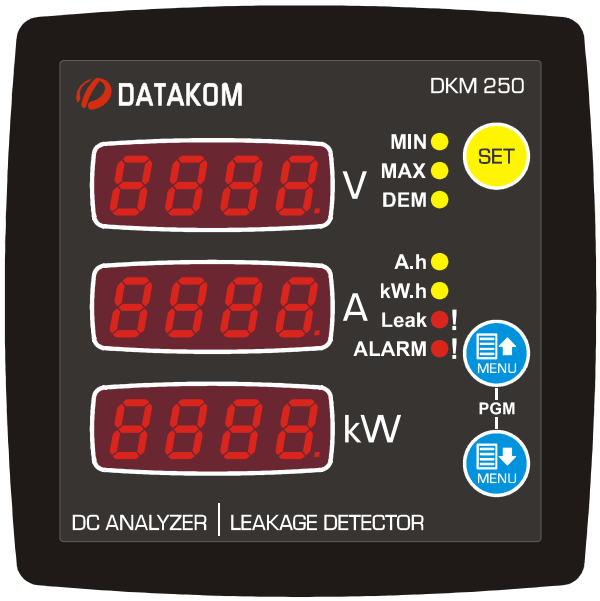
DATAKOM

DKM-250 DC ENERGY ANALYZER



DESCRIPTION

The DKM-250 is a precision instrument designed for measuring, displaying and remote monitoring earth leakage and various DC parameters in a DC distribution box.

The unit features a 32-bit ARM core microcontroller.

The unit is supplied from the measuring DC voltage input. Operating range is between 19 and 150VDC.

The current input of the unit is isolated from the rest of the circuit and has different circuit options:

- External current shunt (standard)
- Internal current shunt
- Hall Effect sensor input
- 4-20mA analog input

The unit has 2 digital inputs and 2 relay outputs, both of them programmable for required functions.

Thanks to its isolated RS-485 Modbus RTU comport, the device is free from ground potential difference issues and data are safely transferred to automation and monitoring systems. Program parameters may be uploaded to the unit through the RS-485 port.

The unit may output any measured value as analog signal through its 4-20mA port. This output allows easy connection to PLC systems.

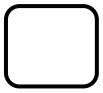
FEATURES

- ***Displays earth leakage in %***
- ***Various current input options***
- ***2 programmable relay outputs***
- ***2 programmable digital inputs***
- ***Programmable 4-20mA analog output***
- ***Demand, Min & Max records***
- ***Fully isolated RS-485 serial port***
- ***MODBUS-RTU communications***
- ***Bidirectional current & power measurement***
- ***Bidirectional kW-h energy counter***
- ***Bidirectional A-h counter***
- ***Hours run counter***
- ***Front panel programming***
- ***Wide operating temperature range***
- ***Sealed front panel (IP65 with gasket)***
- ***Two part connection system***

SAFETY NOTICE

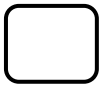
Failure to follow below instructions will result in death or serious injury

- **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 are no serviceable parts inside.**



- **Fuses must be connected to the power supply and voltage inputs, in close proximity of the unit.**

- **Fuses must be of fast type 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.**

- **Any electrical parameter applied to the device must be in the range specified in the user manual. Although the unit is designed with a wide safety margin, over-range parameters may reduce lifetime, alter operational precision or even damage the unit.**

- **Do not try to clean the device with solvent or the like. Only clean with a dump cloth.**

- **Verify correct terminal connections before applying power.**

- **Only for front panel mounting.**

TABLE OF CONTENTS

1. INSTALLATION INSTRUCTIONS

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 damage the enclosure.
- Make electrical connections with plugs removed from sockets, then place plugs to their sockets.
- Be sure that adequate cooling is provided.
- Be sure that the temperature of the environment will not exceed the maximum operating temperature in any case.
- Be sure that the unit is not subject to water spill.

Below conditions may damage the device:

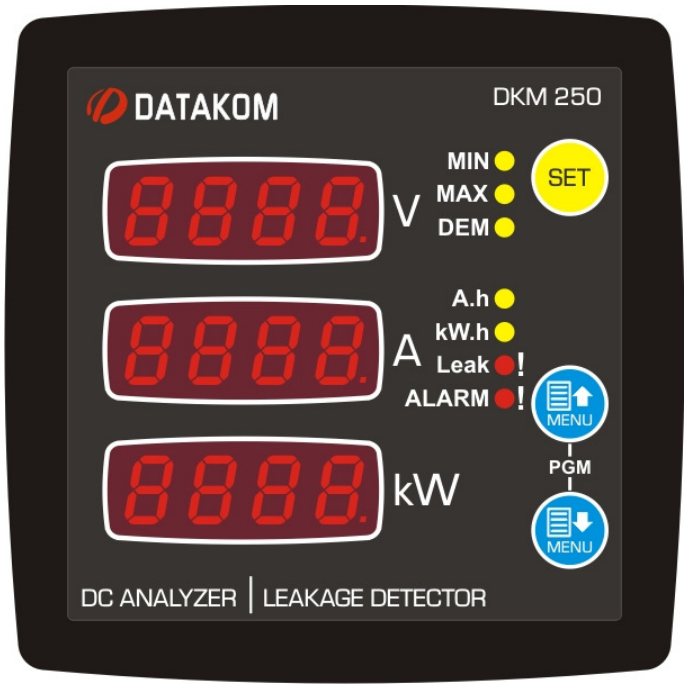
- Incorrect connections.
- Incorrect power supply voltage.
- Voltage at measuring terminals beyond specified range.
- Current at measuring terminals beyond specified range.
- Voltage applied to digital inputs over specified range.
- Overloading or short-circuiting relay outputs
- Connecting or removing data terminals when the unit is powered-up.
- High voltage applied to communication ports.
- Excessive vibration, direct installation on vibrating parts.

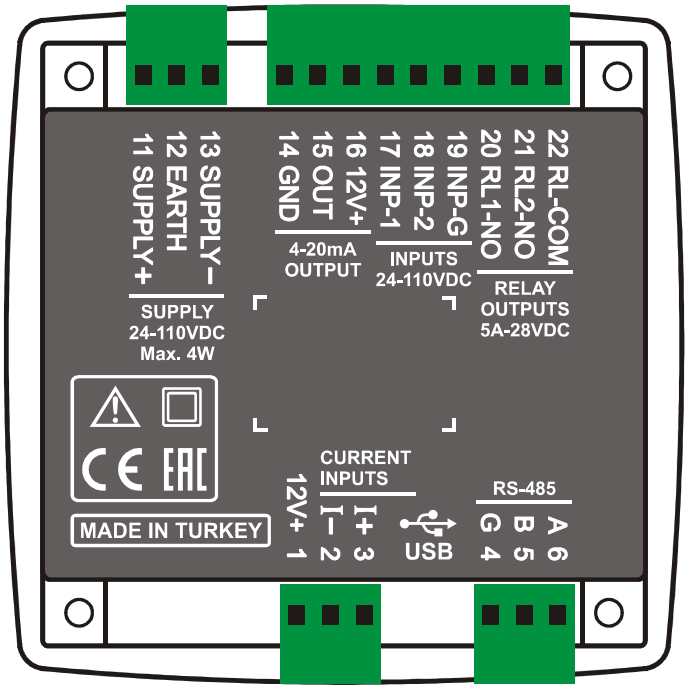
Current Shunt must be used for current measurement.
No direct connection allowed.

Below conditions may cause abnormal operation:

- Power supply voltage below minimum acceptable level.

1.1 FRONT AND BACK PANELS





1.2 ELECTRICAL INSTALLATION

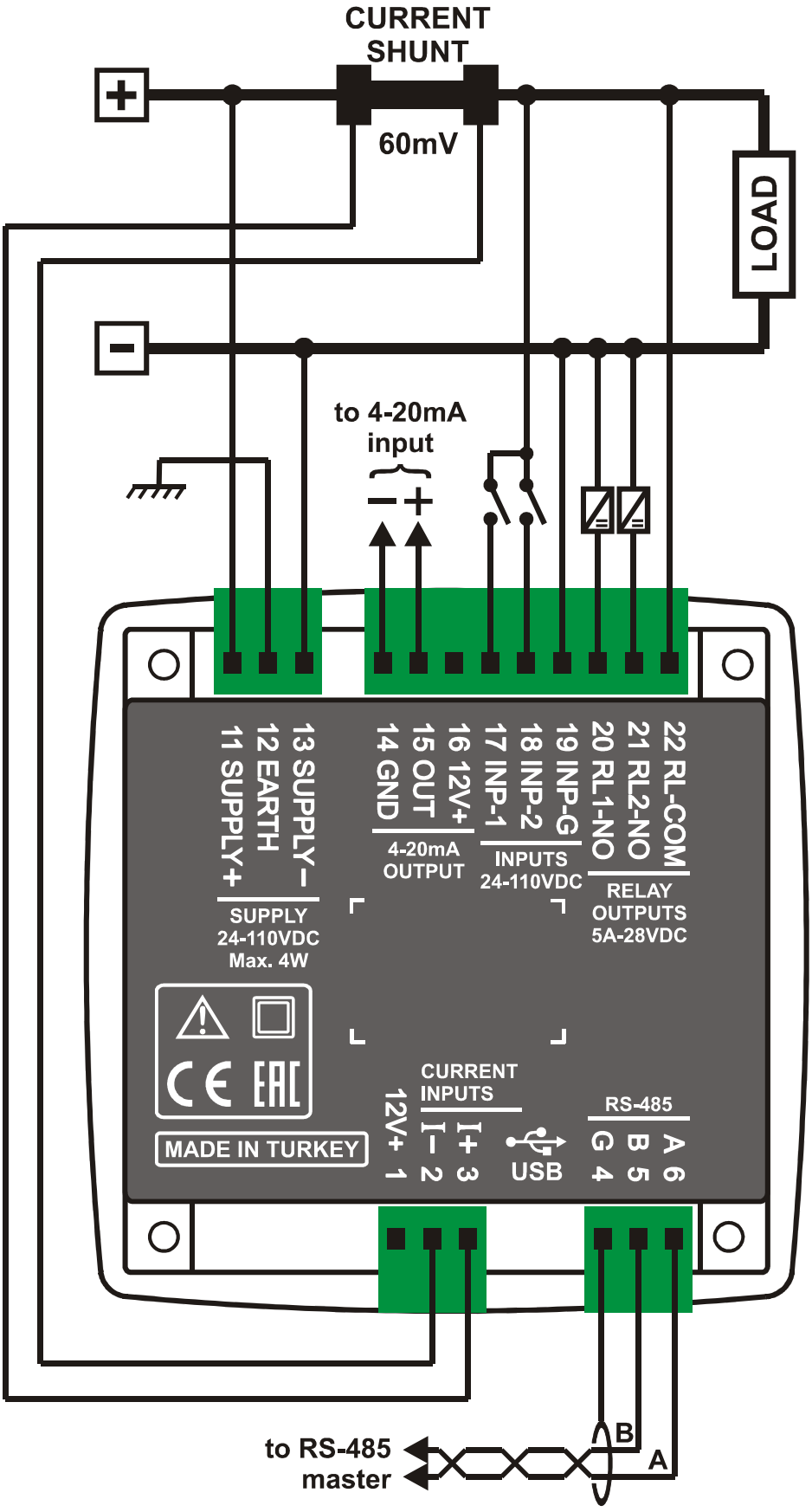
Do not install the unit close to high electromagnetic noise emitting devices like contactors, high current busbars, switchmode power supplies and the like.

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 voltage inputs, in close proximity of the unit.**
- **Fuses must be of fast type with a maximum rating of 6A.**
- **Use cables of appropriate temperature range.**
- **Use adequate cable section, at least 0.75mm^2 (AWG18).**
- **Follow national rules for electrical installation.**

Current Shunt must be used for current measurement.
No direct connection allowed.

1.3 INSTALLATION DIAGRAM

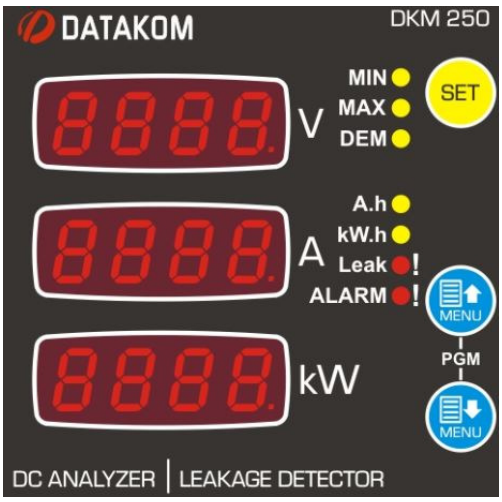


2. PUSHBUTTON FUNCTIONS

3 front panel buttons allow navigation between measurement and programming screens.

BUTTON	FUNCTION
	**If more than one active alarm exists, then display next alarm.** **HELD PRESSED FOR 2 SECONDS:** **Resets Min-Max values and alarms and displays the minimum values.** **PROGRAMMING: Save adjusted parameter and switch to the next parameter. If long-pressed then switch to previous parameter.**
	**Switch to the upper screen.** **PROGRAMMING: increase value**
	**Switch to the lower screen.** **PROGRAMMING: decrease value**
 	**HELD PRESSED TOGETHER FOR 2 SECONDS:** **Selects programming mode. If held pressed in programming mode, then returns to normal mode.**
	NO KEY PRESSED DURING 1 MINUTE: **Returns to the selected main display screen.**

3. SCREEN NAVIGATION



Buttons allow navigation between measurement values. The yellow led related to the currently displayed values will turn on. As an exception, if the total run hours is displayed, “Ah” and “kWh” leds will turn on.

In the occurrence of an alarm the red ALARM led turns on and the alarm is displayed on the screen.

If positive or negative earth leakage occurs, both LEAK and ALARM leds will turn on.

If Ah and kWh leds are off, the upper screen shows the voltage (in volts), the mid-screen shows the current (in amperes) and the lower screen shows the power (in kilowatts).

When no yellow led is on and the upper screen displays “EARH” and the middle screen displays “LEAK”, then the lower display will show the earth leakage in percent (%).

If no led is on then these are instantaneous measured values. The “MIN” led denotes minimum values, the “MAX” led denotes maximum values, the “DEM” led denotes demand values. If MAX and DEM leds are both on, the display shows maximum demand values.

Display of measured current: If the measured current value is below 100A, then it is displayed with 0.01A precision. Between 100A and 1000A it is displayed with 0.1A precision. Between 1000A and 10000A it is displayed with 1A precision. When read from Modbus, the current will have 0.01A precision.

Display of measured voltage: If the measured voltage value is below 100V then it is displayed with 0.01V precision. If the voltage is between 100V and 1000V it is displayed with 0.1V precision. Between 1000V and 10000V the voltage is displayed with 1 V precision. When read from Modbus, the voltage will have 0.01V precision.

Display of measured power: If the measured power is below 10kW then it is displayed with 0.001kW precision. Between 10kW and 100kW it is displayed with 0.01kW precision. Between 100kW and 1000kW it is displayed with 0.1kW precision. Between 1000kW and 10000kW it is displayed with 1kW precision. When read from Modbus, the power will have 0.001kW precision.

Display of earth leakage:

The measured earth leakage is displayed with 1% precision from both Modbus and the screen.

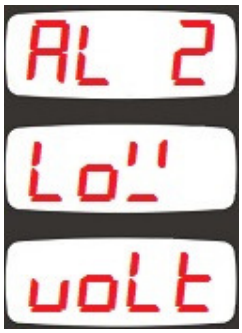
kWh counters display: kWh (energy) counters are always read (from both Modbus and screen) with 0.1kWh precision.

Ah counters display: Ah counters are always read (from both Modbus and screen) with 0.1Ah precision.

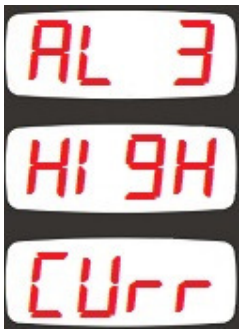
Total run hours display: Total run hours counters are always read (from both Modbus and screen) with 0.1hour precision.

Alarm display: When an alarm occurs, then the ALARM led will turn on and the display will show the alarm information every 2 seconds. If multiple alarms are present, other alarms may be displayed by pressing the SET pushbutton.

Alarm 1 : High Voltage Alarm

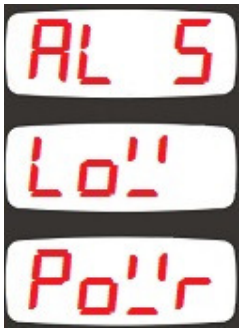


Alarm 2 : Low Voltage Alarm

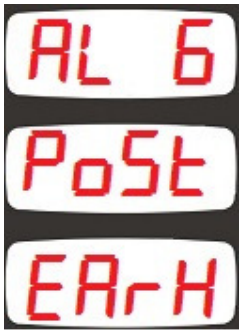


Alarm 3 : Excess Current Alarm

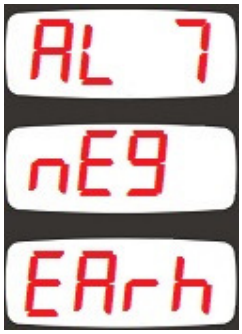
Alarm 4 : Excess Power (kW) Alarm



Alarm 5 : Low Power (kW) Alarm



Alarm 6 : Positive (+) earth leakage alarm



Alarm 7 : Negative (-) earth leakage alarm

4. PROGRAMMING

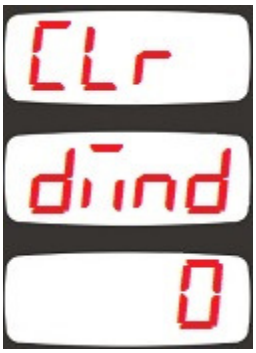
4.1 ENTERING THE PROGRAMMING MODE

In order to offer the maximum flexibility to the customer, the module has several programmable parameters.

- **Device configurations**
  - Default screen configuration
- **Measurement configurations**
  - Demand reset
  - Counter reset
  - Alarm reset
- **Current shunt configuration**
- **Alarm high/low limit adjustments**
- **Input/Output Configurations**
  - Alarm configuration
  - Modbus Codbus configuration
- **Unit Calibration**

	**In order to enable the programming menu, hold both MENU buttons pressed for 2 seconds.**
	**In order to exit programming menu, hold both MENU buttons pressed for 2 seconds.** **If no button is pressed during 1 minute, then the unit will automatically close the programming mode.**
	**Parameter values are modified with UP and DOWN Menu buttons. If the button is held pressed, the the value will change with larger steps.**
	**When SET button is pressed, the value on the screen is recorded and the next parameter is displayed.**
	**If the SET button is held pressed for 2 seconds, then the previous parameter is displayed.**

4.2 RESETTING DEMANDS

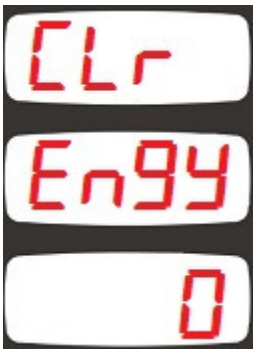


Parameter value
0: No operation
1: Reset demand counters

Setting this parameter to 1 causes demand and max_demand values to be reset.

The parameter value is not saved and always reads 0.

4.3 RESETTING ENERGY COUNTERS

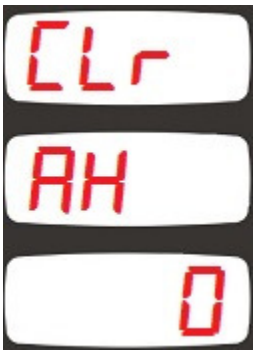


Parameter value
0: No operation
1: Reset kWh counters

Setting this parameter to 1 causes both positive and negative energy counters (kWh) values to be reset.

The parameter value is not saved and always reads 0.

4.4 RESETTING Ah (ampere*hour) COUNTERS

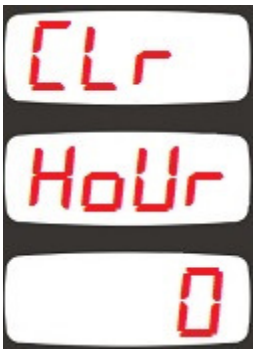


Parameter value
0: No operation
1: Reset Ah counters

Setting this parameter to 1 causes both positive and negative ampere*hour counters (Ah) values to be reset.

The parameter value is not saved and always reads 0.

4.5 RESETTING RUN HOURS

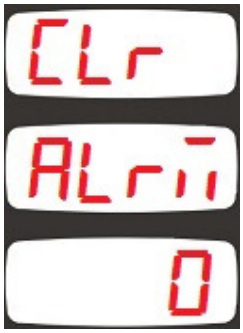


Parameter value
0: No operation
1: Reset hour counter

Setting this parameter to 1 causes the run hour counter to be reset.

The parameter value is not saved and always reads 0.

4.6 RESETTING ALARMS



Parameter value
0: No operation
1: Reset alarms

Setting this parameter to 1 causes alarms to be reset.

The parameter value is not saved and always reads 0.

4.7 ADJUSTING CURRENT MEASUREMENT INPUT

This parameter adjusts the rated value of the current shunt in amperes.

The factory set value is 40.0A

Adjustement range is between 0.1 and 3200amperes

This parameter adjusts the rated voltage of the current shunt in volts.

The factory set value is 0.060V

Adjustement range is between 0.001 and 0.100volts.

4.8 ADJUSTING CURRENT HIGH LIMIT

This parameter adjusts the overcurrent limit.

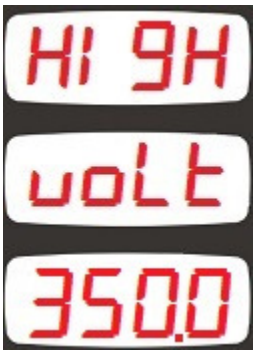
Positive and negative currents are monitored for their absolute value and the alarm occurs for any direction of the current.

If this parameter is adjusted to 3200 (dI SbE ,DISB) then the overcurrent limit is not monitored and the overcurrent alarm does not occur.

Factory set value is 3200A

Adjustment range is between 0.1A and 3200A

4.9 ADJUSTING VOLTAGE LOW AND HIGH LIMITS

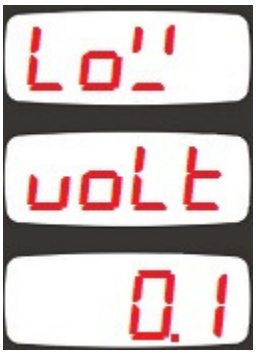


This parameter adjusts the upper limit of the high voltage alarm.

If this parameter is set to 400.0 (dI 5b ,DISB) then high voltage is not monitored and no alarm occurs.

Factory set value is 400.0V

Adjustment range is between 0.1 and 400.0V



This parameter adjusts the lower limit of the low voltage alarm.

If this parameter is set to 0.0 (dI 5b ,DISB) then low voltage is not monitored and no alarm occurs.

Factory set value is 0.0V

Adjustment range is between 0.0 and 300.0V

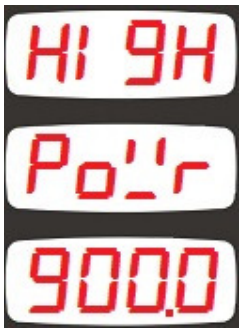
4.10 SELECTING VOLTAGE MEASUREMENT INPUT

This parameter selects the voltage threshold where the voltage measurement switches from the sensitive range normal range.

Factory set value is 70.0V.

Adjustment range is between 0.00V and 70.00V.

4.11 ADJUSTING LOW AND HIGH POWER LIMITS

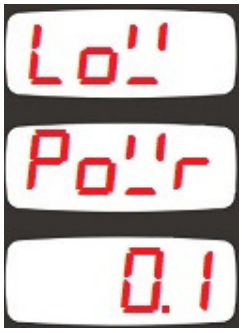


This parameter adjusts the upper limit of the high power alarm. Positive and negative powers are monitored for their absolute value and the alarm occurs for any direction of the power flow.

If this parameter is set to 0.0 then high power is not monitored and no alarm occurs.

Factory set value is 0.0kW

Adjustment range is between 0.0 and 3200.0kW



This parameter adjusts the lower limit of the low power alarm. Positive and negative powers are monitored for their absolute value and the alarm occurs for any direction of the power flow.

If this parameter is set to 0.0 then high power is not monitored and no alarm occurs.

Factory set value is 0.0kW

Adjustment range is between 0.0 and 3200.0kW

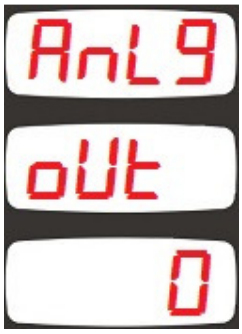
4.12 ADJUSTING THE DEMAND PERIOD

This parameter determines the demand period for voltage, current and power measurements. The average value is calculated during the demand period and at the end of the period new demand values overwrite older values.

Factory set value is 15 minutes.

Adjustment range is 1 to 240 minutes.

4.13 ADJUSTING THE 4-20mA ANALOG OUTPUT

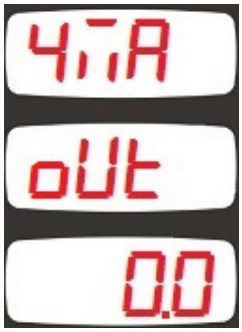


This parameter determines the analog value to be output from the 4-20mA analog output.

Factory set value is 0.

Adjustment range is 0 to 22.

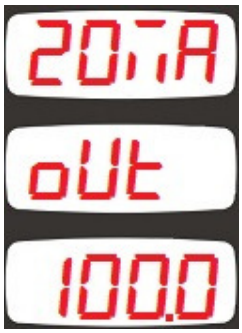
Parameter value	Measurement at output
0	Instantaneous voltage (V)
1	Instantaneous current (A)
2	Instantaneous power (kW)
3	Current demand (absolute value)
4	Current demand (positive direction)
5	Current demand (negative direction)
6	Power demand (positive direction)
7	Power demand (negative direction)
8	Maximum Voltage Demand
9	Maximum current demand (positive direction)
10	Maximum current demand (negative direction)
11	Maximum power demand (positive direction)
12	Maximum power demand (negative direction)
13	Maximum Voltage
14	Minimum Voltage
15	Maximum current (positive direction)
16	Minimum current (positive direction)
17	Maximum power (positive direction)
18	Minimum power (positive direction)
19	Maximum current (negative direction)
20	Minimum current (negative direction)
21	Maximum power (negative direction)
22	Minimum power (negative direction)
23	Earth leakage percent (%)



This parameter defines the value corresponding to 4mA current output. (low limit)

Factory set value is 0.

Adjustment range is between -999.9 and 3000.0

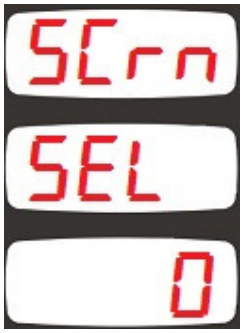


This parameter defines the value corresponding to 20mA current output. (high limit)

Factory set value is 100.0.

Adjustment range is between -999.9 and 3200.0

4.14 SELECTING THE DEFAULT SCREEN



This parameter selects the screen menu where the unit returns when no pushbutton is pressed during 5 minutes.

It also determines the screen that comes when the programming mode is closed.

Factory set value is 0.

Adjustment range is 0 to 13.

Parameter valuei	Display menu
0	Instantaneous measurements
1	Earth leakage percent (%)
2	Ah counter (positive direction)
3	Ah counter (negative direction)
4	kWh counter (positive direction)
5	kWh counter (negative direction)
6	Total run hour counter
7	Minimum values (positive direction)
8	Minimum values (negative direction)
9	Maximum values (positive direction)
10	Maximum values (negative direction)
11	Demand values (positive direction)
12	Demand values (negative direction)
13	Max demand values (positive direction)
14	Max demand values (negative direction)

4.15 ALARM CONFIGURATION

This parameter determines the delay between an alarm condition occurs and the alarm given.

Factory set value is 0.

Adjustment range is 0 to 255 seconds.

0: Alarm lock disabled

1: Alarm lock enabled

When this parameter is set to 1, even if the alarm cause is removed, alarms will persist until manually reset.

When this parameter is set to 0, when the alarm cause is removed, alarms automatically disappear.

Factory set value is 0.

Adjustment range is 0 to 1.

4.16 MODBUS PARAMETERS

This parameter determines the Modbus node address of the unit. Every unit in the same Modbus loop must have a different node address.

Factory set value is 1.

Adjustment range is 0 to 245.

This parameter determines the data rate (baud rate) used in the Modbus communication. Every unit in the same Modbus loop must use the same data rate.

0: Baud rate = 2400

1: Baud rate = 4800

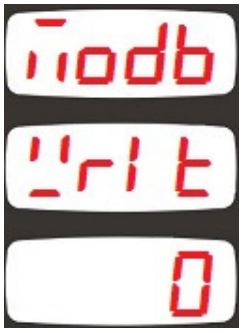
2: Baud rate = 9600

3: Baud rate = 19200

4: Baud rate = 38400

Factory set value is 2.

Adjustment range is 0 to 4.



If this parameter is set to a value different from 0, then the unit will require this parameter as a password prior to Modbus writes or Modbus commands.

If the parameter is set to 0 then no password is required.

Factory set value is 0.

Adjustment range is 0 to 9999.

4.17 ADJUSTING LOW AND HIGH EARTH LEAKAGE LIMITS

This parameter adjusts the upper limit of the ratio of the earth voltage to supply voltage.

The factory set value is 70%.

Adjustment range is 0 to 100%

This parameter adjusts the lower limit of the ratio of the earth voltage to supply voltage.

The factory set value is 30%.

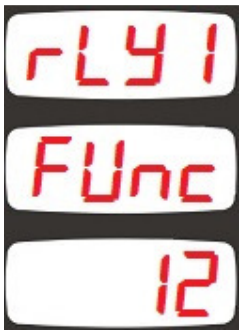
Adjustment range is 0 to 100%

4.18 PROGRAMMABLE RELAY SETUP

This is the wait delay between the conditions that will activate the relay occur and the relay is activated.

The factory set value is 0.

Adjustment range is 0 to 255 seconds.



This parameter selects the RELAY_1 function.

The factory set value is 12.

Adjustment range is 0 to 17

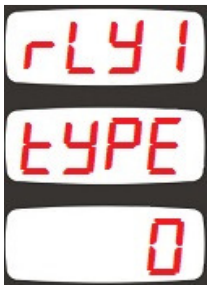
This parameter selects the RELAY_2 function.

The factory set value is 13.

Adjustment range is 0 to 17

Relay function is selected from below list:

Value	Relay function
0	-
1	High voltage alarm
2	Low voltage alarm
3	High current alarm
4	High power (kW) alarm
5	Low power (kW) alarm
6	Positive (+) earth leakage alarm
7	Negative (+) earth leakage alarm
8	Active if any alarm occurs
9	Low or high voltage alarm
10	Low or high power (kW) alarm
11	Positive (+) or negative (-) earth leakage alarm
12	Follows the digital input_1
13	Follows the digital input_2
14	kWh, Ah or hour pulse
15	If the value 1234 is written to Modbus address 35 then the function is active
16	If the value 1234 is written to Modbus address 36 then the function is active
17	-



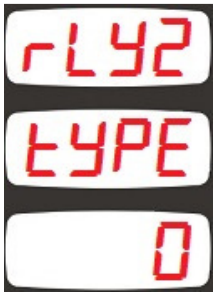
This parameter determines the RELAY_1 contact type.

0: Normally open (NO)

1: Normally closed (NC)

The factory set value is 0.

Adjustment range is 0 to 1.



This parameter determines the RELAY_2 contact type.

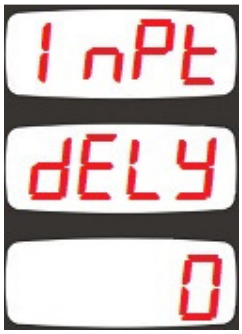
0: Normally open (NO)

1: Normally closed (NC)

The factory set value is 0.

Adjustment range is 0 to 1.

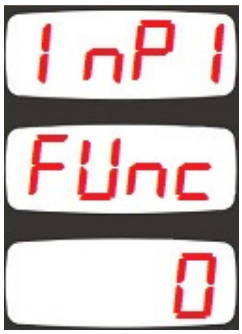
4.19 PROGRAMMABLE DIGITAL INPUT SETUP



This parameter determines the wait delay between the digital input signal and the activation of input function.

The factory set value is 0.

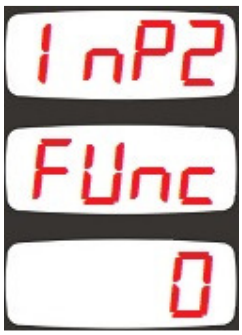
Adjustment range is 0 to 80 seconds.



This parameter selects the function performed when the digital input_1 signal is active.

The factory set value is 0.

Adjustment range is 0 to 11.



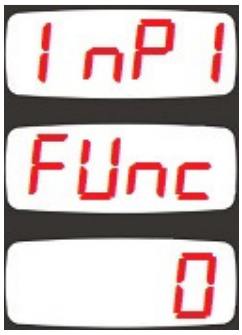
This parameter selects the function performed when the digital input_2 signal is active.

The factory set value is 0.

Adjustment range is 0 to 11.

Digital input functions are selected from below list:

Value	Function when signal is active	Function when signal is passive
0	-	-
1	kWh and Ah counters operate	kWh and Ah counters are stopped
2	When signal is activated, kWh and Ah counters are reset, then they start counting	kWh and Ah counters are stopped
3	kWh, Ah and hours-run counters operate	kWh, Ah and hours-run counters are stopped
4	When signal is activated, kWh, Ah and hours-run counters are reset, then they start counting	kWh, Ah and hours-run counters are stopped
5	hours-run counter operates	hours-run counter is stopped
6	When signal is activated, the hours-run counter is reset, then it starts counting	hours-run counter is stopped
7	When signal is activated, kWh and Ah counters are reset	-
8	When signal is activated, The hours-run counter is reset	-
9	When signal is activated, kWh and Ah counters are reset	-
10	Alarms are reset	-
11	When signal is active, displays turn off	Displays operate normally



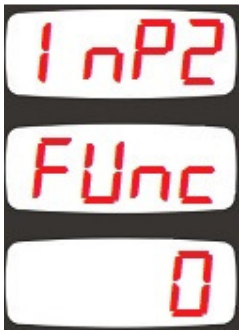
This parameter selects when the input function is activated for the digital input_1.

0: active when signal present

1: active when signal is absent

The signal is applied to digital inputs with the polarity shown in the installation diagram.

The factory set value is 0.



This parameter selects when the input function is activated for the digital input_2.

0: active when signal present

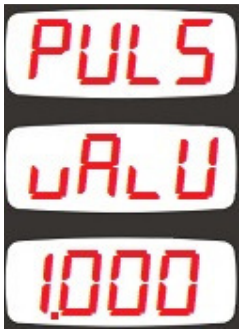
1: active when signal is absent

The signal is applied to digital inputs with the polarity shown in the installation diagram.

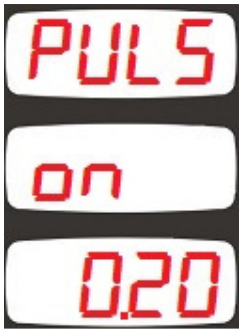
The factory set value is 0.

4.20 OUTPUT PULSE (kWh, Ah, hour) SETUP

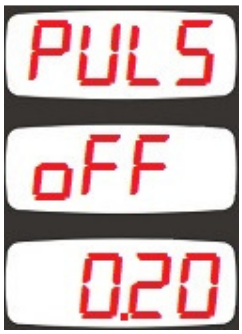
If any of relay functions (explained in chapter 4.17) is set to 14 (kWh, Ah or hour-run pulse), then below parameters will determine the pulse charateristics.



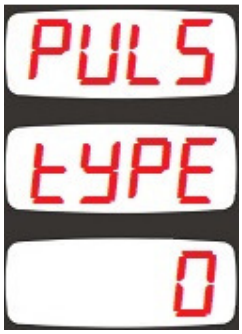
This parameter defines the counter increment step to provide 1 pulse.
The factory set value is 1.000 kWh or Ah or hour.
Adjustement range is 0.001 to 10.000



This parameter defines the active pulse duration in seconds.
The factory set value is 0.20 second (200 ms).
Adjustment range is 0.10 to 9.99 seconds.
WARNING: Excessive pulse duration may cause a missing pulse.

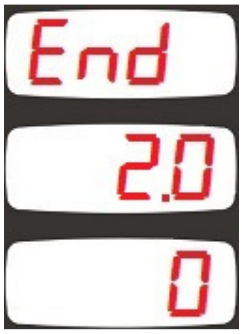


This parameter defines the minimum duration between 2 pulses.
The factory set value is 0.20 second (200 ms).
Adjustment range is 0.10 to 9.99 seconds.
WARNING: Excessive duration may cause a missing pulse.



This parameter determines the counter providing pulses.
0: Positive direction kWh counter
1: Negative direction kWh counter
2: Positive direction Ah counter
3: Negative direction Ah counter
4: Total hours-run counter
The factory set value is 0.
Adjustment range is 0 to 4 seconds.

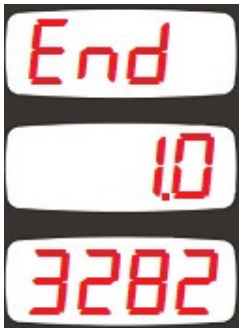
4.21 DISPLAYING THE FIRMWARE VERSION



The firmware version is displayed in te second line of the "End , End" screen.

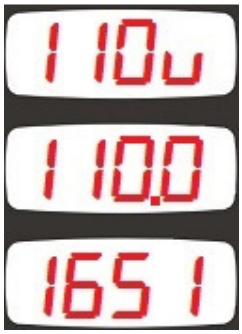
Any inquiry to the manufacturer must state the firmware version in question.

4.22 CALIBRATION



The unit leaves the production in a calibrated status.

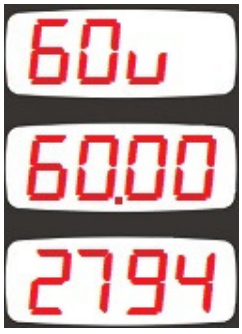
If recalibration is required, enter the password "3282" to the third line of the "End , End" screen and press the SET button.



The calibration screen about the 110V voltage input will be seen. The first display will show "110V". The second screen will display the measured instantaneous voltage from the input. The third display will display the calibration coefficient (high 4 digits only)

Adjust UP and DOWN menu buttons until the value displayed in the second screen is correct.

When the value is correct then press SET button. The unit will switch to 60V voltage input calibration.



In 60V input calibration mode, the first display will show "60V". The second screen will display the measured instantaneous voltage from the input. The third display will display the calibration coefficient (high 4 digits only)

Adjust UP and DOWN menu buttons until the value displayed in the second screen is correct.

When the value is correct then press SET button. The unit will switch to first current input zero point calibration.

WARNING: The supply voltage should not exceed 70VDC.

In the first current input zero mode, the first display will show “1CRZ”. The second screen will display the measured instantaneous current from the input. The third display will display the offset value causing display 00.00 at no current.

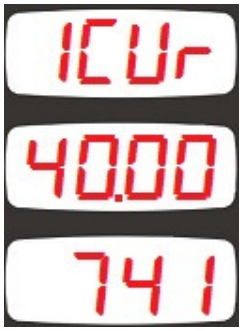
Adjust UP and DOWN menu buttons until the value displayed in the second screen is correct.

When the value is correct then press SET button. The unit will switch to second current input zero point calibration.

In the second current input zero mode, the first display will show “2CRZ”. The second screen will display the measured instantaneous current from the input. The third display will display the offset value causing display 00.00 at no current.

Adjust UP and DOWN menu buttons until the value displayed in the second screen is correct.

When the value is correct then press SET button. The unit will switch to first current input sensitivity calibration.

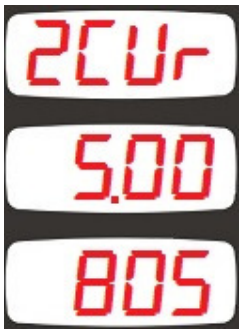


In the first current input sensitivity calibration mode, the first display will show “1CUR”. The second screen will display the measured instantaneous current from the input. The third display will display the calibration coefficient (high 4 digits only)

Adjust UP and DOWN menu buttons until the value displayed in the second screen is correct.

When the value is correct then press SET button. The unit will switch to second current input sensitivity calibration.

The second current input is internal and makes a more precise measurement in low currents. The switching between two internal inputs is automatic. Between -10mV and +10mV the sensitive input is used. Above this signal amplitude the normal input is active.



In the second current input sensitivity calibration mode, the first display will show “2CUR”. The second screen will display the measured instantaneous current from the input. The third display will display the calibration coefficient (high 4 digits only)

Adjust UP and DOWN menu buttons until the value displayed in the second screen is correct.

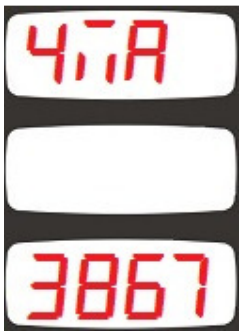
When the value is correct then press SET button. The unit will switch to Vin voltage calibration.

Vin voltage is generated internally and used to check that the internal power supply is operating.

In Vin calibration mode, the first display will show “vIn”. The second screen will display the measured instantaneous Vin voltage. The third display will display the calibration coefficient (high 4 digits only)

Adjust UP and DOWN menu buttons until the value displayed in the second screen is correct. In normal operation Vin should be 17.80volts.

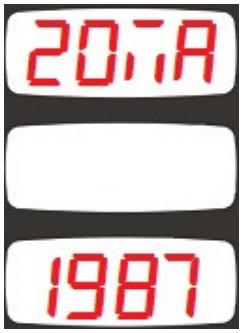
When the value is correct then press SET button. The unit will switch to 4mA calibration of the 4-20mA output.



In 4mA calibration mode, the first display will show “4mA”. The second display is blank. The third display will show the calibration coefficient necessary to send 4mA from the analog output.

Measure the analog output with a precision ampermeter. Adjust UP and DOWN menu buttons until the value displayed in the ampermeter is 4.00mA.

When the value is correct then press SET button. The unit will switch to 20mA calibration of the 4-20mA output.



In 20mA calibration mode, the first display will show “20mA”. The second display is blank. The third display will show the calibration coefficient necessary to send 20mA from the analog output.

Measure the analog output with a precision ampermeter. Adjust UP and DOWN menu buttons until the value displayed in the ampermeter is 20.00mA.

When the value is correct then press SET button.

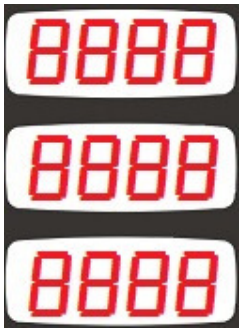
In earth voltage calibration mode, the first display will show “EarH”. The second display shows the instantaneous voltage measured at the EARTH input. The third display shows the calibration coefficient.

If no earth leakage is present (input open) then half the supply voltage should be measured. Adjust UP and DOWN menu buttons until the value displayed in half the supply voltage.

When the value is correct then press SET button.

As this is the last calibration parameter, the display will switch to the first calibration parameter, which is 110V voltage input calibration.

4.23 LAMP TEST



When programming is over, hold pressed UP and DOWN MENU buttons for 2 seconds.

The unit will exit program mode and will turn on all lights for lamp testing purpose.

Check that all lights are on.

Press any button to resume normal operation.

5. MODBUS COMMUNICATIONS

5.1. 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: 2400-38400 bps, 8 bit data, no parity, 1 bit stop
-Supported functions:
-Function 3 (Read multiple registers)
-Function 6 (Write single register)
-Function 10 (Write multiple 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: http://www.modbus.org/specs.php

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 120. If more registers are requested, the unit will send only the first 120 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 254
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 78h (120 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) or function 10h (write multiple registers) is used for data writing. A maximum of 32 registers 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 254
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 254
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.

5.2. COMMANDS

Commands to the unit are written to below addresses.

If the Modbus Write Password parameter **("Modb Writ")** is left 0 as in the factory settings, then the unit will not ask any password for Modbus commands and Modbus writes.

If the Modbus Write Password parameter **("Modb Writ")** is set to a value other than 0, then the unit will require a password for commands and data writes.

If the value recorded as Modbus Write Password parameter **("Modb Writ")** or 3271 is written to the address 7168, then during next 10 minutes, Modbus area can be written and below commands can be executed. All commands (other than the password) may be activated by writing a value other than zero to the related register.

ADRESS	NAME	DESCRIPTION	LENGTH	R/W	DATA TYPE	COEFF
7168	Password	Programming password	16 BIT	W-O	unsigned word	1
7169	Reset demand	Reset all demand registers	16 BIT	W-O	unsigned word	1
7170	Reset kWh	Reset all kWh counters	16 BIT	W-O	unsigned word	1
7171	Reset Ah	Reset all Ah counters	16 BIT	W-O	unsigned word	1
7172	Reset hour	Reset run counter	16 BIT	W-O	unsigned word	1
7173	Reset alarm	Reset all alarms	16 BIT	W-O	unsigned word	1
7174	Reset Min-Max	Reset all min and max values	16 BIT	W-O	unsigned word	1
7175	Factory set	Return to factory settings	16 BIT	W-O	unsigned word	1
7176	Boot mode	The unit switches to the boot mode for firmware download through USB.	16 BIT	W-O	unsigned word	1

5.3. PROGRAM PARAMETERS

Program parameters of the unit may be read from below registers or program parameters may be set by writing to these registers.

ADRESS	NAME	DESCRIPTION	DIMENS	R/W	DATA TYPE	COEFF
01	Shunt max current	Explained ch 4.7	16 BIT	R/W	signed word	0.1
02	Shunt max voltage	Explained ch 4.7	16 BIT	R/W	signed word	0.001
03	Overcurrent limit	Explained ch 4.8	16 BIT	R/W	signed word	0.1
04	Voltage high limit	Explained ch 4.9	16 BIT	R/W	signed word	0.1
05	Voltage low limit	Explained ch 4.9	16 BIT	R/W	signed word	0.1
06	Voltage input selection (60V or 400V)	Explained ch 4.10	16 BIT	R/W	signed word	1
07	Power high limit	Explained ch 4.11	16 BIT	R/W	signed word	0.1
08	Power low limit	Explained ch 4.11	16 BIT	R/W	signed word	0.1
09	Demand periode	Explained ch 4.12	16 BIT	R/W	signed word	1
10	4-20mA Analog out function selection	Explained ch 4.13	16 BIT	R/W	signed word	1
11	Analog out 4mA value	Explained ch 4.13	16 BIT	R/W	signed word	0.1
12	Analog out 20mA value	Explained ch 4.13	16 BIT	R/W	signed word	0.1
13	Default screen	Explained ch 4.14	16 BIT	R/W	signed word	1
14	Alarm delay	Explained ch 4.15	16 BIT	R/W	signed word	1
15	Alarm lock	Explained ch 4.15	16 BIT	R/W	signed word	1
16	Modbus node address	Explained ch 4.16	16 BIT	R/W	signed word	1
17	Modbus baudrate	Explained ch 4.16	16 BIT	R/W	signed word	1
18	Modbus password	Explained ch 4.16	16 BIT	R/W	signed word	1
19	Earth lekage % upper limit (%)	Explained ch 4.17	16 BIT	R/W	unsigned word	1
20	Earth lekage % lower limit (%)	Explained ch 4.17	16 BIT	R/W	unsigned word	1
21	Relay delay (sec)	Explained ch 4.18	16 BIT	R/W	unsigned word	1
22	Relay-1 function	Explained ch 4.18	16 BIT	R/W	unsigned word	1
23	Relay-1 type	Explained ch 4.18	16 BIT	R/W	unsigned word	1
24	Relay-2 function	Explained ch 4.18	16 BIT	R/W	unsigned word	1
25	Relay-2 type	Explained ch 4.18	16 BIT	R/W	unsigned word	1
26	Digital input delay	Explained ch 4.19	16 BIT	R/W	unsigned word	1
27	Digital input_1 function	Explained ch 4.19	16 BIT	R/W	unsigned word	1
28	Digital input_1 type	Explained ch 4.19	16 BIT	R/W	unsigned word	1
29	Digital input_2 function	Explained ch 4.19	16 BIT	R/W	unsigned word	1
30	Digital input_2 type	Explained ch 4.19	16 BIT	R/W	unsigned word	1

ADRESS	NAME	DESCRIPTION	DIMENS	R/W	DATA TYPE	COEFF
31	Counter increment for 1 pulse	Explained ch 4.20	16 BIT	R/W	unsigned word	0.001
32	Pulse duration (sec)	Explained ch 4.20	16 BIT	R/W	unsigned word	0.01
33	Min delay between pulses	Explained ch 4.20	16 BIT	R/W	unsigned word	0.01
34	Counter selection for pulses	Explained ch 4.20	16 BIT	R/W	unsigned word	1
35	Relay_1 control through Modbus	Explained in chapter 4.18 as relay function 15. If a value of 1234 is written to this address then the relay will be active.	16 BIT	R/W	unsigned word	1
36	Relay_2 control through Modbus	Explained in chapter 4.18 as relay function 15. If a value of 1234 is written to this address then the relay will be active.	16 BIT	R/W	unsigned word	1

5.4. MEASUREMENTS AND CONTROLLER RECORDS

ADRESS	NAME	DESCRIPTION	DIMENS	R/W	DATA TYPE	COEFF
8192	Voltage measured from 110V input		32 BIT	R-O	unsigned long	0.01
8194	Voltage measured from 60V input		32 BIT	R-O	unsigned long	0.01
8196	Voltage measured from selected input		32 BIT	R-O	unsigned long	0.01
8198	Vin voltage		32 BIT	R-O	unsigned long	0.01
8200	Current (A)		32 BIT	R-O	signed long	0.01
8202	Power (kW)		32 BIT	R-O	signed long	0.001
8204	Voltage demand		32 BIT	R-O	unsigned long	0.01
8206	Positive current demand		32 BIT	R-O	unsigned long	0.01
8208	Negative current demand		32 BIT	R-O	signed long	0.01
8210	Positive power demand		32 BIT	R-O	unsigned long	0.001
8212	Negative power demand		32 BIT	R-O	signed long	0.001
8214	Max demand voltage		32 BIT	R-O	unsigned long	0.01
8216	Max demand current positive		32 BIT	R-O	unsigned long	0.01
8218	Max demand current negative		32 BIT	R-O	signed long	0.01
8220	Max demand power positive		32 BIT	R-O	unsigned long	0.001
8222	Max demand power negative		32 BIT	R-O	signed long	0.001
8224	Max voltage		32 BIT	R-O	unsigned long	0.01
8226	Min voltage		32 BIT	R-O	unsigned long	0.01
8228	Max current positive		32 BIT	R-O	unsigned long	0.01
8230	Min current positive		32 BIT	R-O	unsigned long	0.01
8232	Max power positive		32 BIT	R-O	unsigned long	0.001
8234	Min power positive		32 BIT	R-O	unsigned long	0.001
8236	Max current negative		32 BIT	R-O	signed long	0.01
8238	Min current negative		32 BIT	R-O	signed long	0.01
8240	Max power negative		32 BIT	R-O	signed long	0.001
8242	Min power negative		32 BIT	R-O	signed long	0.001
8244	Current measured from input-1 (normal scale, large currents)		32 BIT	R-O	signed long	0.01
8246	Current measured from input-2 (sensitive scale, small currents)		32 BIT	R-O	signed long	0.01

ADRESS	NAME	DESCRIPTION	DIMENS	R/W	DATA TYPE	COEFF
8248	Earth leakage voltage (V)		32 BIT	R-O	unsigned long	0.01
8240	Earth leakage percent (%)		32 BIT	R-O	unsigned long	0.01
8252	reserved		32 BIT	R-O	unsigned long	0.01
8254	Energy counter (kWh), positive direction		32 BIT	R-O	unsigned long	0.1
8256	Energy counter (kWh), negative direction		32 BIT	R-O	unsigned long	0.1
8258	Ah (amperes*hour) counter, positive direction		32 BIT	R-O	unsigned long	0.1
8260	Ah (amperes*hour) counter, negative direction		32 BIT	R-O	unsigned long	0.1
8262	Total run hour counter		32 BIT	R-O	unsigned long	0.1
8264	Alarms	Alarm durum kaydı	16 BIT	R-O	unsigned word	1
8265	reserved		16 BIT	R-O	unsigned word	1
8266	Unit model		16 BIT	R-O	unsigned word	1
8267	Unit firmware version		16 BIT	R-O	unsigned word	0.1

Alarm status record is 16 bit long. Each bit indicates the existence of one alarm.

BIT NO:	DESCRIPTION
0	-
1	High voltage (Alarm 1)
2	Low voltage (Alarm 2)
3	Overcurrent (Alarm 3)
4	Excess power (kW) (Alarm 4)
5	Low power (kW) (Alarm 5)
6	Positive (+) Earth Leakage (Alarm 6)
7	Nega tive (-) Earth Leakage (Alarm 7)
8	-
9	-
10	-
11	-
12	-
13	-
14	-
15	-

6. TECHNICAL SPECIFICATIONS

Supply Input: 19-150VDC
Power Consumption: < 4W
Voltage Measurements Inputs:
0-70V Input Sensitivity: 0.02V
70-150V Input Sensitivity: 0.40V
Current Measurement Input:
Measurement range: -100 to +100mV.
Accuracy: % 0.2
Isolation: 1000V AC, 1 minute
Internal Current Shunt Option:
Measurement range: 0-15A
Analog Output: 0-20mA
Analog Output Precision: 16 bit
Digital Input Range: 19 to 150VDC
Relay Outputs: 5 Amps @ 28VDC
Serial Port:
Signal type: RS-485
Protocol: Modbus RTU
Data Rate: 2400-38400baud
Isolation: 1000V AC, 1 minute
Operating Temp. Range: -20°C...+70 °C (-4°F...158°F)
Max. Relative Humidity: %95 non-condensing
Protection Degree: IP 65 (Front panel, w. gasket)
IP 30 (Back panel)
Enclosure: Flame retardent, ROHS compliant high temperature ABS/PC (UL94-V0)
Installation: Flush mounting with rear brackets
Dimensions: 102x102x53mm (WxHxD)
Panel Cutout: 92x92mm
Weight: 200 gr

EU Directives:	**Reference Standards:**
2014/35/EC (LVD)	EN 61010 (safety)
2014/30/EC (EMC)	EN 61326 (EMC)