

The communication is handled in a different document “PFC24 TCR Modbus RTU Communication Guide”



1.2. Safety Precautions

- Installation, commissioning, maintenance and repairing should be done by qualified technical personals.
- Strictly follow the instructions while connections are made, do not work with live wires.
- A dry dust cloth should be used for cleaning; corrosive, caustic/flammable materials should be avoided.
- Device should be de-energized before cleaning or demounting.
- No replaceable parts in PFC24 TCR. Device case should not be opened.
- Four current transformers can be connected to PFC24 TCR.
- Three current transformers are connected to PFC24 TCR. If the current transformer terminals wanted to be disconnected, transformer terminals should be short circuited first.
- The device should not be used for any other purpose than is it designed for.

2. DESCRIPTIONS

In this section the general structure, input and output connections, button and display design of the PFC relay will be introduced.

2.1. General Properties

PFC24 TCR relay is an automatic power factor control relay designed for switching three phase, di-phase and single phase shunt capacitor and reactor banks.

PFC24 TCR, at the same time can control delta or star connected thyristor controlled reactor (TCR) modules.

The steps to be switched can be introduced to controller automatically or manually.

Operator determines the PFC target by setting the target power factor or target reactive power. With the aid of a digital input, relay can operate according to one of two target power factors or target reactive powers.

PFC24 TCR also operates as a power analyzer. Grid voltages, line currents, active, reactive and apparent powers for each phase and total, power factors, energies, frequency, voltage and current harmonics, voltage and current waveforms can be monitored on LCD display.

The operating time and switching count of each step are recorded and can be monitored.

The relay measures the inner temperature. For panel cooling, a fan can be controlled by a dry contact of the relay.

The relay has adjustable overcurrent, overvoltage, undervoltage, harmonics and temperature protection.

PFC24 TCR is used with thyristor switched applications and optionally with contactor switched and hybrid applications.

With Modbus RTU communication protocol, monitored parameters can be remotely accessed and relay settings can be changed.

Automatic connection correcting and automatic step identification features make quick installation possible.

2.2. Technical Properties

Power Supply	
Supply Voltage	85-265VAC
Supply Frequency	50Hz
Power Consumption	<15W
Input Specifications	
Current Inputs	3 Phase, Neutral (optional), In:5A
Current Transformer Setting Range	1-9999
Voltage Inputs	0-275V RMS
Voltage Transformer Setting Range	1-999
Connection Type	3P4W
Digital Inputs	24VDC, Optically Isolated
Output Specifications	
Number of Output Steps	24
Type of Output Steps	Optically isolated transistor output (24V-50mA) (suitable for Thyristor Switching Modules), Dry Contact (Optional)
Types of Compatible Steps	Three Phase Capacitor Banks, Single Phase Capacitor Banks, Phase to Phase Capacitor Banks, Three Phase Shunt Reactors, Single Phase Shunt Reactors, Phase to Phase Shunt Reactors
Step Power Range	999.99kVar Capacitive – 999.99kVar Inductive
Step ON Delay	0.02sec-999min, Independently Adjustable
Step OFF Delay	0.02sec-999min, Independently Adjustable
TCR Output	Optically isolated outputs for two TCRs (Star TCR, Delta TCR)
TCR Power Range	0-999.99kVar
Auxiliary Outputs	Dry Contact 1 (5A, 250VAC, Form C) Can be Programmed for Faults. Dry Contact 2 (5A, 250VAC, Form A) Can be Programmed for FAN and Faults.
Control Specifications	
Target Options	Target Cos(ϕ) mod, Target VAr mod
Step Control Method	Best Max. two steps direct switching
TCR Control Method	PI Control
Decision Time	20ms
Protection Specifications	
Protections	Overvoltage, Undervoltage, Overcurrent, THDv, Temperature
Fan Control	Adjustable ON and OFF temperature
Measurements	
Measurements	Three Phase Currents (Ia, Ib, Ic), Neutral Current (In), Phase to Neutral Voltages (Va, Vb, Vc, Vn), Phase to Phase Voltages (Vab, Vbc, Vca), Three Phase and Total Active (Pa, Pb, Pc, Pt), reactive (Qa, Qb, Qc, Qt), apparent powers (Sa, Sb, Sc, St), Frequency (f), Power Factor (PFa, PFb, PFC), Voltage and Current Harmonics (H1-H31, THD), Three Phase and Total Active Energy (Wh), Three Phase and Total Import Reactive Energy (VArh+), Three Phase and Total Export Reactive Energy (VArh-), Reactive Energy/Active

	Energy Ratios, Total Switching Duration and Switching Count for Each Step
Accuracy	%1 I,V - %2 P,Q,S - %2 Harmonics - %2 Energy
Communication	
Communication Protocol	Modbus RTU
Communication Interface	RS485
Supported Baud Rates (kbaud)	2400, 4800, 9600, 19200, 38400
Mechanical Specifications	
Dimensions (mm)	144x144x94,5
Mounting	Panel from front side
Weight (gr)	560
Terminals	0.5 - 2.5mm ² , spring
Protection Class	IP41
Operating Temperature	-10 +70°C
Relative Humidity	Max. 95%
Other Specifications	
Supported Language	English, Turkish
Display	240*160 Monochrome LCD Display
Auxiliary Features	Automatic Step Identification, Automatic Connection Error Correction, Test Function

2.3. Display

PFC24 TCR has 240*160 monochrome graphical LCD display.







All the relay parameters can be set and measurements can be monitored from the graphical display pages with the aid of buttons.

When any of the buttons are pressed, the display backlight will be ON, and one minute after last button was pressed backlight will be OFF.

2.4. Buttons

The user interface of the PFC24 TCR is controlled by six buttons located on the front size of the device.



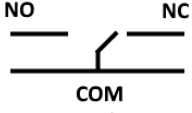
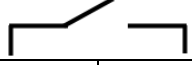
	Pressing the button in menu and setting pages, the cursor or the selectable item shifts to the left. In “Output Setting” page, if the cursor is at leftmost, pressing the button shift it to upper line.
	Pressing the button in menu and setting pages, the cursor or the selectable item shifts to the right. In “Output Setting” page, if the cursor is at rightmost, pressing the button shift it to lower line.
	Pressing the button in menu and setting pages, the cursor or the selectable item shifts to up. If the cursor is on a number or a selectable item in a setting page, pressing the button increases the number or changes the selectable item.
	Pressing the button in menu and setting pages, the cursor or the selectable item shifts to down. If the cursor is on a number or a selectable item in a setting page, pressing the button decreases the number or changes the selectable item.
	In menus, pressing the button opens the selected page and when pressed in setting pages, the changes are saved to temporary memory.
	Returns the previous page. If any changes are done in the setting pages, returns to previous page without saving the changes. If pressed in “Settings Menu” page, the parameters saved to temporary memory are saved to non-volatile memory and main menu page is opened.

2.5. Terminals

Terminals are located at the rear side of the relay and suitable for 2.5mm wire sizes. The symbols of the terminals and their descriptions are given in the following tables.

PART 1	
P	Supply Input 220VAC Phase - Neutral
N	
V1	Measurement Voltages Phase 1, Phase 2, Phase 3 and Neutral
V2	
V3	
N	
K1	
L1	Measurement Currents Line 1 K, Line 1 L, Line 2 K, Line 2 L, Line 3 K, Line 3 L
K2	
L2	
K3	
L3	

PART 2	
DI1+	Digital Input 1 (+) and (-)
DI1-	
DI2+	Digital Input 2 (+) and (-)
DI2-	

PART 4		
1	2	Outputs for Steps
3	4	
5	6	
7	8	
9	10	
11	12	
13	14	
15	16	
17	18	
19	20	
21	22	
23	24	
COM		Return for outputs
		NO-NC dry contact
		NO dry contact
A	B	RS485 Interface

PART 3			
Y1	Y3	U1	U3
Y2	COM	U2	COM
Star TCR Control Outputs		Delta TCR Control Outputs	

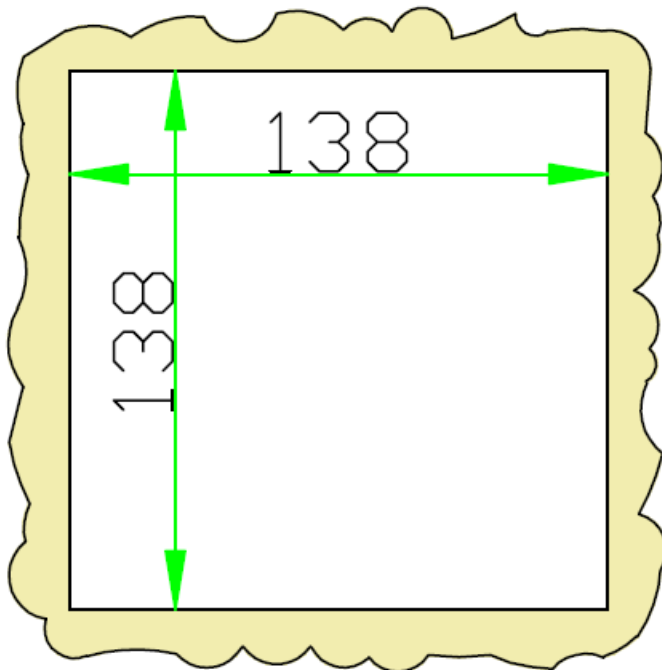
3. INSTALLATION

3.1. Mounting

Before the wiring, the device should be fixed on the panel.

A cross-sectional area of 138x138mm should be cut on the panel in order to mount the device.

After the device is plugged in to the panel from the front side, it is tightened by the fixing apparatus.



3.2. Wiring

Do not wire or demount on live conditions.

The terminals are suitable for maximum 2.5mm diameter wire sizes. For a healthier wiring, use cord end terminals.

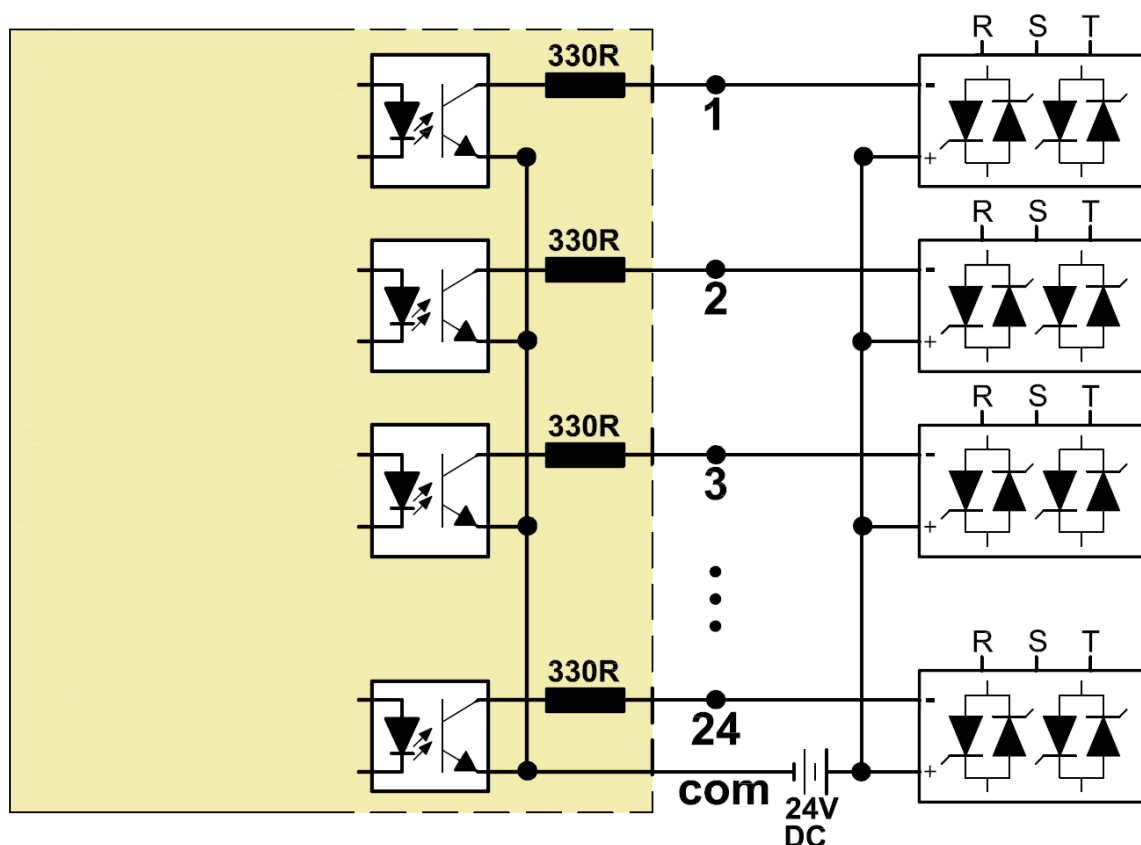
For wiring spring terminals use a screw driver to loosen the spring and plug the cable to its hole. Releasing the spring cable will be locked. If demounting is needed than again loosen the spring with the help of the screw driver demount the cable and release the spring.

It is advised to use a 1A fuse for voltage inputs.

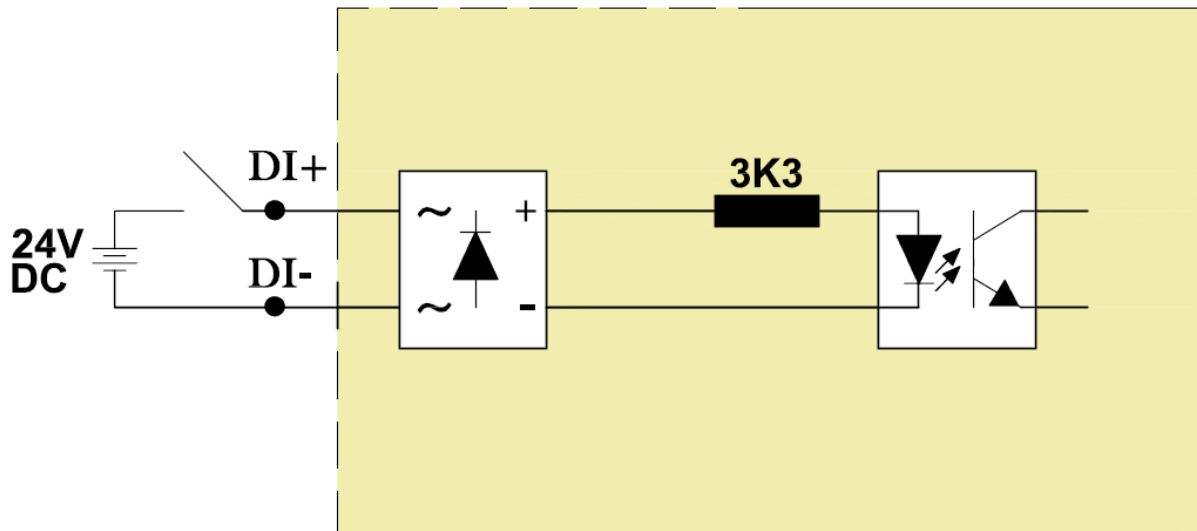
Special attention must be paid to current transformer wiring. The wiring must not be loose.

Step and TCR outputs are optically isolated transistor outputs. A DC power supply should be used to drive Thyristor modules. See the diagram.

Star and Delta TCR phases have to be in order with the input voltages of the relay. Otherwise, there may be failures either for switching devices and reactors due to incorrect firing.

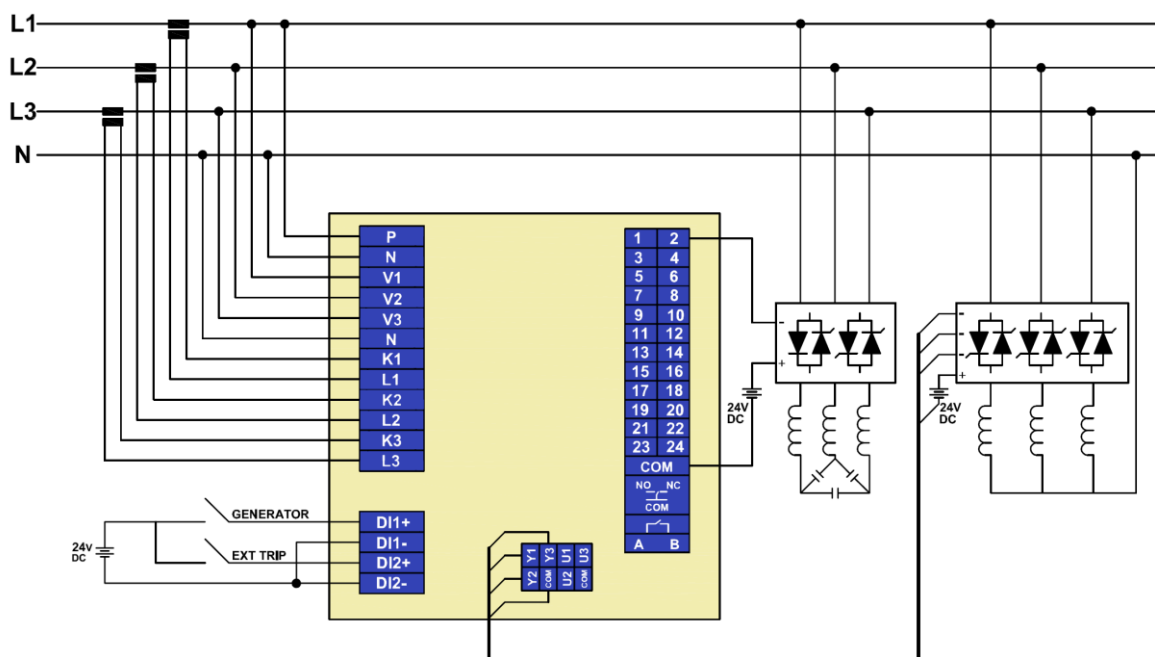


Digital inputs are optically isolated, should be driven by a DC signal. Although positive and negative signs are indicated on the label, reverse connection is also tolerated.



See the wiring diagram in the next section.

3.3. Wiring Diagram



4. EASY COMMISSIONING

Step 1

After mounting and wiring the device, double check the connections.

Power the relay and energize the grid voltages.

Remove the current transformer shunts.

Step 2



Main menu will be displayed first. Select the overview screen and press enter.

Check the voltages. If there is load in the system, current values should also be greater than zero. But these are correct yet, because current transformer ratio is not entered yet.

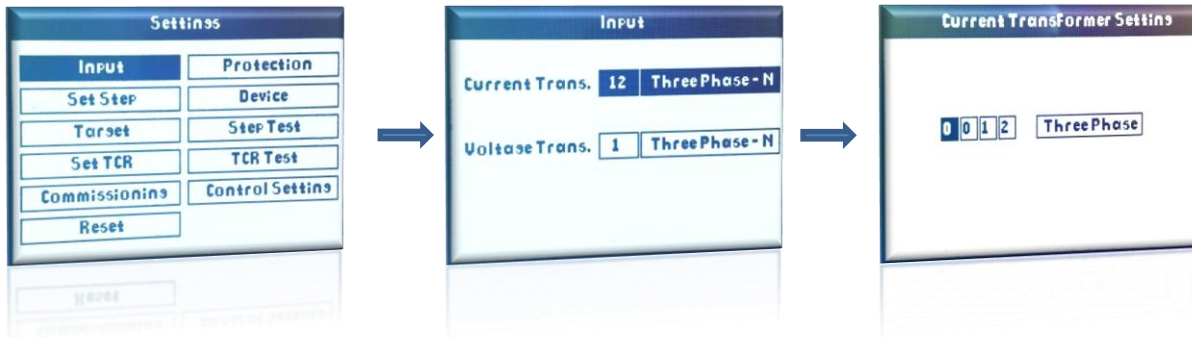
Step 3



Return to “Main Menu” by pressing ESC button, and select “Settings” and press enter.

Password page will be displayed first. The factory Settings for the password is 0000. Press enter to open the Settings menu.

Step 4



Select “Inputs” from the Settings menu and press enter.

Select the Current Transformer and press enter.

When the Current Transformer Set page is displayed, adjust the current transformer ratio by using direction buttons and press enter.

Repeat the same procedure for voltage transformer if voltage inputs are introduced by a voltage transformer.

Step 5



Return to “Settings Menu” by pressing ESC button.

Select “Set Step” and press enter. In order to automatic connection error detection should be successful; a three phase capacitive input should be introduced to the relay.

Select a step which a three phase capacitive load is placed and press enter.

Introduce the step connection type and power and be sure its status is “active”.

Press enter to save.

Step 6



Return to “Settings Menu” by pressing ESC button.

Select “Commissioning” menu and press enter.

In “Commissioning” page, select “Detect Input” and press enter. Wait a while. The relay will switch ON and OFF the biggest three phase capacitive step.

After successful switching, the relay checks the order and direction of current transformers referred to voltage inputs.

If there is any disorder or misdirection it will be automatically corrected and “DONE” inscription will be displayed in the right side.

Sometimes due to fast changing loads, the relay cannot successfully detect the order and direction. This time a “FAILED” inscription will be displayed. Repeat the procedure or manually correct the connection errors.

Step 7



Select the “Detect Output” and press enter. Wait a while.

The relay will switch each step one by one and identifies the power, connection type (3P, AN, BN, CN, AB, BC, CA), step type (Inductive or Capacitive) of the connected loads.

The switched step will be indicated on the left. When all finished, a “DONE” inscription will be displayed.

Step 8

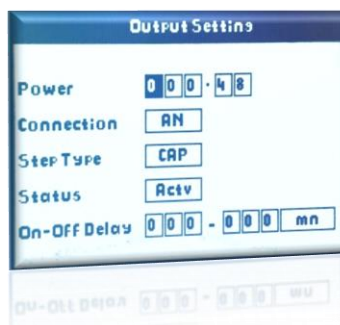


The identified values are advised to be checked.

Select “Go to Output Page” and press enter. Check the renewed values.

If there is any mistaken value, select the step and press enter to make changes.

The default output ON-OFF times are 1 sec in factory settings. If needed, change these values.



Step 9



The factory settings for target is 1.00 cos(ϕ) mode.

If any change is required return to “Settings” menu. Select “Target” and press enter.

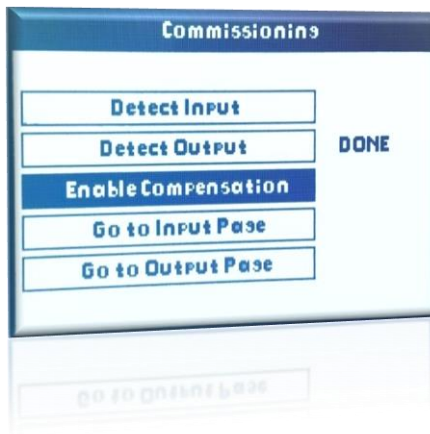
Adjust the target. See the “Target page” for details.

Step 10

Return to “Settings” menu, select “Commissioning” and press enter.

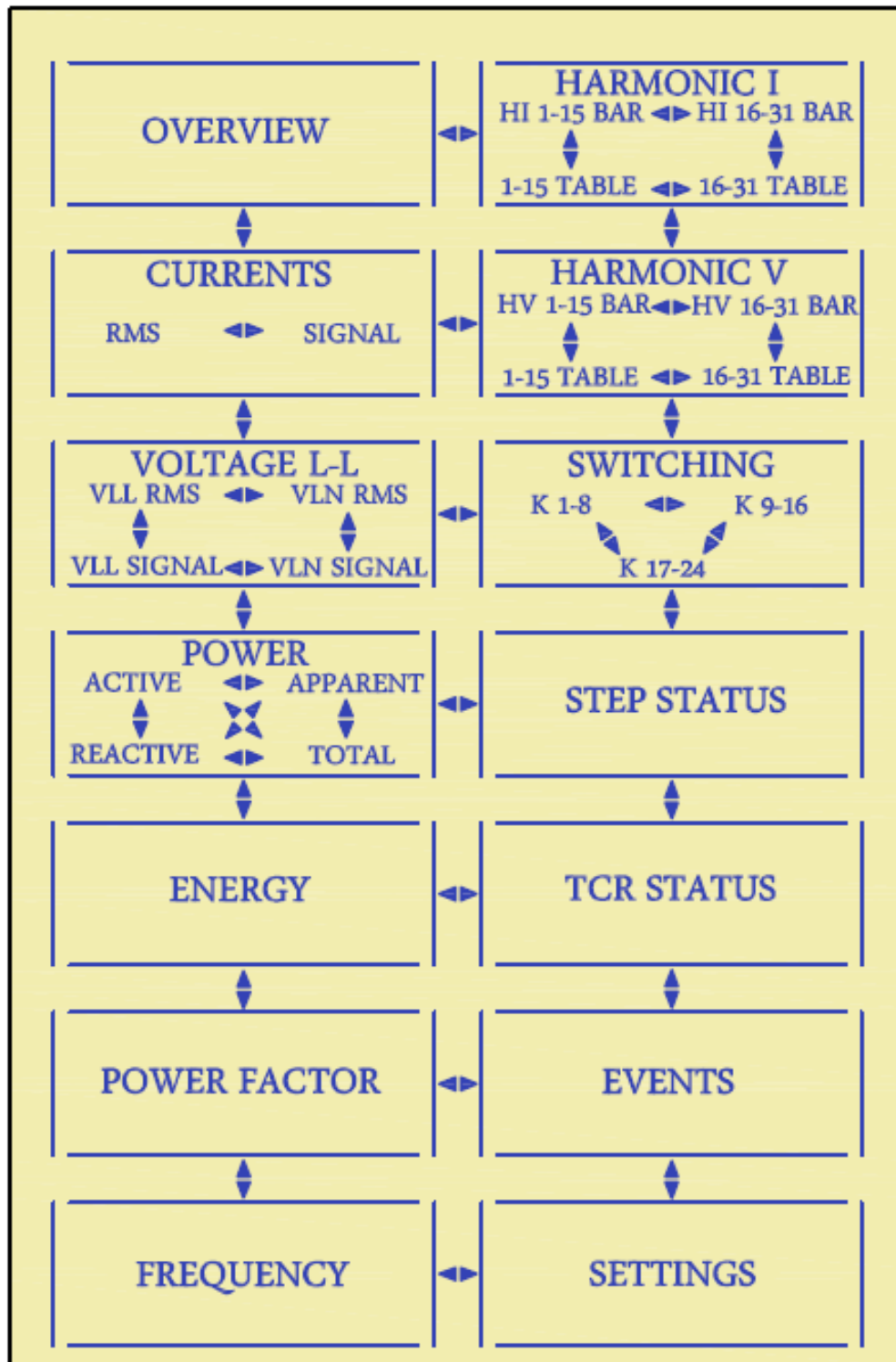
Select “Enable Compensation” and press enter.

Commissioning is done.



5. MAIN MENU

Main Menu is displayed at first when the device is powered. There are a total of 12 items selected from main menu. With the aid of direction buttons these items can be selected and displayed by pressing enter. In this section each menu item and their sub-menus are introduced.



5.1. Overview Page

Overview			
IA (A)	4.8	PT (kW)	3.6
IB (A)	4.7	QT (kVar)	0.9
IC (A)	4.2	PF-A	0.995
IN (A)	0.1	PF-B	0.998
VAN (V)	231.3	PF-C	0.997
VBN (V)	229.2	THDv	1.4
VCN (V)	230.6	THDi	10.9
ACH (A)	55.8	THDi	10.9
ACH (A)	55.8	THDi	10.9

Overview page displays a summary of general system parameters.

Line currents (IA, IB, IC, IN), phase to neutral voltages (VAB, VBC, VCA), total active power (PT), total reactive power (QT), power factors for each phase (PF-A, PF-B, PF-C), voltage total harmonic distortion (THDv) and current total harmonic distortion (THDi) are displayed in this page.

5.2. Current Page



RMS values of line currents (IA, IB, IC, IN) are displayed on this screen. Neutral current (IN) is calculated from the vector sum of line currents.

By selecting “signal” from the left side and pressing enter, the current waveforms can be observed. The darkest signal represents IA, while medium one is IB and the lighter one is IC.

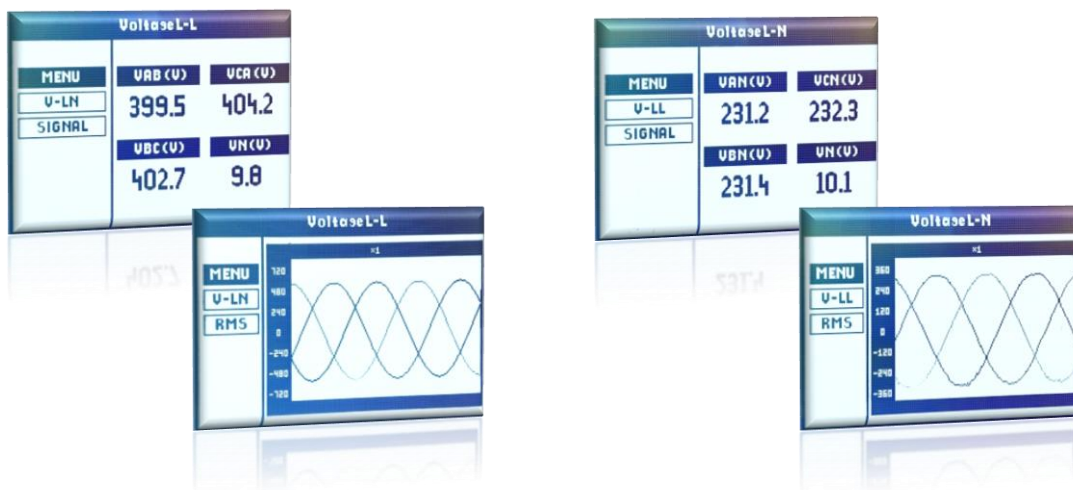
Using the left menu user can switch back to RMS values or the “Main Menu”

5.3. Voltage Page

RMS values of phase to phase voltages (VAB, VBC, VCA, VN) are displayed on this screen. Neutral voltage (VN) is calculated from the vector sum of phase to neutral voltages.

User can switch phase to neutral voltages (VAN, VBN, VCN) by selecting the V-LN item or waveform of the voltages by selecting the SIGNAL item from the menu on the left and pressing enter.

Pressing ESC or selecting MENU from the left side and pressing enter, user can switch to “Main Menu”.



5.4. Power Page



Total active power (PT), total reactive power (QT) and total apparent power (ST) are displayed when first entered this page.

User can switch to active power page to display each phases active power (PA, PB, PC) separately by selecting the P(W) item, or can switch to reactive power page to display each phases reactive power (QA, QB, QC) by selecting the Q(VAr) item or each phases apparent power (SA, SB, SC) by selecting the S(VA) item from the left side of the screen and pressing enter.

Active Power			
MENU	PA (kW)	PB (kW)	
P/Q/S	1.17	1.21	
Q (VAr)			
S (VA)	PC (kW)	PT (kW)	
	1.24	3.62	

Reactive Pow			
MENU	QA (kVAr)	QB (kVAr)	
P/Q/S	0.24	0.32	
P (W)			
S (VA)	QC (kVAr)	QT (kVAr)	
	0.32	0.88	

Apparent Pow			
MENU	SA (kVA)	SB (kVA)	
P/Q/S	1.32	1.41	
P (W)			
Q (VAr)	SC (kVA)	ST (kVA)	
	1.42	4.51	

Using the left menu user can switch to another power page or return to “Main Menu”.

The units for displayed values of active powers are kW, reactive powers are kVAr and apparent powers are kVA.

Minus sign in active power means that system is generating active power. If this is not the case the current directions or orders are wrong.

The minus sign for reactive power indicates that system is capacitive and positive sign (no sign) indicates that system is inductive.

5.5. Energy Page

Energy (kWh)			
MENU	1.8.0	102.21	
	5.8.0	1.01	
	8.8.0	0.60	
	5.8.0/1.8.0	0.90 %	8.8.0/1.8.0 0.60 %

Cumulative import active energy (1.8.0), cumulative reactive inductive energy (5.8.0), cumulative reactive capacitive energy (8.8.0), inductive energy, active energy ratio (5.8.0/1.8.0) and capacitive energy, active energy ratio (8.8.0/1.8.0) are displayed in this page.

The units are kWh for active energy, kVAh for inductive and capacitive energy.

The energies can be reset in a desired period or manually. The settings are done from the “Reset” page.

5.6. Power Factor Page

Power Factor		
MENU	PF-A	PF-B
	0.995	0.998
	PF-C	
	0.997	

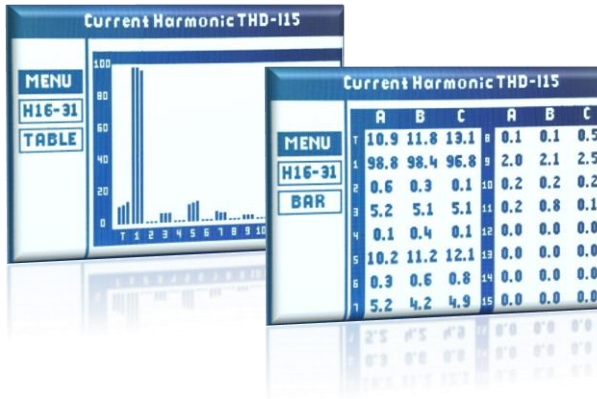
Cos(ϕ) value for each phase is displayed in this page. Negative sign means system is capacitive, while positive means the system is inductive.

5.7. Frequency Page

Frequency	
MENU	FRQ
	50.02

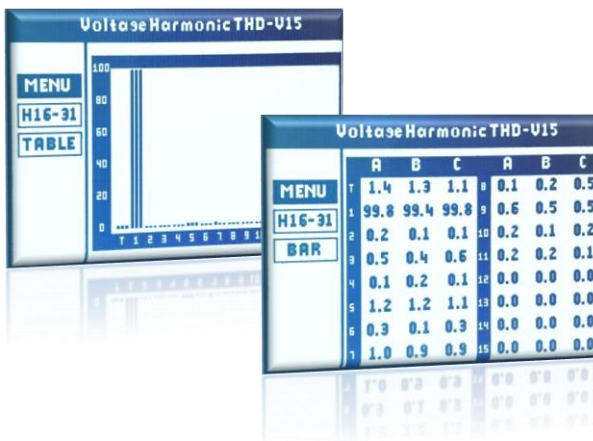
Frequency is displayed referred to phase A, unit is Hz.

5.8. Current Harmonics Page (Harmonic I)



When first entered, the bar graph of THD and H1-H15 of the three phase currents are displayed. To switch H16-H31 user can use the left menu. Harmonic values are also seen in table form. Left menu "Table" item should be selected in order to switch the Table form.

5.9. Voltage Harmonics Page (Harmonic V)



When first entered, the bar graph of THD and H1-H15 of the three phase voltages are displayed. To switch H16-H31 user can use the left menu. Harmonic values are also seen in table form. Left menu "Table" item should be selected in order to switch the Table form.

5.10. Switching Page

Switching		
MENU	Counter	Duration h
K9-16 K17-24	K1	121
	K2	111
	K3	25
	K4	56
	K5	43
	K6	23
	K7	5
	K8	19

The “counter” column displays how many times a step is switched while the “duration” column display the total switching duration of a step.

Each 24 step “counter” and “duration” can be monitored from this page. In the first page only first 8 steps counters and durations are displayed. Users have to select “K9-16” and “K17-24” from left menu to see the others.

The counters and the durations can be reset from the “Reset” page.

5.11. Step Status Page

Step Status							
K1	K2	K3	K4	K5	K6	K7	K8
K9	K10	K11	K12	K13	K14	K15	K16
K17	K18	K19	K20	K21	K22	K23	K24

The status of each step (switched ON or OFF) is displayed in this page. The switched ON steps in the example screen are K2, K6, K10 and K12. Others are switched off.

5.12. TCR Status Page

TCR Status		
MENU	Star TCR	Delta TCR
AN	100.0 0.0	AB 120.0 0.0
BN	100.0 0.0	BC 120.0 0.0
CN	100.0 0.0	CA 120.0 0.0

The firing angles and the currents of each branch of star and delta TCR are displayed in this page. The TCR currents are not measured but calculated according to power and angle of the TCR.

5.13. Events Page



EVENT	VALUE	DATE	TIME
U >>	236.2(B)	3.3.17	21:5:23
U <<	136.2(A)	3.3.17	22:15:52
°C >>	43.1	4.3.17	12:45:51
none	0.0.0	0:0:0	
none	0.0.0	0:0:0	
none	0.0.0	0:0:0	
none	0.0.0	0:0:0	
none	0.0.0	0:0:0	
none	0.0.0	0:0:0	
U>>	0.0.0	0:0:0	
U>>	0.0.0	0:0:0	
U>>	0.0.0	0:0:0	

“Events” Page displays the alarms and faults occurred. The conditions of alarms and faults for overvoltage, undervoltage, overcurrent, high THDV and high temperature are set in protection settings page.

External trip from digital input 2 (DI2) and loss of power supply are also considered as events.

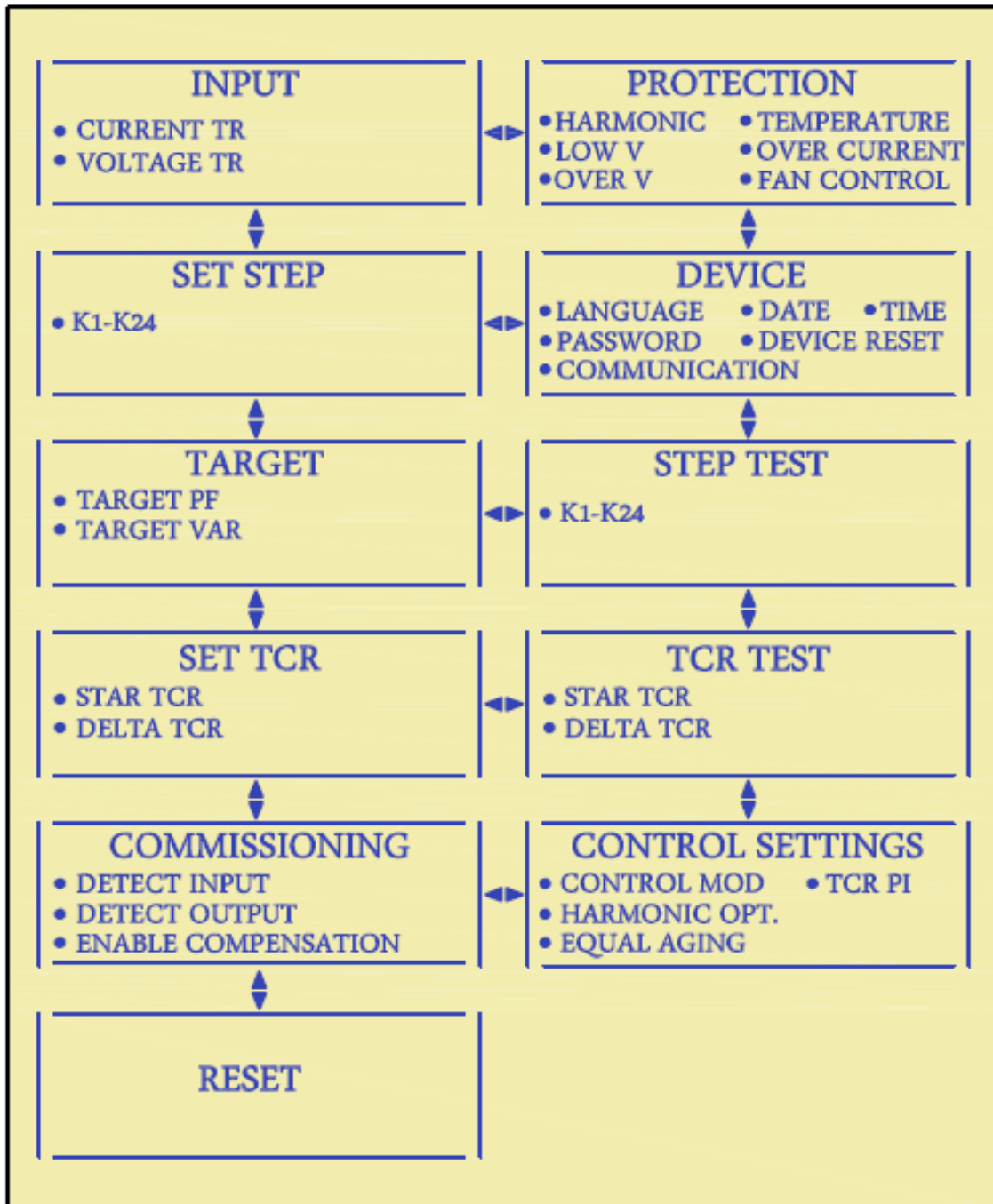
The last 8 events are logged. The time, value and occurring phase are displayed for protection events.

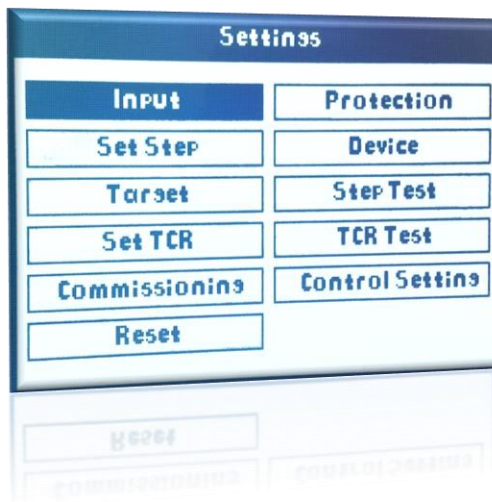
The symbols and descriptions of the events are listed in the table.

Symbol	Description
THD>>	High Voltage Total Harmonic Distortion
°C>>	High Temperature
U>>	Overvoltage
I>>	Overcurrent
U<<	Undervoltage
Ext	External Event (Digital Input 2)
LPS	Loss of Power Supply

6. SETTINGS MENU

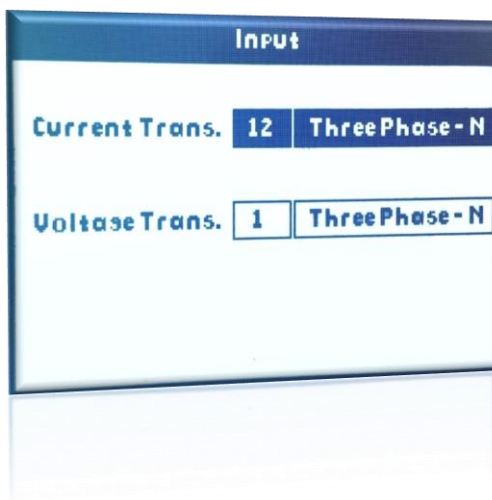
“Settings” page is reached from “Main Page”. There are 11 sub-menus in the “Settings” page.





When “Settings” is selected from main page and enter is pressed, a password page will be displayed first. The factory Settings for the password is 0000. Press enter to open the Settings menu.

6.1. Input Page



The current transformer ratio and the voltage transformer ratio are set from this page.

In order to change Current Transformer ratio, select the item and press enter. Another setting page will be displayed. With the aid of direction buttons user can set the ratio of the current transformer.

For example, if the current transformer is 300/5 type, then enter 60 in the boxes and press enter to save.

The connection type is three phase. Other options will be available in the future firmware.

The voltage transformer ratio can also be changed. It is needed when a medium voltage system is to be compensated. For low voltage systems leave it 1.

In order to change Voltage Transformer ratio, select the item and press enter. Another setting page will be displayed. With the aid of direction buttons user can set the ratio of the voltage transformer.

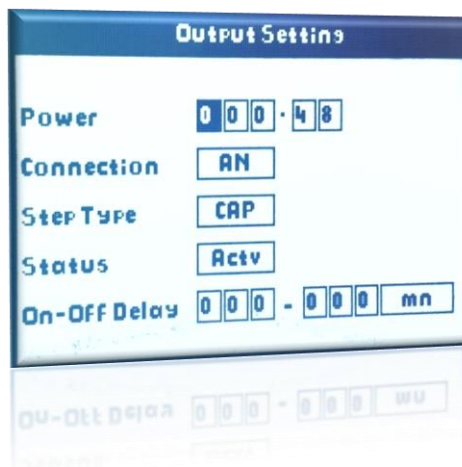
For example, if the voltage transformer is 34500/100 type, then enter 345 in the boxes and press enter to save.

The connection type is three phase. Other options will be available in the future firmware.

6.2. Set Step Page



When the Set Step page is selected and enter is pressed, the summaries of settings of the first 8 steps are displayed. To switch the other steps, ">>>" symbol should be selected by direction buttons and enter should be pressed. The next page displays step 9 to step 17 and the last page displays, step 18 to step 24.



Each steps setting is done individually. If any of the settings wanted to be changed, that step should be selected. A “step setting” screen is displayed when enter is pressed.

Using the direction buttons, the step properties can be changed.

The unit of power is kVAr and can be adjusted between 0 and 999,99.

The connection type determines how a step is connected to system: AN, BN, CN, AB, BC, CA, 3P. AN, BN and CN are for single phase connected steps. AB, BC and CA stands for phase to phase connected steps, while 3P stands for three phase steps.

The step type determines if a step is inductive (IND) or capacitive (CAP).

The step status can be set “active”, “passive” and “constant”. An active step is step that can be manually or automatically controlled by the relay. A constant step is not automatically controlled by relay, it can be switched ON or OFF manually. A passive step is always OFF. The unconnected steps or faulty steps should be selected passive.

The ON and OFF delay of the steps determines the least switching ON and OFF delay time for a step. After switching a step OFF, it should wait the time of ON delay to be re-switched ON. Contrary, after switching a step ON, it should wait the time of OFF delay to be switched OFF.

The ON and OFF delay can be adjusted between 0-999. Its unit is selected as minute (min), second (sec) or millisecond (ms). The minimum step is 20 milliseconds. If ms is selected as a unit, the relay convert the selected value to nearest 20ms step.

When pressed enter, the values saved and previous step setting page is opened with updated values.

6.3. Target Page

The screenshot shows a software interface titled "Target". It contains two main sections. The first section, "Target Cos(φ)", has two rows: "Cos(φ) 1" with a value of "1.00" and "Cos(φ) 2" with a value of "1.00". The second section, "Target KVAR", has two rows: "Reference 1" with a value of "0" and "Reference 2" with a value of "0". Each value is displayed in a blue box next to its label.

Two target operation modes are selectable: Target Power Factor or Target kVAR.

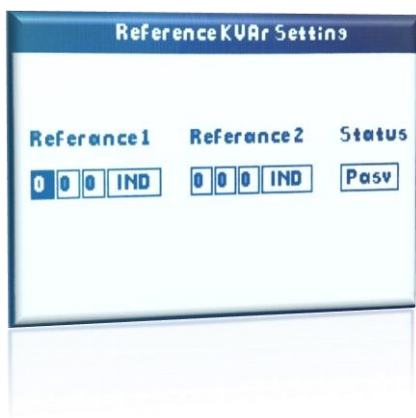
The selected target is indicated by negative color. In the sample page, Target Power Factor is selected for operation.

Each operation modes have also two selectable target values which are controlled by Digital Input 1 (DI1). If DI1 is “Low” the relay operates according to first value of selected target mode. If DI1 is “High” then the relay operates according to second value of selected target mode.

To change the settings, cursor should be on the selected target mode and enter should be pressed. A new page will be displayed for settings.



Use the direction buttons to do the settings. If Target Power Factor will be selected as operating mode, the values can be set between 0.01 and 1.00. The power factor can be selected either inductive or capacitive. The status should be selected active. When enter is pressed, the display will return to previous page with updated values and Target Power Factor is the selected operation mode.



If Target kVAR will be selected as operating mode, the values can be set between 000 to 999 kVAR. The Target kVAR value can be selected either inductive or

capacitive. The status should be selected active. When enter is pressed, the display will return to previous page with updated values and Target kVAR is the selected operation mode.

6.4. Set TCR Page



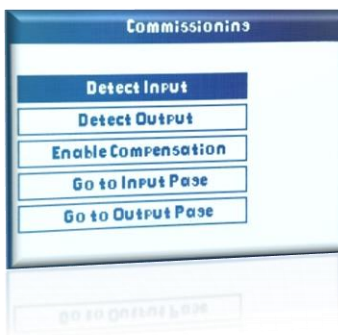
Two types of TCR can be connected to the Relay: Star and Delta. Each TCR settings are done from this page separately.

Selecting the TCR type and pressing to enter a new page will be displayed. TCR power and the status of TCR can be set from this page. If TCR KP and KI values are wanted to be updated according to the power of the TCR, user should turn the Update KP/KI section to active.

TCR power is the total power of the TCR and can be set between 0 and 999,99kVAR. If there is not any TCR connected the status should be selected passive.

6.5. Commissioning Page

Detect Input



“Detect Input” helps to correct the current order and direction referenced to voltage inputs.

When “Detect Input” is selected and enter is pressed, the relay will switch ON and OFF the biggest three phase capacitive step.

After successful switching, relay checks the order and direction of current transformers referred to voltage inputs.

If there is any disorder or misdirection it will be automatically corrected and a “DONE” inscription will be displayed in the right side.

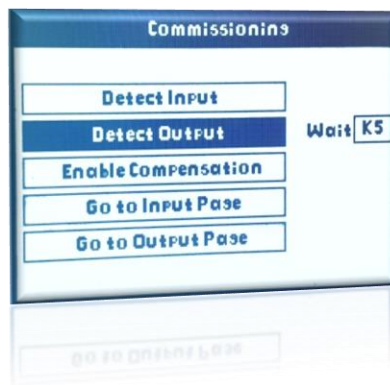
If detection fails, this time a “FAILED” inscription will be displayed.

The possible reasons for fail:

1. No three phase capacitor bank available as load.
2. There phase capacitor bank is available but it is not introduced to Relay.
3. One or more current transformers are missing.
4. Sometimes due to fast changing loads, the relay cannot successfully detect the order and direction.

After checking the above, repeat the procedure or manually correct the connection errors.

Detect Output

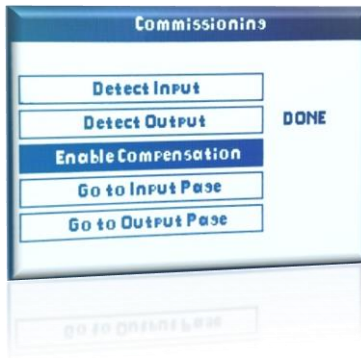


When “Detect Output” is selected and “enter” is pressed, the relay will switch ON and OFF each step one by one.

In each switching, the relay will identify the power, connection type (3P, AN, BN, CN, AB, BC, CA), step type (Inductive or Capacitive) of the connected loads.

The switched step will be indicated on the left. When all finished, a “DONE” inscription will be displayed.

Enable / Disable Compensation



When all setting are done, selecting this item and pressing enter will initiate the automatic compensation.

If the automatic compensation is active the item turns to “Disable Compensation” on the other hand if the automatic compensation is not active the item turns to “Enable Compensation”

After starting the compensation the user do not need to restart it in the case of a power loss. Compensation will continue automatically after the power loss restored.

Go to Input Page

This is a short cut to Input page.

Go to Output Page

This is a short cut to Output page.

6.6. Reset Page



The selectable reset options are listed below.

Reset Energy

When activated, resets the 1.8.0, 5.8.0 and 8.8.0 energy values and ratios.

Reset Input

When activated, resets the order and direction of current transformers to default configuration

Reset Outputs

When activated, resets the counter and duration of the steps.

Reset All

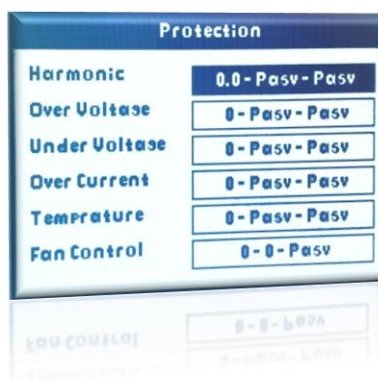
When activated, resets energy values, the order and direction of current transformers and the counter and duration of the steps at the same time.

In order to activate a reset, the reset type should be selected from the options and passive row should be turned to active by direction buttons and enter should be pressed.

Periodical Energy Reset

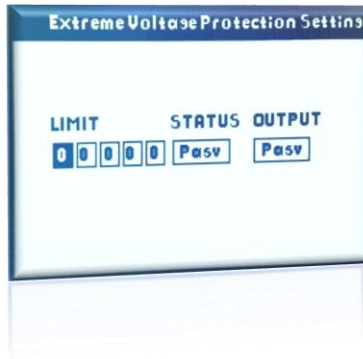
Periodical energy reset is used for resetting the energy values in a defined period. The period can be adjusted between 1 and 99, and the unit of the period can be adjusted as day, month and year.

6.7. Protection Settings Page



The device has harmonic, overvoltage, undervoltage, overcurrent, high temperature protections and fan control feature.

When the protection page is first entered, settings of each protection is listed as a table. In order to change a setting, the related row should be selected and enter should be pressed.



A new screen opens for settings. The “Limit” determines the upper value (lower value for undervoltage) of the protection.

The status of the protection can be set to three options:

Passive

The protection is disabled.

Alarm

The protection is enabled. The output is triggered but compensation is not deactivated if an alarm occurs.

Fault

The protection is enabled. The selected output is triggered and compensation is deactivated if a fault condition occurs. The compensation will re-activate after the device reset time is elapsed and the fault condition is restored.

Output can be selected as passive, O1 and O2. If a protection is enabled and occurred, the selected output will be triggered. The output will be low after the device reset time is elapsed and the condition is restored.

Fan Control Feature

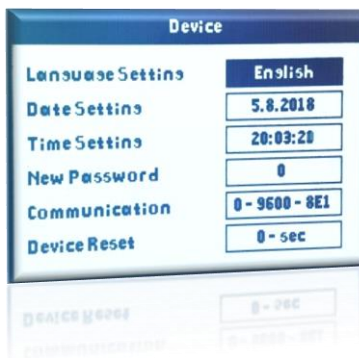


The fan control feature can be activated for cooling of the panel. The FAN ON and FAN OFF values are adjusted by the user.

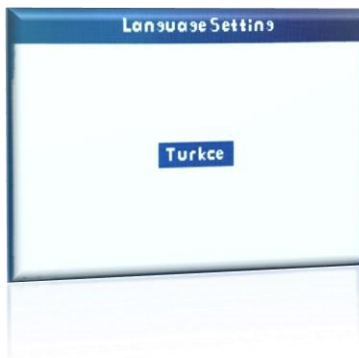
The FAN ON temperature should be greater than FAN OFF temperature for stability.

When an output is assigned for FAN control, output should not be defined for an Alarm or Fault.

6.8. Device Settings Page



Language



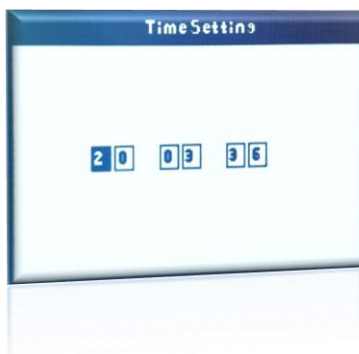
Supported device languages are Turkish and English. In order to set language, select language and press enter. Use direction buttons to select the language and press enter.

Date



Date of the device is adjusted in date/month/year. In order to update date, select date and press enter. Use direction buttons to select the new date and press enter.

Time



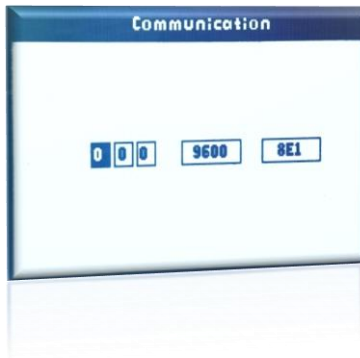
Time of the device is adjusted in hour/minute/second. In order to update time, select time and press enter. Use direction buttons to select the new time and press enter.

Password



Setup password of the device is a four digit number. In order to update password, select password and press enter. Use direction buttons to select the new password and press enter.

Communication



MODBUS RTU protocol is supported by the device. In order to update Modbus parameters, select communication and press enter. Use direction buttons to select the new parameters and press enter.

Modbus address can be between 1 and 255

Five baud rates are supported: 2400, 4800, 9600, 19200, 38400, 57600

Parity and stop bits can be selected from one of the following:

8E1: 8bit, Even Parity, 1 Stop bits

8O1: 8bit, Odd Parity, 1 Stop bits

8N1: 8bit, No Parity, 1 Stop bits

8N2: 8bit, No Parity, 2 Stop bits

Device Reset

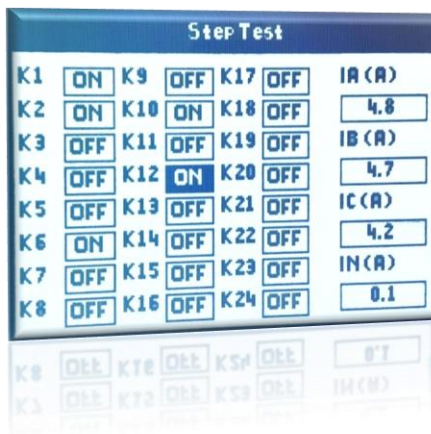


Device reset time is the time that has to elapse to re-start compensation and to set “LOW” to related output when a fault occurs or when a restore occurs following a supply loss.

It can be adjusted between 1 and 99; unit can be selected either second or minute.

In order to set reset time, select device reset and press enter. Use direction buttons to select the new time and unit and press enter.

6.9. Step Test Page



The 24 outputs of the relay can be tested manually. Enter the Step Test page and select the desired step to turn ON or OFF by direction buttons. When pressed enter if the previous position of a step is OFF it will be ON vice versa.

When Step Test page is displayed automatic compensation stops and it is restored when exited from page.

The line currents are also displayed in the page, so the user can see the difference, when a step is turned on and off. This function is useful when a panel is first installed.

6.10. TCR Test Page

The screenshot shows the 'TCR Test' interface. It has a title bar 'TCR Test'. Below it, there are two rows of controls: 'Star TCR' and 'Delta TCR'. Each row has three input boxes for firing angles (100, 100, 100 for Star; 120, 120, 120 for Delta) and an 'ON' button. Below these are four input boxes for line currents: 'IA (A)' (4.8), 'IB (A)' (4.2), 'IC (A)' (4.7), and 'IN (A)' (0.1). At the bottom, there are two buttons labeled 'F' and 'T'.

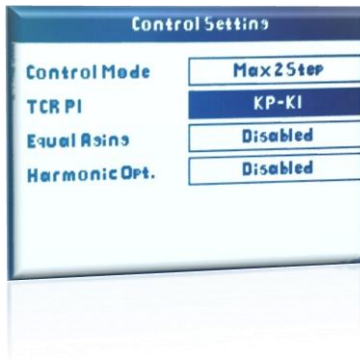
The Delta or Star TCR can be fired manually from this page. The firing angles must be between 90 and 180.

Angle 90 generates the maximum power on the reactor while 180 generate the minimum. Each branches' firing angle can be adjusted separately.

Select TCR to be tested, press enter. Enter the firing angles by direction buttons, pressing enter return to first page. Select the box on the left side; press enter to switch the TCR.

The line currents are also displayed in the page, so the user can see the difference when TCR is fired with different angles.

6.11. Control Settings Page



There are four sub-menus in control settings. Control Mode, TCR PI, Equal Aging, Harmonic Optimization.

Control Mode

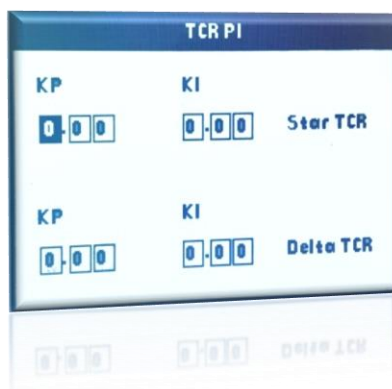
Control Mode of the relay is Max. 2. Step. For switching steps, the relay searches the best options to reach its target.

The decision time is 20ms. The relay can either decide to:

- Switch ON two steps
- Switch ON one step
- No switching
- Switch one step ON, one step OFF
- Switch one step OFF
- Switch two steps OFF

The user cannot change control mode in this firmware.

TCR PI



Delta and Star TCR KP and KI parameters can be adjusted from this section.

These parameters can also be updated according to power of the TCR automatically. It is explained in section 6.4. TCR Status Page.

If it is wanted to manually replace the KP, KI parameters, press enter. In the new page, using direction buttons to adjust parameters, and press enter.

The KP, KI parameters cause oscillatory control over TCR, so it is not advised to change them manually for non-professionals.

Equal Aging –Harmonic Optimization

This control options are not available in this firmware.

APPENDICES

A.1 Measurements Table

Measurements	Range	Step	Accuracy
Current (A)	[0 – 62.418,3]	0,1	%1
Voltage (V)	[0 – 999.999,9]	0,1	%1
Active Power (kW)	[0 – 999,999,9]	0,1	%2
Apparent Power (kVA)	[0 – 999,999,9]	0,1	%2
Reactive Power (kVAr)	[-999.999,9 - 999.999,9]	0,1	%2
Active Energy (kWh)	[0 – 99.999.999,99]	0,01	%2
Reactive Energy (kVArh)	[0 – 99.999.999,99]	0,01	%2
Inductive– Capacitive /Active Energy Ratio	[0 – 99,99]	0,01	%2
Power Factor	[-1,00 – 1,00]	0,001	%2
Frequency (Hz)	[0 – 99,99]	0,01	%2
Harmonics (Current) %	[0 – 99,9]	0,1	%2
Harmonics (Voltage) %	[0 – 99,9]	0,1	%2
Switching Counter of Steps	[0 – 655.369.999]	1	
Switching Duration of Steps (Hour)	[0 – 22.311,20]	0,01	

A.2 Parameters Table

Control Parameters	Adjustable	Adim
Current Transformer	[0 – 9999]	1
Voltage Transformer	[0 – 999]	1
Step Power (kVAr)	[0 – 999,99]	0,01
Step On-OFF Delay (ms, sec, min)	[0 – 999]	0,02
Target Cos(ϕ)	[0 – 1]	0,01
Target VAr (kVAr)	[0 – 999]	1
Harmonic Protection Limit (%)	[0 – 99]	1
Overvoltage Protection Limit (V)	[0 – 99.999]	1
Undervoltage Protection Limit (V)	[0 – 99.999]	1
Overcurrent Protection Limit (A)	[0 – 9.999]	1
High Temperature Limit (°C)	[0 – 99]	1
FAN ON-OFF (°C)	[0 – 99]	1
TCR Power (kVAr)	[0 – 9,999.99]	0,01
TCR PI Control Parameters (KP-KI)	[0 – 1,00]	0,01
Reset Time (sec, min)	[0 – 99]	1

A.3 Dimensions and Panel Cross Section

