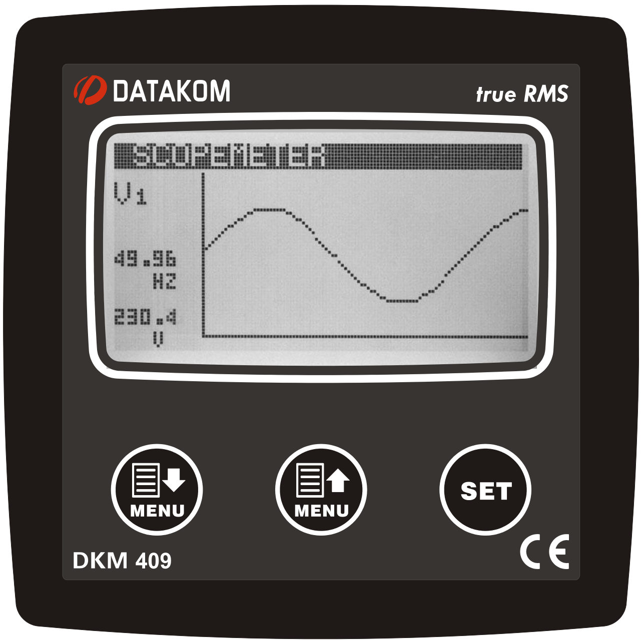
DKM-409 NETWORK ANALYSER

WITH HARMONIC MEASUREMENT AND SCOPEMETER



INTRODUCTION

The DKM-409 is a precision instrument designed for displaying various AC parameters in 3-phase distribution panels.

Thanks to its isolated RS-485 Modbus RTU communication port, the device is free from ground potential difference issues and measured parameters are safely transferred to factory and building automation systems.

The power supply of the unit is isolated, thus the device can be used safely in 230/400V systems.

The graphic screen allows display of waveforms and harmonic analysis graphs.

Various display screens can be scrolled automatically. The user configurable screen where any measured parameter set can be displayed, transforms the unit to a custom designed measurement panel.

FEATURES

True RMS measurements
Harmonic distortion display (31 harmonics)
Oscilloscope, waveform display
Max demand display
User configurable display screen
Fully isolated RS-485 serial port
MODBUS-RTU communication
2 configurable relay outputs
Energy pulse output capability
Optically isolated, configurable digital inputs
Switched dual active-reactive power counters
Independent mains/generator energy metering
Configurable user counters
Voltage transformer ratio for MV applications
Password protected front panel programming
High visibility, 128x64 pixels graphic LCD
Reduced panel depth
Wide operating temperature range
Sealed front panel (IP54)
Plug-in connection system

SAFETY NOTICE

Failure to follow below instructions will result in death or serious injury

- **Electrical equipment should be installed only by qualified specialist. No responsibility is assured by the manufacturer or any of its subsidiaries for any consequences resulting from the non-compliance to these instructions.**
- **Check the unit for cracks and damages due to transportation. Do not install damaged equipment.**
- **Do not open the unit. There is no serviceable parts inside.**
- **Fuses must be connected to the power supply and phase voltage inputs, in close proximity of the unit.**
- **Fuses must be of fast type (FF) with a maximum rating of 6A.**
- **Disconnect all power before working on equipment.**
- **When the unit is connected to the network do not touch terminals.**
- **Short circuit terminals of unused current transformers.**
- **Any electrical parameter applied to the device must be in the range specified in the user manual.**
- **Do not try to clean the device with solvent or the like. Only clean with a dry cloth.**
- **Verify correct terminal connections before applying power.**
- **Only for front panel mounting.**

TABLE OF CONTENTS

Section

1. INSTALLATION

Before installation:

- Read the user manual carefully, determine the correct connection diagram.
- Remove all connectors and mounting brackets from the unit, then pass the unit through the mounting opening.
- Put mounting brackets and tighten. Do not tighten too much, this can brake the enclosure.
- Make electrical connections with plugs removed from sockets, then place plugs to their sockets.
- Note that the power supply terminal is separated from measurement terminals.

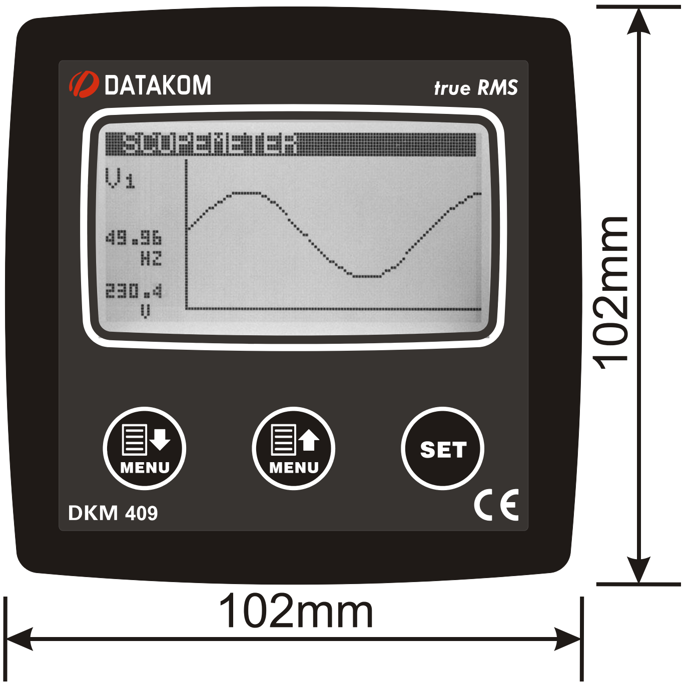
Below conditions may damage the device:

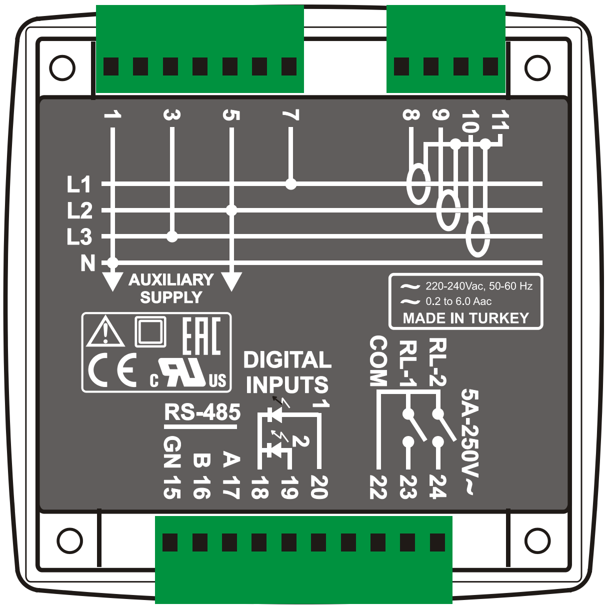
- Incorrect connections.
- Incorrect power supply voltage.
- Voltage at measuring terminals beyond specified range.
- Current at measuring terminals beyond specified range.
- Connecting or removing data terminals when the unit is powered-up.
- Overload or short circuit at relay outputs
- Voltage applied to digital inputs over specified range.
- High voltage applied to communication port.

Below conditions may cause abnormal operation:

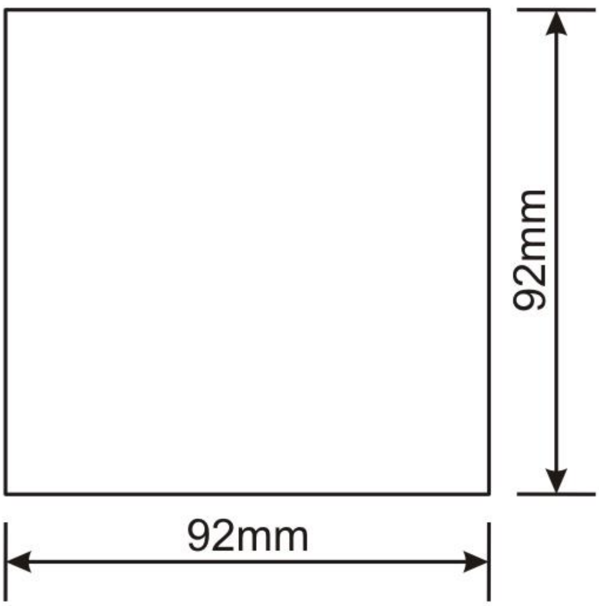
- Power supply voltage below minimum acceptable level.
- Power supply frequency out of specified limits
- Phase order of voltage inputs not correct.
- Current transformers not matching related phases.
- Current transformer polarity incorrect.

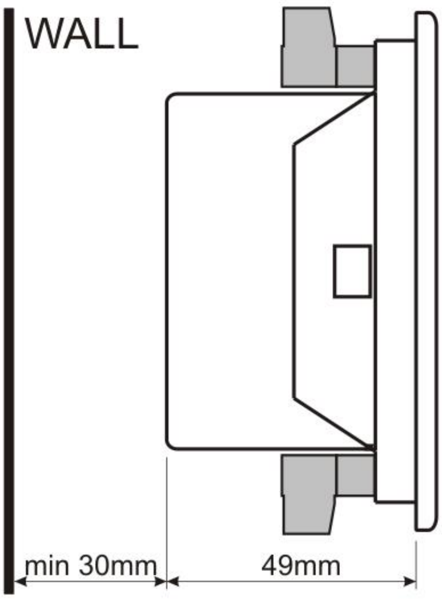
1.1 FRONT / REAR PANELS





1.2 MECHANICAL INSTALLATION





Panel Cutout **Required Panel Depth**

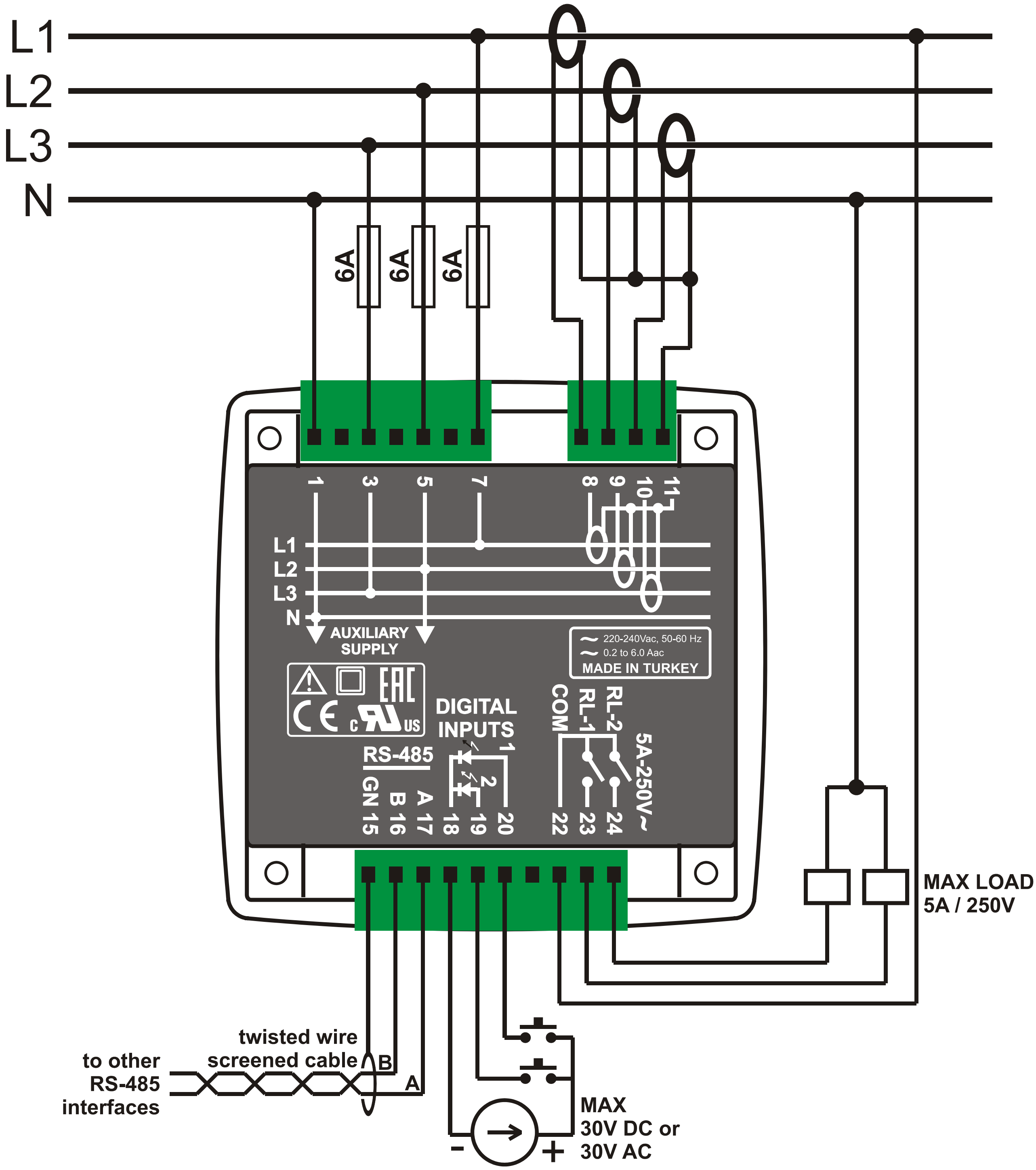
1.3 ELECTRICAL INSTALLATION

Do not install the unit close to high electromagnetic noise emitting devices like contactors, high current busbars, switchmode power supplies and the like.

Although the unit is protected against electromagnetic disturbance, excessive disturbance can affect the operation, measurement precision and data communication quality.

- **ALWAYS remove plug connectors when inserting wires with a screwdriver.**
- **Fuses must be connected to the power supply and phase voltage inputs, in close proximity of the unit.**
- **Fuses must be of fast type (FF) with a maximum rating of 6A.**
- **Use cables of appropriate temperature range.**
- **Use adequate cable section, at least 0.75mm^2 (AWG18).**
- **For current transformer inputs, use at least 1.5mm^2 section (AWG15) cable.**
- **The current transformer cable length should not exceed 1.5 meters. If longer cable is used, increase the cable section proportionally.**
- **Follow national rules for electrical installation.**
- **Current transformers must have 5A output.**
- **For the RS-485 connection, use appropriate shielded twisted wire cable. Communication quality will depend highly on the cable used.**

1.4 CONNECTION DIAGRAM FOR 230/400V NETWORK

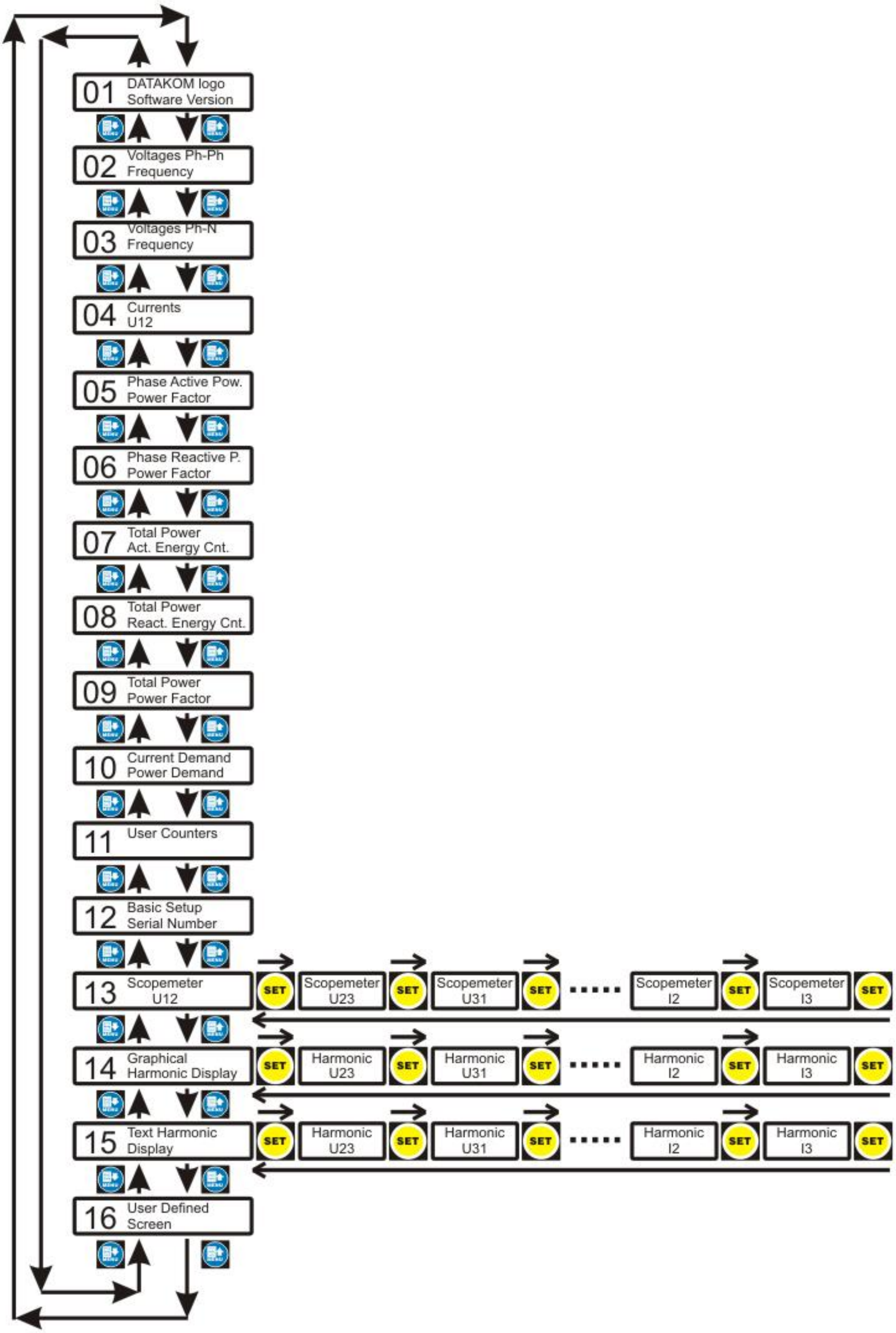


2. PUSHBUTTON FUNCTIONS

Three buttons on the front panel provide access to configuration and measurement screens.

BUTTON	FUNCTION
	**Previous screen** **or** **Decrease related value (configuration mode)**
	**Next screen** **or** **Increase related value (configuration mode)**
	**<u>Changes voltage and current channels for</u>** • **scopemeter display** • **harmonic display** • **digital harmonic display** **Available channels: U12-U23-U31- V1-V2-V3- I1-I2-I3**
	**<u>HELD PRESSED FOR 3 SEC:</u>** **enable/disable auto-scroll function**
	**<u>HELD PRESSED TOGETHER FOR 3 SEC:</u>** • **Clears visual warning condition if any.** • **If no warning condition, enters configuration mode.**

3. DISPLAY NAVIGATION



4. DISPLAY SCREEN

4.1 DISPLAY SCREEN DETAILS

Display 1

DATAKOM LOGO
Software version

Display 2

U1-2 (V)
U2-3 (V)
U3-1 (V)
Frequency (Hz)

Display 3

V1-N (V)
V2-N (V)
V3-N (V)
Frequency (Hz)

Display 4

I1 (A)
I2 (A)
I3 (A)
U1-2 (V)

Display 5

P1 Active power (kW)
P2 Active power (kW)
P3 Active power (kW)
Total Active Power

Display 6

Q1Reactive power(kVAr)
Q2Reactive power(kVAr)
Q3Reactive power(kVAr)
Total Reactive Power

Display 7

Total active power (kW)
Total reactive power (kVAr)
Power factor
Total active energy (kWh)

Display 8

Total active power (kW)
Total reactive power (kVAr)
Power factor
Total reactive energy (kVArh)

Display 9

Total apparent power (kVA)
Total active power (kW)
Total reactive power (kVAr)
Power factor

Display 10

I1 (A) demand value
I2 (A) demand value
I3 (A) demand value
P (kW) demand value

Display 11

USR1 – User counter 1
USR2 – User counter 2
USR3 – User counter 3
USR4 – User counter 4

Display 12

CT x VT ratio
Transmission speed (bps)
Modbus address
Instrument serial number

Display 13

Time Display Screen
Channel time curve
Channel frequency
Channel value (V/A)

Display 14

Harmonic Display Screen
Channel harmonic bars
Channel frequency
Channel value (V/A)

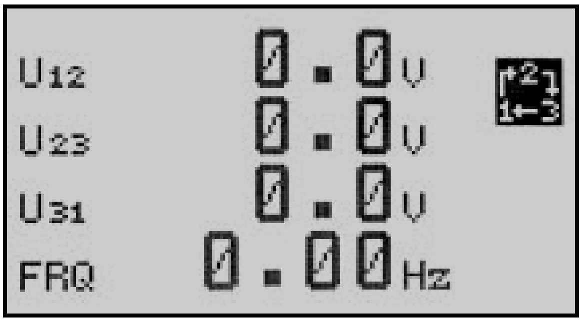
Display 15

Channel Harmonic List
(1-31 %)

Display 16

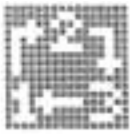
User configurable screen
Default values are:
USR1 USR4 – User counters

4.2 PHASE SEQUENCE DISPLAY



The unit checks continuously the sequence of AC phase voltages.

If voltages are in the correct sequence, below symbol appears on voltage display pages, namely pages 2 and 3



If voltages are in wrong order, the symbol disappears.

The effect of phase sequence failure is configurable. It can be a visual warning, a relay output or nothing.

To learn more about the phase sequence failure output, please review the section **PHASE SEQUENCE FAILURE** in the **CONFIGURATION** menu.

5. DISPLAY SYMBOLS

SYMBOL	DESCRIPTION
ver	Software version
U12	Phase 1 to phase 2 AC RMS voltage value
U23	Phase 2 to phase 3 AC RMS voltage value
U31	Phase 3 to phase 1 AC RMS voltage value
FRQ	Frequency value
V1	Phase 1 to Neutral AC RMS voltage value
V2	Phase 2 to Neutral AC RMS voltage value
V3	Phase 3 to Neutral AC RMS voltage value
I1	Phase 1 AC RMS current value
I2	Phase 2 AC RMS current value
I3	Phase 3 AC RMS current value
P1	Phase 1 active power (kW) value
P2	Phase 2 active power (kW) value
P3	Phase 3 active power (kW) value
∑P	Total active power (kW) value
Q1	Phase 1 reactive power (kVAr) value
Q2	Phase 2 reactive power (kVAr) value
Q3	Phase 3 reactive power (kVAr) value
∑Q	Total reactive power (kVAr) value
S1	Phase 1 apparent power (kVA) value
S2	Phase 2 apparent power (kVA) value
S3	Phase 3 apparent power (kVA) value
∑ S	Total apparent power (kVA) value
Cos1	Phase 1 power factor
Cos2	Phase 2 power factor
Cos3	Phase 3 power factor
∑ Cos	Power factor
Pc1	Active power counter 1 (kWh)
Pc2	Active power counter 2 (kWh)
Qc1	Reactive power counter 1 (kVArh)
Qc2	Reactive power counter 2 (kVArh)
I1mx	Phase 1 maximum apparent current value
I2mx	Phase 2 maximum apparent current value
I3mx	Phase 3 maximum apparent current value
Pmax	Total active power maximum value
USR1	User counter 1
USR2	User counter 2
USR3	User counter 3
USR4	User counter 4
VTxIT	Current Transformer Ratio x Voltage Transformer Ratio
BAUD	Transmission speed (bps)
MODBUS	Modbus node address
SERIAL	Instrument serial number
I	Power factor is inductive
C	Power factor is capacitive
H1-H31	Harmonic values

6. SETTING AUTO-SCROLL MODE

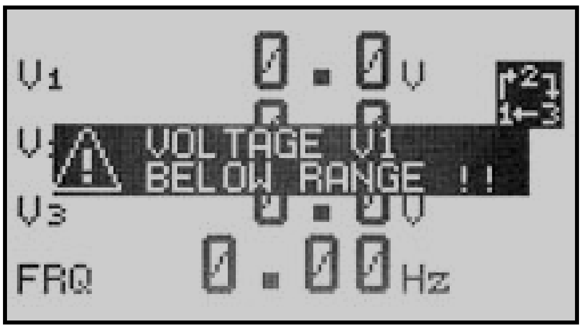
The unit offers the possibility of automatically scanning of all display screens.

In order to enable auto-scroll function hold the SET button pressed for 3 seconds.

In order to disable auto-scroll function hold the SET button pressed for 3 seconds.

When the auto-scroll is enabled, the unit will switch to the next screen every 5 seconds.

7. RESETTING VISUAL WARNINGS



In order to reset visual warnings, hold both MENU buttons pressed for 3 seconds.
If no fault conditions exists this will enable the configuration menu.

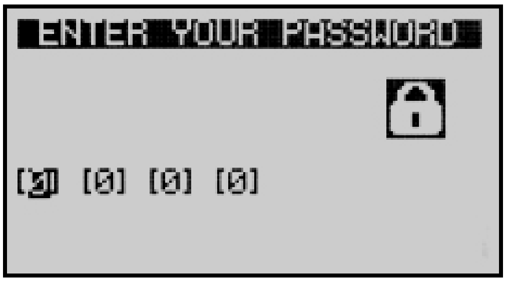
8. DEVICE CONFIGURATION

8.1 INTRODUCTION

In order to offer the maximum flexibility to the user, the unit has several configurable parameters.

- **Device configurations**
  - LCD Contrast
  - Language selection
  - Modbus node address
  - User display screen configuration
- **Input/Output Configurations**
  - Reference value setting
  - Input Configurations
  - Relay Configurations
- **Line Configurations**
  - Clearing Counters
  - Resetting demand values
  - Overcurrent configuration
  - Setting the current transformer ratio
  - Setting the voltage transformer ratio
  - Input calibration
- **Return to factory settings**

In order to enable the configuration menu, hold both MENU buttons pressed for 3 seconds.



When the configuration mode is entered, the password entry screen will be displayed.

A 4 digit password must be entered using buttons. The factory default password is **“9876”**. Each digit is adjusted with **MENU** buttons and the next digit is selected with **SET** button.

When the configuration mode is entered, a list of available configuration topics will be displayed as in the below screen.

In order to exit the configuration menu, hold both MENU buttons pressed for 3 seconds. If no button is pressed, the unit will automatically close the configuration menu after 30 seconds.

Navigation on the list is made with  and  buttons. Selected configuration topic is shown in reverse video (black on white). In order to enter inside a configuration topic, please press  button.

8.2 ADJUSTING THE LCD CONTRAST

Select "**LCD CONTRAST**" on "**CONFIGURATION MENU**". Change the contrast value with 

and 

until best visibility is obtained and then press 

to save new LCD contrast value and return back to "**CONFIGURATION MENU**".

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8.3 LANGUAGE SELECTION

Select "**LANGUAGE**" on "**CONFIGURATION MENU**". Change language with 

and 

until the desired language is selected and then press 

to save the new language and return to "**CONFIGURATION MENU**" again.

8.4 CURRENT TRANSFORMER RATIO

For the correct current measurement, the current transformer ratio has to be set properly.

The secondary of the current transformer is always supposed to be 5 Amps. Only the primary value is set.

Select "**CRNT TRF RATIO**" on "**CONFIGURATION MENU**".

Then adjust the current transformer ratio with 

and 

buttons until required value then press 

button to save the new current transformer ratio and return to "**CONFIGURATION MENU**".

8.5 VOLTAGE TRANSFORMER RATIO

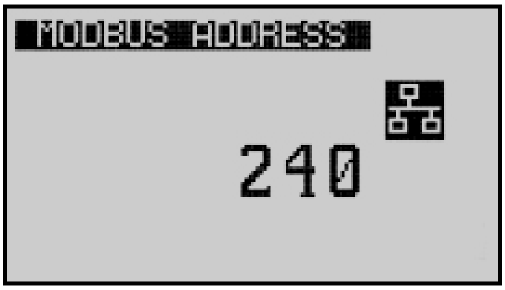
If a voltage transformer is used, then its ratio needs to be set to the unit.

The voltage transformer ratio is defined as primary voltage / secondary voltage. The secondary is always supposed 1.0. Thus only the primary is programmed.

Select "**VOLT TRF RATIO**" on "**CONFIGURATION MENU**".

Adjust the voltage transformer ratio with and buttons until required value then press button to save new voltage transformer ratio and return to "**CONFIGURATION MENU**".

8.6 MODBUS ADDRESS



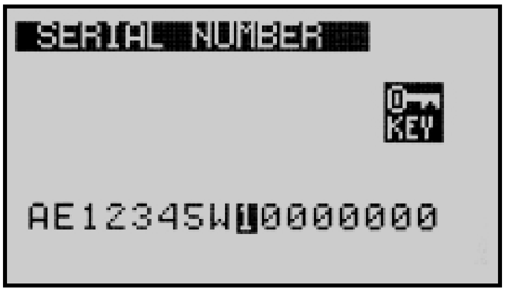
Select "**MODBUS ADDRESS**" on "**CONFIGURATION MENU**". Change the modbus node address with and until the desired address is displayed and then press to save the new modbus node address and return to "**CONFIGURATION MENU**" again.

8.7 CHANGING THE PASSWORD

Select "**CHANGE PASSWORD**" on "**CONFIGURATION MENU**".
Write new password with **MENU** buttons. Every depression of button will switch to the next digit.

Long press (3 sec) to save the new password and return to "**CONFIGURATION MENU**" again.

8.8 MODIFYING THE SERIAL NUMBER



The unit holds a user definable 16 characters serial number.
Every character can take values between 0-9 and A-Z.
The default value of serial number is "0000000000000000".

Select "**SERIAL NUMBER**" on "**CONFIGURATION MENU**". Write new serial number with **MENU** buttons. Every depression of  button will switch to the next character.

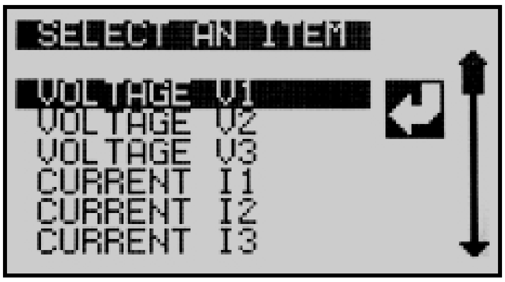
Long press (3 sec)  to save new serial number and return to "**CONFIGURATION MENU**" again.

8.9 USER DISPLAY PAGE CONFIGURATION

The unit offers a user-configurable screen (display page 16) through "**USER MENU**" topic.

There are 2 sizes of characters that can be selected (5x7 and 10x14 pixels).

Select the character size with  and , and then press  to select item menu.



Select an item to display on "**SELECT AN ITEM**" menu, then press .

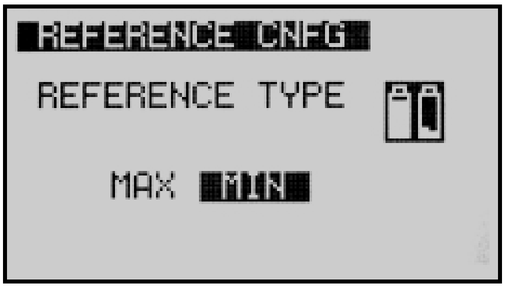
This will return to character type selection menu for the next displayed item.

As long as the screen setting continues, the current status the user display page is constantly displayed.

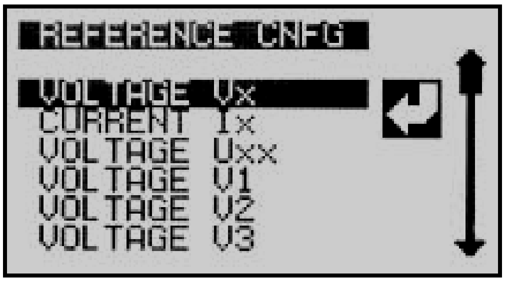
The display configuration will resume when there is no place to show another item.

The user can terminate anytime by long pressing (3 sec) the  button.

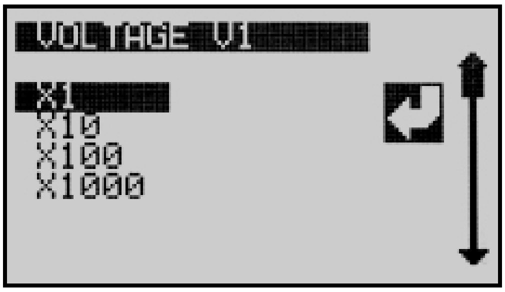
8.10 CONFIGURING AN ITEM'S LOW OR HIGH LIMIT



Select "**REFERENCE CNFG**" on "**CONFIGURATION MENU**". Select low limit (minimum acceptable value) or high limit (maximum acceptable value) of the item to configure then press .

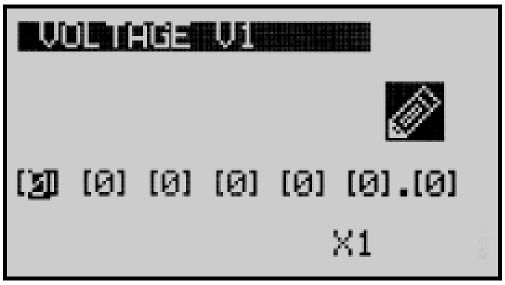


Then select the item to configure on the list and press  again.

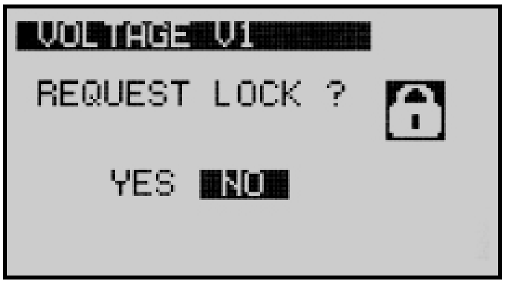


After selection of the item, the limit value should be entered. Especially for power or user counters, large values may be needed. Thus the user must select the multiplier first ('x1','x100' or 'x1000').

For example; 'x10' means "**multiply set value by 10**". Then the user will enter a smaller value.



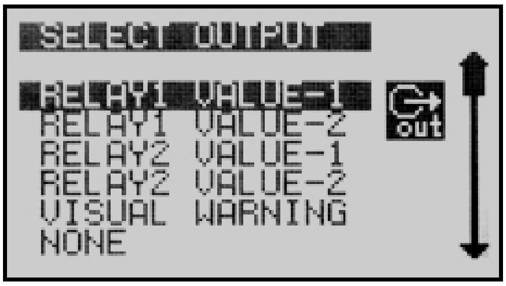
The format of the value is "000000.0" and can be between 0.0 and 999999.9



After entering the limit value of the item, the action to be taken when the condition occurs has to be selected.

LOCK means that, once the condition occurs, it will persist until manually reset by the user.

Otherwise the condition will reset automatically when the event causing the condition goes off.



The user can select between actions to be taken when the condition occurs.

”**VISUAL WARNING**” means there is no output function, but a message is displayed on the screen.

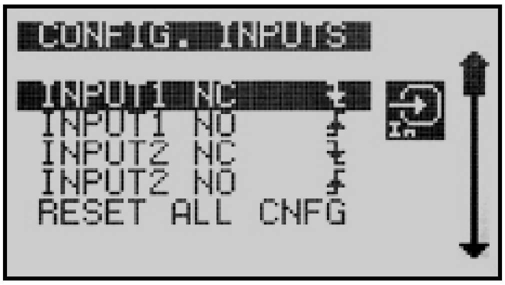
The unit has 2 internal relays and each one has four input registers referred as “**VALUE-1**”, “**VALUE-2**”, “**VALUE-3**”, and “**VALUE-4**”.

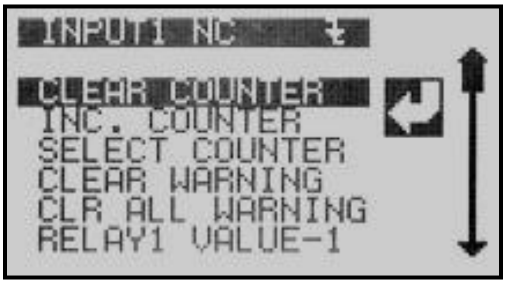
The condition may be directed to any relay’s VALUE registers.

VALUE registers will be used in relay configuration.

The “**RELAY CONFIGURATION**” chapter will describe in detail the use of VALUE registers.

8.11 INPUT CONFIGURATION





The unit has two configurable inputs.

Level transitions from high to low (NC=normally closed contact) and low to high (NO=normally open contact) may be programmed independently.

There are various functions that can be assigned for each input. Some of these actions can be clearing a counter, selecting between counters, clearing fault conditions, assigning the input to relay input registers.

- **Clear Counter:** Sets the selected counter to zero.
- **Increment Counter:** Increments the selected counter by 1.
- **Select Counter:** The unit has 2 sets of active and reactive power counters additionally to 4 user counters.

  Active/Reactive 1 counters are default selections and incremented with consumed power. As there may be more than one power source (like gensets) and these sources supply power on different occasions, the user may want to measure consumed powers from different sources with separate counters. If an input is assigned as “SELECT COUNTER”, “kW/kVAr 1&2”, then the unit will increment the first counter set when there is no signal at the input, and it will increment the second set when the signal is present. In the same way, user counters can be switched with input signal.
- **Clear Alarm:** Resets selected alarm.
- **Clear All Alarms:** Resets all alarms.
- **Relay Value:** Write input status to relay VALUE register.

8.12 RELAY CONFIGURATION

The unit has 2 relay outputs with configurable functions.

Relays can be configured as kW or kVAr tick outputs, sending 1 pulse per kW (or kVAr).

Each relay has 4 input value registers. Relays can operate depending on a logical function of their input value registers.

There are several available logical functions:

- **Relay = VALUE 1:** The relay output will follow the **VALUE 1** register. When the value is TRUE then the relay contact will close.
- **Relay = NOT VALUE 1:** The relay output will be the opposite of the **VALUE 1** register. When the value is FALSE then the relay contact will close.
- **Relay = VALUE 1 OR VALUE 2:** If at least one of value registers is TRUE then the relay contact will close. Otherwise it will open.
- **Relay=VALUE 1 AND VALUE 2:** If both value registers are TRUE then the relay contact will close. Otherwise it will open.

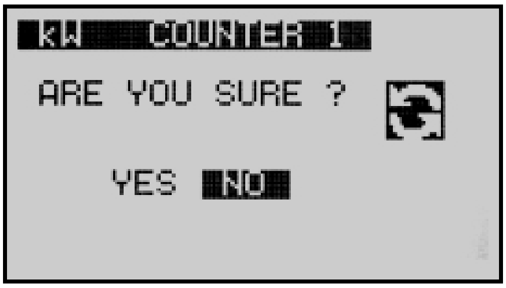
- **Relay = VALUE 1 NOR VALUE 2:** If at least one of value registers is TRUE then the relay contact will open. Otherwise it will close.
- **Relay = VALUE 1 NAND VALUE 2:** If both value registers are TRUE then the relay contact will open. Otherwise it will close.
- **Relay = V1 OR V2 OR V3 OR V4:** If at least one of value registers is TRUE then the relay contact will close. Otherwise it will open.
- **Relay = V1 NOR V2 NOR V3 NOR V4:** If at least one of value registers is TRUE then the relay contact will open. Otherwise it will close.
- **Relay = VALUE 1 OR (NOT VALUE 2):** If VALUE 1 is true or VALUE 2 is false then the relay contact will close. Otherwise it will open.
- **Relay = VALUE 1 AND (NOT VALUE 2):** If VALUE 1 is true and VALUE 2 is false then the relay contact will close. Otherwise it will open.
- **Relay = VALUE 1 NOR (NOT VALUE 2):** If VALUE 1 is true or VALUE 2 is false then the relay contact will open. Otherwise it will close.
- **Relay = VALUE 1 NAND (NOT VALUE 2):** If VALUE 1 is true and VALUE 2 is false then the relay contact will open. Otherwise it will close.

A “delay before response can be set for relays. The screen below will be displayed after first two steps. Set the required delay time here.

8.13 RESETTING A COUNTER

The unit offers 2 sets of active and reactive power counters together with 4 user counters. Counters can be reset via the configuration menu whenever required.

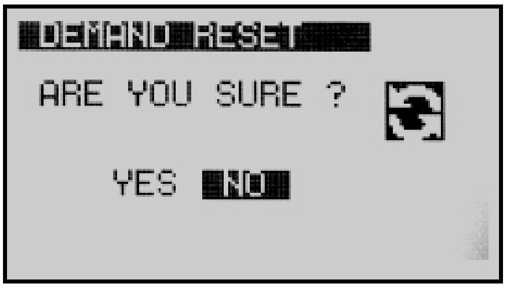
Select “**CLEAR COUNTERS**” on “**CONFIGURATION MENU**”. From the list select the counter required to be reset.



A confirmation screen will appear. Selecting “**YES**” option on this screen will reset the counter and return to “**CONFIGURATION MENU**”.

Counter value cannot be restored.

8.14 RESETTING DEMAND VALUES



The unit always stores the maximum values of both current inputs (I1-I2-I3) and the total active power (∑P).
These values are visualized on **Display page 10.**

The user can reset these values and restart the monitoring via “**DEMAND RESET**” menu.

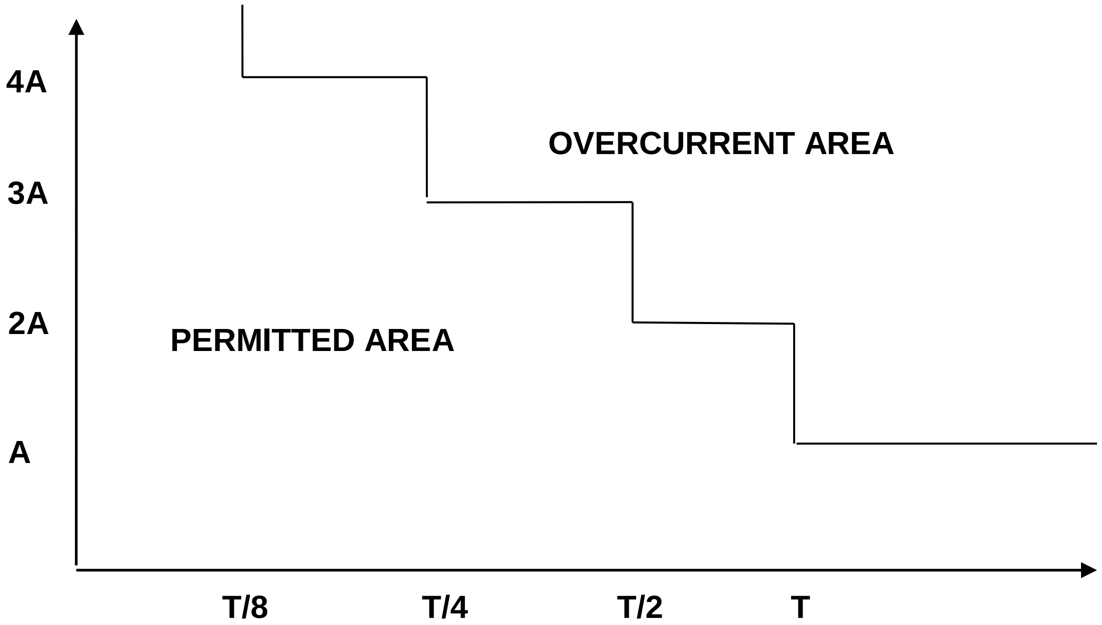
Select “**DEMAND RESET**” on “**CONFIGURATION MENU**”. Then select “YES” and press 

to reset demand values and return to the “**CONFIGURATION MENU**” .

8.15 OVERCURRENT DETECTOR CONFIGURATION

The “OVERCURRENT” function is used in order to generate a protection relay output when any of the phase currents exceeds the preset value for “TIMEOUT” duration.

The response time depends on the overcurrent rate as shown on below graph.

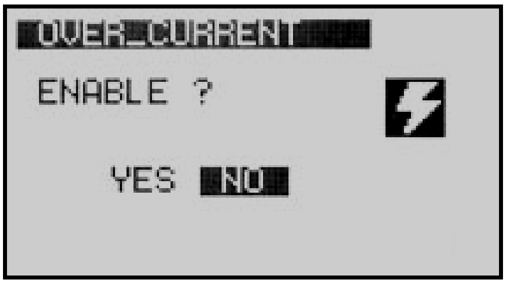


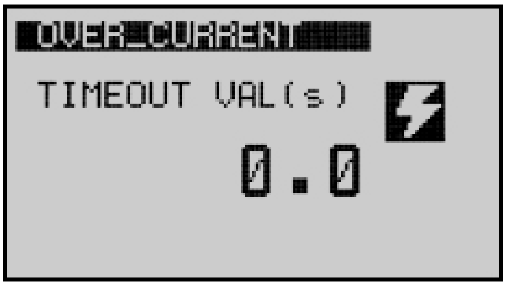
A: Over current value
T: Timeout value

The fastest detection time is 500 milliseconds.

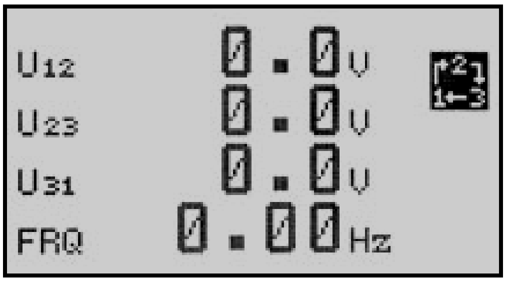
The overcurrent function will be assigned to a relay output.

When overcurrent function is assigned to a relay, then other configurations for that relay is discarded.



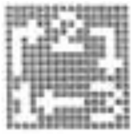


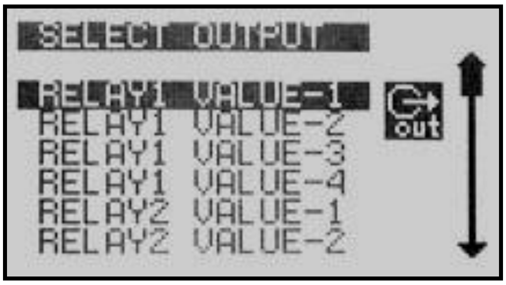
8.16 PHASE SEQUENCE FAILURE



The unit checks continuously the sequence of AC phase voltages.

If voltages are in the correct sequence, below symbol appears on voltage display pages, namely pages 2 and 3.





If voltages are in wrong order, the symbol disappears.

The effect of phase sequence failure is configurable. It can be:

- assigned to a relay’s value register
- a visual warning
- nothing (no effect).

Select “**PHASE SEQUENCE**” on “**CONFIGURATION MENU**”. Select action to take then press 
.

Note that PHASE SEQUENCE FAILURE may be combined with other conditions using VALUE registers. (see section **RELAY CONFIGURATION**)

8.17 RESETTING LOW/HIGH LIMITS

It is possible to clear every items low and high limit configurations.

For this select “**RESET ALL REFS**” on “**CONFIGURATION MENU**”. Select “YES” and then press 
 to clear all reference configurations and return to “**CONFIGURATION MENU**”.

8.18 RETURN TO FACTORY SETTINGS

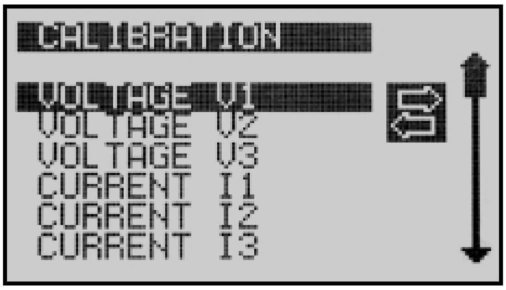
It is possible to reset the unit to factory settings, before starting a new configuration process.

For this select "**RETURN FACTORY**" on "**CONFIGURATION MENU**".

Then select "YES" and press to reset the unit to factory configuration and return to "**CONFIGURATION MENU**".

8.19 CALIBRATION

Calibration can be modified only with a special password.



CHANNEL MEASUREMENT

The unit is factory calibrated but it is possible to recalibrate it in order to obtain equal display values on different measuring instruments.

Select "**CALIBRATION** " on "**CONFIGURATION MENU**". Then select channel with and , and then press .

Then adjust the coefficient until required measured value is displayed on the bottom right of the screen then press to save the new calibration coefficient and return "**CONFIGURATION MENU**".

9. MODBUS COMMUNICATIONS

9.1 DESCRIPTION

The unit offers serial data communication port allowing it to be integrated in automation systems.

The serial port is of RS-485 MODBUS-RTU standard. It is fully isolated from power supply and measurement terminals for failure-free operation under harsh industrial conditions.

The MODBUS properties of the unit are:

- -Data transfer mode: RTU
- -Serial data: 9600 bps, 8 bit data, no parity, 1 bit stop
- -Supported functions:
  - -Function 3 (Read multiple registers)
  - -Function 6 (Write single register)
- -The answer to an incoming message is sent with a minimum of 4.3ms delay after message reception.

Each register consists of 2 bytes (16 bits). Larger data structure contain multiple registers.

Detailed description about the MODBUS protocol is found in the document "**Modicon Modbus Protocol Reference Guide"**. This document may be downloaded at: www.modbus.org/docs/PI_MBUS_300.pdf

Data Reading

The function 03 (read multiple registers) will be used for data reading. The MODBUS master will send a query. The answer will be one of the below:

- -A response containing the requested data
- -An exceptional response indicating a read error.

The maximum number of registers read in one message is 123. If more registers are requested, the unit will send only the first 123 registers.

The query message specifies the starting register and quantity of registers to be read. The message structure is below:

Byte	Description	Value
0	Controller address	1 to 253
1	Function code	3
2	Starting address high	See below the description of available registers
3	Starting address low	
4	Number of registers high	always 0
5	Number of registers low	max 7Bh (123 decimal)
6	CRC low byte	See below for the checksum calculation
7	CRC high byte	

Here is the sequence to read 16 registers starting from address 20h (32 decimal):
01 03 00 20 00 10 45 CC (each byte is expressed as 2 hexadecimal characters)

The checksum value in the above message may be used for the verification of checksum calculation algorithm.

The normal response will be:

Byte	Description	Value
0	Controller address	same as in the query
1	Function code	3
2	Data lenght in **bytes** (L)	number of registers * 2
3	High byte of 1st register	
4	Low byte of 1st register	
5	High byte of 2nd register	
6	Low byte of 2nd register	
....		
L+1	High byte of the last register	
L+2	Low byte of the last register	
L+3	CRC low byte	See below for the checksum calculation
L+4	CRC high byte	

The exceptional response will be:

Byte	Description	Value
0	Controller address	same as in the query
1	Function code	131 (function code + 128)
2	Exception code	2 (illegal address)
3	CRC low byte	See below for the checksum calculation
4	CRC high byte	

Data Writing

The function 06 (write single register) is used for data writing. Only **one register** can be written at a time.

The MODBUS master will send a query containing data to be written. The answer will be one of the below:

-A normal response confirming successful write,
-An exceptional response indicating a write error.

Only some of the available registers are authorized to be written. An attempt to write a write protected register will result to the exceptional response.

The query message specifies the register address and data. The message structure is below:

Byte	Description	Value
0	Controller address	1 to 253
1	Function code	6
2	Register address high	See below the description of available registers
3	Register address low	
4	Data high byte	
5	Data low byte	
6	CRC low byte	See below for the checksum calculation
7	CRC high byte	

Here is the sequence to write the value 0010h to the register 40h (64 decimal):
01 06 00 40 00 10 89 D2 (each byte is expressed as 2 hexadecimal characters)

The checksum value in the above message may be used for the verification of checksum calculation algorithm

The normal response will be the same as the query:

Byte	Description	Value
0	Controller address	1 to 253
1	Function code	6
2	Register address high	See below the description of available registers
3	Register address low	
4	Data high byte	
5	Data low byte	
6	CRC low byte	See below for the checksum calculation
7	CRC high byte	

The exceptional response will be:

Byte	Description	Value
0	Controller address	same as in the query
1	Function code	134 (function code + 128)
2	Exception code	2 (illegal address) or 10 (write protection)
3	CRC low byte	See below for the checksum calculation
4	CRC high byte	

CRC calculation

Here is a procedure for generating a CRC:

1) Load a 16–bit register with FFFF hex (all 1's). Call this the CRC register.

2) Exclusive OR the first 8–bit byte of the message (the function code byte) with the low–order byte of the 16–bit CRC register, putting the result in the CRC register.

3) Shift the CRC register one bit to the right (toward the LSB), zero–filling the MSB. Extract and examine the LSB. The LSB is the least significant bit of the CRC **before** the shift operation.

4) If the LSB is 1: Exclusive OR the CRC register with the polynomial value A001 hex.

5) Repeat Steps 3 and 4 until 8 shifts have been performed. Thus, a complete 8–bit byte will be processed.

6) Repeat Steps 2 through 5 for the next 8–bit byte of the message. Continue doing this until all bytes have been processed.

7) The final contents of the CRC register is the CRC value.

8) Place the CRC into the message such that the low byte is transmitted first. The algorithm should give the correct CRC for below messages:

01 03 00 20 00 10 45 CC
01 06 00 40 00 10 89 D2

Error codes

Only 3 error codes are used:
01: illegal function code
02: illegal address
10: write protection (attempt to write a read_only register)

Data types

Each register consists of 16 bits (2 bytes)

If the data type is a byte, only the low byte will contain valid data. High byte is don't care.

For data type longer than 16 bits, consecutive registers are used. The least significant register comes first.

Register definitions

Write single register is only used for changing channel to calculate harmonics. Thus only register 1 is writable.

9.2 MODBUS REGISTERS

ADDRESS	NAME	DESCRIPTION	LENGTH	R/W	TYPE	X
40001	Channel	Channel for harmonic calculation	16 BIT	R/W	unsigned word	1
40002	1. Harmonic	1. harmonic of selected channel (%)	16 BIT	R-O	unsigned word	0.1
40003	3. Harmonic	3. harmonic of selected channel (%)	16 BIT	R-O	unsigned word	0.1
40004	5. Harmonic	5. harmonic of selected channel (%)	16 BIT	R-O	unsigned word	0.1
40005	7. Harmonic	7. harmonic of selected channel (%)	16 BIT	R-O	unsigned word	0.1
40006	9. Harmonic	9. harmonic of selected channel (%)	16 BIT	R-O	unsigned word	0.1
40007	11. Harmonic	11. harmonic of selected channel (%)	16 BIT	R-O	unsigned word	0.1
40008	13. Harmonic	13. harmonic of selected channel (%)	16 BIT	R-O	unsigned word	0.1
40009	15. Harmonic	15. harmonic of selected channel (%)	16 BIT	R-O	unsigned word	0.1
40010	17. Harmonic	17. harmonic of selected channel (%)	16 BIT	R-O	unsigned word	0.1
40011	19. Harmonic	19. harmonic of selected channel (%)	16 BIT	R-O	unsigned word	0.1
40012	21. Harmonic	21. harmonic of selected channel (%)	16 BIT	R-O	unsigned word	0.1
40013	23. Harmonic	23. harmonic of selected channel (%)	16 BIT	R-O	unsigned word	0.1
40014	25. Harmonic	25. harmonic of selected channel (%)	16 BIT	R-O	unsigned word	0.1
40015	27. Harmonic	27. harmonic of selected channel (%)	16 BIT	R-O	unsigned word	0.1
40016	29. Harmonic	29. harmonic of selected channel (%)	16 BIT	R-O	unsigned word	0.1
40017	31. Harmonic	31. harmonic of selected channel (%)	16 BIT	R-O	unsigned word	0.1
40018	Warnings [1]	Warnings Register 1 (See Warnings)	16 BIT	R-O	unsigned word	1
40019	Warnings [2]	Warnings Register 1 (See Warnings)	16 BIT	R-O	unsigned word	1
40020	Warnings [3]	Warnings Register 1 (See Warnings)	16 BIT	R-O	unsigned word	1
40021	Warnings [4]	Warnings Register 1 (See Warnings)	16 BIT	R-O	unsigned word	1
40022	Warnings [5]	Warnings Register 1 (See Warnings)	16 BIT	R-O	unsigned word	1

ADDRESS	NAME	DESCRIPTION	LENGTH	R/W	TYPE	X
40023 40024	V1 RMS	V1 phase to neutral voltage AC RMS value	32 BIT	R-O	unsigned long	0.1
40025 40026	V2 RMS	V2 phase to neutral voltage AC RMS value	32 BIT	R-O	unsigned long	0.1
40027 40028	V3 RMS	V3 phase to neutral voltage AC RMS value	32 BIT	R-O	unsigned long	0.1
40029 40030	I1 RMS	I1 current AC RMS value	32 BIT	R-O	unsigned long	0.1
40031 40032	I2 RMS	I2 current AC RMS value	32 BIT	R-O	unsigned long	0.1
40033 40034	I3 RMS	I3 current AC RMS value	32 BIT	R-O	unsigned long	0.1
40035 40036	V12 RMS	U12 phase to phase voltage AC RMS value	32 BIT	R-O	unsigned long	0.1
40037 40038	V23 RMS	U23 phase to phase voltage AC RMS value	32 BIT	R-O	unsigned long	0.1
40039 40040	V31 RMS	U31 phase to phase voltage AC RMS value	32 BIT	R-O	unsigned long	0.1
40041 40042	S1 Apparent Power	Phase 1 apparent power (kVA)	32 BIT	R-O	unsigned long	0.1
40043 40044	S2 Apparent Power	Phase 2 apparent power (kVA)	32 BIT	R-O	unsigned long	0.1
40045 40046	S3 Apparent Power	Phase 3 apparent power (kVA)	32 BIT	R-O	unsigned long	0.1
40047 40048	∑S Apparent Power	Total apparent power (kVA)	32 BIT	R-O	unsigned long	0.1
40049 40050	P1 Active Power	Phase 1 active power (kW)	32 BIT	R-O	signed long	0.1
40051 40052	Q1 Reactive Power	Phase 1 reactive power (kW)	32 BIT	R-O	signed long	0.1
40053 40054	P2 Active Power	Phase 2 active power (kW)	32 BIT	R-O	signed long	0.1
40055 40056	Q2 Reactive Power	Phase 2 reactive power (kW)	32 BIT	R-O	signed long	0.1
40057 40058	P3 Active Power	Phase 3 active power (kW)	32 BIT	R-O	signed long	0.1
40059 40060	Q3 Reactive Power	Phase 3 reactive power (kW)	32 BIT	R-O	signed long	0.1
40061 40062	∑P Active Power	Total active power (kW)	32 BIT	R-O	signed long	0.1

ADDRESS	NAME	DESCRIPTION	LENGTH	R/W	TYPE	X
40063 40064	∑Q Reactive Power	Total reactive power (kW)	32 BIT	R-O	signed long	0.1
40065	Cosф 1	Phase 1 power factor	16 BIT	R-O	signed word	0.001
40066	Cosф 2	Phase 2 power factor	16 BIT	R-O	signed word	0.001
40067	Cosф 3	Phase 3 power factor	16 BIT	R-O	signed word	0.001
40068	∑Cosф	Total power factor	16 BIT	R-O	signed word	0.001
40069	Frequency	Frequency	16 BIT	R-O	unsigned word	0.01
40070 40071	kW Counter 1	Active power counter 1	32 BIT	R-O	unsigned long	0.1
40072 40073	kVAr Counter 1	Reactive power counter 1	32 BIT	R-O	unsigned long	0.1
40074 40075	kW Counter 2	Active power counter 2	32 BIT	R-O	unsigned long	0.1
40076 40077	kVAr Counter 2	Reactive power counter 2	32 BIT	R-O	unsigned long	0.1
40078 40079	User Counter 1	User Counter 1	32 BIT	R-O	unsigned long	1
40080 40081	User Counter 2	User Counter 2	32 BIT	R-O	unsigned long	1
40082 40083	User Counter 3	User Counter 3	32 BIT	R-O	unsigned long	1
40084 40085	User Counter 4	User Counter 4	32 BIT	R-O	unsigned long	1
40086	THD	Total harmonic distortion of the selected channel	16 BIT	R-O	signed word	0.01
40087 40088	I1 MAX	Phase L1, max current in a month’s period.	32 BIT	R-O	unsigned long	0.1
40089 40090	I2 MAX	Phase L2, max current in a month’s period.	32 BIT	R-O	unsigned long	0.1
40091 40092	I3 MAX	Phase L3, max current in a month’s period.	32 BIT	R-O	unsigned long	0.1
40093 40094	P MAX	Max active power in a month’s period.	32 BIT	R-O	unsigned long	0.1
40095	Device type	The device will send 409	16 BIT	R-O	unsigned word	-
40096	Firmware version	Device firmware version	16 BIT	R-O	unsigned word	-
40097 40098	I1 MIN	Phase L1, min current in a month’s period.	32 BIT	R-O	unsigned long	0.1
40099 40100	I2 MIN	Phase L2, min current in a month’s period.	32 BIT	R-O	unsigned long	0.1
40101 40102	I3 MIN	Phase L3, min current in a month’s period.	32 BIT	R-O	unsigned long	0.1

9.3 WARNING REGISTERS

MODBUS warnings register section contains 5 x 16 bit registers, 80 bits in total.

First 40 bits indicate values below set limit, last 40 bits indicate values above set limits.

ADDRESS	REG. BIT	TOTAL BIT	DESCRIPTION
40018	0	0	Vx RMS value below the set value
	1	1	Ix RMS value below the set value
	2	2	Uxx RMS value below the set value
	3	3	V1 RMS value below the set value
	4	4	V2 RMS value below the set value
	5	5	V3 RMS value below the set value
	6	6	I1 RMS value below the set value
	7	7	I2 RMS value below the set value
	8	8	I3 RMS value below the set value
	9	9	U12 RMS value below the set value
	10	10	U23 RMS value below the set value
	11	11	U31 RMS value below the set value
	12	12	Phase 1 active power below the set value
	13	13	Phase 2 active power below the set value
	14	14	Phase 3 active power below the set value
	15	15	Phase 1 reactive power below the set value

ADDRESS	REG. BIT	TOTAL BIT	DESCRIPTION
40019	0	16	Phase 2 reactive power below the set value
	1	17	Phase 3 reactive power below the set value
	2	18	Phase 1 apparent power below the set value
	3	19	Phase 2 apparent power below the set value
	4	20	Phase 3 apparent power below the set value
	5	21	Total active power below the set value
	6	22	Total reactive power below the set value
	7	23	Total apparent power below the set value
	8	24	Phase 1 power factor below the set value
	9	25	Phase 2 power factor below the set value
	10	26	Phase 3 power factor below the set value
	11	27	Total power factor below the set value
	12	28	Frequency below the set value
	13	29	Active power counter 1 below the set value
	14	30	Reactive power counter 1 below the set value
	15	31	Active power counter 2 below the set value

ADDRESS	REG. BIT	TOTAL BIT	DESCRIPTION
40020	0	32	Reactive power counter 2 below the set value
	1	33	User counter 1 below the set value
	2	34	User counter 2 below the set value
	3	35	User counter 3 below the set value
	4	36	User counter 4 below the set value
	5	37	Reserved
	6	38	Reserved
	7	39	Reserved
	8	40	Vx RMS value above the set value
	9	41	Ix RMS value above the set value
	10	42	Uxx RMS value above the set value
	11	43	V1 RMS value above the set value
	12	44	V2 RMS value above the set value
	13	45	V3 RMS value above the set value
	14	46	I1 RMS value above the set value
	15	47	I2 RMS value above the set value

ADDRESS	REG. BIT	TOTAL BIT	DESCRIPTION
40021	0	48	I3 RMS value above the set value
	1	49	U12 RMS value above the set value
	2	50	U23 RMS value above the set value
	3	51	U31 RMS value above the set value
	4	52	Phase 1 active power above the set value
	5	53	Phase 2 active power above the set value
	6	54	Phase 3 active power above the set value
	7	55	Phase 1 reactive power above the set value
	8	56	Phase 2 reactive power above the set value
	9	57	Phase 3 reactive power above the set value
	10	58	Phase 1 apparent power above the set value
	11	59	Phase 2 apparent power above the set value
	12	60	Phase 3 apparent power above the set value
	13	61	Total active power above the set value
	14	62	Total reactive power above the set value
	15	63	Total apparent power above the set value

ADDRESS	REG. BIT	TOTAL BIT	DESCRIPTION
40022	0	64	Phase 1 power factor above the set value
	1	65	Phase 2 power factor above the set value
	2	66	Phase 3 power factor above the set value
	3	67	Total power factor above the set value
	4	68	Frequency above the set value
	5	69	Active power counter 1 above the set value
	6	70	Reactive power counter 1 above the set value
	7	71	Active power counter 2 above the set value
	8	72	Reactive power counter 2 above the set value
	9	73	User counter 1 above the set value
	10	74	User counter 2 above the set value
	11	75	User counter 3 above the set value
	12	76	User counter 4 above the set value
	13	77	Reserved
	14	78	Reserved
	15	79	Reserved

10. TECHNICAL SPECIFICATIONS

Power Supply Input: 170 - 275VAC, 50 - 60Hz nominal (± 10%)
Measurement Input Range:
Voltage inputs: 10 - 300 V AC (L-N)
20 - 520 V AC (L-L)
Current inputs: 0.2 – 5.5 A AC
Frequency: 30 - 100 Hz
Accuracy:
Voltage: 0.5%+1digit
Current: 0.5%+1 digit
Frequency: 0.5%+1 digit
Power(kW,kVAr): 1.0%+2digit
Power factor: 2.0%+2digit
Measurement Range:
CT range: 5/5A to 5000/5A
VT range: 1.0/1 to 5000.0/1
kW range: 1.0 kW to 50.0 MW
Power Consumption: < 4 VA
Voltage burden: < 0.1VA per phase
Current burden: < 1VA per phase
Relay Outputs: 5A @ 250VAC
Digital Inputs:
Active level: 5 to 30V-DC or AC
Min pulse duration: 250ms.
Isolation: 1000V AC, 1 minute
Serial Port:
Signal level: RS-485
Communication: Modbus RTU
Data Rate: 9600 bauds, no parity, 1 bit stop.
Isolation: 500V AC, 1minute
Serial port cable: 2 wires twisted, shielded cable. Max 60pF/meter
Operating Temperature: -20°C to +70°C (-4 to +158 °F).
Maximum humidity: 95% non-condensing.
Degree of Protection: IP 54 (Front Panel) , IP 30 (Back panel)
Enclosure: Non-flammable, ROHS compliant, ABS/PC (UL94-V0)
Installation: Flush mounting with rear retaining brackets
Dimensions: 102x102x53mm (WxHxD)
Panel Cutout: 92x92mm
Weight: 350 gr

EU Directives Conformity:
2006/95/EC (low voltage)
2004/108/EC (EMC)

Norms of reference:
EN 61010 (safety requirements)
EN 61326 (EMC requirements)

PACKAGING INFORMATION

Pieces per Package: 12 pieces
Package Size: 280 x 170 x 215mm (LxWxH)
Package Weight: 4.4 kg