
| Type | Description | Code | Weight [kg] | Packaging [pcs] |
|---|---|---|---|---|
| 3MEM80-BEVRSPO | 3phase, 80A, IR, S0, RS485, EVSE, bidirectional | 004657206 | 0,248 | 1/96 |

- COMPACT **THREE-PHASE** DIRECT CONNECTED **DIN-RAIL** MOUNTING METER.
- **CLASS B FOR ACTIVE ENERGY** AND **CLASS 2 FOR REACTIVE ENERGY, MID** APPROVED.
- MAXIMUM CURRENT **80 A** ($I_{max}$).
- Communication: **S0 & RS485 (Modbus)**
- **TARIFF INPUT**.
- SIDE **IR COMMUNICATION** FOR ADDONS**.**
- **NFC** FOR EASY SETTING AND READING.
- **70°C** AMBIENT OPERATIONAL TEMPERATURE.

## FEATURES

- Three phase direct connected DIN-rail mounting meter.
- Class 1 for active energy according to EN 62053-21 and class B according to EN 50470-3.
- Class 2 for reactive energy according to IEC 62053-23.
- Bidirectional energy measurement (import/export).
- Maximum current 80 A ($I_{max}$).
- Display segment Matrix LCD.
- LCD display with backlight.
- Multifunctional front red LED.
- IR serial communication.
- Measurements of:
  - power (active/reactive/apparent),
  - energy (active/reactive/apparent, each phase and total),
  - voltage for each phase,
  - current for each phase,
  - phase to phase voltage
  - phase to phase angle,
  - frequency,
  - power factor (for each phase and total),
  - power angle (for each phase and total),
  - active tariff,
  - THD of voltage,
  - THD of current.
- S0 pulse output
- Modbus RS485 Serial communication
- Tariff input (230 V AC).
- Tariff management (up to 6 tariffs manageable via communication).
- -25°C - 70°C ambient operation temperature.
- Sealable terminal cover.
- DIN-rail mounting according to EN 60715.
- 3 DIN modules width.

## DESCRIPTION

3MEM80-EVRS energy counter is intended for energy measurements in three-phase electrical power network and can be used in residential, industrial and utility applications. Meter measures energy directly in 3-wire and 4-wire networks according to the principle of fast sampling of voltage and current signals. A built-in microprocessor calculates energy and other electrical quantities from the measured signals. It also controls LCD, LED, IR communication and optional extensions.

A capacitive touch button on the front of the energy meter enables access to switch between measurements and settings in the menu.

Connecting terminals can be sealed up against non-authorised access with protection covers.

Communication:

- **RS485 serial communication with the MODBUS protocol** — data is available in different formats prepared for easier integration into third party control and monitoring systems.
- **S0 output** — intended for connection to the devices that are checking and monitoring consumed energy.
- **NFC communication** — implemented for parametrization as well as for reading data (e.g. counters, measurements, etc.) from the smart meter.

  **PLEASE NOTE: mobile application for NFC communication is not available**
- **Tariff input** – provides measurement of two tariffs for selected energy registers.

Alarms are useful tool for fast detection of exceeded parameters, monitoring proper magnitude level and notification in combination with alarm outputs.

## INSTALLATION

**WARNING:** Installation must be carried out and inspected by a specialist or under his supervision. When working on the meter, switch off the mains voltage! It is recommended to use 3x80 A fuse for the line protection.

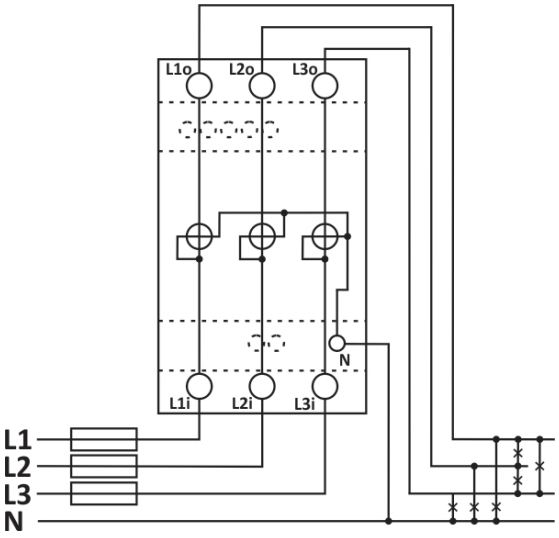



***Figure 1**: Three-phase 4-wire connection diagram (3W4)*

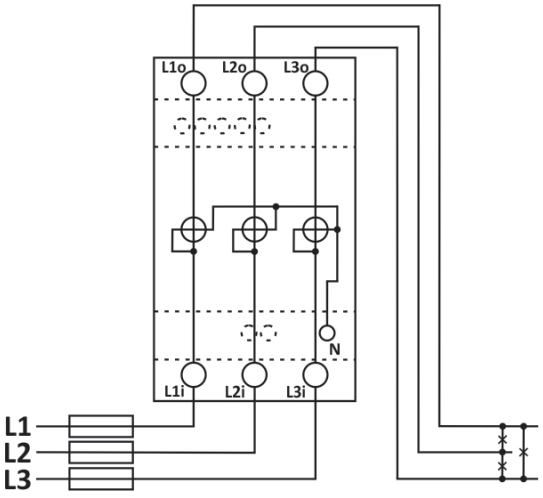



***Figure 2**: Three-phase 3-wire 3 system connection diagram (3W3)*

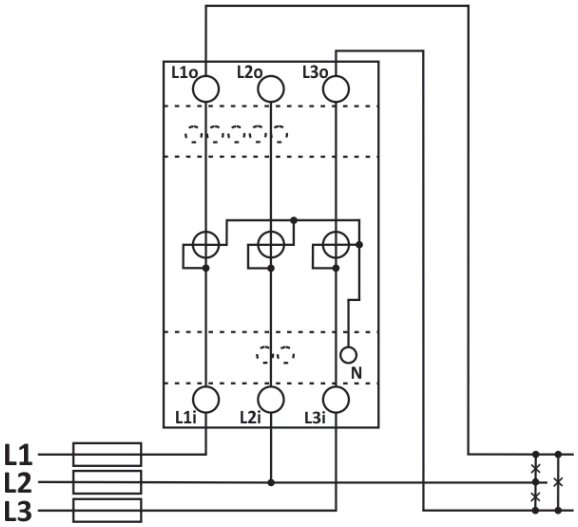



***Figure 3**: Three-phase 3-wire 2 system connection diagram (2W3)*

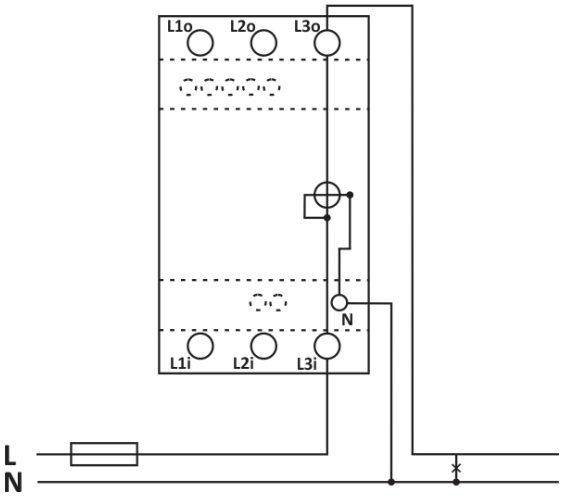



***Figure 4**: Single-phase connection diagram 1W*

| ***Mark*** | ***Meaning*** |
|---|---|
| $L_{I,2,3}$ | *Line input* |
| *N* | *Neutral input* |

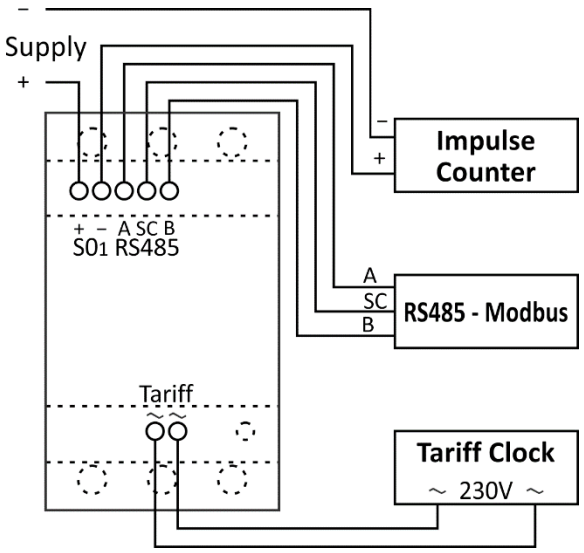



***Figure 5**: Connection diagram of S0 output, impulse counter, RS485 - Modbus and tariff clock*

## DIMENSIONAL DRAWINGS

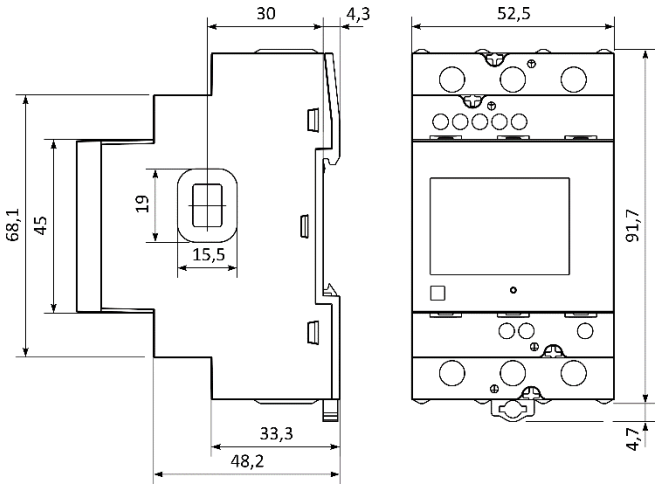



***Figure 6**: Dimensional drawing*

## TECHNICAL DATA

*Rail mounting according DIN EN60715.*

### *Mechanical characteristics of input:*

Main inputs

- Contacts capacity:
  Flexible (Rigid) 1.5 $mm^2$ ...25 (16) $mm^2$
  **Ferrule contact length should be 12 mm. Wire stripped to 14 mm.*
- Connection screws: M5
- Max torque: 3.5 Nm (PH2)
- Length or removed isolation: 10 mm

Auxiliary contacts

- Contact capacity: 0.05 $mm^2$...1.5 $mm^2$
- Screws: M3
- Max torque: 0.6 Nm
- Length or removed isolation: 8 mm

### *Measuring input:*

Type: three-phase (3W4, 3W3, 2W3)
single-phase (1W)
Reference (nominal) current ($I_{ref}$): 5 A
Maximum current ($I_{max}$): 80 A
Minimum current ($I_{min}$): 0.25 A
Transitional current ($I_{tr}$): 0.5 A
Starting current: 20 mA
Power consumption at $I_{ref}$: < 0.1 VA
Nominal voltage ($U_n$):
3x230 V/400 V (-20 %...+15 %)
Power consumption per phase at $U_n$: < 8 VA
Nominal frequency ($f_n$): 50 Hz and 60 Hz
Minimum measuring time: 10 s

### *Accuracy:*

Active energy:

- class 1 EN 62053-21
- class B EN 50470-3
- ±1.5 % from $I_{min}$ to $I_{tr}$
- ±1 % from $I_{tr}$ to $I_{max}$

Reactive, Apparent energy:

- class 2 IEC 62053-23
- ±2.5 % from $I_{min}$to $I_{tr}$
- ±2 % from $I_{tr}$ to $I_{max}$

Voltage:

- ±1 % of measured value

Current:

- ±1 % of $I_{ref}$ from $I_{st}$ to $I_{ref}$
- ±1 % of measured value from $I_{ref}$ to $I_{max}$

Active Power:

- ±1 % of nominal power ($U_n * I_{ref}$) from $I_{st}$ to $I_{ref}$
- ±1 % of measured value from $I_{ref}$ to $I_{max}$

Reactive, Apparent power:

- ±2 % of nominal power from $I_{st}$ to $I_{ref}$
- ±2 % of measured value from $I_{ref}$ to $I_{max}$

Frequency:

- ±0.5 % of measured value

### *LCD:*

Display type: Matrix (128 x 64)
Illumination: white (normal operation)
red (alarm indication)

### *LED:*

Colour: red
Pulse rate: 1000 imp/kWh
LED on: no load indication

### *Pulse output $S0_1$:*

| | |
|---|---|
| Pulse rate: | 500 imp/kWh |
| Pulse duration: | 32 ms ± 2 ms |
| Rated voltage DC (max): | 27 V |
| Switched current (max): | 27 mA |
| Standard: | EN 62053-31 (A&B) |

### *Tariff input:*

| | |
|---|---|
| Rated voltage: | 230 V (-20 %...+15 %) |
| Input resistance: | 360 kΩ |

### *RS485 Serial communication (option):*

| | |
|---|---|
| Type: | RS485 |
| Speed: | |
| 1200 bit/s to 115200 bit/s (default 115200 bit/s) | |
| Frame: | 8, N, 2 |
| Protocol: | MODBUS RTU |
| Address: | 33 – (default) |

### *Optical IR communication (option):*

| | |
|---|---|
| Type: | IR |
| Connection: | via USB adapter |
| Speed: | 19200 bit/s |
| Frame: | 8, N, 2 |
| Protocol: | MODBUS RTU |
| Address: | 33 |
| Remark: | all settings are fixed |

### *NFC:*

| | |
|---|---|
| Protocol: | ISO/IEC 14443 Part 2 and 3 compliant |
| Frequency range: | 13.56 Mhz |
| Baudrate: | 106 kbps |
| Operating distance: | up to 15 mm from LCD (distance depends on used reader) |

### *Ambient conditions and Safety:*

According standards for indoor active energy meters. Temperature and climatic condition according to EN 62052-11:

- Dust/water protection IP50 (For IP51 it should be installed in appropriate cabinet.)
- Operating temp. range: -25°C... +70°C (non-condensing humidity)
- Storage temp. range -40 °C... +85°C
- Enclosure material: self-extinguish complying UL94 V
- Indoor meter: yes
- Degree of pollution: 2
- Protection class: II
- Installation category 300 $V_{rms}$ cat.III
- Standard: IEC 62052-31

| | |
|---|---|
| Mechanical environment: | M1 |
| Electromagnetic environment: | E2 |
| Humidity: | non condensing |
| Max weight (with packaging): | 225 g (258.5 g) |
| Installation: | DIN Rail 35 mm |
| Dimensions (W x H x D): | 52.5 mm x 91.7 mm x 68.2 mm |
| Package dimensions (W x H x D): | 74 mm x 106 mm x 80 mm |
| Colour: | RAL 7035 |

## EU DIRECTIVES CONFORMITY

EU Directive on Measuring Instruments **2014/32/EU.**
EU Directive on EMC **2014/30/EU.**
EU Directive on Low Voltage **2014/35/EU.**
EC Directive WEEE **2002/96/EC.**

## DISPOSAL

It is forbidden to deposit electrical and electronic equipment as municipal waste.
The manufacturer or provider shall take waste equipment free of charge.

**Three-phase electrical energy meter 3MEM65**

***User and Installation manual***


| | *3MEM65-BPO* | *3MEM65-BMB* | *3MEM65-BRS* | *3MEM65-BT* |
|---|---|---|---|---|
| ***General hardware features*** | | | | |
| ***MID approval*** | ***x*** | ***x*** | ***x*** | ***x*** |
| ***Pulse output*** | ● | ***x*** | ***x*** | ***x*** |
| ***Tariff input*** | ***x*** | ***x*** | ***x*** | ● |
| ***MODBUS comm. Protocol RS485*** | × | × | ● | ***x*** |
| ***M-bus serial comm.*** | × | ● | × | ***x*** |

| | *3MEM65-BPO-MID* | *3MEM65-BMB-MID* | *3MEM65-BRS-MID* | *3MEM65-BT-MID* |
|---|---|---|---|---|
| ***General hardware features*** | | | | |
| ***MID approval*** | ● | ● | ● | ● |
| ***Pulse output*** | ● | ***x*** | ***x*** | ***x*** |
| ***Tariff input*** | ***x*** | ***x*** | ***x*** | ● |
| ***MODBUS comm. Protocol RS485*** | × | × | ● | ***x*** |
| ***M-bus serial comm.*** | × | ● | × | ***x*** |

| **Auxiliary terminal** | **15** | **16** |
|---|---|---|
| M-Bus | M- | M+ |
| Pulse output | SO- | SO+ |
| Tariff input | AC2 | AC1 |
| RS485* | B | A |

*It is recommended to use ferrite bead on communication line RS485 (two turns) to reduce radiated emission.

# Security Advices and Warnings

Please read this chapter carefully and examine the equipment carefully for potential damages which might arise during transport and to become familiar with it before continue to install, energize and work with a three-phase energy meter 3MEM65.
This chapter deals with important information and warnings that should be considered for safe installation and handling with a device in order to assure its correct use and continuous operation.
Everyone using the product should become familiar with the contents of chapter »Security Advices and Warnings«.
If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

**PLEASE NOTE**

*This booklet contains instructions for installation and use of three-phase energy meter 3MEM65. Installation and use of a device also includes handling with dangerous currents and voltages therefore should be installed, operated, serviced and maintained by qualified personnel only. ETI Company assumes no responsibility in connection with installation and use of the product. If there is any doubt regarding installation and use of the system in which the device is used for measuring or supervision, please contact a person who is responsible for installation of such system.*

## Before switching the device ON

Check the following before switching on the device:

- Nominal voltage.
- Terminals integrity.
- Protection fuse for voltage inputs (recommended maximal external fuse size is 65 A).
- External switch or circuit breaker must be included in the installation for disconnection of the devices' power supply. It must be suitably located and properly marked for reliable disconnection of the device when needed.
- Proper connection and voltage level of I/O module.

# Used symbols on devices' housing and labels

| SYMBOL | EXPLANATION |
|---|---|
|  | **DANGER**<br>Indicates proximity of hazardous high voltage, which might result in serious injury or death if not handled with care. |
|  | **WARNING**<br>Indicates situations where careful reading of this manual is required and following requested steps to avoid potential injury is advised. |
|  | Compliance of the product with directive 2002/96/EC, as first priority, the prevention of waste electrical and electronic equipment (WEEE), and in addition, the reuse, recycling and other forms of recovery of such wastes so as to reduce the disposal of waste. It also seeks to improve the environmental performance of all operators involved in the life cycle of electrical and electronic equipment. |
|  | Compliance of the product with European CE directives. |
|  | Compliance of the product with UK Conformity Assessed (UKCA) directives. |

## Disposal

It is strongly recommended that electrical and electronic equipment (WEEE) is not deposit as municipal waste. The manufacturer or provider shall take waste electrical and electronic equipment free of charge. The complete procedure after lifetime should comply with the Directive 2002/96/EC about restriction on the use of certain hazardous substances in electrical and electronic equipment.

# Table of contents

# 1 BASIC DESCRIPTION AND OPERATION

The following chapter presents basic information about a three-phase energy meter 3MEM65 required to understand its purpose, applicability and basic features connected to its operation.
In this chapter you will find:

## 1.1 Description of the device

The three-phase energy meters **3MEM65, 3MEM65 (MID certified)** are intended for energy measurements in three-phase electrical power network and can be used in residential, industrial and utility applications. Meters measure energy directly in 4-wire networks according to the principle of fast sampling of voltage and current signals. A built-in microprocessor calculates active/reactive/apparent power and energy, current, voltage, frequency, power factor, power angle and frequency (for each phase and total sum) from the measured signals. This smart meter can also perform basic harmonic analysis (THDU, THDI). This enables quick overview of harmonic distortion either coming from a network or generated by the load. Microprocessor also controls LCD, LED, IR communication and optional extensions.

Connecting terminals can be sealed up against non-authorised access with protection covers. They are built to be fastened according to EN 60715 standard.

### *1.1.1 Appearance*


1. **Current terminals – to load**
2. **AUX terminals (options):**
   - RS485
   - M-BUS
   - PULSE OUTPUT
   - TARIFF INPUT
3. **IR COMM PORT –ON SIDE**
4. **Information display**
5. **DIN-Rail fitting**
6. **User button and LED indicator (1000 imp/kWh)**
7. **Current terminal – source (max 65 A)**

**LCD**

| | |
|---|---|
| Number of digits: | 8 (7+1) |
| Height of digits: | 4.52 mm |

**LED**

| | |
|---|---|
| Colour: | red |
| Pulse rate: | 1000 imp/kWh |
| LED on: | no load indication |

***Figure 1:*** *Appearance of three-phase electric energy meter 3MEM65*

## 1.2 Three-phase energy meters application

Optional the meter can be equipped with the following communications:

- **RS485** serial communication with the MODBUS protocol,
- **M-BUS** serial communication,

Communication modules enables data transmission and thus connection of the measuring places into the network for the control and management with energy.

Instead of communication modules, there can be also **tariff input** (option) or built-in **pulse output** (option).

Tariff input provides measurement of two tariffs for selected energy registers.

Pulse output is sending data to the devices for checking and monitoring consumed energy.

On the housing there are only two terminals, thus only one functional extension is possible (serial communication, tariff input, pulse output).

## 1.3 Main features

- Three-phase direct connected DIN-rail mounting meters up to maximum current ($\mathbf{I_{max}}$) **65 A.**
- Basic current ($I_b$) 5 A.
- **MID** approval (option for 3MEM65).
- **Class 1** for active energy according to EN 62053-21 and **B** according to EN 50470-3 .
- **Class 2** for reactive energy according to EN 62053-23.
- Reference frequency **50 Hz and 60 Hz.**
- **Bidirectional** energy measurement (import/export).
- Reference voltage 3x230 V/400 V ($U_n$).
- Voltage operating range (-20 % ... +15 %) $U_n$.
- **Pulse output** according to EN 62053-31 (option).
- **Tariff input** (option).
- **RS485** serial communication (option).
- **M-BUS** serial communication (option).
- Display **LCD 7+1** digit (**100 Wh** resolution).
- Multifunctional front LED.
- LED constant 1000 imp/kWh.
- Built-in optical (**IR**) communication port.
- Measurement of:
    - power (active, reactive, apparent) and energy (each phase and total).
    - Voltage (each phase).
    - Current (each phase).
    - Phase to phase voltage.
    - Phase to phase angle.
    - Frequency.
    - Power factor (each phase and total).
    - Power angle (each phase and total).
    - Active tariff (option).
    - THD of voltage.
    - THD of current.
- **3-DIN rail** width mounting according to EN 60715.
- **Sealable** terminal cover.

# 2 CONNECTION

This chapter deals with the instructions for three-phase electrical energy meter 3MEM65 connection. Both the use and connection of the device includes handling with dangerous currents and voltages. Connection shall therefore be performed ONLY by a qualified person using an appropriate equipment. ETI, d.o.o. does not take any responsibility regarding the use and connection. If any doubt occurs regarding connection and use in the system which device is intended for, please contact a person who is responsible for such installations.
In this chapter you will find:

## 2.1 Mounting

Threee-phase electrical energy meter 3MEM65 is intended for DIN-rail mounting. In case of using the stranded wire, the ferrule must be attached before the mounting.

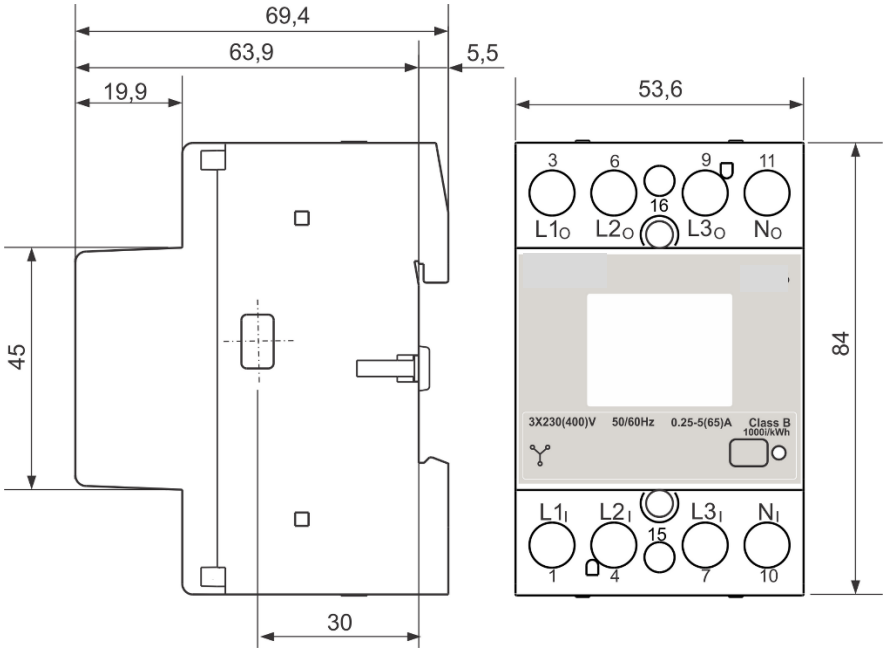



***Figure 2:*** *Dimensional drawing and rear connection terminals position*

## 2.2 Electrical connection

**WARNING**

*Wrong or incomplete connection of voltage or other terminals can cause non-operation or damage to the device.*

Meter is used for direct connection into the four-wire networks.

Recommended installation:

1 Mounting to DIN rail according to DIN EN60715

2 Power contacts:

a. Power contacts capacity 2.5 $mm^2$ – 16 $mm^2$

b. Connection screws M5

c. Recommended / Maximum torque: 3/3.5 Nm (PZ2).

d. Length or removed isolation: 10 mm.

3 Auxiliary terminals:

a. Auxiliary terminals contact capacity 1 $mm^2$ – 2.5 $mm^2$

b. Auxiliary terminals screws M3

c. Recommended / Maximum torque: 0.7/0.8 Nm (PZ1).

d. Length or removed isolation: 8 mm.

**PLEASE NOTE**

*Neutral wire must be connected to the meter.*

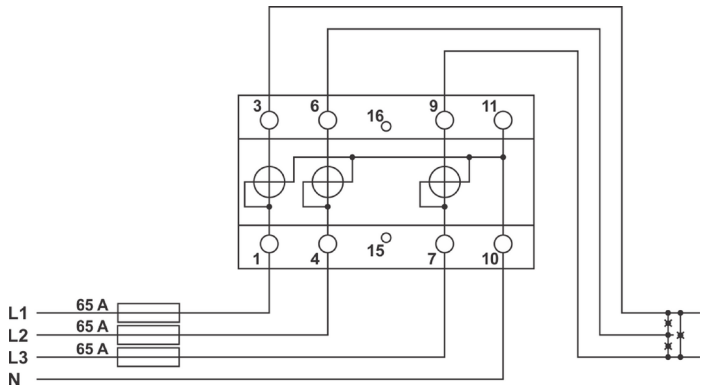



***Figure 3:*** *Neutral connection of energy meters*

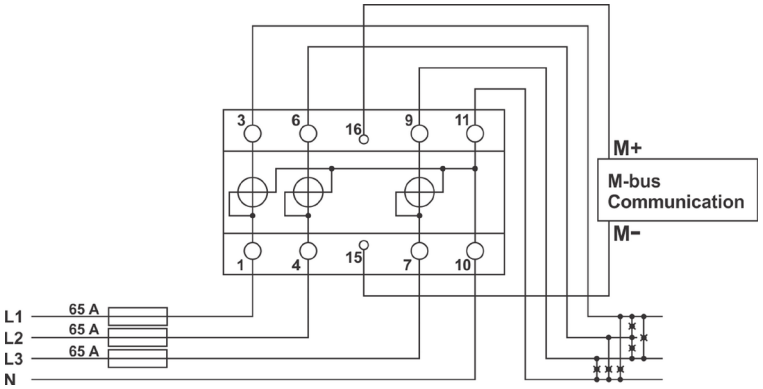



***Figure 4:*** *Connection diagram for M-BUS option*

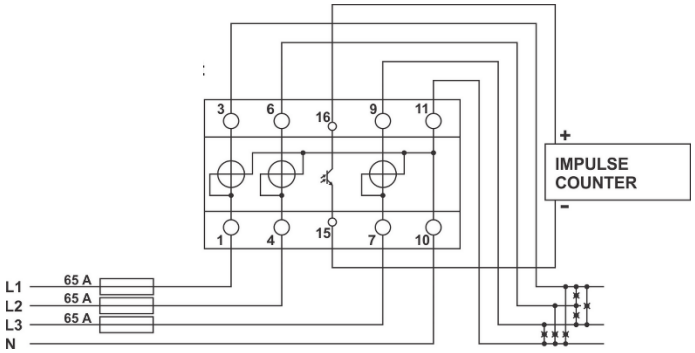



***Figure 5:*** *Connection diagram for pulse output option*

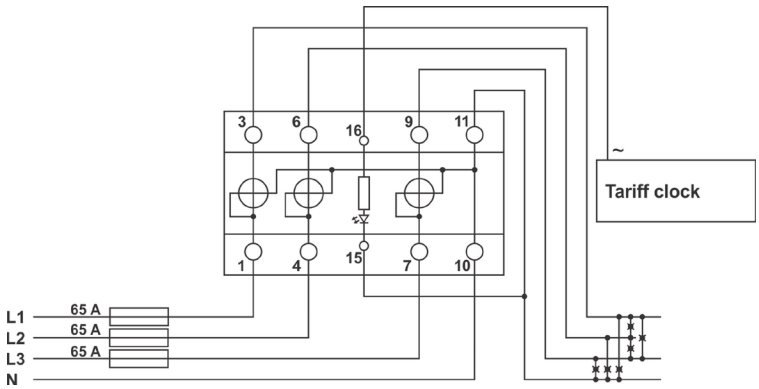



***Figure 6:*** *Connection diagram for tariff input option*

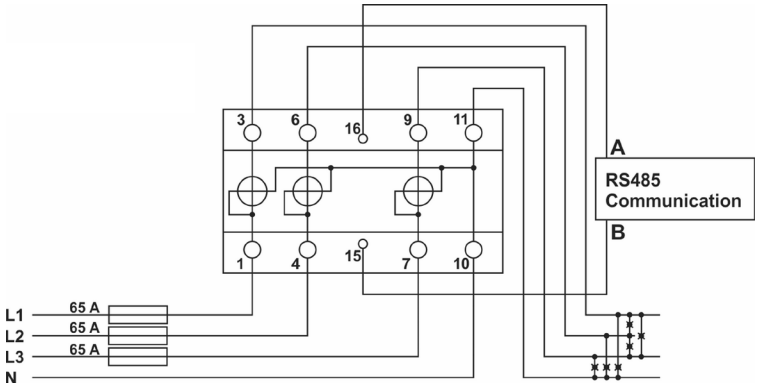



***Figure 7:*** *Connection diagram for RS485*

Complete 3MEM65 system is assembled with three main units and optionally communication unit:

- Individual phase measurement unit.
- Power supply unit (based on configuration).
- Processing unit (MCU) with IR communication, LED indicator, LCD support and EEPROM.
- Optionally available different communication units or extension modules (RS485, M-BUS, TARIFF, PULSE).

### *2.2.1 Communication connection*

For communication with outside world multiple manners are used:

- **IR** communication module using MODBUS protocol is equipped on each meter.
- **Pulse output (option)** module is used for counting number of pulses depending on consumed energy.
- **Tariff input (option)** module is used to set active tariff.
- **LED** diode is used for indication of no-load condition and test output proportional to measured active energy. It can be also switched to reactive energy for test purpose using IR communication.
- **RS485 (option)** communication module is galvanic isolated form meter. It enables setting the meter, data readout in the network and tariff setting.
- **M-BUS (option)** communication module is galvanic isolated form meter. It enables setting the meter, data readout in the network and tariff setting.
- **Push button** is used to select display of desired measured or group of them.

***Table 1:*** *Survey of communication connection*

| **Auxiliary terminal** | **15** | **16** |
|---|---|---|
| M-Bus | M- | M+ |
| Pulse output | SO- | SO+ |
| Tariff input | AC2 | AC1 |
| RS485* | B | A |

*It is recommended to use ferrite bead on communication line RS485 (two turns) to reduce radiated emission.

**PLEASE NOTE**

*Check labels on the side of the meter to check what modules are built in.*

# 3 FIRST STEPS

Programming a three-phase electrical energy meter 3MEM65 is very transparent and user friendly. Numerous settings are organized in groups according to their functionality.

In this chapter you will find basic programming steps:

## 3.1 Display of device info

Energy meters have LCD display with following layout.

1 Tariff setting for displayed counter/actual tariff
2 (→) Energy import/active power import
   – (←) Energy export/active power export
3 kWh display
4 kvarh display
5 Actual Value
6 Info:
   – VAh display
   – PF – power factor
   – VA – apparent power
   – PA – power angle
   – Four numbers - Code of MID approved energy counter.
7 A – currently active counter, nr – non-resettable counter or r – resettable counter
8 W – active power
   – var – reactive power
9 Inductive or capacitive load
10 Active phase display

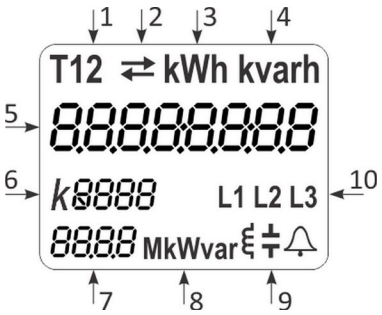



***Figure 8:*** *Layout of LCD (welcome screen)*

Energy registers are displayed with resolution 7 + 1 (kWh, kvarh and kVAh). The meter can be set to *Test measuring mode* which displays energy registers with better resolution. The test mode is used for test purposes during type testing and test of meter constant during initial verification. After power off meter automatically goes back to normal operation.

Test output is provided as LED with number of impulses proportional to active energy. Pulse constant is 1000 imp/kWh. Optionally the S0 impulse output with the same constant can be used for active energy. Pulse output is defined to be (32 ± 2) ms long according EN 62053-31.

Energy measurement is blocked for the currents less than 20 mA. The meter measures actual voltage and frequency. Current and power values are set to zero and there is no energy registration. No load condition is indicated with the LED on.

If the supply voltage is too low, the energy measurements are also blocked and communication is disabled. LCD stops to cycle and displays only value of voltage.

## 3.2 LCD User Interface

After the electrical connection, the display shows a welcome screen for two seconds then the firmware version for the next two seconds. The following is a measurement screen automatically cycling on the screen, regarding the period that is defined in settings.

Regarding the period that is defined in settings, measurement screen cycling is started until any key is pressed.

The LCD display allows displaying the following measurement values:

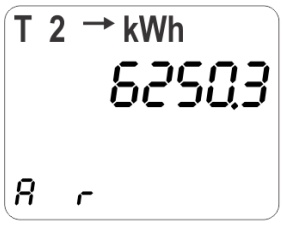
1. **Energy registers**. Two different types (resettable and non-resettable), both of them count the same quantity. The resettable energy counter can be reset, while the non-resettable has been measuring the quantity continuously. The energy counter you reset starts to re-measure the value from the zero.
    - **I. Resettable energy counters**
        - i. Energy counter 1 (default)
        - ii. Energy counter 2
        - iii. Energy counter 3
        - iv. Energy counter 4
    - **II. Non resettable energy counters**
        - i. Energy counter 1
        - ii. Energy counter 2
        - iii. Energy counter 3
        - iv. Energy counter 4
2. **Actual measured values**
    - I. Active Power, total, ph1, ph2, ph3
    - II. Reactive Power, total, ph1, ph2, ph3
    - III. Apparent Power total, ph1, ph2, ph3
    - IV. Power Factor, total, ph1, ph2, ph3
    - V. Voltages U1, U2, U3
    - VI. Phase to phase voltages U12, U13, U23
    - VII. Frequency
    - VIII. Current I1, I2, I3
    - IX. Power Angle total

The measured values can be scrolled automatically or can be selected by pressing a button.

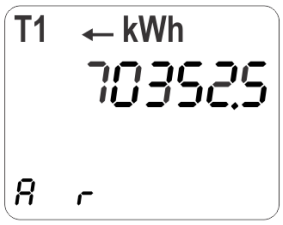
The button is used for navigating between measurement screens and for selecting/confirming the settings.

### 3.2.1 Energy counters

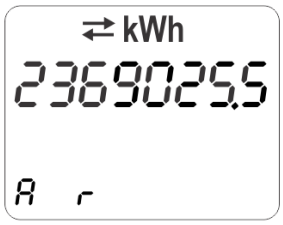
Energy counters are represented as shown on LCD examples bellow (up to 4 resettable counters, letter r representing it). At the top of the screen is settings of energy counter (tariff, import/export/total, active/reactive/apparent), the 8-digit numerical number shows the value of the energy and the letter at the bottom shows actual activity (counting (A)/not counting ( )).



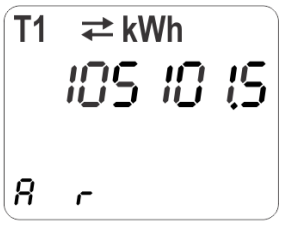
counter 1



counter 2

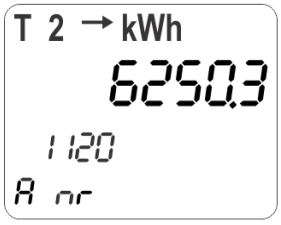


counter 3

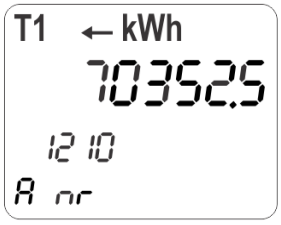


counter 4

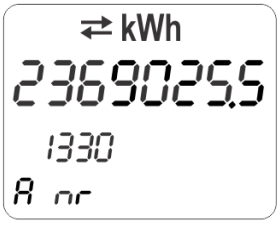
Non-MID meters show resettable counters (letter r representing it).



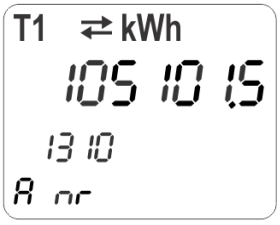
counter 1



counter 2



counter 3



counter 4

MID meters show non-resettable counters (letters nr representing it).

Counter 1 shows: Import Active Energy = 6250.3 kWh at Tarif 2.

Counter 2 shows: Export Active Energy = 70352.5 kWh at Tarif 1.

Counter 3 shows: Total Active Energy = 2369025.3 kWh at both Tarif 1 and 2.

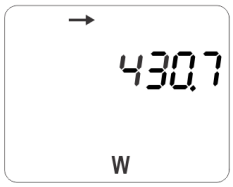
Counter 4 shows: Total Active Energy = 105101.5 kWh at Tarif 1.

### 3.2.2 Other measurements

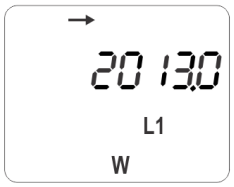
The number on the screen shows the actual value of the measured quantity (P-W, Q-var, S, PF, U, f and I). On the screen as well is the direction of active energy flow (import/export), reactance (inductive/capacitive) and active tariff (regarding tariff input).

**Active power:**

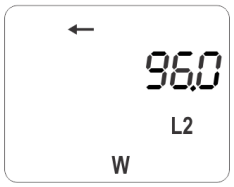
Active power total



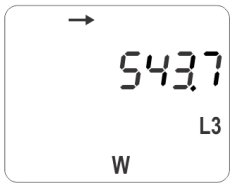

Active power phase 1




Active power phase 2



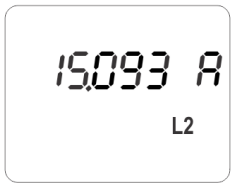

Active power phase 3



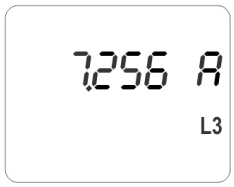

**Phase currents:**

Current phase 1


Current phase 2




Current phase 3



**Phase Voltages:**

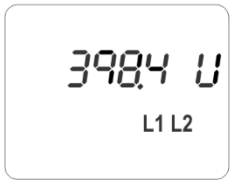
Voltage phase 1


Voltage phase 2

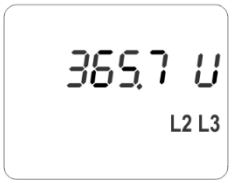

Voltage phase 3


**Phase to phase Voltages:**

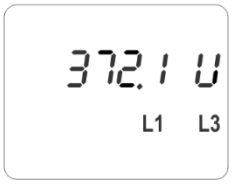
Phase to phase $U_{12}$




Phase to phase $U_{23}$



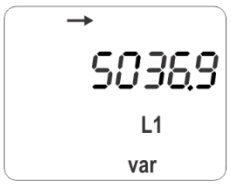

Phase to phase $U_{13}$



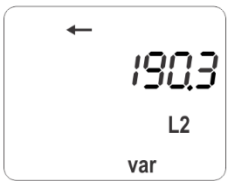

**Reactive powers:**

Reactive power total


Reactive power phase 1




Reactive power phase 2




Reactive power phase 3


**Apparent powers:**

Apparent power total


Apparent power phase 1

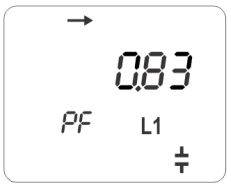

Apparent power phase 2


Apparent power phase 3

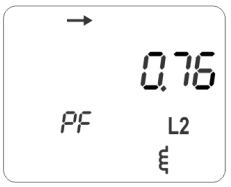

**Power factors:**

Power factor total


Power factor phase 1



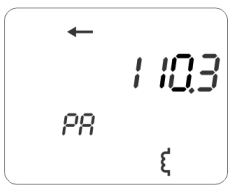

Power factor phase 2



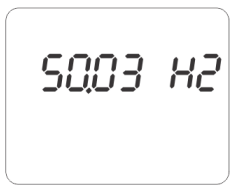

Power factor phase 3


**Power angle:**

Power angle total

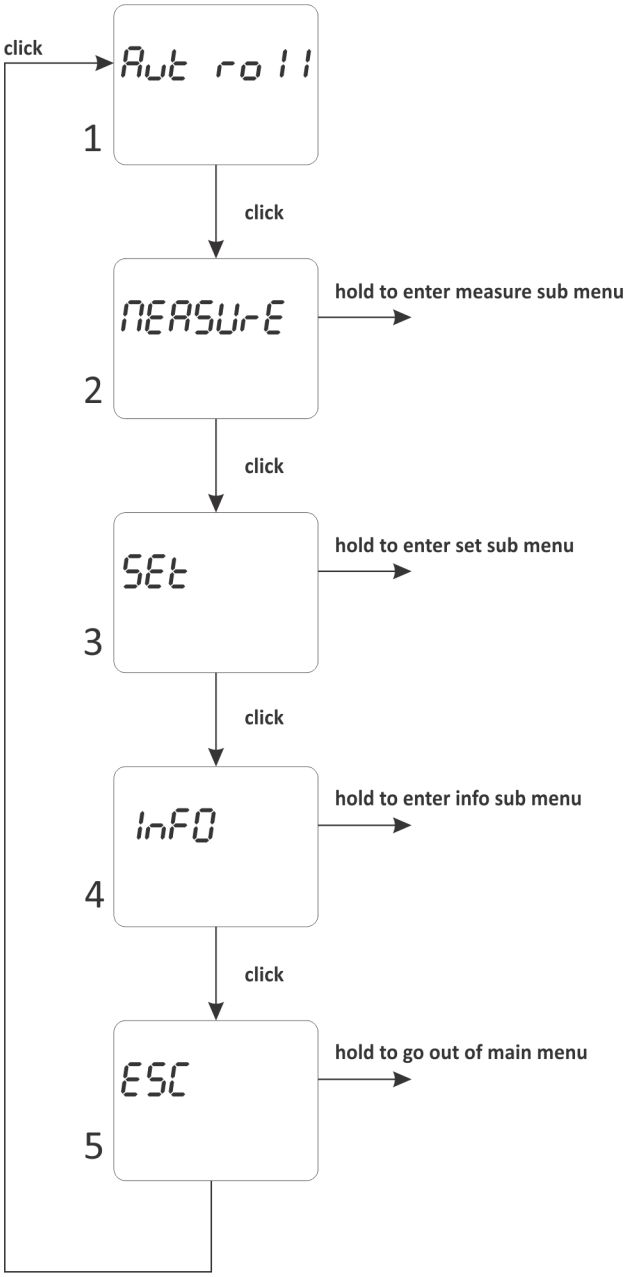



**Frequency:**



### *3.2.3 Display menu structure*

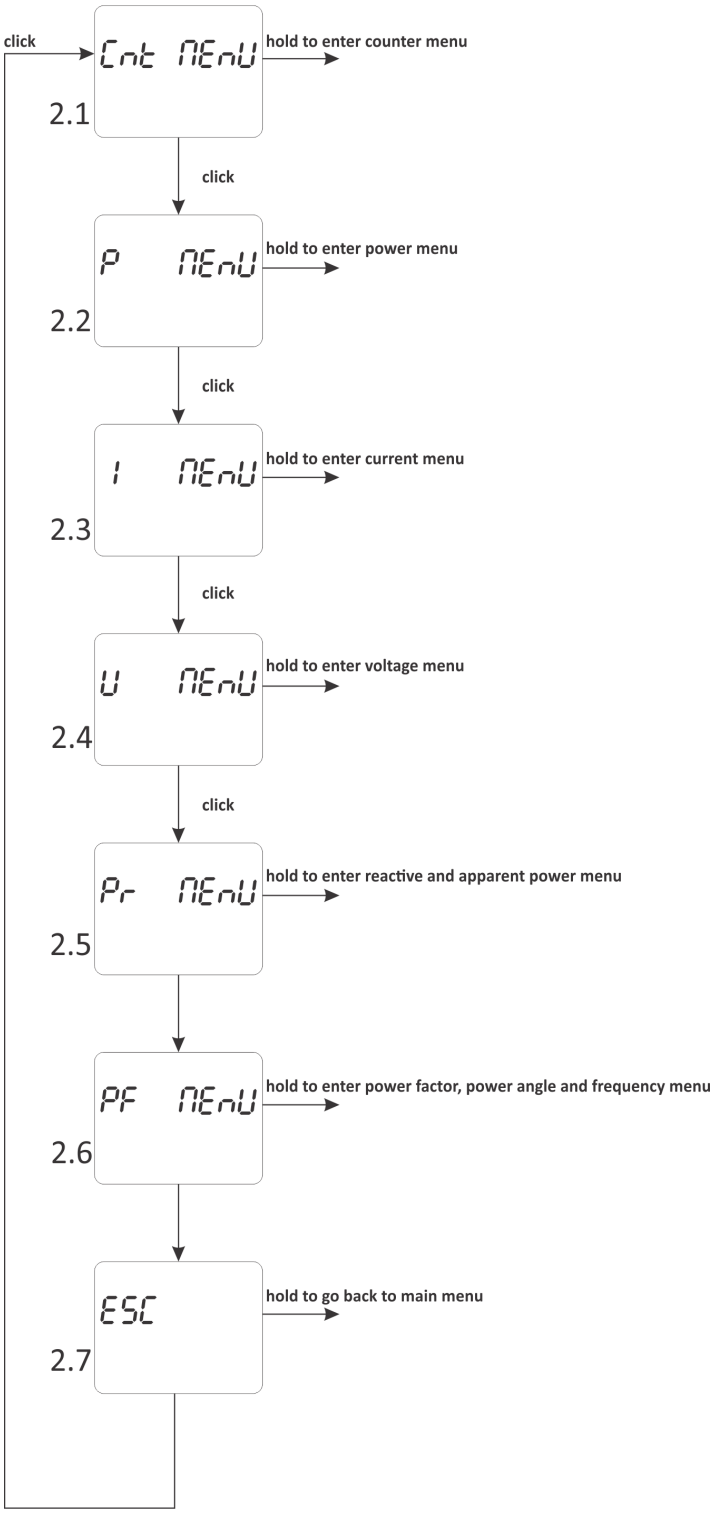
The display menu is entered by holding the push button for more than one second. Blinking of the screen indicates that.
Short clicks then move user through the main menu.



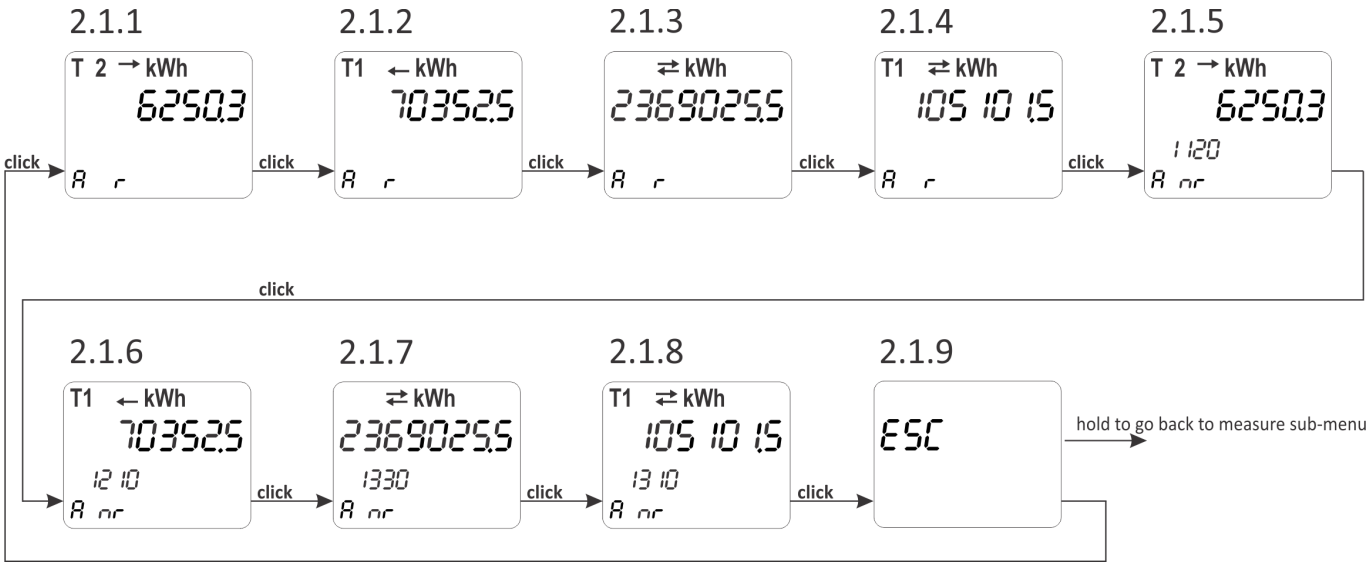

By holding the button when positioned on certain screen ( e.g. measure, set, etc…) the sub-menu is entered.

### *3.2.3.1 Measure sub-menu*

When in measure sub-menu, short clicks move user through it, allowing her/him to select a dedicated menu.



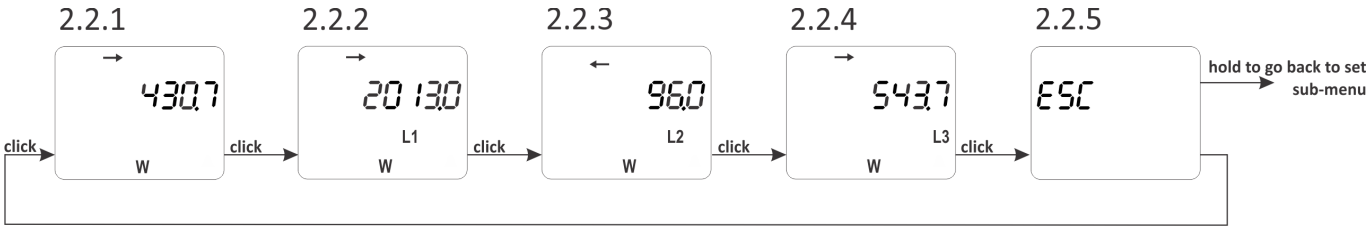
#### *3.2.3.1.1 Counter menu*




Holding button on any of screens 2.1.1 through 2.1.8 sets this screen as a meter screen.

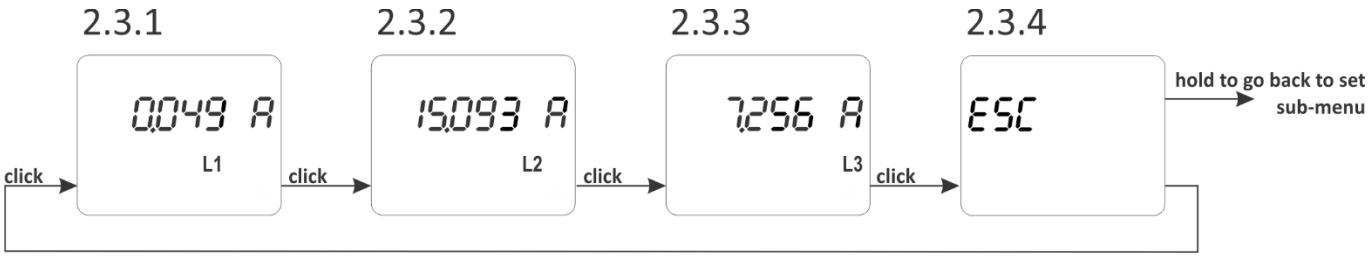
In the Counter menu all counters (resettable and non-resettable) are displayed for both – MID and non MID meters.

#### *3.2.3.1.2 Power menu*



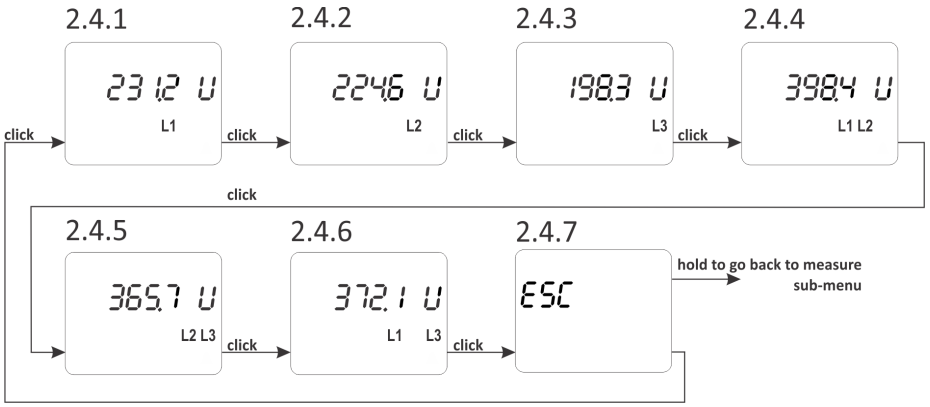

Holding button on any of screens 2.2.1 through 2.2.4 sets this screen as a meter screen.

#### *3.2.3.1.3 Current menu*



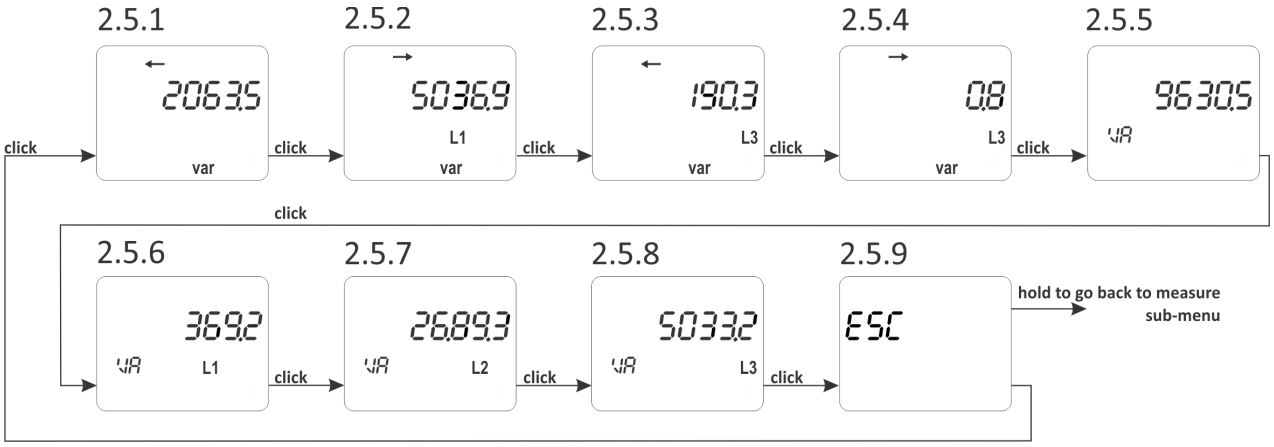

Holding button on any of screens 2.3.1 through 2.3.3 sets this screen as a meter screen.

#### *3.2.3.1.4 Voltage menu*



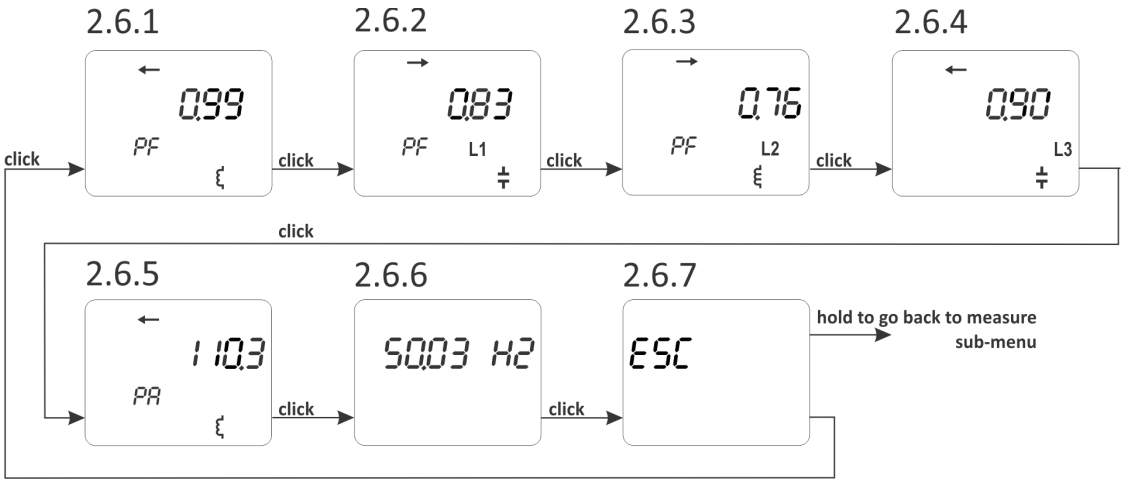

Holding button on any of screens 2.4.1 through 2.4.6 sets this screen as a meter screen.

#### *3.2.3.1.5 Reactive and apparent power menu*




Holding button on any of screens 2.5.1 through 2.5.8 sets this screen as a meter screen.

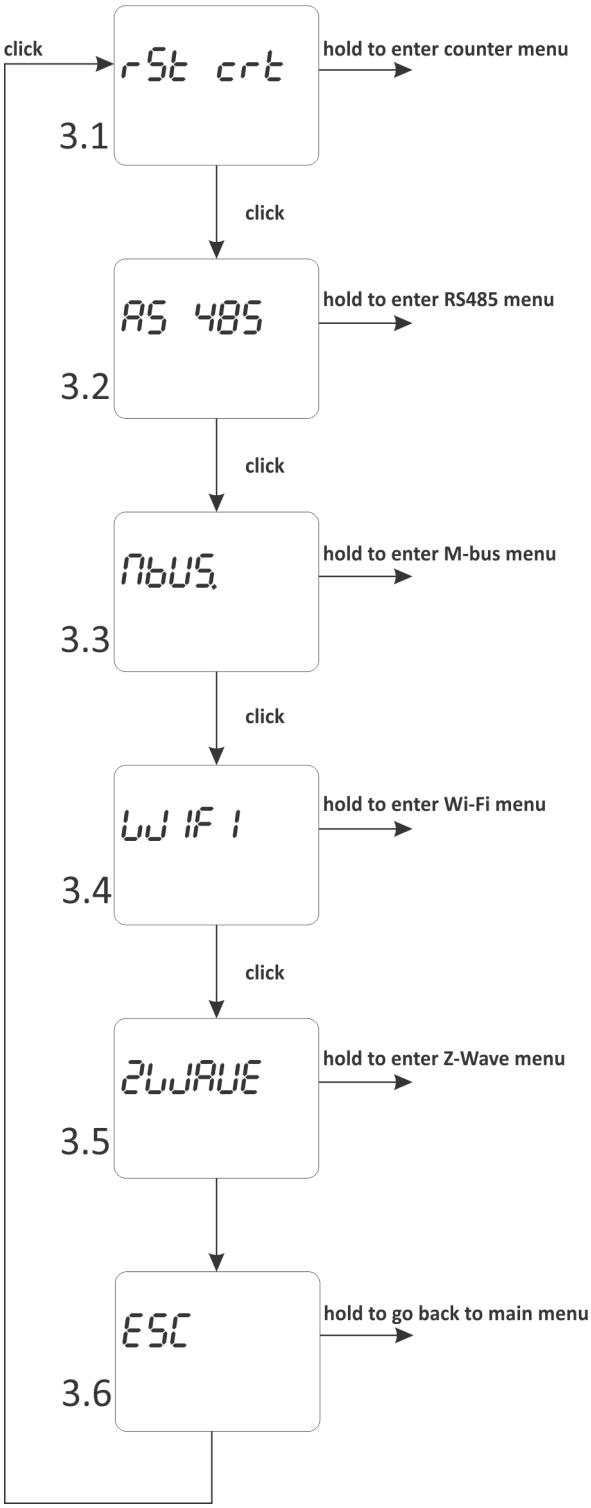
#### *3.2.3.1.6 Power factor, power angle and frequency menu*




Holding button on any of screens 2.6.1 through 2.6.6 sets this screen as a meter screen.

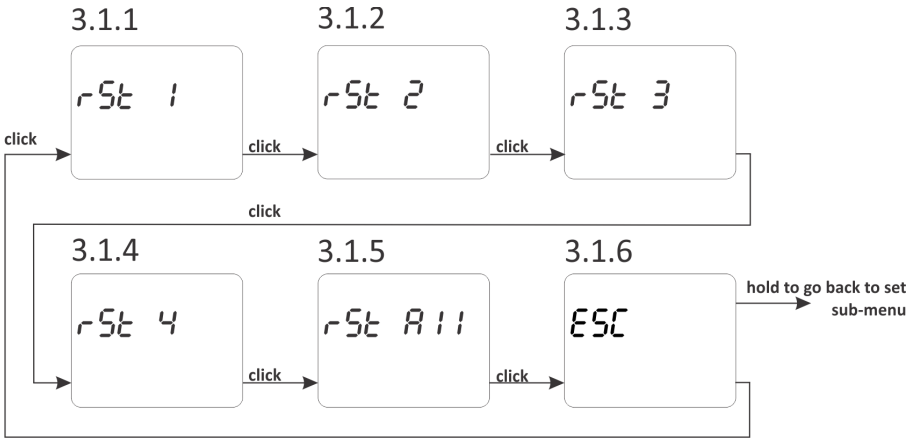
### *3.2.3.2 Set sub-menu*

When in set sub-menu, short clicks move user through it, allowing her/him to select a dedicated menu.



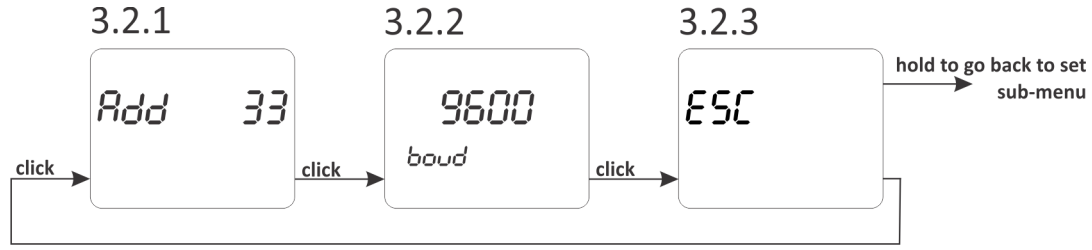

The screens 3.2 to 3.4 appear only in case the actual option is available on the meter.

#### *3.2.3.2.1 Reset counters menu*



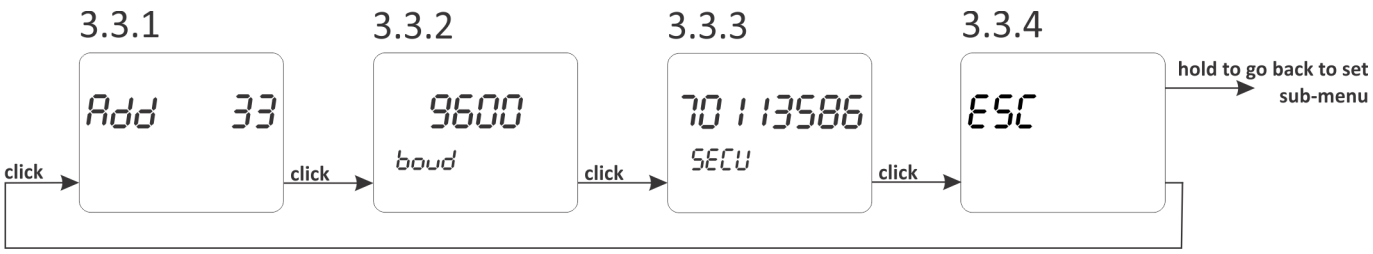

Holding button on any of screens 3.1.1 through 3.1.5 resets any of counters or all of them respectively.

#### *3.2.3.2.2 RS485 menu*




Screen 3.2.1 shows the address of RS 485 communication and screen 3.2.2 shows the baud rate.

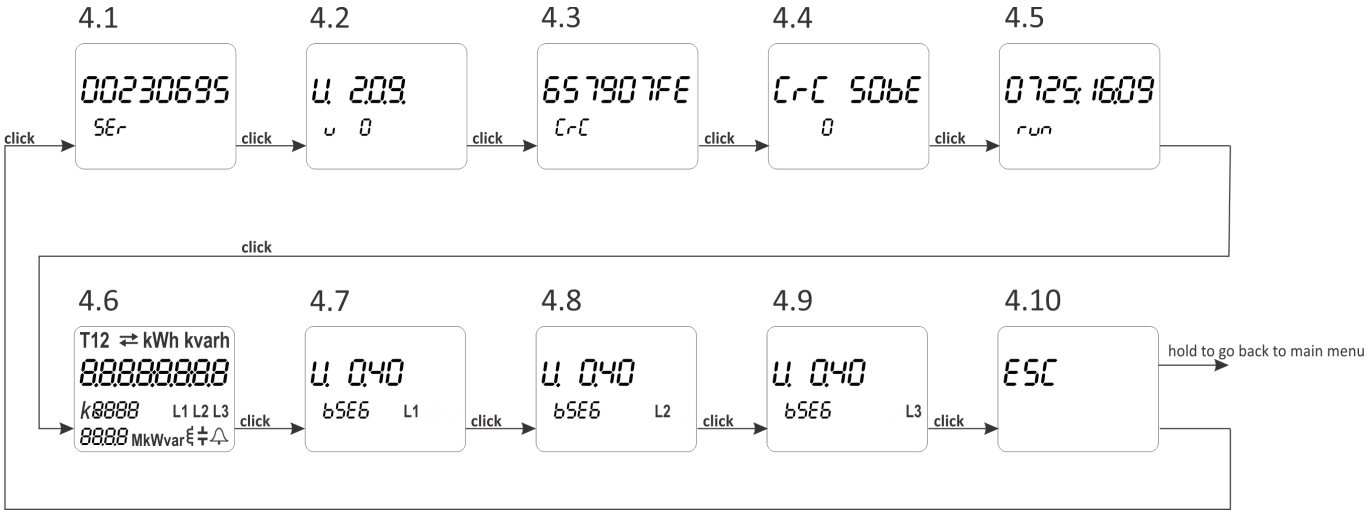
#### *3.2.3.2.3 M-bus menu*




Screens 3.3.1 shows the primary address of M-bus communication, screen 3.3.2 shows baud rate and screen 3.3.3 shows the secondary address.

### *3.2.3.4 Info sub-menu*

When in info sub-menu, short clicks move user through it, allowing her/him to get required information about smart meter.




Screen 4.1 shows the serial number of the smart meter.

Screen 4.2 shows the software version present on the smart meter and below the number of Firmware upgrades.

Screen 4.3 shows CRC32 of code.

Screen 4.4 shows CRC of parameters and below the number of times the smart meter 3MEM65 (MID version) was unlocked.

Screen 4.5 shows operating time (days:hour:minute) of the smart meter.

Screen 4.6 shows initial LCD screen with al segments on.

Screens 4.7 through 4.9 show software versions and below CRC of code of each phase modules.

### *3.2.4 Set device ModBus address*

Non configured devices have the same factory Modbus address set to 33. One of the options for changing the Modbus address is the following. Holding the button for more than 6 seconds, the energy meter will switch to Modbus address configuration mode (you will see the screen below).


During this time, the 3MEM65 responds to the 149 address via the ModBus. The device remains in configuration mode until the ModBus address is modified or when 3 minutes pass or with a long press of 1 second to 3 seconds.
The purpose of the procedure is to modify Modbus address in case if you want to connect more devices with the same address to the RS485 network.

## 3.3 Limits

3MEM65 has a built-in limit function which can control the bistable relay using IR communication. The user can set one or two logically combined limits.

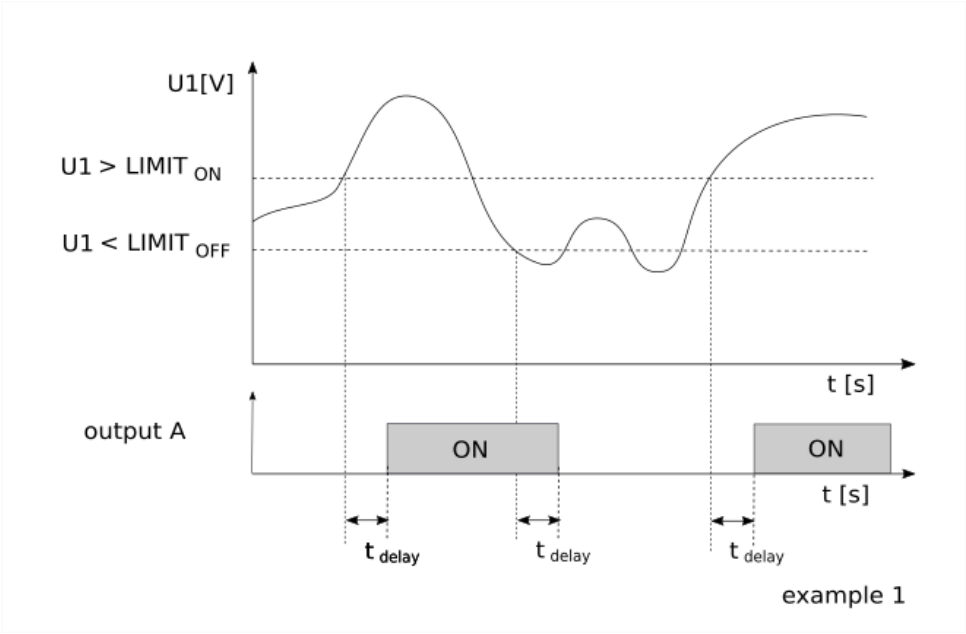
1 The following logic operations can be selected:
- Limit A
- Limit B
- Limit A AND Limit B
- Limit A OR Limit B

2 Limit function can monitor the following measured values:
- Voltages: $U_1$, $U_2$, $U_3$, $U_{12}$, $U_{23}$, $U_{13}$
- Currents: $I_1$, $I_2$, $I_3$
- Active power: $P_{tot}$, $P_1$, $P_2$, $P_3$
- Reactive Power: $Q_{tot}$, $Q_1$, $Q_2$, $Q_3$
- Apparent Power: $A_{tot}$, $A_1$, $A_2$, $A_3$
- Power Factor: $PF_{tot}$, $PF_1$, $PF_2$, $PF_3$
- Frequency
- Energy: Counter1, Counter2, Counter3, Counter4

Limits can be set by setting the correct Modbus registers.

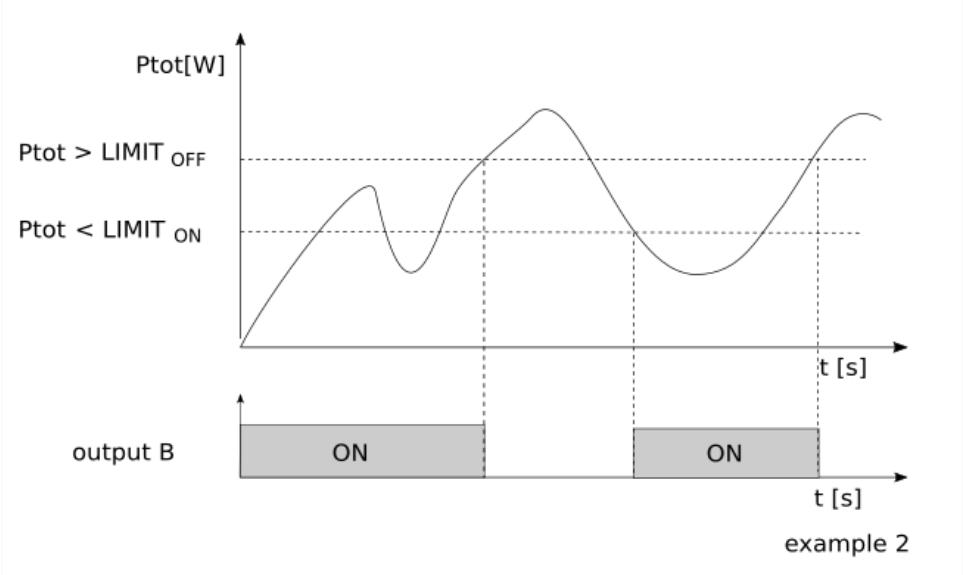
### 3.3.1 Limit A

User can set the ON state of an output A, when the threshold is reached (any from the above specified measured values can be set as a threshold). Likewise the OFF state can be set, when the same measured value falls below the OFF state threshold. Optionally the delay time can be set (the time between reaching a threshold and setting output A).
Figure below (example 1) shows the example using U1 as a limit A and delay time $t_{delay}$.




### 3.3.2 Limit B

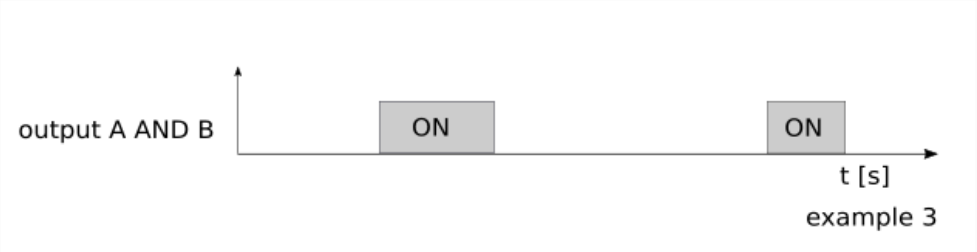
User can set the OFF state of an output B, when the threshold is reached (any from the above specified measured values can be set as a threshold). Likewise the ON state can be set, when the same measured value falls below the ON state threshold. Optionally the delay time can be set (the time between reaching a threshold and setting output B).
Figure below (example 2) shows the example using Ptot as a limit B and no delay time.



## *Limit A AND Limit B*

Limit A AND Limit B is a logical operation, which sets the output A AND B ON, when both output A and output B are in ON.

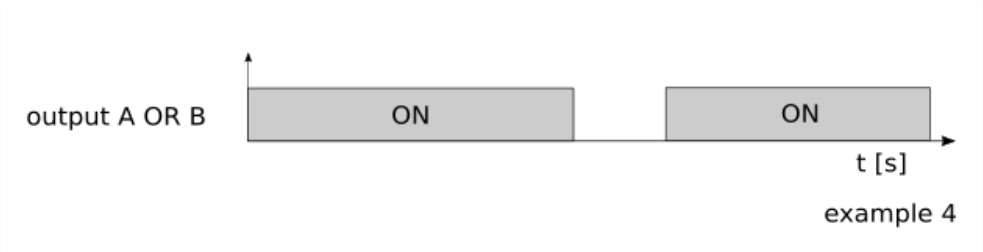
Figure below (example 3) shows the example of output A AND B being ON. For clearer picture refer also to output A (example 1) and output B (example 2) figures.



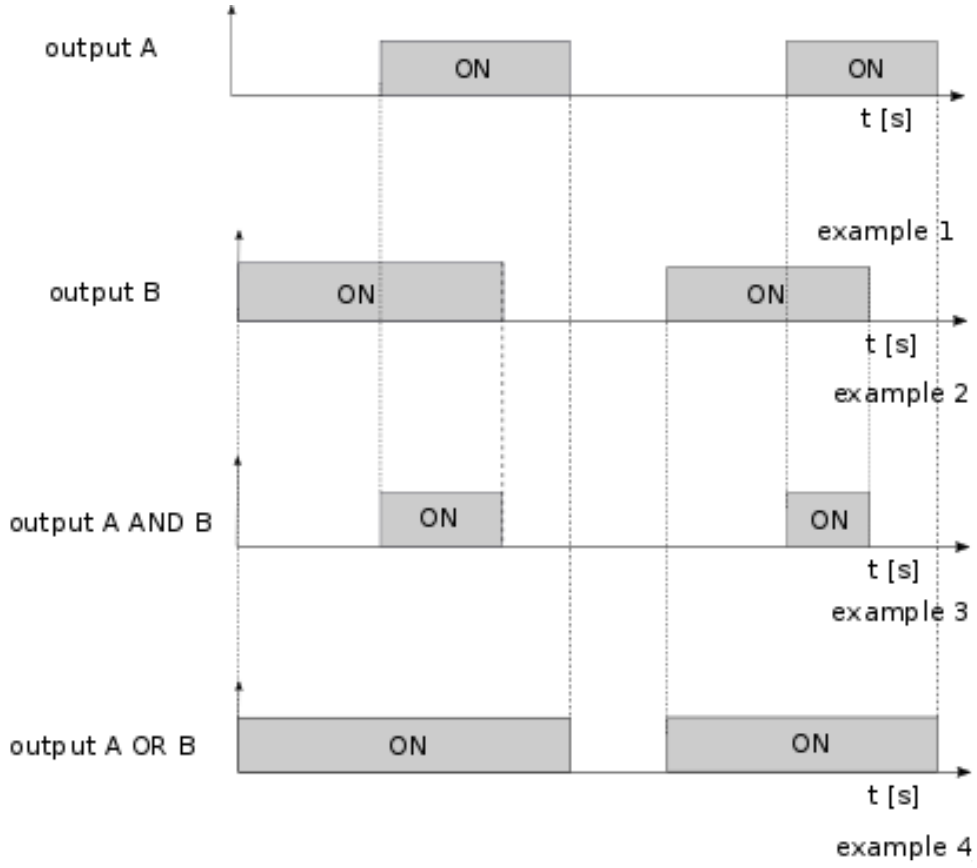

## *Limit A OR Limit B*

Limit A OR Limit B is a logical operation, which sets the output A OR B ON, when any of output A or output B is ON.

Figure below (example 4) shows the example when output A OR B is ON. For clearer picture refer also to output A (example 1) and output B (example 2) figures.




Below graphical representation of both output A AND B as well as output A OR B.



## Following Modbus registers define Limit function:

| Address | | Contents | Data | Ind | Values | min | max | P. Level |
|---|---|---|---|---|---|---|---|---|
| | | **LIMIT** | | | | | | |
| 40187 | | **Limits enabled** | T1 | 0 | None | | | |
| | | | | 1 | Limit 1 | | | |
| | | | | 2 | Limit 2 | | | |
| | | | | 3 | Limit 1 OR Limit 2 | | | |
| | | | | 4 | Limit 1 AND Limit 2 | | | |
| 40188 | | **Display notification** | T1 | 0 | None | 0 | 2 | 2 |
| | | | | 1 | Relay ON | | | |
| | | | | 2 | Relay OFF | | | |
| 40189 | | **Limit 1: Parameter** | T1 | | See OutTypes | | | |
| 40190 | | **Limit 1: Compare relation** | T1 | 0 | measurement > limit | 0 | 1 | 2 |
| | | | | 1 | measurement < limit | | | |
| 40191 | | **Limit 1: ON level** | T17 | | % of parameter value | -300 | 300 | 2 |
| 40192 | | **Limit 1: OFF level** | T17 | | % of parameter value | -300 | 300 | 2 |
| 40193 | | **Limit 1: Compare time delay** | T1 | | seconds | 0 | 600 | 2 |
| 40194 | 40198 | **Limit 2** | | | see Limit 1 | | | |

## OutTypes:

| Code | Ident | Parameter | | Limit | WM1-6 | 3MEM65 | Value 100% |
|---|---|---|---|---|---|---|---|
| 1 | U | U | U | * | * | | Un |
| 2 | U1 | U1 | U1 | * | | * | Un |
| 3 | U2 | U2 | U2 | * | | * | Un |
| 4 | U3 | U3 | U3 | * | | * | Un |
| 5 | U12 | U12 | U12 | * | | * | Un |
| 6 | U23 | U23 | U23 | * | | * | Un |
| 7 | U31 | U31 | U31 | * | | * | Un |
| 9 | I | I | I | * | * | | In |
| 10 | I1 | I1 | I1 | * | | * | In |
| 11 | I2 | I2 | I2 | * | | * | In |
| 12 | I3 | I3 | I3 | * | | * | In |
| 16 | P | P | Active Power P | * | * | * | Pn |
| 17 | P1 | P1 | Active Power Phase L1 (P1) | * | | * | Pn |
| 18 | P2 | P2 | Active Power Phase L2 (P2) | * | | * | Pn |
| 19 | P3 | P3 | Active Power Phase L3 (P3) | * | | * | Pn |
| 20 | Q | Q | Reactive Power Q | * | * | * | Pn |
| 21 | Q1 | Q1 | Reactive Power Phase L1 (Q1) | * | | * | Pn |
| 22 | Q2 | Q2 | Reactive Power Phase L2 (Q2) | * | | * | Pn |
| 23 | Q3 | Q3 | Reactive Power Phase L3 (Q3) | * | | * | Pn |
| 24 | S | S | Apparent Power S | * | * | * | Pn |
| 25 | S1 | S1 | Apparent Power Phase L1 (S1) | * | | * | Pn |
| 26 | S2 | S2 | Apparent Power Phase L2 (S2) | * | | * | Pn |
| 27 | S3 | S3 | Apparent Power Phase L3 (S3) | * | | * | Pn |
| 28 | PF | PF | Power Factor PF | * | * | * | 1 |
| 29 | PF1 | PF1 | Power Factor Phase 1 (PF1) | * | | * | Pn |
| 30 | PF2 | PF2 | Power Factor Phase 2 (PF2) | * | | * | Pn |

| Code | Ident | Parameter | | Limit | WM1-6 | 3MEM65 | Value 100% |
|---|---|---|---|---|---|---|---|
| 31 | PF3 | PF3 | Power Factor Phase 3 (PF3) | * | | * | Pn |
| 36 | PA | PA | PA angle between U and I | * | * | * | 100° |
| 37 | PA1 | PA1 | j1 (angle between U1 and I1) | * | | * | 1 |
| 38 | PA2 | PA2 | j2 (angle between U2 and I2) | * | | * | 1 |
| 39 | PA3 | PA3 | j3 (angle between U3 and I3) | * | | * | 1 |
| 40 | A12 | fi U12 | j12 (angle between U1 and U2) | * | | * | 100° |
| 41 | A23 | fi U23 | j23 (angle between U2 and U3) | * | | * | 100° |
| 42 | A31 | fi U31 | j31 (angle between U3 and U1) | * | | * | 100° |
| 43 | f | f | Frequency | * | * | * | 100%=Fn+10Hz, 0%=Fn, -100%=Fn-10Hz |
| 70 | E1 | E1 | Energy Counter 1 (resettable) | * | * | * | (32-bit value) MOD 20000 |
| 71 | E2 | E2 | Energy Counter 2 (resettable) | * | * | * | (32-bit value) MOD 20000 |
| 72 | E3 | E3 | Energy Counter 3 (resettable) | * | * | * | (32-bit value) MOD 20000 |
| 73 | E4 | E4 | Energy Counter 4 (resettable) | * | * | * | (32-bit value) MOD 20000 |

Un = Modbus register 30015

In = Modbus register 30017

Pn = Un * In

Fn = 55 Hz

## 3.4 Freeze counters

### 3.4.1 Meaning

Since 3MEM65 energy meter does not support internaly synchronised real-time clock (RTC) for the purpose of simultaneous capture of measurements, the freeze function is implemented. Use is enabled only when the meter is on.

Freeze function enables using 3MEM65 smart meters for billing or sub-billing purposes and to compare sub-metering data with main energy meter. Reading several hundred serially connected counters can last more than 10 minutes. That is why 3MEM65 supports command Freeze counters. Its purpose is to freeze data simultaneously on all devices in the network.

The freeze function operation is also performed in case of device power supply failure or device reset.

### 3.4.2 Set up

To perform the freeze function, the energy meters should be connected to the serial communication RS485 and belonging software which use Modbus registers.

The energy meter 3MEM65 enables several ways to activate freeze function:

- Freeze status register,
- time to freeze register,
- auto freeze interval register.

### 3.4.3 Time to freeze register (41902)

The purpose of the time to freeze register is to freeze all energy meters simultaneously. Set the number of time to freeze register (41902), the value of appropriate time (in seconds) before the time of the freeze and time of the freeze. After an expired time, the freeze command is executed automatically. Due to unreliability in communication, it is recommended that the desired time is sent more than ones, to ensure that freeze is simultaneous on all instruments. The desired time need to be sent in the interval of one minute.

For example, if you want that freeze function is executed at 10 am, run the command seven times, starting 7 s before 10 am and repeat it with a one second interval (see the picture below).


All instruments that received one of the commands will freeze at the same time. This is the advantage of the described register, so it is recommended to use it.

It is also possible to individually enter the appropriate time in register 41902 of each instrument.

### 3.4.4 Auto freeze interval register (41901)

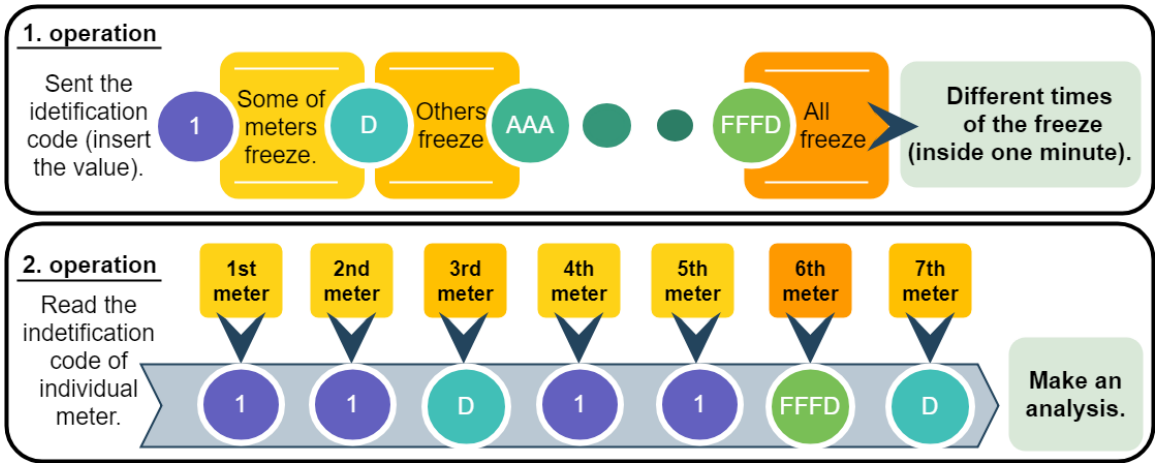
The purpose of the auto freeze interval register is to freeze energy meters in the same time interval, for example, every day. Set the certain auto freeze interval (in minutes). Maximum allowed value is 65535 minutes. Periodic synchronization is activated automatically after the entered interval. If the interval is set to 0, the auto freeze interval function is turned off.

The disadvantage of this register is that the time is not appropriate if the meters reset or in case of another failure.

### 3.4.5 Status register of freeze (41905)

The purpose of the status register is to test the reliability of RS485 communication. Enter the broadcast command of different identification codes between 1 to FFFD in the freeze status register (41905). Repeatedly send a different identification code to the freeze status register (41905) in order to increase the reliability of receiving commands. The reliability of reading different numbers of identification code enables analysis of communication reliability. In the case of 100% reliability of communication, all instruments have the value of the first sent identification code, when reading the status register.

After the instrument receives the identification code, it ignores all entries in the status register in the interval of one minute. Send as many different identification codes in a short time interval. For example, send the different identification codes ten times within one second. Use numbers from 1 to FFFD (1 - 65533). For example, first use value 1, then D, AAA and at the end FFFD (see picture below). Please note that you never know if all the meters will freeze, so send as many commands as possible within one minute.




**PLEASE NOTE**

*Please do not use the values 0000, FFFF or FFFE. The 0000 is reserved to start the meter when connected to the power supply. Freeze function is performed. The FFFF is reserved to trigger freezing function automatically (same as time to freeze register 41902). The FFFE is reserved for the auto interval freeze.*

Send the command for reading the register, so you can see which identification code has been accepted by the individual instrument. The server calculates time from a freeze of the device.

### 3.4.6 Access and interpretation of data

After the execution of the freeze command, the counters are stored into registers 41906 to 41938, which can be read by the master. Register 41906 displays frozen tariff counter and registers 41907 to 41938 display frozen energy counters (1 - 16). The data we read on all devices can this way be compared. Encoded information should be read with Modbus table (see Appendix A).

In addition, the time since the last freeze can be checked with time from freeze register (41903, 41904). The purpose of these register is to control if displayed measurements are relevant. The register contains time (in seconds) from the last freeze counters executio

# 4 MEASUREMENTS

The ***3MEM65*** is bidirectional energy meter measures voltage and current. From which it is able to calculate two quantities, imported and exported energy. The ***3MEM65*** energy meter performs measurements with a sampling frequency equal to 3906,25 Hz.

## 4.1 Selection of available quantities

Microprocesor calculates the RMS voltage, RMS current, active, reactive and apparent power, U-I phase angle, first harmonic of voltage, first harmonic of current, peak to peak voltage, THD of voltage and THD of current. Complete selection of available online measuring quantities is shown in a table below.

| Meas. type | Measurement | 3-phase | comments |
|---|---|---|---|
| Phase measurements | Voltage | | |
| | $U_{1\text{-}3\_RMS}$ | ☑ | |
| | Current | | |
| | $I_{1\text{-}3\_RMS}$ | ☑ | |
| | Power | | |
| | $P_{1\text{-}3\_RMS}$ | ☑ | |
| | $P_{TOT\_RMS}$ | ☑ | |
| | $Q_{1\text{-}3\_RMS}$ | ☑🕮 | Reactive power can be calculated as a squared difference between S and P or as sample delayed |
| | $Q_{TOT\_RMS}$ | ☑ | |
| | $S_{1\text{-}3\_RMS}$ | ☑ | |
| | $S_{TOT\_RMS}$ | ☑ | |
| | $PF_{1\text{-}3\_RMS}$ | ☑ | |
| | $PF_{TOT}$ | ☑ | |
| | $\varphi_{1\text{-}3\_RMS}$ | ☑ | |
| | $\varphi_{TOT\_RMS}$ | ☑ | |
| | Harmonic analysis | | |
| | THD-$U_{1\text{-}3}$ | ☑ | |
| | THD-$I_{1\text{-}3}$ | ☑ | |
| Phase to phase measurements | Voltage | | |
| | $Upp_{1\text{-}3\_RMS}$ | ☑ | |
| | $\varphi_{x\text{-}y\_RMS}$ | ☑ | Phase-to-phase angle |
| Metering | Energy | ☑ | |
| | Counter $E_{1\text{-}8}$ | ☑ | Each counter can be dedicated to any of four quadrants (P-Q, import-export, L-C). Total energy is a sum of one counter for all tariffs. Tariffs can be fixed, date/time dependent or tariff input dependent |
| | Active tariff | ☑ | |
| Other measurements | Miscellaneous | | |
| | Frequency | | |
| Status | Checksum status | | |
| | External relay status | | |
| | Limit control status | | |

🕮 Further description is available in following subchapters

***Table 2:*** *Selection of available measurement quantities*

## 4.2 Calculation and display of measurements

This chapter deals with capture, calculation and display of all supported measurement quantities. For more information about display presentation see chapter 3.2 LCD User Interface. Only the most important equations are described; however, all of them are shown in a chapter APPENDIX C: EQUATIONS with additional descriptions and explanations.

### *4.2.1 Voltage*

Voltage related measurements are listed below:

- Real effective (RMS) value of all phase voltages ($U_1$, $U_2$, $U_3$) and phase-to-phase voltages ($U_{12}$, $U_{23}$, $U_{31}$).
- Phase and phase-to-phase voltage angles ($\varphi_{12}$, $\varphi_{23}$, $\varphi_{31}$)

$$U_f = \sqrt{\frac{\sum_{n=1}^{N} u_n^2}{N}}$$

$$U_{xy} = \sqrt{\frac{\sum_{n=1}^{N} (u_{xn} - u_{yn})^2}{N}}$$

All voltage measurements are available through communication as well as on standard or customized displays.

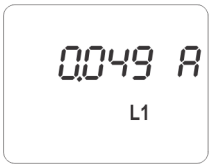

### *4.2.2 Current*

3MEM65 energy meter measures:

- real effective (RMS) value of phase currents

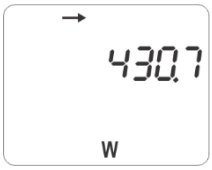
$$I_{RMS} = \sqrt{\frac{\sum_{n=1}^{N} i_n^2}{N}}$$

All current measurements are available on communication as well as standard and customized displays on LCD.




### *4.2.3 Active, reactive and apparent power*

Active power is calculated from instantaneous phase voltages and currents. All measurements are seen on communication or are displayed on LCD. For more detailed information about calculation see chapter APPENDIX C: EQUATIONS.



### 4.2.4 Power factor and power angle

PF or distortion power factor is calculated as the quotient of active and apparent power for each phase separately and total power angle. It is called distortion power factor since true (distorted) signals are using in equation (all equations are presented in chapter APPENDIX C: EQUATIONS). A symbol for a coil (positive sign) represents inductive load and a symbol for a capacitor (negative sign) represents capacitive load.

### 4.2.5 Frequency

Network frequency is calculated from time periods of measured voltage. Instrument uses synchronization method, which is highly immune to harmonic disturbances.

### 4.2.6 Energy counters

Two different variants of displaying Energy counters are available:

- by individual counter,
- by tariffs for each counter separately.

### 4.2.7 Harmonic distortion

3MEM65 energy meter calculates THD for phase currents and phase voltages and is expressed as percent of high harmonic components regarding to fundamental harmonic.

# 5 TECHNICAL DATA

In following chapter all technical data regarding operation of a three-phase electrical energy meter is presented.

## 5.1 Accuracy

| *Measured values* | *Accuracy class* |
|---|---|
| ***Active energy:*** | *class 1 EN 62053-21* |
| | *class B EN 50470-3* |
| | *±1.5% from $I_{min}$ to $I_{tr}$* |
| | *±1% from $I_{tr}$ to $I_{max}$* |
| ***Reactive energy:*** | *class 2 EN 62053-23* |
| | *±2.5% from $I_{min}$ to $I_{tr}$* |
| | *±2% from $I_{tr}$ to $I_{max}$* |
| ***Voltage:*** | *±1% of measured value* |
| ***Current:*** | *±1% of $I_{ref}$ from $I_{st}$ to $I_{ref}$* |
| | *±1% of measured value from $I_{ref}$ to $I_{max}$* |
| ***Active Power:*** | *±1% of nominal power ($U_n * I_{ref}$) from $I_{st}$ to $I_{ref}$* |
| | *±1% of measured value from $I_{ref}$ to $I_{max}$* |
| ***Reactive, Apparent power:*** | *±2% of nominal power from $I_{st}$ to $I_{ref}$* |
| | *±2% of measured value from $I_{ref}$ to $I_{max}$* |
| ***Frequency:*** | *±0.5% of measured value* |

## 5.2 Mechanical characteristics of input

Rail mounting according DIN EN 60715. In case of using the stranded wire, the ferrule must be attached before the mounting.

| ***Terminals*** | | ***Max. conductor cross-sections*** |
|---|---|---|
| ***Main inputs*** | *Contacts capacity:* | *2.5 $mm^2$ ... 25 (16) $mm^2$* |
| | *Connection screws:* | *M5* |
| | *Recommended / Max torque:* | *3/3.5 Nm (PZ2)* |
| | *Length of removed isolation:* | *10 mm* |
| ***Optional modules*** | *Contacts capacity:* | *1 mm²... 2.5 mm²* |
| | *Connection screws:* | *M3* |
| | *Recommended / Max torque:* | *0.7/0.8 Nm (PZ1)* |
| | *Length or removed isolation:* | *8 mm* |

## 5.3 Electrical characteristics of input

| ***Inputs and outputs*** | | |
|---|---|---|
| ***Measuring input*** | *Type (connection):* | *three-phase (4u)* |
| | *Reference current ($I_{ref}$)* | *5 A* |
| | *Maximum current ($I_{max}$):* | *65 A* |
| | *Minimum current ($I_{min}$):* | *0.25 A* |
| | *Transitional current ($I_{tr}$):* | *0.5 A* |
| | *Starting current:* | *20 mA* |
| | *Power consumption at $I_{ref}$* | *0.1 VA* |
| | *Nominal voltage ($U_n$):* | *230 V (-20 - +15)%* |
| | *Power consumption per phase at $U_n$:* | *< 8 VA* |
| | *Nominal frequency ($f_n$):* | *50 Hz and 60 Hz* |
| | *Minimum measuring time:* | *10 s* |

| | | |
|---|---|---|
| ***Pulse output (option)*** | *Pulse rate:* | *1000 imp/kWh* |
| | *Pulse duration:* | *32 ms ± 2 ms* |
| | *Rated voltage DC:* | *27 V max* |
| | *Switched current* | *27 mA max* |
| | *Standard:* | *EN 62053-31 (A&B)* |
| ***M-BUS Serial communication (option)*** | *Type:* | *M-BUS* |
| | *Speed:* | *300 bit/s to 9600 bit/s (default 2400 bit/s)* |
| | *Protocol:* | *M-BUS* |
| | *Primary address:* | *0 – (default)* |
| ***RS485 Serial communication (option)*** | *Type:* | *RS485* |
| | *Speed:* | *1200 bit/s to 19200 bit/s (default 38400 bit/s)* |
| | *Frame:* | *8, N, 2* |
| | *Protocol:* | *MODBUS RTU* |
| | *Address:* | *33 – (default)* |
| ***Optical communication*** | *Type:* | *IR* |
| | *Connection:* | *via WM-USB adapter* |
| | *Speed:* | *19200 bit/s* |
| | *Frame:* | *8, N, 2* |
| | *Protocol:* | *MODBUS RTU* |
| | *Address:* | *33* |
| | *Remark:* | *All settings are fixed* |
| ***Tariff input (option)*** | *Rated voltage:* | *230 V (+15 %- 20 %)* |
| | *Input resistance:* | *450 kOhm* |
| | *Rated voltage:* | *230 V (+15 %- 20 %)* |
| | *Maximum load current:* | *50 mA* |

## 5.4 Safety and ambient conditions

According to standards for indoor active energy meters.

Temperature and climatic condition according to EN 62052-11.

| | |
|---|---|
| ***Dust/water protection:*** | *IP50 (For IP51 it should be installed in appropriate cabinet.)* |
| ***Operating temperature:*** | *-25 °C - +55 °C (non-condensig humudity)* |
| ***Storage temperature:*** | *-40 °C - + 70 °C* |
| ***Enclosure:*** | *self extinguish, complying UL94-V* |
| ***Indoor meter:*** | *Yes* |
| ***Degree of pollution:*** | *2* |
| ***Protection class:*** | *II* |
| ***Installation category*** | *300 Vrms cat.III* |
| ***Standard:*** | *IEC 62052-31* |
| ***Mechanical environment:*** | *M1* |
| ***Electromagnetic environment:*** | *E2* |
| ***Humidity:*** | *non condensing* |
| ***Weight (with packaging):*** | *216 g (230 g)* |
| ***Installation:*** | *DIN Rail 41 mm* |
| ***Dimensions (W x H x D):*** | *53,6 mm x 84 mm x 64 mm (69 mm)* |
| ***Package dimensions (W x H x D):*** | *57 mm x 93 mm x 85 mm* |
| ***Colour:*** | *RAL 7035* |

## 5.5 EU directives conformity

### *5.5.1 3MEM65 MID certified meters*

MID approval applies to non-resettable active energy counters.

EU Directive on Measuring Instruments **2014/32/EU**

EU Directive on EMC **2014/30/EU**

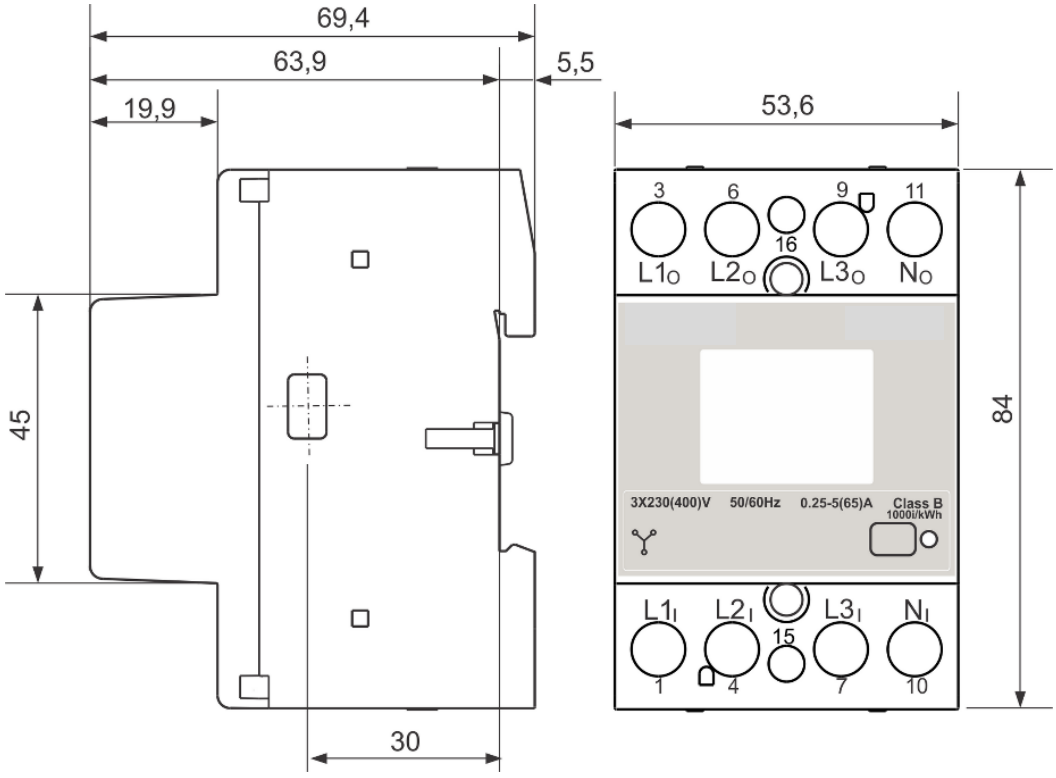
EU Directive on Low Voltage **2014/35/EU**

EU Directive WEEE **2002/96/EC**

EU RED Directive **2014/53/EU**

## 5.6 Dimensions

### *5.6.1 Dimensional drawing*

| ***Construction*** | ***Appearance*** |
|---|---|
| ***Dimensions*** | All dimensions are in mm   |

# 6 ABBREVIATION/GLOSSARY

Abbreviations are explained within the text where they appear the first time. Most common abbreviations and expressions are explained in the following table:

| ***Term*** | ***Explanation*** |
|---|---|
| *MODBUS* | *Industrial protocol for data transmission* |
| *AC* | *Alternating quantity* |
| *IR* | *Infrared (optical) communication* |
| *RMS* | *Root Mean Square* |
| *PO* | *Pulse output* |
| *PA* | *Power angle (between current and voltage)* |
| *PF* | *Power factor* |
| *THD* | *Total harmonic distortion* |
| | |

*List of common abbreviations and expressions*

# 7 APPENDICES

## 7.1 Appendix A: MODBUS communication protocol

Modbus protocol enables operation of device on Modbus networks. For 3MEM65\3MEM65 with serial communication the Modbus protocol enables multi drop communication via RS485 communication. Modbus protocol is a widely supported open interconnect originally designed by Modicon.
The memory reference for input and holding registers is 30000 and 40000 respectively.

**PLEASE NOTE**

*The Modbus table is subject to change without notice. For the latest and complete Modbus table please visit ETI web page.*

Communication operates on a master-slave basis where only one device (the master) can initiate transactions called 'Requests'. The other devices (slaves) respond by supplying the requested data to the master. This is called the 'Request - Response Cycle'.
The master could send the MODBUS request to the slaves in two modes:

- **Unicast mode**, where the master sends the request to an individual slave. It returns a replay to the master after the request is received and processed. A MODBUS transaction consists of two messages. Each slave should have an unique address.
- **Broadcast mode**, where the master sends a request to all slaves and an answer is never followed. All devices should accept the broadcast request function. The Modbus address 0 is reserved to identify the broadcast request.

### Master to Slave Request

| Device address | Function Code | nx8 bit data bytes | Error check |
|---|---|---|---|

### Slave to Master Response

| Device address | Function Code | nx8 bit data bytes | Error check |
|---|---|---|---|

### Request

This Master to Slave transaction takes the form:

- **Device address**: master addressing a slave (Address 0 is used for the broadcast address, which all slave devices recognize.)
- **Function code** e.g. 03 asks the slave to read its registers and respond with their contents.
- **Data bytes**: tells the slave which register to start at and how many registers to read.

### Response

This Slave to Master transaction takes the form:

- **Device address**: to let the master know which slave is responding.
- **Function code**: this is an echo of the request function code.
- **Data bytes**: contains the data collected from the slave.

### Request Frame

| | | Starting Register | Register Count | CRC |
|---|---|---|---|---|
| Slave | Function | HI LO | HI LO | LO |
| 21 | 04 | 00 6B | 00 02 | |

### Response Frame

| | | | Register Data | CRC |
|---|---|---|---|---|
| Slave Address | Function Code | Byte Count | HI LO HI LO | LO HI |
| 21 | 04 | 04 | FE 00 59 96 | |

### Request- response cycle example

Address number of slave: 21
Function code: 04 → 30000
Starting register HI…LO: 00…$6B_{(16)}$ → $107_{(10)}$ +$30000_{(10)}$ = **$30107_{(10)}$** (Meaning that actual measurement is U1. For further informations *see REGISTER TABLE FOR THE ACTUAL MEASUREMENTS*.)
Register count HI…LO: 00…$02_{(16)}$ → $2_{(10)}$ (Two registers: 30107 and 30108)
Data type: T5 (Unsigned Measurement (32 bit) – *see table of DATA types decoding*)
Register data: FE 00 59 $74_{(16)}$ → $22934 * 10^{-2}$ V = **229,34 V**

## REGISTER TABLE FOR THE ACTUAL MEASUREMENTS

The tables below represent the complete set of MODBUS register map. Register refresh frequency for actual measurement from register 30105 to register 30190 is one second. Register refresh frequency for energy counters (from 30406 to 30441) is 40 ms. The registers from 30426 to 30441 (1000 x Energy Counter from 30406 to 30413 and from 30418 to 30425) represent the same energy counters at 1000-times higher resolution. This registers cam be read to calculate the energy difference in the time interval more accurate.

### INFO REGISTERS

| Address | | Contents | Data | Ind | Values / Dependencies |
|---|---|---|---|---|---|
| | | Input Registers | | | |
| | | READ ONLY INFO | | | |
| 30000 | | Device group | T1 | 4 | WM |
| 30001 | 30008 | Model Number | T_Str16 | | 3MEM65 Energy |
| 30009 | 30012 | Serial Number | T_Str8 | | WM###### |
| 30013 | | Software Reference | T1 | | 100=1.00 |
| 30014 | | Hardware Reference | T_Str2 | | A (B,C,D…) |
| 30015 | | Calibration voltage | T4 | | 230 V |
| 30017 | | Calibration current | T4 | | 65 A |
| 30019 | | Accuracy class | T17 | | 100=1.0 |
| 30020 | | MiNet Flag | T1 | 0 | |
| 30024 | | COM1: Communication Type | T1 | 2 | RS485 |
| | | | | 9 | Infra-red |
| | | | | 13 | M-BUS |

| | | | | | |
|---|---|---|---|---|---|
| | | READ ONLY INFO | | | |

| Address | | Contents | Data | Ind | Values / Dependencies |
|---|---|---|---|---|---|
| | | Input Registers | | | |
| 30029 | | I/O 1 | T1 | 0 | No I/O |
| | | | | 5 | Tariff Input |
| | | | | 10 | Digital input |
| 30030 | | I/O 2 | T1 | 0 | No I/O |
| | | | | 12 | Pulse Output (SO) |
| | | | | 26 | Load control Output |
| 30047 | 30048 | Calibration Time Stamp | T10 | | |
| 30051 | | Digital input voltage range | T1 | 0 | 230V |
| | | | | 1 | 63V - 110V |
| 30052 | | Digital input 2 voltage range | T1 | | See Digital input 1 voltage range |
| 30076 | | MID lock status | T1 | 0 | unlocked |
| 30079 | | MID unlock counter | T1 | | |
| 30080 | | FW upgrade counter | T1 | | |
| 30081 | | Software Checksum HI | T1 | | |
| 30082 | | Software Checksum LO | T1 | | == reg. 30097 |
| 30087 | | phase module 1 Software reference | T1 | | 100=1,0 |
| 30088 | | phase module 2 Software reference | T1 | | 100=1,0 |
| 30089 | | phase module 3 Software reference | T1 | | 100=1,0 |
| 30090 | | phase module 0 CheckSum | T1 | | |
| 30091 | | phase module 1 CheckSum | T1 | | |
| 30092 | | phase module 2 CheckSum | T1 | | |
| 30093 | | phase module 1 calibration data CheckSum | T1 | | 100=1,0 |
| 30094 | | phase module 2 calibration data CheckSum | T1 | | 100=1,0 |
| 30095 | | phase module 3 calibration data CheckSum | T1 | | 100=1,0 |
| 30096 | | CheckSum Parameters | T1 | | |
| 30097 | | CheckSum Firmware | T1 | | |
| 30098 | | Active Communication Port | T1 | 0 | IR |
| | | | | 1 | COM1 |
| 30099 | | Modbus Max. Register Read at Once | T1 | | |

## ACTUAL MEASUREMENTS

| Address | | Contents | Data | Ind | Values / Dependencies |
|---|---|---|---|---|---|
| | | Input Registers | | | |
| | | ACTUAL MEASUREMENTS | | | |
| 30101 | | Phase valid measurement | T1 | Bit 0 | Invalid measurement phase 1 |
| | | | | Bit 1 | Invalid measurement phase 2 |
| | | | | Bit 2 | Invalid measurement phase 3 |

| Address | | Contents | Data | Ind | Values / Dependencies |
|---|---|---|---|---|---|
| | | Input Registers | | | |
| | | ACTUAL MEASUREMENTS | | | |
| 30105 | 30106 | Frequency | T5 | | |
| 30107 | 30108 | U1 | T5 | | |
| 30109 | 30110 | U2 | T5 | | |
| 30111 | 30112 | U3 | T5 | | |
| 30113 | 30114 | Uavg (phase to neutral) | T5 | | |
| 30115 | | j12 (angle between U1 and U2) | T17 | | |
| 30116 | | j23 (angle between U2 and U3) | T17 | | |
| 30117 | | j31 (angle between U3 and U1) | T17 | | |
| 30118 | 30119 | U12 | T5 | | |
| 30120 | 30121 | U23 | T5 | | |
| 30122 | 30123 | U31 | T5 | | |
| 30124 | 30125 | Uavg (phase to phase) | T5 | | |
| 30126 | 30127 | I1 | T5 | | |
| 30128 | 30129 | I2 | T5 | | |
| 30130 | 30131 | I3 | T5 | | |
| 30136 | 30137 | Iavg | T5 | | |
| 30138 | 30139 | ∑ I | T5 | | |
| 30140 | 30141 | Active Power Total (Pt) | T6 | | |
| 30142 | 30143 | Active Power Phase L1 (P1) | T6 | | |
| 30144 | 30145 | Active Power Phase L2 (P2) | T6 | | |
| 30146 | 30147 | Active Power Phase L3 (P3) | T6 | | |
| 30148 | 30149 | Reactive Power Total (Qt) | T6 | | |
| 30150 | 30151 | Reactive Power Phase L1 (Q1) | T6 | | |
| 30152 | 30153 | Reactive Power Phase L2 (Q2) | T6 | | |
| 30154 | 30155 | Reactive Power Phase L3 (Q3) | T6 | | |
| 30156 | 30157 | Apparent Power Total (St) | T5 | | |
| 30158 | 30159 | Apparent Power Phase L1 (S1) | T5 | 30158 | 30159 |
| 30160 | 30161 | Apparent Power Phase L2 (S2) | T5 | 30160 | 30161 |
| 30162 | 30163 | Apparent Power Phase L3 (S3) | T5 | 30162 | 30163 |
| 30164 | 30165 | Power Factor Total (PFt) | T7 | 30164 | 30165 |
| 30166 | 30167 | Power Factor Phase 1 (PF1) | T7 | 30166 | 30167 |
| 30168 | 30169 | Power Factor Phase 2 (PF2) | T7 | 30168 | 30169 |
| 30170 | 30171 | Power Factor Phase 3 (PF3) | T7 | 30170 | 30171 |

| Address | | Contents | Data | Ind | Values / Dependencies |
|---|---|---|---|---|---|
| | | Input Registers | | | |
| | | ACTUAL MEASUREMENTS | | | |
| 30172 | | Power Angle Total (atan2(Pt,Qt)) | T17 | | |
| 30173 | | ϕ1 (angle between U1 and I1) | T17 | | Valid: Reg 30001<7 |
| 30174 | | ϕ2 (angle between U2 and I2) | T17 | | |
| 30175 | | ϕ3 (angle between U3 and I3) | T17 | | |
| 30181 | | Internal Temperature | T17 | | |
| 30182 | | U1 THD% | T16 | | |
| 30183 | | U2 THD% | T16 | | |
| 30184 | | U3 THD% | T16 | | |
| 30188 | | I1 THD% | T16 | | |
| 30189 | | I2 THD% | T16 | | |
| 30190 | | I3 THD% | T16 | | |
| 30197 | | External relay status | T1 | 0 | Off |
| | | | | 1 | On |
| | | | | 250 | Comm. Error |
| | | | | 255 | Not connected |
| 30198 | | Load control output status | T1 | 0 | Off |
| | | | | 1 | On |
| 30199 | | Digital input status | T1 | 0 | Off |
| | | | | 1 | On |
| 30200 | | Limit control output status | T1 | 0 | Off |
| | | | | 1 | On |
| | | | | 255 | Disabled |
| 30201 | | Button status | T1 | 0 | Not pressed |
| | | | | 1 | pressed |

| Address | | Contents | Data | Ind | Values / Dependencies |
|---|---|---|---|---|---|
| | | Input Registers | | | |
| | | ENERGY | | | |
| 30400 | | CheckSum Status | T1 | 0 | No Error (OK) |
| | | | | Bit 0 | Error Parameter CRC |
| | | | | Bit 1 | Error Firmware CRC |
| | | | | Bit 2 | Error MID-lock |
| | | | | Bit 3 | Error phase module 1 CheckSum |
| | | | | Bit 4 | Error phase module 2 CheckSum |
| | | | | Bit 5 | Error phase module 3 CheckSum |
| | | | | Bit 6 | Error Measurement module CheckSum |
| | | | | Bit 8 | Error Calibration Data CheckSum |
| | | | | Bit 11 | Error phase module 1 cal. data CheckSum |
| | | | | Bit 12 | Error phase module 2 cal. data CheckSum |
| | | | | Bit 13 | Error phase module 3 cal. data CheckSum |
| 30401 | | Energy Counter 1 Exponent (resettable) | T2 | | |
| 30402 | | Energy Counter 2 Exponent (resettable) | T2 | | |
| 30403 | | Energy Counter 3 Exponent (resettable) | T2 | | |
| 30404 | | Energy Counter 4 Exponent (resettable) | T2 | | |
| 30405 | | Current Active Tariff | T1 | | |
| 30406 | 30407 | Energy Counter 1 (resettable) | T3 | | |
| 30408 | 30409 | Energy Counter 2 (resettable) | T3 | | |
| 30410 | 30411 | Energy Counter 3 (resettable) | T3 | | |
| 30412 | 30413 | Energy Counter 4 (resettable) | T3 | | |
| 30414 | | Energy Counter 1 Exponent (Non-reset) | T2 | | |
| 30415 | | Energy Counter 2 Exponent (Non-reset) | T2 | | |
| 30416 | | Energy Counter 3 Exponent (Non-reset) | T2 | | |
| 30417 | | Energy Counter 4 Exponent (Non-reset) | T2 | | |
| 30418 | 30419 | Energy Counter 1 (Non-reset) | T3 | | |
| 30420 | 30421 | Energy Counter 2 (Non-reset) | T3 | | |
| 30422 | 30423 | Energy Counter 3 (Non-reset) | T3 | | |
| 30424 | 30425 | Energy Counter 4 (Non-reset) | T3 | | |
| 30426 | 30427 | 1000 x Energy Counter 1 (res.) | T3 | | |
| 30428 | 30429 | 1000 x Energy Counter 2 (res.) | T3 | | |
| 30430 | 30431 | 1000 x Energy Counter 3 (res.) | T3 | | |
| 30432 | 30433 | 1000 x Energy Counter 4 (res.) | T3 | | |
| 30434 | 30435 | 1000 x Energy Counter 1 (Non -res.) | T3 | | |
| 30436 | 30437 | 1000 x Energy Counter 2 (Non -res.) | T3 | | |
| 30438 | 30439 | 1000 x Energy Counter 3 (Non -res.) | T3 | | |
| 30440 | 30441 | 1000 x Energy Counter 4 (Non -res.) | T3 | | |
| 34999 | 35000 | Run time | T3 | | seconds |
| | | | | | |

| Address | | Contents | Data | Ind | Values | min | max | P. Level |
|---|---|---|---|---|---|---|---|---|
| | | RAM logger | | | | | | |
| 36000 | | Measurement parameter | T1 | | See OutTypes | | | |
| 36001 | | Time interval | T1 | | minutes | | | |
| 36002 | | Number of valid results | T1 | | | | | |
| 36003 | | Time stamp of last result | T2 | | minutes since midnight (<0 if no time) | | | |
| 36004 | 36515 | Logger table (newest to oldest) | T17 | | Normalised values | | | |

## INTERVAL MEASUREMENTS

Interval measurements are intended for data collection and synchronization of the time for data reading, trough the communication. The time interval of data reading is programmable, by default is one minute. The minimum and maximum measurements could be read within a given time interval.

| Address | | Contents | Data | Ind | Values / Dependencies |
|---|---|---|---|---|---|
| | | Input Registers | | | |
| | | AVERAGE MEASUREMENTS | | | |
| 35500 | | The last Average interval duration | T1 | | Seconds/10 |
| 35501 | | Time since the last average meaurements | T1 | | Seconds/10 |
| 35502 | | Average measurements counter | T1 | | |
| 35503 | 35504 | Timestamp (Run time) | T3 | | '= 0 after reset |
| 35505 | 35506 | Frequency | T5 | | |
| 35507 | 35508 | U1 | T5 | | |
| 35509 | 35510 | U2 | T5 | | |
| 35511 | 35512 | U3 | T5 | | |
| 35513 | 35514 | Uavg (phase to neutral) | T5 | | |
| 35515 | | ϕ12 (angle between U1 and U2) | T17 | | |
| 35516 | | ϕ23 (angle between U2 and U3) | T17 | | |
| 35517 | | ϕ31 (angle between U3 and U1) | T17 | | |
| 35518 | 35519 | U12 | T5 | | |
| 35520 | 35521 | U23 | T5 | | |
| 35522 | 35523 | U31 | T5 | | |
| 35524 | 35525 | Uavg (phase to phase) | T5 | | |
| 35526 | 35527 | I1 | T5 | | |
| 35528 | 35529 | I2 | T5 | | |
| 35530 | 35531 | I3 | T5 | | |
| 35536 | 35537 | Iavg | T5 | | |
| 35540 | 35541 | Active Power Total (Pt) | T6 | | |
| 35542 | 35543 | Active Power Phase L1 (P1) | T6 | | |
| 35544 | 35545 | Active Power Phase L2 (P2) | T6 | | |
| 35546 | 35547 | Active Power Phase L3 (P3) | T6 | | |
| 35548 | 35549 | Reactive Power Total (Qt) | T6 | | |
| 35550 | 35551 | Reactive Power Phase L1 (Q1) | T6 | | |
| 35552 | 35553 | Reactive Power Phase L2 (Q2) | T6 | | |
| 35554 | 35555 | Reactive Power Phase L3 (Q3) | T6 | | |
| 35556 | 35557 | Apparent Power Total (St) | T5 | | |
| 35558 | 35559 | Apparent Power Phase L1 (S1) | T5 | | |
| 35560 | 35561 | Apparent Power Phase L2 (S2) | T5 | | |
| 35562 | 35563 | Apparent Power Phase L3 (S3) | T5 | | |
| 35564 | 35565 | Power Factor Total (PFt) | T7 | | |
| 35566 | 35567 | Power Factor Phase 1 (PF1) | T7 | | |
| 35568 | 35569 | Power Factor Phase 2 (PF2) | T7 | | |
| 35570 | 35571 | Power Factor Phase 3 (PF3) | T7 | | |
| 35572 | | Power Angle Total (atan2(Pt,Qt)) | T17 | | |
| 35573 | | φ1 (angle between U1 and I1) | T17 | | |
| 35574 | | φ2 (angle between U2 and I2) | T17 | | |
| 35575 | | φ3 (angle between U3 and I3) | T17 | | |
| 35581 | | Internal Temperature | T17 | | |

| Address | | Contents | Data | Ind | Values / Dependencies |
|---|---|---|---|---|---|
| | | Input Registers | | | |
| | | AVERAGE MEASUREMENTS | | | |
| | | **THD HARMONIC DATA** | | | |
| 35582 | | U1 THD% | T16 | | |
| 35583 | | U2 THD% | T16 | | |
| 35584 | | U3 THD% | T16 | | |
| 35588 | | I1 THD% | T16 | | |
| 35589 | | I2 THD% | T16 | | |
| 35590 | | I3 THD% | T16 | | |
| | | **MAXIMUM MEASUREMENTS** | | | |
| 35600 | 35604 | Reserved | | | |
| 35605 | 35606 | Frequency | T5 | | |
| 35607 | 35608 | U1 | T5 | | |
| 35609 | 35610 | U2 | T5 | | |
| 35611 | 35612 | U3 | T5 | | |
| 35613 | 35614 | Uavg (phase to neutral) | T5 | | |
| 35615 | | φ12 (angle between U1 and U2) | T17 | | |
| 35616 | | φ23 (angle between U2 and U3) | T17 | | |
| 35617 | | φ31 (angle between U3 and U1) | T17 | | |
| 35618 | 35619 | U12 | T5 | | |
| 35620 | 35621 | U23 | T5 | | |
| 35622 | 35623 | U31 | T5 | | |
| 35624 | 35625 | Uavg (phase to phase) | T5 | | |
| 35626 | 35627 | I1 | T5 | | |
| 35628 | 35629 | I2 | T5 | | |
| 35630 | 35631 | I3 | T5 | | |
| 35636 | 35637 | Iavg | T5 | | |
| 35640 | 35641 | Active Power Total (Pt) | T6 | | |
| 35642 | 35643 | Active Power Phase L1 (P1) | T6 | | |
| 35644 | 35645 | Active Power Phase L2 (P2) | T6 | | |
| 35646 | 35647 | Active Power Phase L3 (P3) | T6 | | |
| 35648 | 35649 | Reactive Power Total (Qt) | T6 | | |
| 35650 | 35651 | Reactive Power Phase L1 (Q1) | T6 | | |
| 35652 | 35653 | Reactive Power Phase L2 (Q2) | T6 | | |
| 35654 | 35655 | Reactive Power Phase L3 (Q3) | T6 | | |
| 35656 | 35657 | Apparent Power Total (St) | T5 | | |
| 35658 | 35659 | Apparent Power Phase L1 (S1) | T5 | | |
| 35660 | 35661 | Apparent Power Phase L2 (S2) | T5 | | |
| 35662 | 35663 | Apparent Power Phase L3 (S3) | T5 | | |
| 35664 | 35665 | Power Factor Total (PFt) | T7 | | |
| 35666 | 35667 | Power Factor Phase 1 (PF1) | T7 | | |
| 35668 | 35669 | Power Factor Phase 2 (PF2) | T7 | | |
| 35670 | 35671 | Power Factor Phase 3 (PF3) | T7 | | |
| 35672 | | Power Angle Total (atan2(Pt,Qt)) | T17 | | |
| 35673 | | φ1 (angle between U1 and I1) | T17 | | |
| 35674 | | φ2 (angle between U2 and I2) | T17 | | |
| 35675 | | φ3 (angle between U3 and I3) | T17 | | |
| 35681 | | Internal Temperature | T17 | | |
| | | | | | |
| Address | | Contents | Data | Ind | Values / Dependencies |

| | | Input Registers | | | |
|---|---|---|---|---|---|
| | | AVERAGE MEASUREMENTS | | | |
| | | **THD HARMONIC DATA** | | | |
| 35682 | | U1 THD% | T16 | | |
| 35683 | | U2 THD% | T16 | | |
| 35684 | | U3 THD% | T16 | | |
| 35688 | | I1 THD% | T16 | | |
| 35689 | | I2 THD% | T16 | | |
| 35690 | | I3 THD% | T16 | | |
| | | **MINIMUM MEASUREMENTS** | | | |
| 35700 | 35704 | Reserved | | | |
| 35705 | 35706 | Frequency | T5 | | |
| 35707 | 35708 | U1 | T5 | | |
| 35709 | 35710 | U2 | T5 | | |
| 35711 | 35712 | U3 | T5 | | |
| 35713 | 35714 | Uavg (phase to neutral) | T5 | | |
| 35715 | | ϕ12 (angle between U1 and U2) | T17 | | |
| 35716 | | ϕ23 (angle between U2 and U3) | T17 | | |
| 35717 | | ϕ31 (angle between U3 and U1) | T17 | | |
| 35718 | 35719 | U12 | T5 | | |
| 35720 | 35721 | U23 | T5 | | |
| 35722 | 35723 | U31 | T5 | | |
| 35724 | 35725 | Uavg (phase to phase) | T5 | | |
| 35726 | 35727 | I1 | T5 | | |
| 35728 | 35729 | I2 | T5 | | |
| 35730 | 35731 | I3 | T5 | | |
| 35736 | 35737 | Iavg | T5 | | |
| 35740 | 35741 | Active Power Total (Pt) | T6 | | |
| 35742 | 35743 | Active Power Phase L1 (P1) | T6 | | |
| 35744 | 35745 | Active Power Phase L2 (P2) | T6 | | |
| 35746 | 35747 | Active Power Phase L3 (P3) | T6 | | |
| 35748 | 35749 | Reactive Power Total (Qt) | T6 | | |
| 35750 | 35751 | Reactive Power Phase L1 (Q1) | T6 | | |
| 35752 | 35753 | Reactive Power Phase L2 (Q2) | T6 | | |
| 35754 | 35755 | Reactive Power Phase L3 (Q3) | T6 | | |
| 35756 | 35757 | Apparent Power Total (St) | T5 | | |
| 35758 | 35759 | Apparent Power Phase L1 (S1) | T5 | | |
| 35760 | 35761 | Apparent Power Phase L2 (S2) | T5 | | |
| 35762 | 35763 | Apparent Power Phase L3 (S3) | T5 | | |
| 35764 | 35765 | Power Factor Total (PFt) | T7 | | |
| 35766 | 35767 | Power Factor Phase 1 (PF1) | T7 | | |
| 35768 | 35769 | Power Factor Phase 2 (PF2) | T7 | | |
| 35770 | 35771 | Power Factor Phase 3 (PF3) | T7 | | |
| 35772 | | Power Angle Total (atan2(Pt,Qt)) | T17 | | |
| 35773 | | φ1 (angle between U1 and I1) | T17 | | |
| 35774 | | φ2 (angle between U2 and I2) | T17 | | |
| 35775 | | φ3 (angle between U3 and I3) | T17 | | |
| 35781 | | Internal Temperature | T17 | | |

| Address | Contents | Data | Ind | Values / Dependencies |
|---|---|---|---|---|
| | Input Registers | | | |

| | | | | | |
|---|---|---|---|---|---|
| | | **THD HARMONIC DATA** | | | |
| 35782 | | U1 THD% | T16 | | |
| 35783 | | U2 THD% | T16 | | |
| 35784 | | U3 THD% | T16 | | |
| 35788 | | I1 THD% | T16 | | |
| 35789 | | I2 THD% | T16 | | |
| 35790 | | I3 THD% | T16 | | |

**LIMIT P MEASUREMENTS (option)**

| | | | | | |
|---|---|---|---|---|---|
| 35900 | | Limit P Value | T1 | | VA |
| 35901 | | Limits Status | T1 | Bit 0 | Limit Output State |
| | | | | Bit 1 | Average P > Limit P |
| | | | | Bit 2 | Predicted P > Limit P |
| | | | | Bit 3 | Actual P > Limit P |
| 35902 | 35903 | Average Total Export Active Power | T5 | | Average P |
| 35904 | 35905 | Predicted Total Export Active Power | T5 | | Predicted P |
| 35906 | 35907 | Actual Total Export Active Power | T5 | | Actual P |

## SETTINGS

| | | | | | |
|---|---|---|---|---|---|
| 40012 | | Operator Command register | T1 | 1 | Save settings |
| | | | | 2 | Abort settings |

Operator Command 1 (Save Settings) **must be used to store all settings changes** into the permanent memory (EEPROM).
Operator Command 2 (Abort Settings) can be used to restore all settings from the permanent memory (EEPROM) as at power up.
**If the "save setting" command is not sent at the end of changing settings, the changes are not written into the EEPROM.**

---

| | | SYSTEM COMMANDS | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 40001 | 40002 | User Password (L1, L2) | T_Str4 | A…Z | Password to attempt user access level upgrade | | | 0 |
| 40003 | 40005 | Factory Password (FAC) | T_Str6 | A…Z | Password to attempt factory access level upgrade | | | 0 |
| 40006 | 40007 | Level 1 - User password | T_Str4 | A…Z | | | | 2 |
| 40008 | 40009 | Level 2 - User password | T_Str4 | A…Z | | | | 2 |
| 40010 | | Active Access Level | T1 | 0 | Full protection | 0 | 0 | 0 |
| | | | | 1 | Access up to level 1 user password | | | |
| | | | | 2 | Access up to level 2 user password | | | |
| | | | | 3 | Access up to level 2 (backup pass.) | | | |
| | | | | 4 | Factory access level | | | |
| 40011 | | Manual password activation | T1 | 1 | Lock instrument | | | 0 |
| 40012 | | Operator Command Register | T1 | 1 | Save Settings | | | 1 |
| | | | | 2 | Abort Settings | | | |
| | | | | 3 | Restart Instrument | | | |

| Address | | Contents | Data | Ind | Values | min | max | P. Level |
|---|---|---|---|---|---|---|---|---|
| 40013 | | Reset command register 1 | T1 | Bit-0 | Reset counter 1 | | | 1 |
| | | | | Bit-1 | Reset counter 2 | | | |
| | | | | Bit-2 | Reset counter 3 | | | |
| | | | | Bit-3 | Reset counter 4 | | | |
| | | | | Bit-4 | Reset alarm output relay 2 | | | |
| 40015 | | IR external relay command action | T1 | 0 | Off | 0 | 1 | 0 |
| | | | | 1 | On | | | |
| 40016 | | Load control Output state | | 0 | Off | 0 | 1 | 0 |
| | | | | 1 | On | | | |
| | | | | | | | | |
| 40017 | | Digital input function | | 0 | | | | |
| | | | | 1 | Tariff input | | | |
| | | | | 2 | IR relay push button | | | |
| | | | | 3 | IR relay switch | | | |
| | | | | 4 | External relay push button | | | |
| | | | | 5 | External relay switch | | | |
| 40101 | 40120 | Description | T_Str40 | | | | | 2 |
| 40121 | 40140 | Location | T_Str40 | | | | | 2 |
| 40151 | | CT connection | T1 | 2 | Reverse Energy flow direction (Fixed) | 2 | 2 | 2 |
| 40173 | | LCD Mode | T1 | 0 | Manual | 0 | 1 | 2 |
| | | | | 1 | Cycling | | | |
| 40174 | | LCD cycling period | T1 | | Seconds | 5 | 60 | 2 |
| 40183 | | WM3 - LCD parameters | T1 | Bit 0 | Active Power P1 | 1 | 65535 | 2 |
| | | | | Bit 1 | Active Power P2 | | | |
| | | | | Bit 2 | Active Power P3 | | | |
| | | | | Bit 3 | Reactive Power Q1 | | | |
| | | | | Bit 4 | Reactive Power Q2 | | | |
| | | | | Bit 5 | Reactive Power Q3 | | | |
| | | | | Bit 6 | Apparent Power S1 | | | |
| | | | | Bit 7 | Apparent Power S2 | | | |
| | | | | Bit 8 | Apparent Power S3 | | | |
| | | | | Bit 9 | Power Factor PF1 | | | |
| | | | | Bit 10 | Power Factor PF2 | | | |
| | | | | Bit 11 | Power Factor PF3 | | | |
| | | | | Bit 12 | Voltage U12 | | | |
| | | | | Bit 13 | Voltage U23 | | | |
| | | | | Bit 14 | Voltage U31 | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 40184 | | LCD parameters | T1 | Bit 0 | Counter 1 (Always) | 1 | 65535 | 2 |
| | | | | Bit 1 | Counter 2 | | | |
| | | | | Bit 2 | Counter 3 | | | |
| | | | | Bit 3 | Counter 4 | | | |
| | | | | Bit 4 | Active Power Total (Pt) | | | |
| | | | | Bit 5 | Reactive Power Total (Qt) | | | |
| | | | | Bit 6 | Apparent Power Total (St) | | | |
| | | | | Bit 7 | Power Factor Total (PFt) | | | |
| | | | | Bit 8 | Power Angle total (atan2(Pt,Qt)) | | | |
| | | | | Bit 9 | Voltage ph.1 | | | |
| | | | | Bit 10 | Voltage ph.2 | | | |
| | | | | Bit 11 | Voltage ph.3 | | | |
| | | | | Bit 12 | Frequency | | | |
| 40184 | | LCD parameters | T1 | Bit 13 | Current ph.1 | | | |
| | | | | Bit 14 | Current ph.2 | | | |
| | | | | Bit 15 | Current ph.3 | | | |
| 40185 | | Operation mode | | 0 | Normal mode | 0 | 1 | 0 |
| | | | | 1 | Test mode P-Fast | | | |
| | | | | 2 | Test mode P –Fast (Counter only) | | | |
| | | | | 4 | Test mode Q | | | |
| | | | | 5 | Test mode Q - Fast | | | |
| | | | | 6 | Test mode Q – Fast (Counter only) | | | |
| | | | | 8 | Test mode P – Fast LED x 1000 | | | |
| | | | | 16 | Test mode P – Fast LED x 10000 | | | |
| 40186 | | External relay operating mode | T1 | 0 | Not connected | 0 | 1 | 2 |
| | | | | 1 | Manual | | | |
| 40187 | | Limits enabled | | 0 | None | 0 | 4 | 2 |
| | | | | 1 | Limit 1 | | | |
| | | | | 2 | Limit 2 | | | |
| | | | | 3 | Limit 1 OR Limit 2 | | | |
| | | | | 4 | Limit 1 AND Limit 2 | | | |
| 40188 | | Display notification | | 0 | None | 0 | 2 | 2 |
| | | | | 1 | Relay ON | | | |
| | | | | 2 | Relay OFF | | | |

| Address | | Contents | Data | Ind | Values | min | max | P. Level |
|---|---|---|---|---|---|---|---|---|
| | | LIMIT | | | | | | |
| 40189 | | Limit 1: Parameter | T1 | | See OutTypes | | | |
| 40190 | | Limit 1: Compare relation | T1 | 0 | measurement > limit | 0 | 1 | 2 |
| | | | | 1 | measurement < limit | | | |
| 40191 | | Limit 1: ON level | T17 | | % of parameter value | -300 | 300 | 2 |
| 40192 | | Limit 1: OFF level | T17 | | % of parameter value | -300 | 300 | 2 |
| 40193 | | Limit 1: Compare time delay | T1 | | seconds | 0 | 600 | 2 |
| 40194 | 40198 | Limit 2 | | | see Limit 1 | | | |
| | | COMMUNICATION | | | | | | |
| 40202 | | Port 1: Device Address (Modbus) | T1 | | | 1 | 247 | 2 |
| 40203 | | Port 1: Baud Rate | T1 | 0 | Baud rate 1200 | 1 | 7 | 2 |
| | | | | 1 | Baud rate 2400 | | | |
| | | | | 2 | Baud rate 4800 | | | |
| | | | | 3 | Baud rate 9600 | | | |
| | | | | 4 | Baud rate 19200 | | | |
| 40204 | | Port 1: Stop Bit | T1 | 0 | 1 Stop bit | 0 | 1 | 2 |
| | | | | 1 | 2 Stop bits | | | |
| 40205 | | Port 1: Parity | T1 | 0 | No parity | 0 | 2 | 2 |
| | | | | 1 | Odd parity | | | |
| | | | | 2 | Even parity | | | |
| 40206 | | Port 1: Data Bits | T1 | 0 | 8 bits | 0 | 0 | 2 |
| | | WIFI adapter | | | | | | |
| 42750 | | WIFI LCD menu time enabled | T1 | | Seconds | | | |
| 42751 | | WIFI status | T1 | | WIFI status | | | |
| 42752 | 42753 | WIFI IP | T3 | | example:<br>129.168.001.255 | | | |
| 42754 | | WIFI command | T1 | | reset WIFI | | | |
| 42755 | 42760 | Reserved for WIFI numbers | T1 | | | | | |
| 42761 | 42770 | WIFI status text 1 | T_Str20 | | | | | |
| 42771 | 42780 | WIFI status text 2 | T_Str20 | | | | | |
| 42781 | | I-Hub status | T1 | 0 | BICom Off | | | |
| | | | | 1 | BICom On | | | |
| | | | | 255 | Disconnect I-Hub | | | |

| Address | | Contents | Data | Ind | Values | min | max | P. Level |
|---|---|---|---|---|---|---|---|---|
| | | ENERGY | | | | | | |
| 40401 | | Active Tariff | T1 | 0 | Tariff input | 0 | 2 | 1 |
| | | | | 1..2 | Tariff 1..2 | | | |
| 40421 | | Energy Counter 1 Parameter | T1 | 1 | Active Power | 1 | 15 | 2 |
| | | | | 2 | Reactive Power | | | |
| | | | | 3 | Apparent Power | | | |
| | | | | 5 | Active Power Phase 1 | | | |
| | | | | 6 | Reactive pover Phase 1 | | | |
| | | | | 7 | Apparent Power Phase 1 | | | |
| | | | | 9 | Active Power Phase 2 | | | |
| | | | | 10 | Reactive pover Phase 2 | | | |
| | | | | 11 | Apparent Power Phase 2 | | | |
| | | | | 13 | Active Power Phase 3 | | | |
| | | | | 14 | Reactive pover Phase 3 | | | |
| | | | | 15 | Apparent Power Phase 3 | | | |
| | | | | 33 | Active Power individual phases | | | |
| | | | | 34 | Reactive Power individual phases | | | |
| | | | | 35 | Apparent Power individual phases | | | |
| 40422 | | Energy Counter 1 Configuration | T1 | Bit-0 | Quadrant I Enabled | 0 | 63 | 2 |
| | | | | Bit-1 | Quadrant II Enabled | | | |
| | | | | Bit-2 | Quadrant III Enabled | | | |
| | | | | Bit-3 | Quadrant IIII Enabled | | | |
| | | | | Bit-4 | Absolute Value | | | |
| | | | | Bit-5 | Invert Value | | | |
| 40424 | | Energy Counter 1 Tarif Selector | T1 | Bit-0 | Tarif 1 Enabled | 0 | 15 | 2 |
| | | | | Bit-1 | Tarif 2 Enabled | | | |
| 40431 | | Energy Cnt 2 Parameter | T1 | | See Energy Counter 1 Parameter | | | |
| 40432 | | Energy Cnt 2 Configuration | T1 | | see Energy Counter 1 Configuration | 0 | 63* | 2 |
| 40434 | | Energy Cnt 2 Tarif Selector | T1 | | see Energy Counter 1 Tarif Selector | 0 | 3 | 2 |
| 40441 | | Energy Cnt 3 Parameter | T1 | | see Energy Counter 2 Parameter | 0 | 3* | 2 |
| 40442 | | Energy Cnt 3 Configuration | T1 | | see Energy Counter 1 Configuration | 0 | 63* | 2 |
| 40444 | | Energy Cnt 3 Tarif Selector | T1 | | see Energy Counter 1 Tarif Selector | 0 | 3 | 2 |
| 40451 | | Energy Cnt 4 Parameter | T1 | | see Energy Counter 2 Parameter | 0 | 3* | 2 |
| 40452 | | Energy Cnt 4 Configuration | T1 | | see Energy Counter 1 Configuration | 0 | 63* | 2 |
| 40454 | | Energy Counter 4 Tarif Selector | T1 | | see Energy Counter 1 Tarif Selector | 0 | 3 | 2 |

| Address | | Contents | Data | Ind | Values | min | max | P. Level |
|---|---|---|---|---|---|---|---|---|
| | | **LIMIT P** | | | | | | |
| 41201 | | Limit P Value | T1 | | W | 0 | 65535 | 2 |
| 41202 | | Predicted Time | T1 | | s | 1 | 30 | 2 |
| | | Counter freeze | | | | | | |
| 41901 | | Auto freeze interval [minutes] | T1 | | | | | |
| 41902 | | time to freeze [s] | T1 | | | | | |
| 41903 | 41904 | time from freeze [s] | T3u | | | | | |
| 41905 | | Freeze status | T1 | | | | | |
| 41906 | | Current Active Tariff | T1 | | | | | |
| 41907 | 41908 | Energy Counter 1 (resettable) | T3 | | | | | |
| 41909 | 41910 | Energy Counter 2 (resettable) | T3 | | | | | |
| 41911 | 41912 | Energy Counter 3 (resettable) | T3 | | | | | |
| 41913 | 41914 | Energy Counter 4 (resettable) | T3 | | | | | |
| 41915 | 41916 | Energy Counter 1 (Non-reset) | T3 | | | | | |
| 41917 | 41918 | Energy Counter 2 (Non-reset) | T3 | | | | | |
| 41919 | 41920 | Energy Counter 3 (Non-reset) | T3 | | | | | |
| 41921 | 41922 | Energy Counter 4 (Non-reset) | T3 | | | | | |
| 41923 | 41924 | 1000x Energy Counter 1 (resettable) | T3 | | | | | |
| 41925 | 41926 | 1000x Energy Counter 2 (resettable) | T3 | | | | | |
| 41927 | 41928 | 1000x Energy Counter 3 (resettable) | T3 | | | | | |
| 41929 | 41930 | 1000x Energy Counter 4 (resettable) | T3 | | | | | |
| 41931 | 41932 | 1000x Energy Counter 1 (Non-reset) | T3 | | | | | |
| 41933 | 41934 | 1000x Energy Counter 2 (Non-reset) | T3 | | | | | |
| 41935 | 41936 | 1000x Energy Counter 3 (Non-reset) | T3 | | | | | |
| 41937 | 41938 | 1000x Energy Counter 4 (Non-reset) | T3 | | | | | |
| | | **INTERVAL MEASUREMENTS** | | | | | | |
| 41990 | | Interval duration [s/10] | T1 | | 600=60,0 sec | 0,1 | 3600 | 0 |
| 41991 | | Time to calculate interval meas. [s/10] | T1 | | | 0,1 | 3600 | 0 |
| | | **Wifi status** | | | | | | |
| 42750 | | Wifi LCD menu time enabled | T1 | | Seconds | | | 0 |
| 42751 | | Wifi status | T1 | | Wifi status | | | 0 |
| 42752 | 42753 | WIFI IP | T3 | | example : 129.168.001.255 | | | 0 |
| 42754 | | WIFI command | T1 | 1 | reset WIFI | | | 0 |
| 42755 | 42760 | Reserved for WIFI numbers | T1 | | | | | 0 |
| 42761 | 42770 | Wifi status text 1 | T_Str20 | | | | | 0 |
| 42771 | 42780 | Wifi status text 2 | T_Str20 | | | | | 0 |
| 42781 | | I-Hub status | T1 | 0 | BICom Off | | | |
| | | | | 1 | BICom On | | | |
| | | | | 255 | disconect I-Hub | | | |

## SUPPORTED FUNCTIONS AND USAGE

| Code DEC | Code HEX | Function | References |
|---|---|---|---|
| 3 | 03 | to read from holding registers | (4XXXX memory references) |
| 4 | 04 | to read from input registers | (3XXXX memory references) |
| 6 | 06 | to write to a single holding register | (4XXXX memory references) |
| 16 | 10 | to write to one or more holding register | (4XXXX memory references) |

## DATA TYPES DECODING

Registers defined in the Modbus database will define data as one of the data types described in the following table:

| Type | Value / Bit Mask | Description |
|---|---|---|
| T1 | | Unsigned Value (16 bit)<br>Example: 12345 stored as 12345 = $3039_{(16)}$ |
| T2 | | Signed Value (16 bit)<br>Example: -12345 stored as -12345 = $CFC7_{(16)}$ |
| T3 | | Signed Long Value (32 bit)<br>Example: 123456789 stored as 123456789 = 075B $CD15_{(16)}$ |
| T4 | <br>bits # 15..14<br>bits # 13..00 | Short Unsigned float (16 bit)<br>Decade Exponent(Unsigned 2 bit)<br>Binary Unsigned Value (14 bit)<br>Example: $10000*10^2$ stored as $A710_{(16)}$ |

| Type | Value / Bit Mask | Description |
|---|---|---|
| T5 | <br>bits # 31..24<br>bits # 23..00 | Unsigned Measurement (32 bit)<br>Decade Exponent(Signed 8 bit)<br>Binary Unsigned Value (24 bit)<br>Example: $123456*10^{-3}$ stored as $FD01\ E240_{(16)}$ |
| T6 | <br>bits # 31..24<br>bits # 23..00 | Signed Measurement (32 bit)<br>Decade Exponent (Signed 8 bit)<br>Binary Signed value (24 bit)<br>Example: $-123456*10^{-3}$ stored as $FDFE\ 1DC0_{(16)}$ |
| T7 | <br>bits # 31..24<br>bits # 23..16<br>bits # 15..00 | Power Factor (32 bit)<br>Sign: Import/Export (00/FF)<br>Sign: Inductive/Capacitive (00/FF)<br>Unsigned Value (16 bit), 4 decimal places<br>Example: 0.9876 CAP stored as $00FF\ 2694_{(16)}$ |
| T8 | <br>bits # 31..24<br>bits # 23..16<br>bits # 15..08<br>bits # 07..00 | Time stamp (32 bit)<br>Minutes 00 - 59 (BCD)<br>Hours 00 - 23 (BCD)<br>Day of month 01 - 31 (BCD)<br>Month of year 01 - 12 (BCD)<br>Example: 15:42, 1. SEP stored as $4215\ 0109_{(16)}$ |
| T9 | <br>bits # 31..24<br>bits # 23..16<br>bits # 15..08<br>bits # 07..00 | Time (32 bit)<br>1/100s 00 - 99 (BCD)<br>Seconds 00 - 59 (BCD)<br>Minutes 00 - 59 (BCD)<br>Hours 00 - 24 (BCD)<br>Example: 15:42:03.75 stored as $7503\ 4215_{(16)}$ |
| T10 | <br>bits # 31..24<br>bits # 23..16<br>bits # 15..00 | Date (32 bit)<br>Day of month 01 - 31 (BCD)<br>Month of year 01 - 12 (BCD)<br>Year (unsigned integer) 1998..4095<br>Example: 10, SEP 2000 stored as $1009\ 07D0_{(16)}$ |
| T_Str4<br>(T11) | | Text String 4 characters<br>Two characters per 16 bit register |
| T_Str6<br>(T12) | | Text String 6 characters<br>Two charcters per 16 bit register |
| T_Str8 | | Text String 8 characters<br>Two characters per 16 bit register. |
| T_Str16 | | Text String 16 characters<br>Two characters per 16 bit register. |
| T_Str20 | | Text String 20 characters<br>Two characters per 16 bit register. |
| T16 | | Unsigned Value (16 bit), 2 decimal places<br>Example: 123.45 stored as $123.45 = 3039_{(16)}$ |
| T17 | | Signed Value (16 bit), 2 decimal places<br>Example: -123.45 stored as $-123.45 = CFC7_{(16)}$ |

| Type | Value / Bit Mask | Description |
|---|---|---|
| T_Time | | Time and Date (64 bit) |
| | bits # 63..56 | 1/100s 00 - 99 (BCD) |
| | bits # 55..48 | Seconds 00 - 59 (BCD) |
| | bits # 47..40 | Minutes 00 - 59 (BCD) |
| | bits # 39..32 | Hours 00 - 24 (BCD) |
| | bits # 31..24 | Day of month 01 - 31 (BCD) |
| | bits # 23..16 | Month of year 01 - 12 (BCD) |
| | bits # 15..00 | Year (unsigned integer) 1998..4095 |
| | | Example: 15:42:03.75, 10. SEP 2000 stored as 7503 4215 1009 $07D0_{(16)}$ |
| T_TimeIEC | | Time and Date (64 bit) = IEC870-5-4 "Binary Time 2a" |
| | bits # 63..55 | Reserved |
| | bits # 54..48 | Years (0 .. 99) |
| | bits # 47..44 | Reserved |
| | bits # 43..40 | Months (1 .. 12) |
| | bits # 39..37 | Day of Week (1 .. 7) |
| | bits # 36..32 | Day of Month (1 .. 31) |
| | bit # 31 | Summer Time (0 .. 1): Summer time (1), Standard time (0) |
| | bits # 30..29 | Reserved |
| | bits # 28..24 | Hours (0 .. 23) |
| | bit # 23 | Invalid (0 .. 1): Invalid (1), Valid (0) |
| | bit # 22 | Reserved |
| | bits # 21..16 | Minutes (0 .. 59) |
| | bits # 15..00 | Miliseconds (0 .. 59999) |
| | | Example: 15:42, 1. SEP stored as $4215\ 0109_{(16)}$ |
| T_Data | | Record Data |
| | | Size and SubTypes depends on the Actual Memory Part |
| T_Str40 | | Text String 40 characters |
| | | Two characters per 16 bit register. |
| T_float | | IEEE 754 Floating-Point Single Precision Value (32 bit) |
| | bits # 31 | Sign Bit (1 bit) |
| | bits # 30..23 | Exponent Field (8 bit) |
| | bits # 22..0 | Significand (23 bit) |
| | | Example: 123.45 stored as 123.45000 = $42F6\ E666_{(16)}$ |
| T9A | | Time (16 bit) |
| | bits # 15..08 | Minutes 00 - 59 (BCD) |
| | bits # 07..00 | Hours 00 - 24 (BCD) |
| | | Example: 15:42 stored as $4215_{(16)}$ |
| T10A | | Date (16 bit) |
| | bits # 15..08 | Day of month 00 - 31 (BCD) |
| | bits # 07..00 | Month of year 00 - 12 (BCD) |
| | | Example: 30, SEP stored as $3009_{(16)}$ |
| T18 | | Signed Value (16 bit), 4 decimal places |
| | | Example: -0.2345 stored as -2345 = $F6D7_{(16)}$ |
| T_DSK | | HEX value 16 bytes |

## 7.2 Appendix B: M-BUS

The M-BUS interface fully complies with M-BUS European standard EN13757-2. The entire communication is ensured with 8 Data Bits, Even Parity, 1 Stop Bit and a Baud Rate from 300 to 9600 Bauds.

### Communication settings

Default communication settings are: 2400, 8, E, 1 primary address 0 and secondary address is set to serial number of device.

### Initialize M-Bus (SNK_NKE)

This Short Telegram initializes the M-BUS 3MEM65. The M-BUS 3MEM65 confirms correct receipt by Single Character Acknowledgement (ACK = E5). If the telegram was not correctly received the 3MEM65 will not send an acknowledgement.

### Select M-BUS 3MEM65 Using Secondary Address (SND_UD)

This Telegram enables to select M-BUS 3MEM65. The M-BUS 3MEM65 confirms the correct receipt by ACK. If the telegram has not been correctly received the M-BUS 3MEM65 will not send an Acknowledgement. After issue of the Single Character Acknowledgement the M-BUS 3MEM65 is ready to transmit the entire Read-out Data within 3 seconds from receiving the Telegram „Transmit Read-out Data“. At the end of 3 seconds the M-BUS 3MEM65 will switch back to normal mode.

### Transmit Read-out Data via Primary/Secondary Address (REQ_UD2)

This Short Telegram enables to select the M-BUS 3MEM65 and to command it to transmit the Read-out Data parameterized. The M-BUS 3MEM65 confirms correct receipt by transmitting of the Read-out Data. If the Short Telegram has not been received correctly; no Data will be transmitted by the M-BUS 3MEM65. The Read-out Data are sent within 35 ms – 75 ms from receipt of the Short Telegram by the M-BUS Meter (fom more infomations see section M-Bus telegrams).

### Set Baud Rate via Primary/Secondary Address (SND_UD)

This telegram enables to set the desired Baud Rate. The M-BUS 3MEM65 confirms the correct receipt by ACK. If the telegram was not received correctly the M-BUS 3MEM65 does not send an Acknowledgement. The (ACK) is sent by the M-BUS 3MEM65 in the Old Baud Rate. As soon as ACK is transmitted the M-BUS Meter switches to the baud rate newly parameterized. If the 3MEM65 now does not receive a new Telegram under the new baud rate within a period of 30 seconds – 40 seconds, it automatically switches back to the old baud rate. This is apt to prevent that a faulty setting of the baud rate may interrupt communication.

### Set Primary Address via Primary/Secondary Address (SND_UD)

This Telegram enables to set a new Primary Address. The M-BUS 3MEM65 confirms the correct receipt by ACK. If the telegram has not been correctly received the M-BUS 3MEM65 will not send an Acknowledgement.

### Set Secondary Address via Primary/Secondary Address (SND_UD)

This Telegram enables to set a new Secondary Address. The M-BUS 3MEM65 confirms the correct receipt by ACK. If the telegram has not been correctly received the M-BUS 3MEM65 will not send an Acknowledgement.

Secondary Address (UD) consists of:

| | | |
|---|---|---|
| Identification Number: | 00000000 – 99999999 | 8-digit Secondary Address number |
| Manufacturer’s Code: | 73 26 | 2 Byte Company Constant (ETI = “73 26”) |
| Version Number: | 01 – FF | 1 Byte |
| Medium: 02 | 1 Byte Constant Electricit | |

### Reset, Restart M-BUS MC350 via Primary/Secondary Address (SND_UD)

This Telegram reset/restarts M-BUS MC350. The M-BUS 3MEM65 confirms correct receipt by ACK. If the telegram was not correctly received the M-BUS 3MEM65 will not send an acknowledgement.

## M-Bus Telegram

### Total Energy counters 0, 1, 2, 3

Energy counters could represent: +/- active energy, +/-reactive energy or apparent energy and one of 4-th tariff.

| | DIF | DIFE | DIFE | VIF | VIFE | VIFE | VIFE | DATA | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | xx.xx.xx.xx | |
| T0: | 04 | none | none | | | | | | |
| T1: | 84 | 10 | none | | | | | | |
| T2: | 84 | 20 | none | | | | | | |
| A+: | | | | 05 | None | none | none | $*10^{5-3}$ | Wh |
| A-: | | | | 85 | 3C | none | none | $*10^{5-3}$ | Wh |
| R+: | | | | FB | 82 | 75 | none | $*10^{5-3}$ | varh |
| R-: | | | | FB | 82 | F5 | 3C | $*10^{5-3}$ | varh |
| App: | | | | FB | 84 | 75 | none | $*10^{5-3}$ | VAh |

### Active Tariff number

Tariff number in progress (1 to 4)

| | DIF | DIFE | DIFE | VIF | VIFE | VIFE | VIFE | DATA |
|---|---|---|---|---|---|---|---|---|
| | 01 | | | FF | 01 | | | xx |

DATA: value represent as 8-bit integer

### Active Power Total Pt (W)

Active power total in 32 bit x $10^{(2-3)}$ W

| | DIF | DIFE | DIFE | VIF | VIFE | DATA |
|---|---|---|---|---|---|---|
| | 04 | | | 2A | | xx.xx.xx.xx |

### Active Power Total (kvar)

Reactive power total in 32bit x$10^{(2-3)}$ var

| | DIF | DIFE | VIF | VIFE | VIFE | VIFE | DATA |
|---|---|---|---|---|---|---|---|
| | 04 | | FB | 97 | 72 | | xx.xx.xx.xx |

### Instant Apparent Power Total (VA)

Apparent power total in 32 bit x $10^{(5-6)}$ VA

| | DIF | DIFE | VIF | VIFE | VIFE | VIFE | DATA |
|---|---|---|---|---|---|---|---|
| | 04 | | FB | B4 | 75 | | xx.xx.xx.xx |

n - 0…7

### Power Factor: -: leading et +: lagging: PF

Power factor as 32-bit integer * $10^{-3}$

| | DIF | DIFE | DIFE | VIF | VIFE | VIFE | VIFE | DATA |
|---|---|---|---|---|---|---|---|---|
| | 04 | | | A8 | B4 | 35 | | xx.xx.xx.xx |

Unit : W/V/A

### Current Total (A)

Total current as 32 bit x $10^{(9-12)}$ A

| | DIF | DIFE | VIF | VIFE | VIFE | DATA |
|---|---|---|---|---|---|---|
| | 04 | | FD | 59 | | xx.xx.xx.xx |

## System frequency (Hz/1000)

Contains the line frequency 32-bit integer in mHz.

| | DIF | DIFE | DIFE | VIF | VIFE | VIFE | VIFE | DATA |
|---|---|---|---|---|---|---|---|---|
| | 04 | | | FB | 2C | | | xx.xx.xx.xx |

## Active Power in Phase 1, 2, 3 (W)

Active power in 32bit x $10^{(2-3)}$ W

| | DIF | DIFE | DIFE | VIF | VIFE | VIFE | DATA |
|---|---|---|---|---|---|---|---|
| | 04 | | | | | | xx.xx.xx.xx |
| P1: | | | | AA | FC | 01 | |
| P2: | | | | AA | FC | 02 | |
| P3: | | | | AA | FC | 03 | |

## Current in Phase 1, 2, 3, Neutral (A)

Phase current as 32 bit x $10^{(9-12)}$ A

| | DIF | DIFE | VIF | VIFE | VIFE | VIFE | DATA |
|---|---|---|---|---|---|---|---|
| | 04 | | | | | | xx.xx.xx.xx |
| I1: | | | FD | D9 | FC | 01 | |
| I2: | | | FD | D9 | FC | 02 | |
| I3: | | | FD | D9 | FC | 03 | |

## Voltages (V)

Voltage as 32 bit x $10^{(7-9)}$ V

| | DIF | DIFE | VIF | VIFE | VIFE | VIFE | DATA |
|---|---|---|---|---|---|---|---|
| | 04 | | | | | | xx.xx.xx.xx |
| U1: | | | FD | C7 | FC | 01 | |
| U2: | | | FD | C7 | FC | 02 | |
| U3: | | | FD | C7 | FC | 03 | |
| U12: | | | FD | C7 | FC | 05 | |
| U23: | | | FD | C7 | FC | 06 | |
| U31: | | | FD | C7 | FC | 07 | |

## 7.4 Appendix C: Equations

Definitions of symbols

| No | Symbol | Definition |
|---|---|---|
| 1 | MP | Average interval |
| 2 | $U_f$ | Phase voltage ($U_1$, $U_2$ or $U_3$) |
| 3 | $U_{ff}$ | Phase-to-phase voltage ($U_{12}$, $U_{23}$ or $U_{31}$) |
| 4 | N | Total number of samples in a period |
| 5 | n | Sample number ($0 \le n \le N$) |
| 6 | x, y | Phase number (1, 2 or 3) |
| 7 | $i_n$ | Current sample n |
| 8 | $u_{fn}$ | Phase voltage sample n |
| 9 | $u_{ffn}$ | Phase-to-phase voltage sample n |
| 10 | $\phi_f$ | Power angle between current and phase voltage f ( $\phi_1$, $\phi_2$ or $\phi_3$) |

### Voltage

| | |
|---|---|
| $U_f = \sqrt{\frac{\sum_{n=1}^{N} u_n^2}{N}}$ | **Phase voltage**<br>N – samples in averaging interval (up to 65 Hz) |
| $U_{xy} = \sqrt{\frac{\sum_{n=1}^{N}(u_{xn} - u_{yn})^2}{N}}$ | **Phase-to-phase voltage**<br>$u_x$, $u_y$ – phase voltages ($U_f$)<br>N – a number of samples in averaging interval |

### Current

| | |
|---|---|
| $I_{RMS} = \sqrt{\frac{\sum_{n=1}^{N} i_n^2}{N}}$ | **Phase current**<br>N – samples in averaging interval (up to 65 Hz) |

## Power

| | |
|---|---|
| $\mathrm{P}_f = \frac{1}{\mathrm{N}} \sum_{\mathrm{n}=1}^{\mathrm{N}} (u_{fn} \times \mathrm{i}_{fn})$ | **Active power by phases**<br>N – a number of periods<br>n – index of sample in a period<br>f – phase designation |
| $P_t = P_1 + P_2 + P_3$ | **Total active power**<br>t – total power<br>1, 2, 3 – phase designation |
| $\mathrm{SignQ_f}(\varphi)$<br>$\varphi \in [0° - 180°] \rightarrow \mathrm{SignQ}_f(\varphi) = +1$<br>$\varphi \in [180° - 360°] \rightarrow \mathrm{SignQ}_f(\varphi) = -1$ | **Reactive power sign**<br>$Q_f$ – reactive power (by phases)<br>φ – power angle |
| $S = U_f \cdot I_f$ | **Apparent power by phases**<br>$U_f$ – phase voltage<br>$I_f$ – phase current |
| $S_t = S_1 + S_2 + S_3$ | **Total apparent power**<br>$S_t$ – apparent power by phases |
| $Q_f = SignQ(\varphi) \times \sqrt{{S_f}^2 - {P_f}^2}$ | **Reactive power by phases**<br>$S_f$ – apparent power by phases<br>$P_f$ – active power by phases |
| $Q_f = \frac{1}{N} \cdot \sum_{n=1}^{N} (u_{fn} \times i_{f[n+N/4]})$ | **Reactive power by phases (displacement method)**<br>N – a number of samples in a period<br>n – sample number (0 ≤ n ≤ N)<br>f – phase designation |
| $Q_t = Q_1 + Q_2 + Q_3$ | **Total reactive power**<br>$Q_t$ – reactive power by phases |
| $\varphi_s = a\ tan2\ (P_f, Q_f)$<br>$\varphi_s = [-180°, 179{,}99°]$ | **Total power angle**<br>$P_t$ – total active power<br>$Q_t$ – total reactive power |
| $PF = \frac{\lvert P \rvert}{S}$ | **Distortion power factor**<br>P – active power<br>S –apparent power |

## THD

| | |
|---|---|
| $I_f\ THD(\%) = \frac{\sqrt{\sum_{n=2}^{63} I_{fn}^2}}{I_{f1}} 100$ | **Current THD**<br>$I_1$ – value of first harmonic<br>n – number of harmonic |
| $U_f\ THD(\%) = \frac{\sqrt{\sum_{n=2}^{63} U_{fn}^2}}{U_{f1}} 100$ | **Phase voltage THD**<br>$U_1$ – value of first harmonic<br>n – number of harmonic |
| $U_{ff}\ THD(\%) = \frac{\sqrt{\sum_{n=2}^{63} U_{ffn}^2}}{U_{ff1}} 100$ | **Phase-to-phase voltage THD**<br>$U_1$ – value of first harmonic<br>n – number of harmonic |