# MT860

High precision multi-function meter 0.2S, C

# Technical description

*Version 2.1, 18.1.2010*

# 1. Overview

MT860 is an electronic multi-function transformer rated electricity meter, for measurement and registration of active, reactive and apparent energy, as well as demands.

High precision multifunction static meters are intended for large and medium size commercial and industrial customers.

Meters are manufactured in compliance with ISO 9001 standard.

## 1.1. Main features

MT860 meters support the new needs arising from deregulation and competition in the electricity market as well as classic metering.

**The main meter features are:**

- High accuracy and long-term measurement stability,
- Modular design, communication modules and input/output modules,
- Connection via CT or CT/VT in three-phase three or four-wire networks,
- Multi-range.

**Energy and demand measurement:**

- Active energy measurement (import, export) in compliance with the IEC 62052–11, IEC 62053-22, EN 50470-3 standard
- Reactive energy measurement (four quadrants and combined quadrants) in compliance with IEC 62053-23 standard,
- Apparent energy in two flow directions calibrated up to 0.5%,
- Current average, maximal and cumulative demand measurement.

**Network quality monitoring:**

- Instantaneous and rms values of phase voltages, currents and frequency,
- THD,
- Harmonic analysis,
- Power factor,
- Phase angle,
- Dips/sags,
- Power interruptions, etc.

**Functions:**

- time of use, on-line registration of energy and demand,
- two independent load profiles,
- two log books,
- possibility of three inputs and eight outputs,
- display of various data, alarms and statuses on LCD by IEC62056-61 (OBIS).

**Advanced features:**

- CT/VT error and Fe-Cu loss compensation,
- security of the meter and meter data,
- supply from internal or external supply with priorities.

*Fig. 1:Iskraemeco -metering tradition since 1945.*

## 1.2. Benefits

New implemented innovative solutions enhance technical capabilities and expand meters functionality.

Furthermore, they bring cost benefits.

Thanks to the meter modularity, a wide multi-ranging measuring range and power supply, industrial and commercial users need only one Iskraemeco type of meter for many different installations.

See
Table 1: MT860 brings new practical and cost benefits.

| Feature | Practical benefits | Cost benefits |
|---|---|---|
| Multi-range | the same meter can be used at all nominal voltages | REDUCED INVENTORY COST<br>Reducing the number of different meters a utility must inventory. |
| | easy connection | |
| | no damage to the meter at wrong connection or voltage | |
| | the same meter can be used for 3-wire or 4-wire networks | |
| | multi-ranging power supply allows the same meter to be used in a wide range of service | |
| | | |
| Modularity | meet your needs both now and in the future | REDUCED COMMUNICATION COST<br>No need for additional data loggers, communicators, etc. |
| | modules can be ordered or replaced when needed | |
| | modules can be used also with other Iskraemeco meters | |
| | IEC standards ensures easily integration into AMR systems | |
| | | |
| USB optical magnetic probe | no power supply needed<br>quick meter reading/writing without wiring the meter | No costs for batteries and time consumption for wiring. |

*Table 1: MT860 brings new practical and cost benefits.*

## 1.3. 60 years of tradition

Meters are approved according to international standards and designed according to even higher internal Iskraemeco standards, based on 60 years of meter manufacturing experience and 50 millions installed meters around the globe.

# 2. Configuration

Meter is modular based. A communication and input/output modules can be built into the meter.

The meter itself consists of the following parts:

- central processing unit (CPU),
- measuring system with ADC and DSP,
- real time clock (RTC),
- display (LCD),

- optical-magnetic interface (O),
- RS 232 or RS485 interface,
- inputs/outputs,
- power supply.

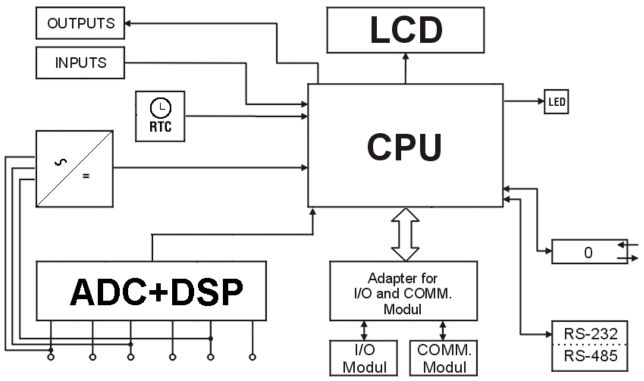



*Fig. 2: Meter block scheme*

## 2.1. Watchdog

Separate integrated circuit is used to control power, reset and watchdog.

Micro controller program execution is controlled on the watchdog input. In a case of disoperation, the watchdog output signal generate a reset to the micro controller.
Watchdog function is also used in a controlled manner when new parameters are written to the meter to start the application on the new set of parameters.

Power supply monitoring circuitry generates a reset output during power-up, power-down and brownout conditions.

## 2.2. Measuring system

A measuring system is based on the three compensated current transformers with linear characteristic and three voltage precise resistor dividers.

Current transformers with high permeability cores are compensated by electronic circuit. In that way, non-linear magnetic curve (histeresis) is eliminated.

The metering elements are protected against over-voltage and high frequency disturbances.

Recalibration of the meter is thus not required during its life span.

### 2.2.1. Analogue to digital converter

Multi-channel analogue to digital converter has three ADC pairs. Each pair measure a single voltage and current signal.

ADC sampling frequency is 4kHz with 16-bit resolution. ADC have implemented anti-aliasing filters.

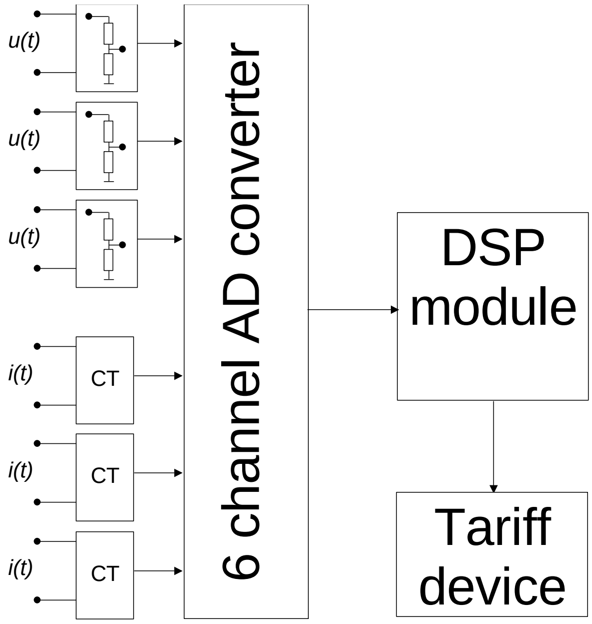


Fig. 3: Measuring system

### *2.2.1. Digital signal processor*

Digital data from ADC is sent by SPI bus to digital signal processor (DSP). DSP calculates energy, demand, frequency, network quality parameters, etc.

On the one side DSP is connected with a SPI bus to ADC and on the other side it is connected to tariff device's micro-controller. DSP sends measured data through SPI bus to tariff device every second.

DSP module controls also output LED diodes.

### *2.2.2. Artificial / natural connection*

Artificial or natural connection is used for reactive energy measurement.

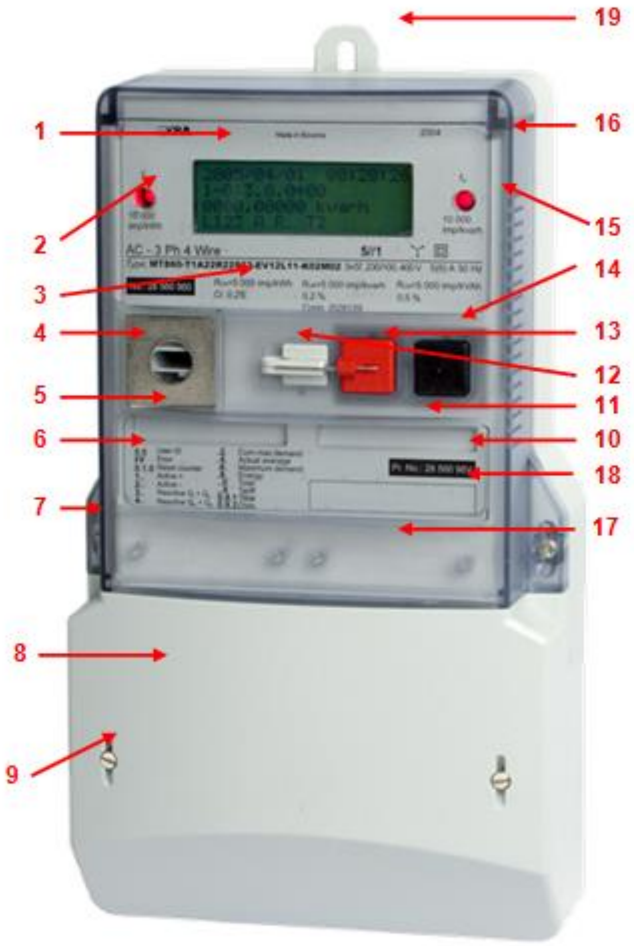
Artificial connection is based on symmetric three-phase system. Drawback of the artificial connection is that it requires all three phases.
With a natural connection for each phase the current and 90º-shifted voltage are multiplied. In this way the information about reactive energy is still correct for each phase.

## *2.3. Maintenance*

The meter is designed and manufactured in such a way that it does not need any maintenance interventions in the entire lifetime. Measuring stability assures that no recalibration is required. The meter with the internal battery assures sufficient capacity for performing battery supported functions for the entire lifetime.

## 3. Meter parts

Next picture shows meter parts:




1. Display
2. Active energy metrological LED
3. Technical data
4. Optical-magnetic interface
5. Input/output module mark
6. Legend for register display
7. Meter cover sealing screw
8. Terminal cover
9. Terminal cover sealing screw
10. Meter program number
11. Communication module mark
12. Reset key blocking element
13. Reset key
14. Scroll key
15. Reactive energy metrological LED
16. Meter cover
17. Labels
18. Bar code
19. Adjustable hook

*Fig. 4: Meter parts*

## *3.1. Housing*

A compact plastic casing is made of high quality self-extinguishable materials and is resistant to water and dust (IP53). Meter dimensions and fixing dimensions comply with the DIN 43857 standard.

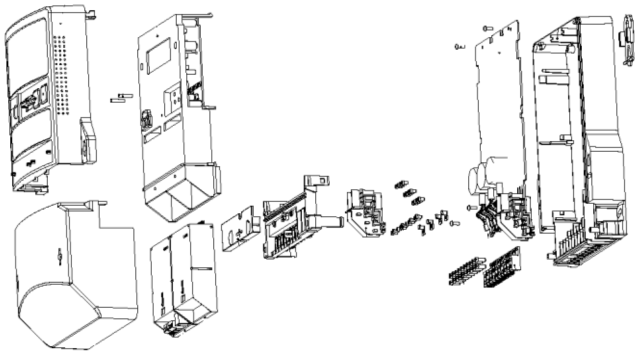
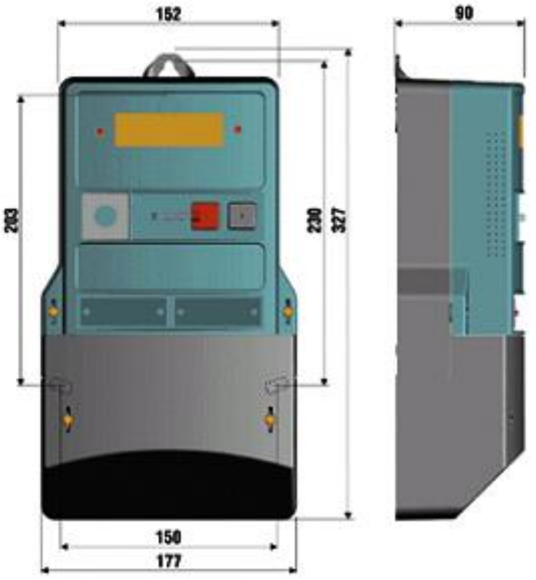


*Fig. 5: Housing*

Sliding hanger enables installation for all fixing dimensions from 165 to 230 mm.

*Fig. 6: Adjustable hook at meter back.*

Meter is made of the materials that can be recycled and are environment friendly.



## *3.2. Front plate*

The following data is printed on the meter front plate:

- serial number,
- ownership number,
- type and version designation,
- accuracy,
- year of manufacturing,
- approval mark,
- rated voltage,
- rated and maximum currents,
- rated frequency,
- LED and output pulse constants,
- software version,
- owner's name or logo,
- bar code,
- code of connection diagram and program number.

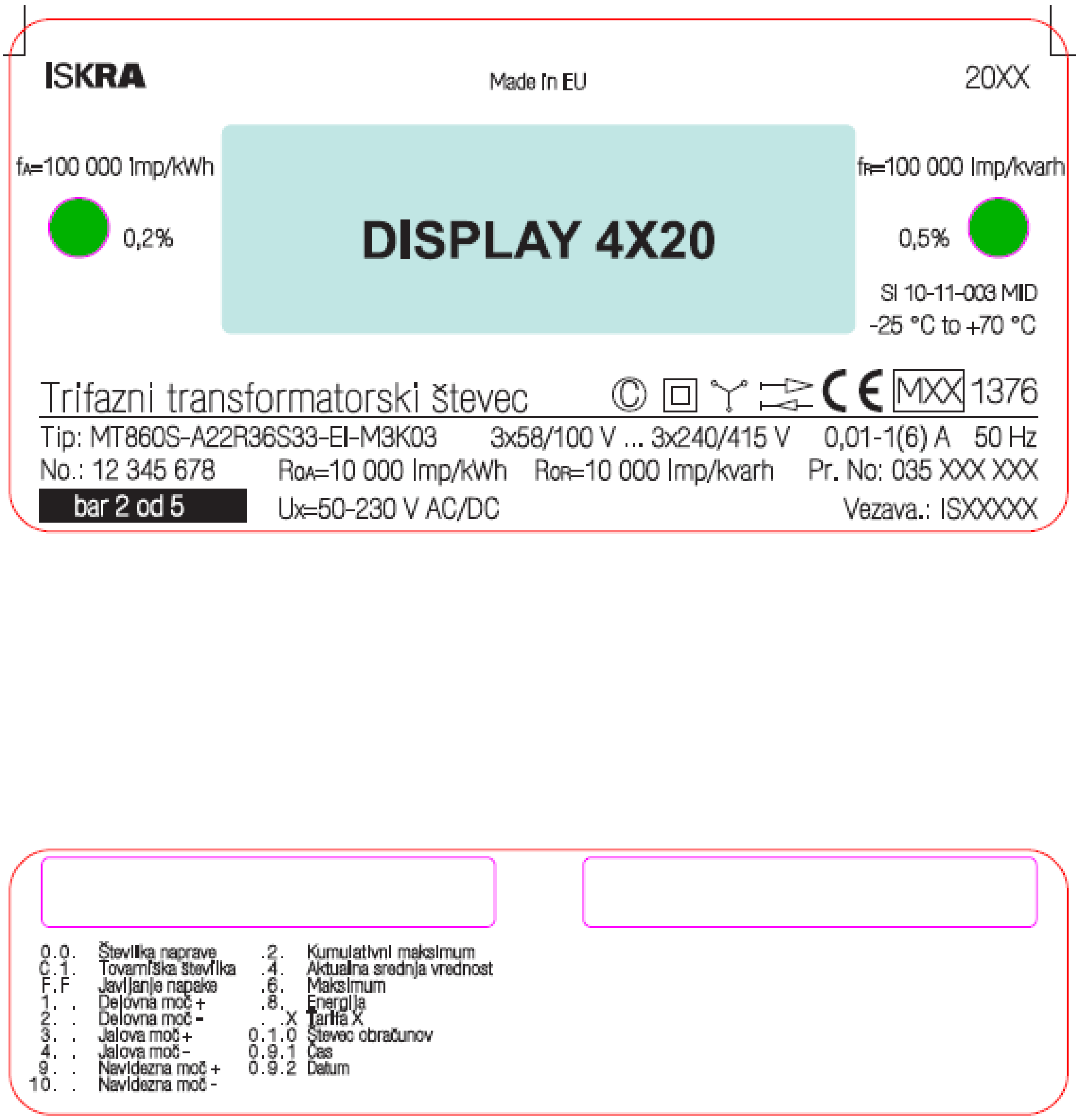



*Fig. 7: Front plate*

## 3.3. Wiring connections

The meters can be connected via current or current and voltage measuring transformer in three-phase three or four-wire networks. They can also be connected by means of Aaron connection of both voltage and current transformers.

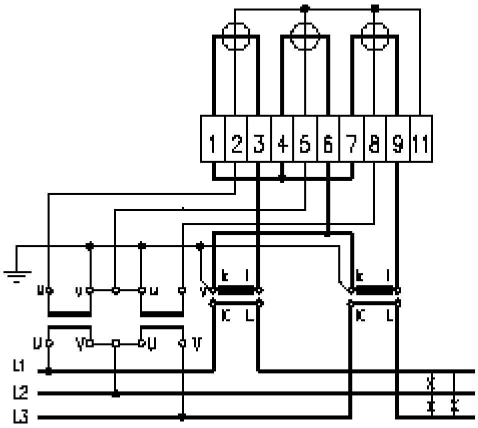



*Fig. 8: Sample 3-wire connection*

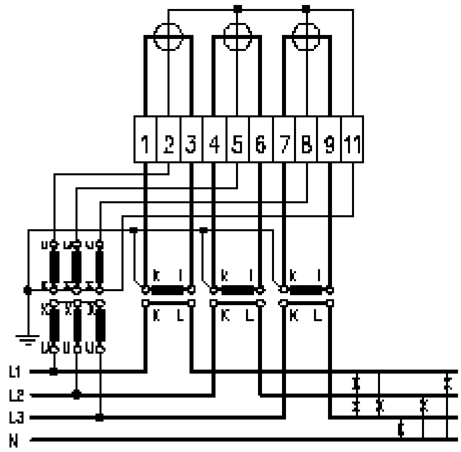



*Fig. 9: Sample 4-wire connection*

## 3.4. Terminals

There are 12 or 6 (with a RJ-11 connector) terminals on the meter basic board. They are used for inputs, outputs, communication and external power supply.

Terminals could be used for RS232 or RS485 communication port and up to 3 inputs and 3 outputs.
Optional modules expand basic input/output and communication meter capabilities.


*Fig. 10: Terminal block*

## 3.5. LED pulse indicators

Two red LEDs on the front plate are used for meter testing and checking. Blinking rate of the LEDs depends on applied load and meter LED constant (imp./kWh or imp./kvarh). LED constants depend on rated voltage and current. Constants are secondary constants.

If load is lower than the meter threshold load or there is no load, the LEDs constantly lit.

| Un (V) | In (A) | LED (imp/kWh, imp/kvarh) | Output (imp/kWh, imp/kvarh) |
|---|---|---|---|
| Multi-range 3x58/100 V…230/400 V | 1 | 500.000 | Output=LED*M/N |
| | 5(6) | 100.000 | |
| | 1(6) | 100.000 | |

*Table 2: LED and output constants*

LED and output constants are software settable. Outputs constant is calculated from LED constant via settable multiplication (M) and division (N) factors (0.0.128.11.4). Multiplication and division factors should be set that the output constant is an integer number.

## 3.6. Optical-magnetic probe

An infra-red optical interface is a standard part of the meter enabling the meter setting and data reading. It is implemented on the meter front side on the part where a probe is fixed. Communication is carried out in compliance with the IEC 62056-2 protocol.

Optional optical-magnetic probe with USB interface enables "no-power" meter reading and setting. With this probe by means of magnetic induction, communication and LCD display work also if meter is not wired at all.
It is also possible to read meter data manually by means of the Scroll key.

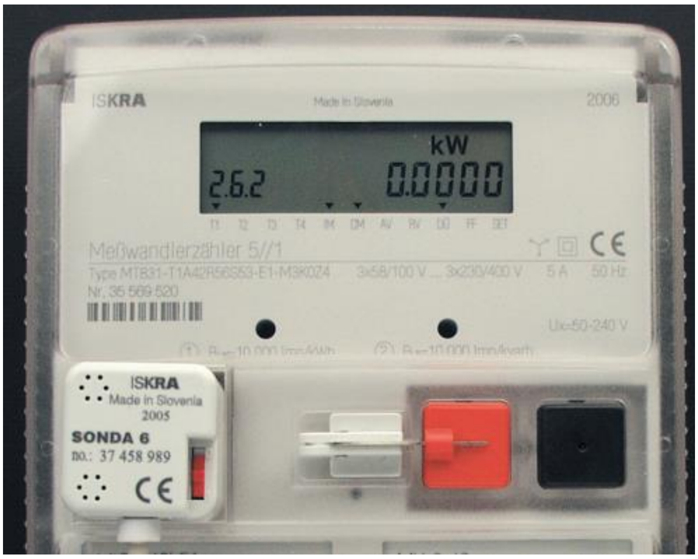



*Fig. 11: Optical-magnetic probe, Iskraemeco SONDA 6.*

## 3.7. Power supply

Meter is supplied from multi-range internal power supply, external power supply or both.
Power supply is used by the meter and by the I/O and communication modules.
Power supply priority is software settable.

### 3.7.1. Internal supply

Multi-ranging three-phase internal power supply allows the same meter to be used in a range from 3x58/100V to 3x240/415V ±20 % voltage, reducing the number of different meters a utility must inventory.

### 3.7.2. External supply

The meter is supplied from a single-phase switching supply unit that functions on the external source of voltage within the voltage range from 50 V to 230 V AC/DC.
It is electrically isolated from other circuits. If the meter is supplied from the external source, it is indicated on a display.

### 3.7.3. Internal and external supply

The meter has two main supply units: internal three-phase and external single-phase switching supply unit.

## 3.8. Power supply priority

Power supply priority is software settable. With a software MeterView it is possible to set which supply is used first if both power supplies are present.

Until the power supply with a priority is present, the meter is supplied from that supply. In case of failure of the power supply with a priority, it immediately switches to the other supply.

To increase precision by unloading voltage transformers choose external power supply priority. Meter is supplied from external power supply.

To avoid external supply (e.g. weak battery supply) set internal power supply priority to supply meter from mains.

## 4. Modules

Meter is modular based. Different types of communication and I/O modules can be chosen. The same module can be used also for other Iskraemeco meter types: MT83x, MT86x, MT37x.

Exchangeable modules are automatically recognised (plug & play). When the module is built in, it sends its identification code via a data bus. The module is automatically recognised by the meter and is correspondingly controlled.

Module can be exchanged without disconnecting power supply (hot-swap) or removing calibration seal.
In case of module break-down 100% safety of other functions is guaranteed.


*Fig. 12: Modules*

### 4.1. Input/output module

I/O modules are plug & play. Two versions regarding the internal programming are available:

- **Input – output module function is predefined in module EEROM**

  The module is pre-programmed in the factory. After inserting the module into the meter, the meter automatically accepts the module parameters (plug and play module). Terminals are marked according to the VDEW requirements. The module can be re- programmed only in the factory

- **Input – output module function is not predefined in module EEROM**

  The function of input-output module terminals is defined when setting meter parameters which are specified in the group "Input/output pins" → MeterView 4 program. Terminal designations:
  - Cx for common terminals
  - Tx for output terminals
  - TEx for input terminals

  where x is from 1 to n (a terminal number).

  Standard versions are:
  - MIO-V12L51 → 4 outputs + 1 output + 1 input
  - MIO-V42L81 → 4 outputs + 4 outputs + 4 inputs
  - MIO-V12L41B11 → 4 outputs + 1 output 5A bistable rele + 1 input

  Error on an input/output module does not influence in the meter operation.

Figure 11 - Input/output module

Definition of input terminals:

| Terminal | Terminal designation | Additional explanation |
|---|---|---|
| 15 | COM | Common terminal for functional inputs |
| 13, 33 | TE1/2, TE3/4 | Energy tariff input T1 – T4 |
| 14, 34 | ME1/2, ME3/4 | Demand tariff input M1 – M4 |
| 16 | MPE | External time/measurement period synchronization input |
| 17 | MZE | External input for disabling of demand measurement |
| 18 | MREa | Input a for external billing reset |
| 19 | MREb | Input b for external billing reset |
| 21 | MKE1 | Alarm input 1 |
| 22 | MKE2 | Alarm input 2 |
| 90 | COM | Common terminal for impulse inputs |
| 91 | IME1 | Impulse input 1 |
| 92 | IME2 | Impulse input 2 |

Table 4 – Input terminals designation

Impulse inputs are realized as passive inputs. An impulse constant is programmable and could be different for each impulse input. Maximum impulse frequency is 25 imp/sec.

Definition of output terminals:

| Terminal | Terminal designation | Additional explanation |
|---|---|---|
| 35 | COM | Common terminal |
| 36 | MKA | Alarm output |
| 37 | MPA | Measurement period output |
| 38 | ERA+A | Energy flow direction +A |
| 39 | ERA+R | Energy flow direction +R |
| 40 | COM | Common terminal |
| 41 | +AA | Pulse output for +A |
| 42 | -AA | Pulse output for -A |

| | | |
|---|---|---|
| 43 | +RA | Pulse output for +R |
| 44 | -RA | Pulse output for -R |
| 45 | RA1 | Pulse output for RA1 |
| 46 | RA2 | Pulse output for RA2 |
| 47 | RA3 | Pulse output for RA3 |
| 48 | RA4 | Pulse output for RA4 |
| 52 | COM | Common terminal for 41 and 42 terminals |
| 54 | COM | Common terminal for 43 and 44 terminals |
| 56 | COM | Common terminal for 45 and 46 terminals |
| 58 | COM | Common terminal for 47 and 48 terminals |
| 59 | COM | Common terminal for terminals from 45 up to 48 |
| 65 | COM | Common terminal |
| 61, 63 | TA1/2, TA3/4 | Demand tariff outputs T1 – T4 |
| 62, 64 | MA1/2, MA3/4 | Demand tariff outputs M1 – M4 |
| 67 | MZA | Output for disabled max. demand measurement |
| 68 | MRAa | Output for external billing reset a |
| 69 | MRAb | Output for external billing reset b |
| 75 | COM | Common terminal |
| 71 | LA1 | Load control output 1 |
| 72 | LA2 | Load control output 2 |

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## 4.2. Communication module

Communication modules are plug & play. Two versions regarding the internal programming available:

- **Communication module parameters setting is predefined in the module EEROM**
  The module is pre-programmed in the factory (baud rate, parity, stop bit, some special modem settings). After inserting the module in the meter, the meter automatically accepts the module parameters (a plug and play module).

- **Communication module parameters setting is not predefined in the module EEROM**
  All settings regarding the communication modem accept from the meter parameters. The modem is automatically initialized after predefined period or meters internal initializations.

Each module, except the RS-232 module with a 25-pin DB connector, has two independent communication interfaces, which enables simultaneous meter reading. Communication interfaces are isolated from each other.
Additional special programming (for example: PSTN modem) is possible with the MeterView 4 program.

Communication module designation:
**MK – the 1st comm. Inter. – the 2nd comm. Inter.**

For example:
**MK – f38 – 3**

First communication interface (**MK** – **f38** – 3):
8 → GSM modem
+
3 → RS-485 interface
+
f → active CS interface
(it is possible to establish multi drop communication via RS-485 and CS communication interface)

Second communication interface (**MK** – f38 – **3**):
3 → RS-485
Second (independent) RS-485 communication interface.

Besides communication towards the centre, the modules also offer possibility of cascade connection (a CS interface and an RS-485 interface). The module enables hot swap installation (modules can be changed or built into the meter during the meter operation). The modules are located under the terminal cover and are not sealed with a metrological seal. On costumer's request, modules could be sealed with an unremovable sticker.
The same communication module can be built into different meter types: MT831 and MT860. All modules are »plug & play« type. When the module is built in, it sends its identification code via a data bus. The module is automatically recognized by the meter and is correspondingly controlled.
The error on the communication module does not influence in the meter operation.

Figure 12 - Communication module

## 5. Display

The liquid crystal matrix-dot display with 4x20 characters enables complex and clear display of different data, messages and events. Depending on meter mode different information is shown.
Displayed data is identified with OBIS IEC 62056-61.

Meters have back-light illumination for easy data reading at metering place with bad light condition. The LCD is illuminated when any pushbutton is pressed. The illumination is switched-off after 3 minutes if no pushbutton was pressed at that time.

The LCD is mounted on a separate printed circuit board that is plugged in a corresponding connector.

### 5.1. Pushbuttons

Display is menu driven and is handled by pressing one pushbutton at time (one-hand handling) as it is required by the VDEW requirements.
Setting parameters are performed by one hand, too.

Employed menu is controlled by two pushbuttons on the meter front side:

- scroll (black),
- reset (red, sealed).

*Fig. 13: Meter pushbuttons*

Each button has three activation times:

- short, up to 1 second,
- long, 1-3 seconds,
- extended, more than 3 seconds.

Pushbuttons perform next actions:

| Activation time | Scroll (black) | Reset (red) |
|---|---|---|
| Short | Move to next selection ■ | Next value, Increase value ■ |
| Long | Confirm selection ■ ■ | Confirm setting, Billing reset ■ ■ |
| Extended | Cancel ■ ■ ■ | |

*Table 3: Pushbutton actions*

## 5.2. Modes

There are the following modes:

- start-up logo (at power-up),
- LCD test,
- auto-scroll (auto-scroll sequence),
- manual
  - registers (manual sequence),
  - load profile,
  - grid,
- settings,
  - settings (settings sequence),
  - testing,
  - billing reset,
- parameterisation.

In each mode different data is shown on a display.
There are three modes with programmable data displaying sequences:

- auto-scroll mode: auto-scroll sequence,

- registers mode: manual sequence,
- settings mode: settings sequence.

Each sequence has defined list of data items to be displayed or set. Displaying sequences can be defined in the meter parameterisation mode.

## *5.3. Status indicators*

In auto-scroll mode following four lines are shown:

1. line: fatal status, date and time,
2. line: OBIS identification code,
3. line: value and unit,
4. line: meter status indicators.

Standard meter status indicators are:

- L123 Phase voltage detection, blinking incorrect phase sequence.
- A+, A- Total active energy direction. Blinking if at least one phase energy direction is opposite.
- R+, R- Reactive energy direction. Blinking if reactive measurement is blocked.
- Tx Valid tariff for energy
- M Meter cover opened
- T Terminal cover opened
- C Communication
- P Parameterisation mode
- E External supply

In abnormal mode the first line on display is changed so that a blinking error message is displayed along with the date and time. Possible error messages are:

- F Error
- BadIO Bad input/output module
- BadCM Bad communication module

When entering special modes the first line on display is also changed. A non blinking warning message is displayed along date and time.

## *5.4. Phase voltages detection*

The meter enables detection and alarming of the presence of phase voltages. Presence of voltage and phase sequence is marked by L123 characters in the bottom line of the LCD.

- If all three symbols L123 are displayed, it means that all three phase voltages are present.
- If cursors L123 are blinking, phase sequence is not correct. In this case it is required to change the cables phase sequence, otherwise the reactive energy is registered in the wrong quadrant. The phase sequence does not impact on measurement and registration of the active energy.
- Any not displayed symbol (1, 2 or 3) means certain phase voltage is lower than Un-25%.
- If number blinks phase voltage is in range from Un-25% to Un-10%.
- If number is blinking on inverse background, phase voltage is higher than Un+10%.

The borders for under voltage, over voltage and voltage failures are settable.

## 5.5. Start-up logo mode

When meter is switched on, start-up logo is shown for up to 5 seconds until meter is not ready for measurement. Then meter automatically switch to the auto-scroll mode.

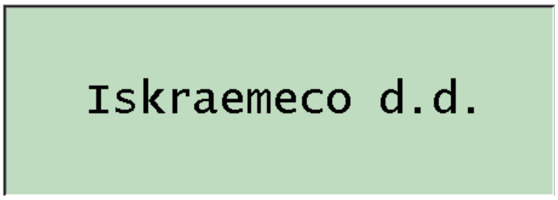



*Fig. 14: Start-up logo mode*

## 5.6. Auto-scroll mode

Auto-scroll mode is a standard display mode. Data defined by auto-scroll sequence are scrolled automatically and displayed for 10 seconds each.

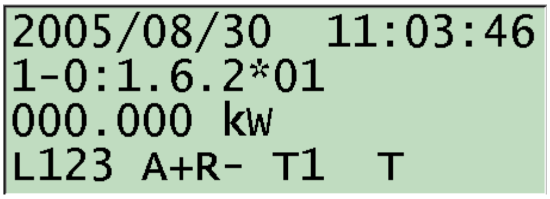



*Fig. 15: Auto-scroll and manual sequence display*

Meter returns to auto mode from any mode automatically if no pushbutton has been depressed in a time span of 2 demand periods or if the scroll button is depressed for extended time.

## 5.7. LCD test mode

LCD test mode is used to check if all LCD dots are displayed. When scroll button is pressed in auto-scroll mode, display is illuminated and all LCD segments (dots) blink. LCD illumination time is set in register 0.0.128.0.5.

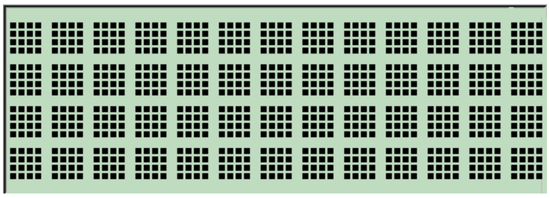


*Fig. 16: LCD test mode, all dots are displayed*

## 5.8. Registers

In registers mode it is possible to list all registers from manual sequence with a scroll button.
The first data item displayed in the manual sequence list is usually the identification code and data on function errors. Each following press of the scroll button displays next data item from the sequence.

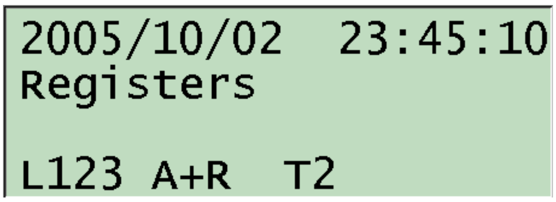



*Fig. 17: Press scroll pushbutton to enter manual sequence*

With long press of scroll button the previous values are skipped, so that the next data is displayed. In this way manual sequence data items can be faster over-viewed.

## *5.9. Load profile*

It is possible to view load profile by selecting date and time. To increase date or time scroll button is pressed for short time. To select date or time a scroll button must be pressed for a long time.

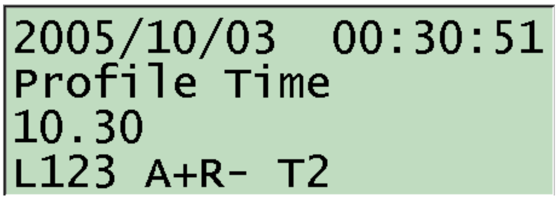



*Fig. 18: After selecting date select time*

After defining desired date and time the status value will be displayed.

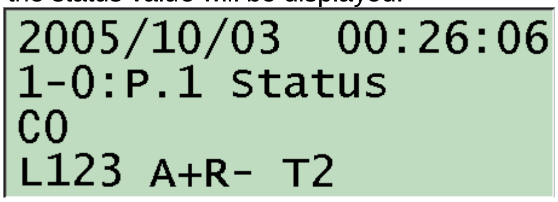



*Fig. 19: Load profile status value*

Multiple status bits can be active simultaneously and indicates an event in displayed period.

| Bit | Character 1 | Character 2 |
|---|---|---|
| 4 | Power-down | Season change |
| 3 | Power-up | |
| 2 | Set time | |
| 1 | MD reset | |

*Example 1: Load profile bits. C0 (hex) = 1100 0000 (bin). Power-up and power-down event occurred*

With next short presses on scroll button all load profile quantities will be shown. On customer request load profile values can be shown as:

- energy absolute x.8,
- energy delta value x.9,
- demand x.5,

where x is 1 (A+), 2 (A-), 3 (R+), 4 (R-), 5 (R1), 6 (R2), 7 (R3) or 8 (R4) respectively.

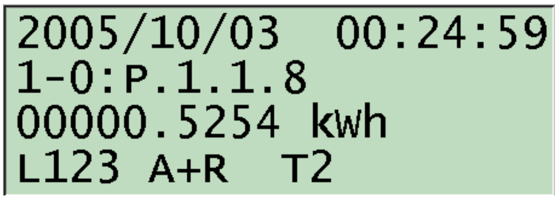



*Fig. 20: Load profile quantity*

To move back to load profile initial screen to set time select End.

## *5.10. Grid*

Main network parameters are shown: phase currents, voltages, angles and frequency.

## *5.11. Settings*

Setting sequence contains the list of parameters to set in setting mode only manually by pushbuttons.

To enter settings mode the seal from reset button must be removed. Status P appears on LCD. Parameters defined in a setting sequence can be changed. While settings are set by buttons (digits blink) setting by communication interfaces is disabled.

To confirm data item selection press scroll button for long time. To move between data item digits press scroll button for a short time. To increase current digit value press reset button.
To confirm data item setting press scroll pushbutton for a long time. To reset the chosen value back to default push the reset button again.

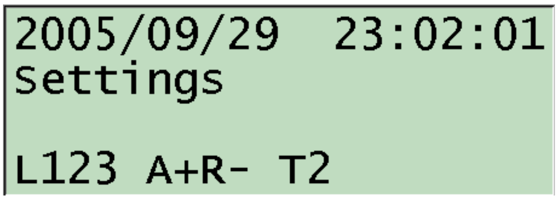



*Fig. 21: Settings mode*

## *5.12. Testing*

Test mode can be used when additional decimals are needed when observing the energy registers on LCD. Data sequence is as in registers mode.

## *5.13. Billing reset*

By pressing scroll pushbutton for a long time a billing reset is executed when billing reset is chosen.

The meter executes a billing reset also when reset button is pressed in the auto-scroll mode. The message “Billing reset” indicates that billing reset has been performed.
Message “Billing reset locked” indicates billing reset blockade period when new billing reset can not performed by pushbuttons.

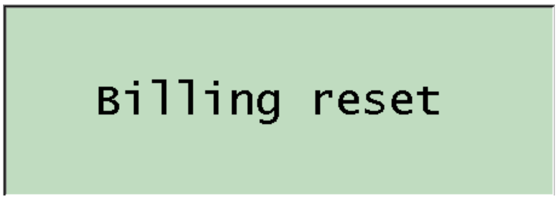



*Fig. 22: Billing reset message*

## *5.14. Parameterisation*

To enter parameterisation mode parameterisation pushbutton under the meter cover should be pressed.

Seals from meter cover must be removed to access parameterisation pushbutton under the meter cover.

When the parameterisation button has been pressed, the cursor P is displayed indicating that the meter is in the parameterisation mode.

The meter is now ready to be programmed via optical communication interface. Setting of all parameters with this protection degree is enabled.

The parameterisation mode is terminated:

- at the end of communication,
- after communication time out,

## *5.15. Flowcharts*

Legend: see Table 3: Pushbutton actions.

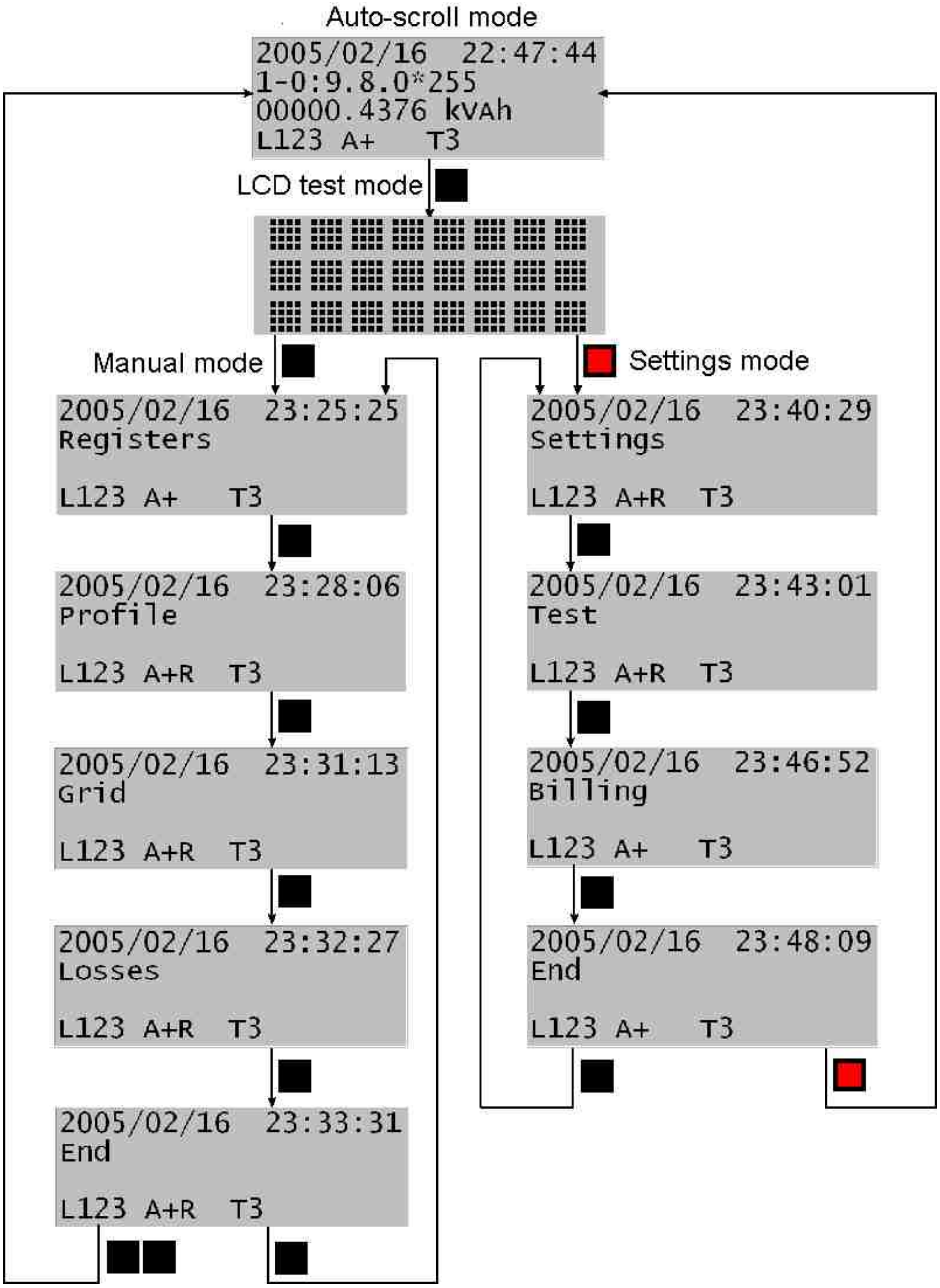



*Fig. 23: Display modes*

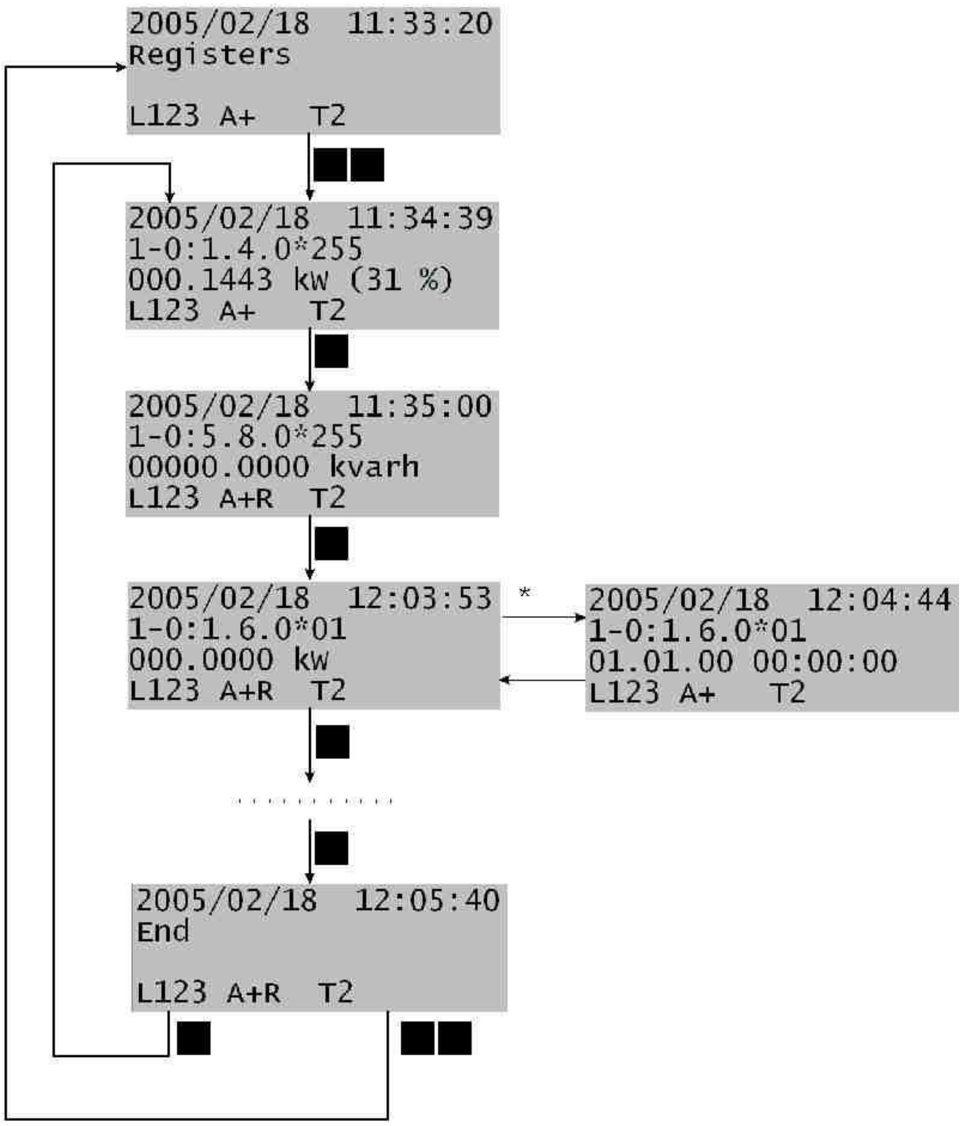



Fig. 24: Register flowchart, scrolling through manual sequence

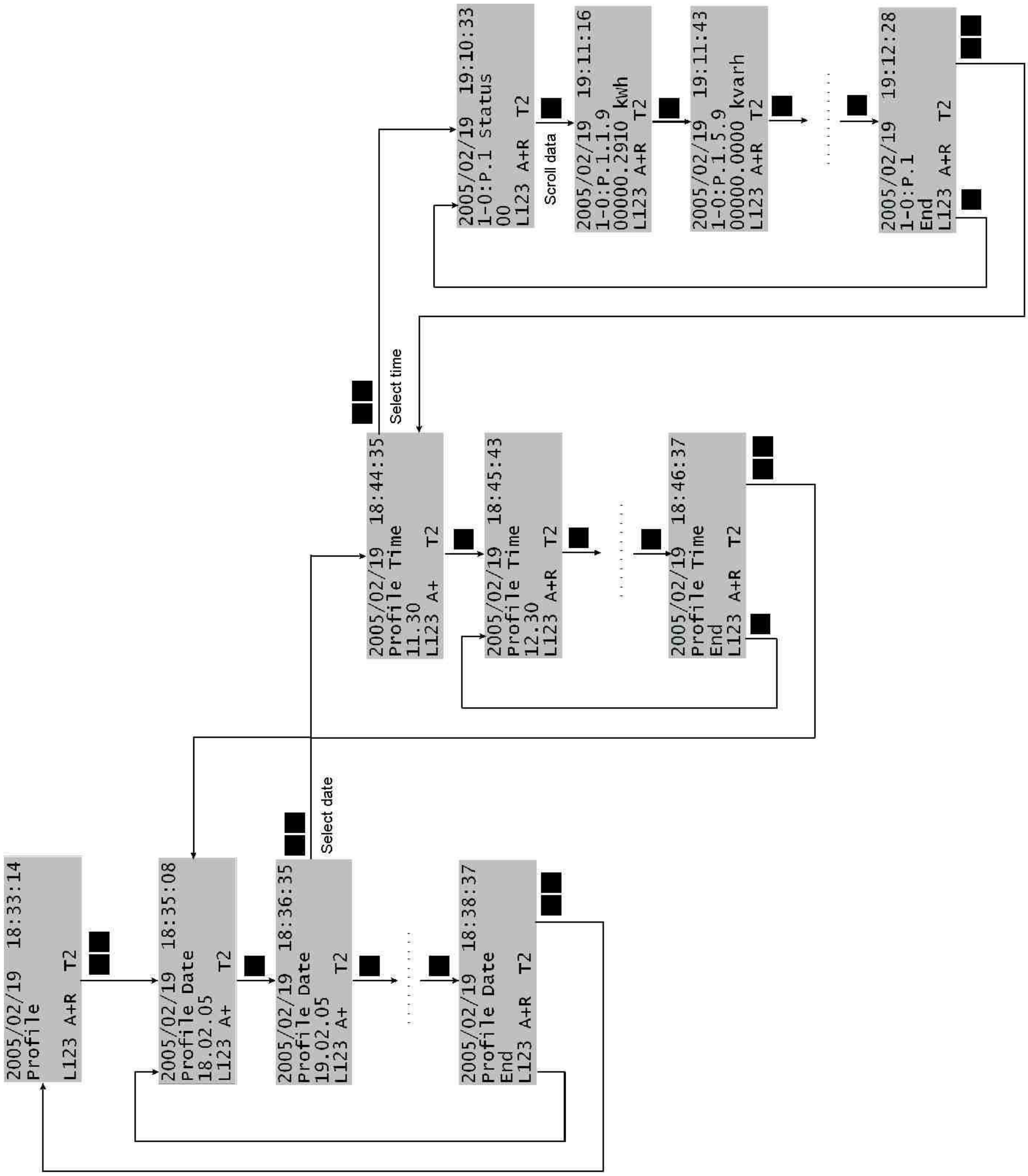



*Fig. 25: Load profile flowchart. Select date, select time, scroll load profile data*

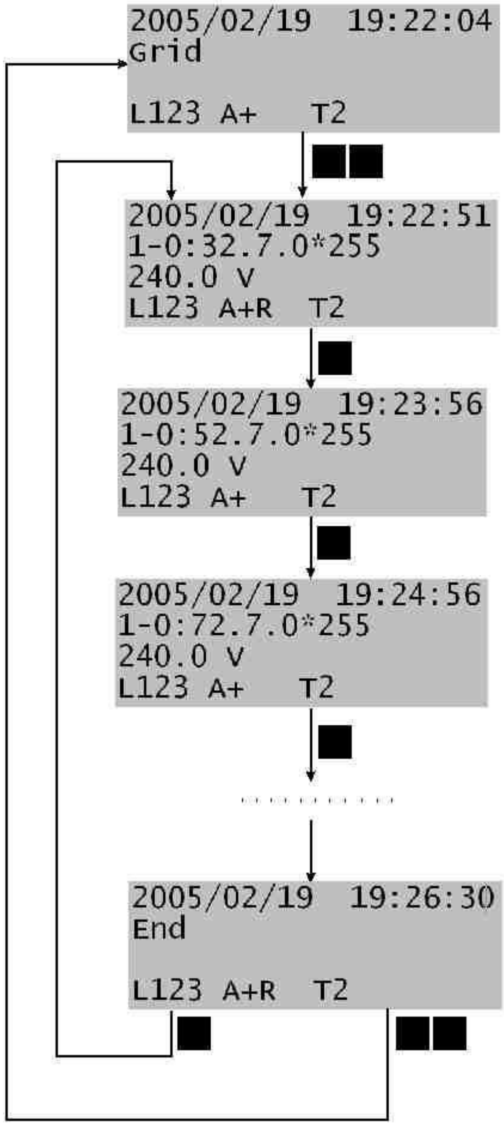



*Fig. 26: Grid flowchart*

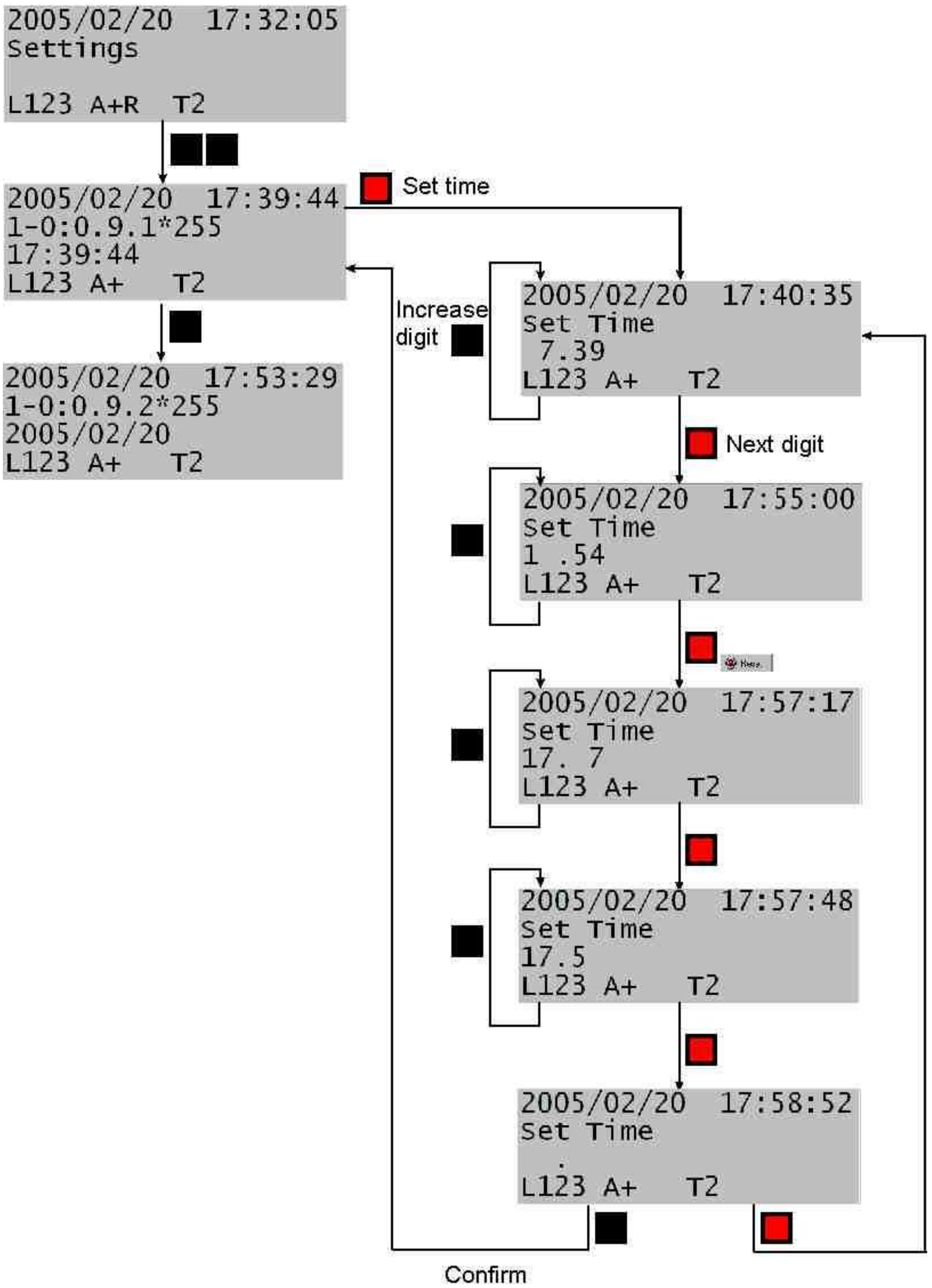



*Fig. 27: Time setting flowchart*

## 6. Real time clock

Real time clock performs all time related meter functions:

- an annual calendar programmed by 2090,
- lunar calendar,
- daylight saving time (DST).

Next registers contains time and date:

| | Format | Register |
|---|---|---|
| Time | hhmmss | 1-0:0.9.1 |
| Date | YYMMDD | 1-0:0.9.2 |
| Date and time | YYMMDDhhmmss | 1-0:0.9.4 |

*Table 4: Format of date and time. hh- hour 0-23, mm- minute 0-59, ss- second 0-59, YY- year 00-99, MM- month 1-12, DD- day 1-31.*

A day of week is set automatically from 1 to 7 regarding the entered date. Each day in a week can be defined as the first one.

RTC can be controlled by 32 kHz oscillator or corrected by input signal MPE.
The RTC power supply is backed-up with a super capacitor or a super capacitor and a Li-battery.

## 6.1. Quartz crystal

The quartz crystal is digitally trimmed during manufacturing. A value of the trimming constant in ppms is stored in register 1.0.96.50.1.
The crystal controlled RTC complies with the IEC 61038 standard. Its accuracy is ±3 min/year at room temperature. The error is cumulative.

## 6.2. MPE correction

Besides quartz crystal MPE input could be applied. When applied, MPE signal rounds current RTC time to the nearest minute and seconds are set to zero.

| | | |
|---|---|---|
| Current time | 10:50:31 | 10:50:29 |
| After MPE correction | 10:51:00 | 10:50:00 |

*Example 2:MPE time correction*

## 6.3. Back-up power supply

The RTC is backed-up with a super capacitor or a super capacitor and a Li-battery.

Super capacitor (1F) enables 250 hours operation reserve of the RTC. It is recharged to full capacity within 1 hour after being exhausted.

Li-battery enables 2-year operation of the RTC. Its shelf life is 20 years. There is a counter (0-0:96.6.0) of elapsed time in hours when RTC was backed-up with the Li-battery and left capacity in percentage (0-0:96.6.1). Message "Battery low" on a LCD indicates that battery was discharged and has to be replaced. As option also output is set for remote alarming.

## 6.4. Setting

The RTC can be set to current time and date by user with buttons (see Fig. 27: Time setting flowchart) or communication interface.
Default setting is performed automatically by the microcomputer when a RTC error occurs. From that moment onwards the RTC date and time is not correct anymore.

Regular setting is performed when date and time are entered manually by the pushbuttons or via a communication interface. With this action exact time and date are set.

## 6.5. Daylight saving time

RTC enables automatic changing to daylight saving time and back to the standard time, also known as a summer and winter time.
DST switching can be done by:

- an algorithm, switching DST each year on the last Sunday of the selected month and hour stated in the 0.0.128.7.3 register,

- a fixed date stated in a form of a table in register 0.0.128.7.3.

DST switching type is set in the 0.0.128.7.5 register.

In case of power shortage at transition from a winter to a summer time or vice versa, meter will correct the time automatically when the power supply is restored.

## 7. Inputs and outputs

Meter can be equipped with up to 3 programmable inputs with a common ground and up to 8 programmable outputs.

| Inputs | Marking |
|---|---|
| Energy tariff change-over | TE1, TE2, TE3 |
| Demand tariff change-over | ME1, ME2, ME3 |
| Billing reset | MRE (MRa, MRb) |
| Time synchronisation or demand period triggering | MPE |
| Demand measurement disabling | MZE |

*Table 5: Inputs*

| Outputs | Marking |
|---|---|
| Energy active tariff | TA1, TA2, TA3 |
| Demand active tariff | MA1, MA2, MA3 |
| Demand period start | MPA |
| Energy flow direction | ERA+A, ERA+R |
| Billing reset | MRA (MRAa, MRAb) |
| Demand measurement disabling | MZA |
| Energy reading pulses | +AA, -AA, +RA, -RA, RA1, RA2, RA3, RA4 |
| Alarm | MKA |

*Table 6: Outputs*

### 7.1. Inputs

#### 7.1.1. Tariff change-over

The inputs are used for external change-over of tariffs for energy or demand registration. There are inputs for demand tariff change-over (ME1, ME2, ME3) and inputs for energy tariff change-over (TE1, TE2, TE3).

The following rules are valid for both demand and energy tariff change-over. There are two possibilities:

- Each input represents one tariff. A combination of tariffs can be activated at the same time. In this case a maximum number of tariffs are 3.
- Only one tariff is active at the moment. In this case the number of tariffs is increased to $2^3 = 8$.

If several tariffs are to be valid at the same time, a suitable combination of tariff inputs should be done.

| No. of tariff inputs | Max. No. of tariffs |
|---|---|
| 1 | 2 |
| 2 | 4 |
| 3 | 8 |

*Table 7: Number of tariff inputs and number of tariffs*

| State of inputs TE1 | TE2 | Active tariffs |
|---|---|---|
| 0 | 0 | 1, 5 |
| 0 | 1 | 2, 6 |
| 1 | 1 | 3, 7 |
| 0 | 1 | 4, 8 |

*Table 8: Multiple tariff control by inputs*

### *7.1.2. Billing reset*

Inputs MRa and MRb enable remote resetting of the meter at the end of billing periods. See chapter 15 Billing reset.

### *7.1.3. Demand measurement disabling*

MZE input enables triggering of demand forgiveness period. As long as a signal is applied demand is not measured.

### *7.1.4. Time synchronisation and demand period triggering*

MPE input is used for either:

- external triggering of demand periods,
- RTC synchronisation.

MPE input has the highest priority. It starts a new demand period irrespectively of elapsed demand period or internal tariff device command.
In case MPE signal is applied for RTC synchronisation, seconds are set to zero and time is

## *7.2. Outputs*

### *7.2.1. Energy reading*

The meters can be equipped with up to six pulse outputs for remote reading of active energy in two energy flow directions and reactive energy in four quadrants or in combined quadrants.

Output pulse constants (imp./kWh or imp./kvarh) depend on rated current of the meter. Output constants are settable, see Table 2: LED and output constants

### *7.2.2. Energy flow direction*

ERA+A output indicates active energy flow direction and ERA+R output indicates reactive energy flow direction. When contact is closed positive direction is indicated.

### *7.2.3. Tariff change-over*

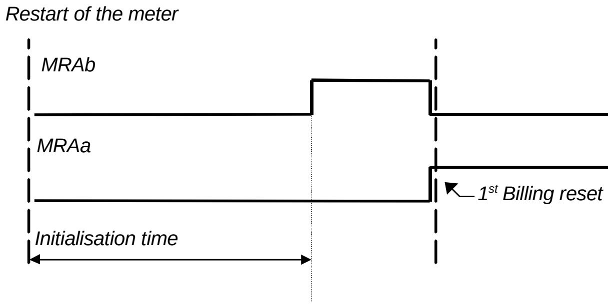
Depending on a number of tariffs for energy or demand the meter can be equipped with up to 3 tariff outputs for energy (TA1, TA2, TA3) and up to 3 tariff outputs for demand (MA1, MA2, MA3).

A make contact is closed at the corresponding tariff output or outputs for remote indication which tariff for energy registration is valid at the moment.

### 7.2.4. Billing reset

Outputs MRAa and MRAb indicate billing reset. At the moment of a billing reset contact on the first output closes and the other output contact opens. Only simultaneously change of both outputs MRAa and MRAb indicates that billing reset was performed.

In case of a power failure contacts are open on both outputs. When power supply is restored contact of the first output is closed and other remains open. Next simultaneously change indicates first billing reset after meter initialisation.




*. 28: MRAa MRAb outputs at restart and first billing reset*

Billing reset can also be done over a single signal that is actually a combination of MRAa and MRAb signals. The length of the impulse is settable in the limits between 30 and 100 ms.

### 7.2.5. Demand measurement disabling

MZA output indicates forgiveness period - demand is not measured.

### 7.2.6. Demand period start

MPA output indicates start of a new demand period. At the beginning of each demand period, make contact is closed for a short period of time. Standard MPA output version define time span of 1% of the demand period. Register 0.0.128.11.3 defines duration of MPA output activity. If set to 0 it means 1% of MP. Values from 1 to 60 represents number of seconds.

### 7.2.7. Alarm

Meter can be equipped with up to 8 status outputs for remote alarming. There can be used particular status that indicates fatal error, phase failure, current without voltage, etc. or status combination.

## 8. Communication

As a standard, meter is equipped with an optical interface. On the meter board there can be implemented one RS232 or RS485 communication port for remote meter readout. Communication protocol IEC 62056-21 is implemented.

Communication activities of the meter do not interrupt the meter operation.

Meter communication capabilities can be expanded with additional communication module. On communication modules different communication interfaces are implemented. Interfaces are completely independent concerning the protocol, rate and data.

It is possible to read data from up to three communication interfaces. If there are more requests to write data to a meter, communication interface where first request occurred has priority.
Next registers defines communication rates:

- C.57.0, COM 0, IR interface,
- C.57.1, COM 1,
- C.57.2, COM 2.

| C.57.0, C.57.1, C.57.2 | Rate (Baud) |
|---|---|
| 0 | disabled |
| 1 | 300 |
| 2 | 600 |

| | |
|---|---|
| 3 | 1200 |
| 4 | 2400 |
| 5 | 4800 |
| 6 | 9600 |
| 7 | 19200 |

*Fig. 29: Communication settings*

## 8.1. RS 232 interface

Three-wire RS 232 interface is used for point-to-point communication in accordance with standard IEC 62056-21. An external device can be connected to the RS 232 terminals. Maximum transmission rate 9600 Baud.

## 8.2. RS 485 interface

Two-wire RS 485 interface is used for multi-drop (daisy chain / multi-drop) communication in accordance with standard IEC 62056-21. Maximum transmission rate 9600 Baud.

## 8.3. IEC 62056-21

The IEC 62056-21 protocol is based on a serial asynchronous half-duplex communication in compliance with the ISO 1177 standard.

Communication settings are as follows:

| | |
|---|---|
| Start bit | 1 |
| Data bits | 7 |
| Parity | even |
| Stop bit | 1 |
| Reply timeout (ms) | 1500 |

*Table 9: IEC 62056-21 communication settings*

A protocol diagram flow is shown in Fig. 30. The following steps of communication are shown:

- login,
- setting of communication rate,
- data reading/writing,
- interruption.

### 8.3.1. Login

In the first step, a message for login to the meter to which communication is required is sent. Each meter has its address consisting of 32 characters (register 0.0.0). It defines a device in a network.

If there is only one meter on a serial channel, login is possible without a meter address.

### 8.3.2. Rate setting

According to the standard, the initial transmission rate is set to 300 Baud and is then changed. The "Z" parameter in a message represents the communication rate after the initial rate of 300 Baud.

Since the request stated in the IEC 62056-21 standard is quite inconvenient, the Iskraemeco meters enable a non-standard additional possibility of communication with only one specified rate (fixed baud rate).

### 8.3.3. Commands R1 and W1

After setting the rate, the meter data can be read or written. Data reading and writing can be protected with a password.

R1 command enables data reading from meter registers:

| | | | | | | |
|---|---|---|---|---|---|---|
| SOH | R1 | STX | Address | Data | ETX | BCC |

W1 command enables data writing into registers:

| | | | | | | |
|---|---|---|---|---|---|---|
| SOH | W1 | STX | Address | Data | ETX | BCC |

Address is defined by the data in the register:

- address; access to individual register,
- address, offset; access to the register with an index (offset) from Address,
- address (number of elements); access to a number of elements from Address onwards,
- address, offset (number of elements); access to a number of elements from the Address with index onwards.

There is only one data or a sequence of several data:

| | | | |
|---|---|---|---|
| (data1) | ( data 2) | ... | (data N) |

Data can consist of both a value and a unit:

| |
|---|
| value (* unit) |

Each data has its own type and is therefore formatted by itself. You can therefore always refer only to the name and get the value in the right format.

The meter answers to the received message:

- ACK, a command has been performed correctly,
- NACK, a command has not been performed correctly,
- a message is sent back with requested data,
- a message about the error is sent back.

A meter message with data:

| | | | |
|---|---|---|---|
| STX | Data | ETX | BCC |

A meter message in case of error:

| | | | |
|---|---|---|---|
| STX | Error | ETX | BCC |

A message with all characters should not be longer than 256 characters.

### *8.3.4. Command R5*

For logbook or load profile reading R5 command is used:

| | | | | | |
|---|---|---|---|---|---|
| SOH | R5 | STX | Address | ETX | BCC |

where address is P.01 (load profile), P.98 (log book), 0.9.1 (time) and 0.9.2 (date). All data in one block.

### *8.3.5. Data read out*

At data read out (DRO), the meter relays all data that are defined in DRO sequence together with their previous values if they are selected.

| | | | | | |
|---|---|---|---|---|---|
| ACK | 0 | Z | 0 | CR | LF |

### *8.3.6. Interruption*

If there is no message at a certain time, communication is interrupted automatically after timeout of 60 seconds. Communication can be interrupted also with a message:

| SOH | B0 | ETX | BCC |
|---|---|---|---|

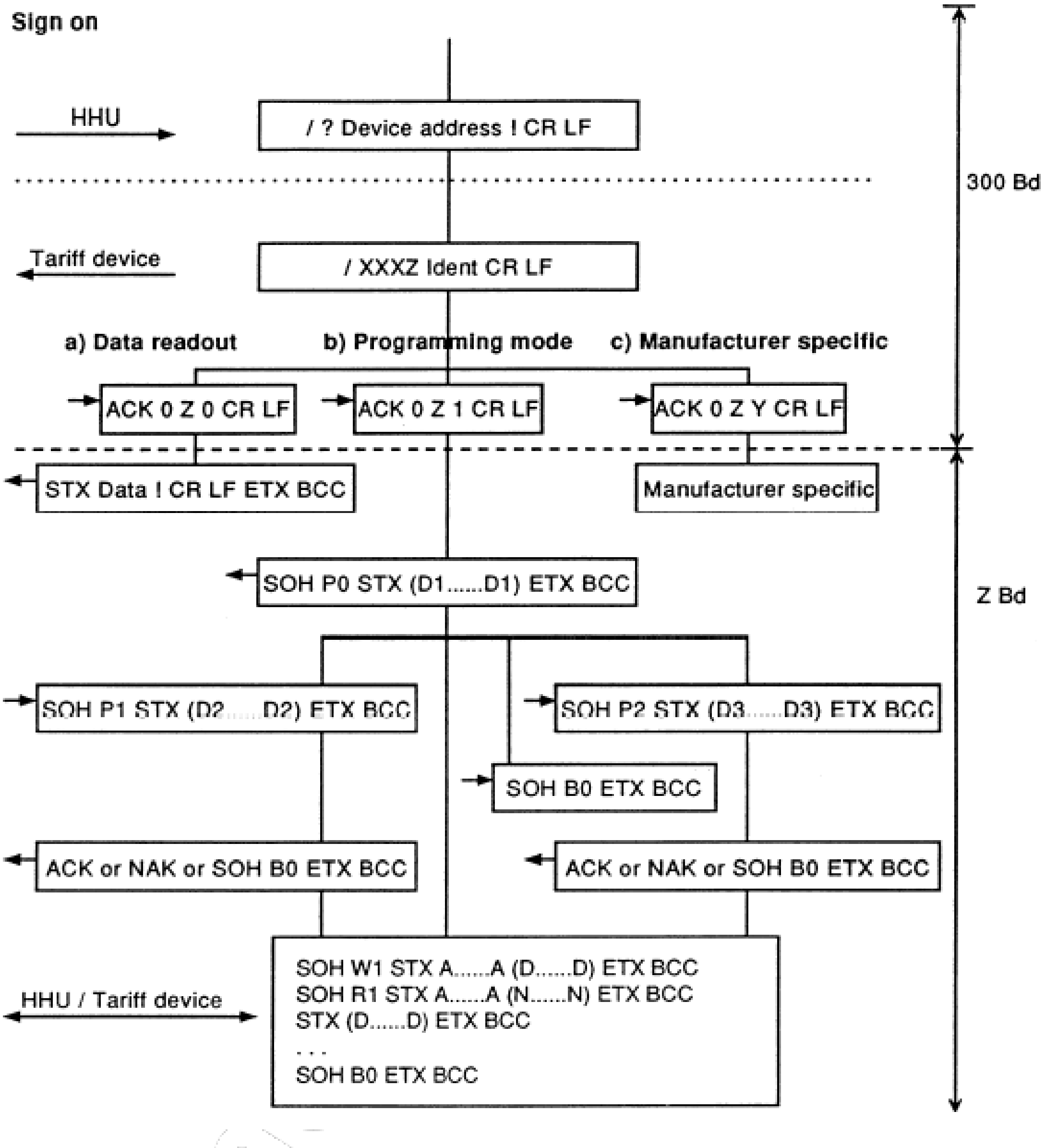



*Fig. 30: IEC 62056-21 (IEC 61107 mode C) protocol diagram*

### *8.3.7. Error messages*

Next table shows list of communication error codes and description.

| ERxy | Explanation |
|---|---|
| 01 | OBIS Code not found |
| 02 | OBIS Code not implemented |
| 03 | Unknown parameter |
| 04 | Unknown index |
| 05 | Unknown value |
| 06 | Unknown command |
| 07 | Access denied |

| ERxy | Explanation |
|---|---|
| 08 | No data |
| 09 | No resource |
| 10 | Device error |
| 11 | Unknown address |

*Table 10: List of error messages on communication*

# 9. Energy measurement

The following types of energy are metered:

Active energy according to standard IEC 62053-22 class 0.2S or 0.5S:

- imported +A,
- exported -A.

Reactive energy according to standard IEC 62053-23 class 2 or 3, calibrated down to 0.2% in:

- four quadrants: R1, R2 , R3 and R4,
- combined quadrants e.g. +R = R1 + R4 and -R = R2 + R3.

Apparent energy according to standard IEC 62053-22, calibrated up to 0.5%:

- imported +S,
- exported -S.

All energies are measured per phase and three-phase.

Meters that are connected via current or current and voltage transformers enable the metering data to be displayed in semi-primary or secondary value.

## 9.1. Previous billing periods

For a current billing period, energies measured by meter are registered in the corresponding registers.
At the meter reset at the end of a billing period, metered data from registers for a current metering period are transferred into the corresponding registers of the previous billing period. Metering values stored in registers of previous billing periods are called previous values.

Up to 50 previous billing periods can be registered. Default is 15 billing periods.

Energy can be registered as:

- Differential value, a difference between cumulative values in two successive billing periods,
- Cumulative value, a cumulative value from a beginning of the energy measurement.

## 9.2. Voltage transformer compensation

All metering values are stored in a raw binary form in the microprocessor. Therefore it is necessary to multiply the raw binary data with a metering output constant $k_{out}$.

The meters connected by voltage transformer enable compensation of the voltage transformer error. To get an energy value raw data must be multiplied with the constant $k_{mc}$:

$$k_{mc} = \frac{k_{out}}{(k_{ct} * k_{vt} * T_{corr})}$$

where:

$k_{ct}$ - a current transformer ratio,
$k_{vt}$ - a product of a voltage transformer ratio and voltage transformer error compensation.
$T_{corr}$ - transformer correction factor in ppms (0.0.128.0.12)

A current transformer ratio $k_{ct}$ is an integer in a range from 1 to 30,000 (0.0.128.0.10). A product of voltage transformer ratio and error compensation of voltage transformer $k_{vt}$ is a floating point number (0.0.128.0.11). If no voltage transformer error compensation is required, the $k_{vt}$ is equal to voltage transformer ratio.

# 10. Demand measurement

Demand is calculated as a quotient of energy integrated over a period of time and the time period. It is an average value. The period of energy integration is called a demand period. Meter calculates:

- cumulative maximum demands (x.2.y),
- actual average demand values in a current demand period (x.4.y),
- demands registered in the last ended demand period (x.5.y),
- maximum demand values in a billing period (x.6.y).

## 10.1. Previous billing periods

Meters enable registration of all maximum demands up to 50 billing periods. Previous billing periods data can be displayed on the LCD or transferred via the communication interfaces.

## 10.2. Maximum demand

Maximum demand is the largest demand in a billing period. A maximum demand can be calculated for all energies that are measured or calculated, like:

- demand of imported and exported active energy +P and -P,
- demand of imported and exported apparent energy +S and -S,
- demand of reactive energy in four quadrants Q1, Q2, Q3 and Q4,
- demand of reactive energy in combined quadrants +Q=Q1+Q2 and -Q=Q3+Q4,

Maximum demand could be registered like:

- tariff rated (x.4.y; x.5.y, x.6.y),
- cumulative (x.2.y).

Date and time of the end of maximum demand is stated by each maximum demand.
At the billing reset maximum demand for a current billing period is transferred into the corresponding register for a previous billing period.

## 10.3. Tariff rated demand

The number of tariff rated maximum demand quantities depends on the number of tariff registers.
Note that tariff changeover schedule for demands can differ from the one for energies.

## 10.4. Cumulative demand

Cumulative tariff rated maximum demands are checking values and are sums of the corresponding maximum demands registered in all completed billing periods since the beginning of the measurement. Therefore there are no registers for previous billing periods.

## 10.5. Modes

The modes of demand measurement differ regarding:

- demand period type,
- triggering of demand period start.

### 10.5.1. Fixed demand period

At fixed demand measurement a new demand period starts when the previous one is ended.

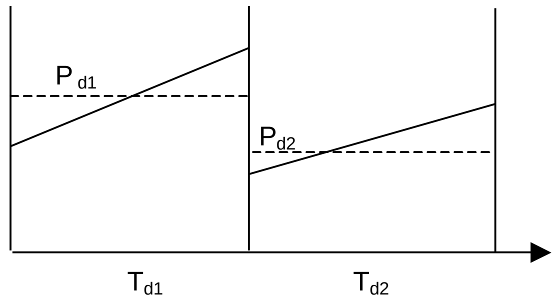



*Fig. 31: Fixed demand period mode*

### 10.5.2. Demand period type settings

Demand period type is set by defining length of a demand period in a register 0.0.128.0.23 expressed in a range from 1 to 60 minutes, with step of 1 minute.

### 10.5.3. Synchronous mode

In synchronous mode only fixed demand period type is possible.

If there is no load profile, demand period start is synchronised with a day. It means that demand a period starts at 00:00 hours and during a day there will be an integer number of demand periods completed.

If there is load profile then the registration period is a multiple of demand periods and a demand period starts synchronously with the registration period. Both the registration period and demand period are synchronised with a day.
In the synchronous mode the demand measurement and load profile can start at any time during a day, but the first demand period may not be complete.

The demand measurement in a synchronous mode differs from the demand measurement in asynchronous mode in cases when the demand period is interrupted due to power shortage.

The main difference is that the demand measurements continue if the power supply is restored in the same demand period; otherwise it is ended for that demand period and the demand measurement is started again at the point of a new demand period when the power supply is restored.

### 10.5.4. Triggering with MPE input

The external triggering of demand period is enabled when a parameter in the register C.59.2 has value 3, 4 or 5. When a parameter in the register C.59.2 has value 0, 1 or 2 the MPE input can be used for synchronisation of the real-time clock only.
The demand period starts on the rising edge of a control signal on the MPE input.

Besides demand period, subinterval and demand mode triggered by MPE also a tolerance (a time span in seconds, register C.55.11, within which a control pulse should appear at the MPE input after the end of the previous demand period) should be defined.

When the demand period is triggered with a MPE input, demand is calculated by dividing measured energy integrated between two successive control pulses with the demand period set in the register 0.8.0 (even if the time between the two pulses is shorter than the demand period).

If the next pulse does not appear on the MPE input within the time span defined in the register C.55.11 after the end of the previous demand period, this is considered that the external triggering of demand period has failed and the meter automatically turn on the corresponding mode of demand measurement with internal triggering of demand periods.

When time between two successive control pulses at the MPE input is longer than the set demand period in the register 0.8.0, energy is integrated over the set demand period only. The demand is not measured in a tolerance time.

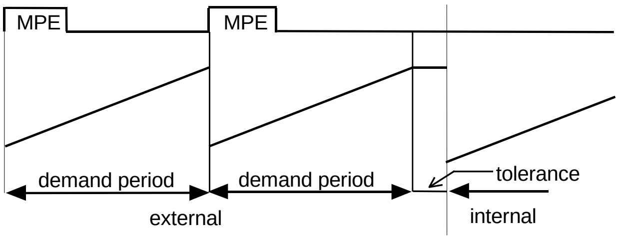



*Fig. 32: Demand not measured in a tolerance time*

## 10.6. Billing reset and tariff changeover

Neither a billing reset and demand period nor tariff changeover and demand period are synchronised. This means that in most cases a billing reset and/or tariff changeover are performed during a current demand period and not at its end.

On the other hand both billing reset and tariff changeover start demand measurement in a new demand period. Due to this fact, the following maximum demand measurement modes regarding a billing reset and tariff changeover are possible:

- billing reset does not interrupt the demand period,
- tariff changeover does not interrupt the demand period,
- billing reset is delayed up to the end of the demand period.

### 10.6.1. Billing reset does not interrupt demand period

Billing reset at the end of a billing period is performed during a current demand period but does not interrupt it. Demand registered in the demand period in which the billing reset was performed is considered in the next billing period although a part of energy was integrated in just ended billing period.

If it will be the largest demand in the new billing period, it will be registered as its maximum demand.

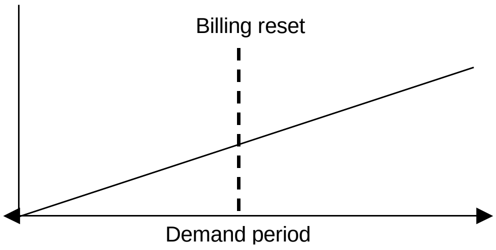



*Fig. 33: Billing reset does not interrupt demand period*

### *10.6.2. Delayed billing reset*

In this mode meter does not execute a command for a billing reset immediately. Instead of that it delays the billing reset up to the end of the current demand period. Consequently the current demand period is not interrupted and the billing period is extended up to its end.
The demand of demand period in which the billing reset was requested is considered in the extended billing period. If the demand is the largest one in the extended billing period, it is registered as the maximum demand.

Billing period timestamp is set at the moment when it was actually performed.

## *11. Network quality*

Network parameters are monitored and displayed:

- instantaneous values of phase voltages, currents and frequency,
- calculation of the neutral line current and phase symmetry,
- rms values of phase voltages and currents,
- power factor and phase angle by phases,
- harmonic analysis up to 30 harmonic,
- short power outages (optional),
- voltage dips/sags (optional).

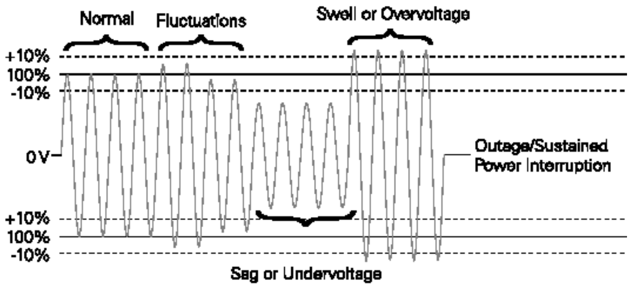



*Fig. 34: Voltage waveform example*

ADC sampling frequency is 4kHz. ADC resolution is 16-bit. ADC have implemented anti-aliasing filters.

Network quality events like short power outages, voltage dips/sags are recorded in a special logbook with a timestamp and a parameter value.

An alarm can be generated on output in case of power shortage.

| Quantity | Avr. | R | S | T |
|---|---|---|---|---|
| Current rms | | 31.7.0 | 51.7.0 | 71.7.0 |
| Current harm. rms | | 31.7.h | 51.7.h | 71.7.h |

| | | | | |
|---|---|---|---|---|
| Voltage rms | | 32.7.0 | 52.7.0 | 72.7.0 |
| Voltage harm. rms | | 32.7.h | 52.7.h | 72.7.h |
| Power factor (cos φ) | 13.7.0 | 33.7.0 | 53.7.0 | 73.7.0 |
| Frequency | 14.7.0 | | | |
| Phase angle | | 81.7.40 | 81.7.51 | 81.7.62 |

Table 11: Network quality codes (h - $h^{th}$ harmonic).

# 12. Multi-rate revenue metering

Meters enable multiple rate registration separately for energy and demand (Time of use - TOU).
The considerable amount of tariffs and 64 tariff registers enable flexible and complex tariff systems. Default value for number of tariffs is 4.
Time of switching individual tariff is defined by hour and minute with a resolution of 1 minute.

A number of periods in a day where one or several tariffs can be valid is defined with configuration. The same is valid for different daily tariff programs. Up to 8 various types of a day (a day in a week and a holiday) can be defined.
A number of seasons in a year is defined with configuration. Besides a current tariff program, the so-called slipping tariff programs can be defined. They are activated at previously defined dates.

An optional number of holidays can be defined. A century-based calendar is built in the meter.

The tariff changeover can be simultaneously controlled by several tariff control sources, which have different or same priorities. Tariff changeover is performed by tariff control source that has the highest priority. Tariff change-over can be controlled by:

- internal tariff device,
- externally by tariff inputs.

## 12.1. Tariff device

Powerful memory and an adaptive tariff device enable to perform various tariff programs. A number of tariff registers, tariffs, programs, seasons, holidays, weekly and daily programs can be adapted to specific customers' requirements.

| | Max. no. |
|---|---|
| Tariff programs | 10 |
| Seasons | 30 |
| Weekly programs | 64 |
| Daily programs | 30 |
| Daily schedules | 96 |
| holidays | 200 |

*Table 12: Tariff device capabilities*

### 12.1.1. Program

Tariff changeover programs for energy and demand are independent and programmed separately. The changeover program is defined with:

- seasons,
- weekly programs,
- daily programs.

A valid tariff program is specified for each season, and daily programs are defined for each weekly program. A weekly program can have several periods. Time of switching individual tariffs is defined with an hour and a minute.

You can define not only a current tariff program but also the so-called sleeping tariff programs that are activated at previously defined dates.

### *12.1.2. Season*

A year is divided into seasons during which one of weekly program is active. Season is defined with a weekly program and with a ending date and time.

| Season | Season end | Weekly program |
|---|---|---|
| 1 | 03.01. 12:00 | 2 |
| 2 | 05.15. 00:00 | 4 |
| 3 | 10.01. 00:00 | 3 |
| 4 | 11.20. 02:30 | 1 |
| 5 | 12.31. 24:00 | 2 |

*Table 13: Annual season schedule*

The first season starts on 1.1. at 00:00 and is valid till the first defined season end, when the second season starts. The last season is terminated at the end of the year 31.1. 24:00.

### *12.1.3. Weekly program*

Weekly program define which daily program is active on each day in a week. In a weekly program 8 different day types can be defined: 7 for days in a week plus 1 for holidays.

| Day in a week | Daily program |
|---|---|
| Sunday | 7 |
| Monday | 2 |
| Tuesday | 2 |
| Wednesday | 2 |
| Thursday | 2 |
| Friday | 2 |
| Saturday | 5 |
| Holiday | 19 |

*Table 14: Weekly program*

### *12.1.4. Daily program*

Daily program defines daily schedules of tariff changeover. It consists of time spans in which certain tariff or their combination is valid. Each time span is defined with its start time. The first time span always started at 00:00.
Daily programs for energy are independent from daily programs for demand.

| Time | Tariffs |
|---|---|
| 00:00 | 1 |
| 06:00 | 2, 7 |
| 09:15 | 3 |
| 11:30 | 5, 7 |
| 15:45 | 3 |
| 18:30 | 6, 7 |
| 21:00 | 1 |

*Table 15: Daily program*

#### 12.1.5. Holidays

Holidays can be connected to a lunar calendar (e.g. Easter) or any other periodical algorithm. Holidays can be programmed using the following algorithms:

- unique holiday,
- every year on selected date (MM.DD.),
- lunar holidays.

### 12.2. Tariff control via inputs

There are three external tariff change-over inputs separated for energy or demand. With three inputs it is possible to control up to 8 tariffs. See also chapter 7.1.1 Tariff change-over.

## 13. Load profiles

Two independent load profiles recorders are implemented in the meter. Each load profile is defined with:

- number of channels,
- registration period,
- quantities to register,
- capacity in days (e.g. 15 min. period, 10 channels, 60 days).

Each load profile has up to 8 channels. Registration period or a load profile can be set within the range from 1 to 60 minutes. Load profile recorder records next quantities:

- active, apparent power and energy (cumulative or absolute values), phase and/or poly-phase values in both energy flow directions,
- reactive power or energy (cumulative or absolute values) in four or combined quadrants (e.g. Q1+Q2 and Q3+Q4),
- phase voltage and current rms values,
- phase voltage and current last measurement period average values,
- network quality parameters (harmonics, power factor, frequency, etc.),
- individual meter statuses (power supply failure, alarms, etc.).

Each record is accompanied with a date and time of the end of a registration period to which it relates.
On display in load profile mode only the first load profile (i.e. P.01) is shown.

### 13.1. Channels

Each load profile has up to 8 channels and 8 status bits. A channel represents one measured quantity.

### 13.2. Registration period

A registration period is set in range from 1 minute to 60 minutes with 1 minute resolution. However, such a time period should be selected that it is contained in a day without a residuum. Suggested registration periods are multiples of measurement period.
Default value for first load profile period is 15 minutes and for a second period is 1 minute.

### 13.3. Quantities

The load profile recorder can record three basic types of quantities:

- measured quantities,
- counters of events and time,
- device statuses and measuring situations.

Measured quantities are energy absolute values or demands of active and reactive energy or last average values of network quality measurements.

Common statuses recorded are power up/down, RTC set, season change, fatal error, etc. Status bits are associated into bytes of eight. Status arrays with 0, 8, 16, 24, 32 status bits are available in load profile.

## 13.4. Capacity

Capacity of both load profiles is limited to 20.000 records. This amount of records is than divided between two load profiles.
A capacity of each load profile stated in days for which data are stored in the load profile depends on:

- number of channels,
- registration period.

| Perio d | Minutes | No. of ch. | Capacity (day) |
|---|---|---|---|
| LP1 | 1 | 1 | 10 |
| LP2 | 15 | 1 | 156 |
| LP1 | 1 | 4 | 5 |
| LP2 | 15 | 4 | 74 |
| LP1 | 1 | 8 | 3 |
| LP2 | 15 | 8 | 43 |

*Table 16: Load profile capacity examples*

Capacity if all records are dedicated to a single load profile illustrates the table bellow:

| Period (min.) | No. of channels | Capacity (day) |
|---|---|---|
| 15 | 4 | 208 |
| 15 | 8 | 104 |
| 30 | 4 | 417 |
| 30 | 8 | 208 |

*Table 17: Maximum load profile capacity*

## 13.5. Format

Load profile format as it is sent via communication and also represented on display can be as:

- energy absolute x.8,
- energy delta value x.9,
- demand x.5,
- network quality,

where x is 1 (+A), 2 (-A), 3 (+R), 4 (-R), 5 (R1), 6 (R2), 7 (R3), 8 (R4), 9 (+S) or 10 (-S) respectively.

# 14. Logbooks

Event logbook is a special kind of recorder as a FIFO buffer. It holds the information of all important events that occurred to the meter.

Each event has a timestamp in format TST12:

YYMMDDhhmmss

where is YY - year, MM - month, DD-day, hh-hour, mm - minute, ss - second.

Meter has two logbooks:

- Standard logbook records events like MD reset, master reset, time setting, parameters setting, load profile and logbook initialisation, etc.

- Special network quality events logbook is used for voltage network analysis like power shortage periods, dips/sags, etc.

Due to security reasons data recorded in the logbook can not be deleted without opening the meter.

# 15. Billing reset

A billing period is a period over which energy is integrated and in which maximum demand is calculated with a purpose to charge consumed energy to the consumer. At the end of a billing period the billing reset is performed in order to:

- transfer metering data from registers for a current billing period into the corresponding registers of a previous billing period,
- transfer data from registers for previous billing periods into corresponding registers for one billing period back,
- to clear registers of demands in a current demand period,
- to clear registers of maximum demands,
- sum up maximum demands of the just ended billing period with corresponding values in the cumulative demand registers.

The meters are provided with two counters for previous billing periods:

- a counter in the register 0.1.0 counts how many billing resets have been performed. This counter increments with each billing reset.
- a constant in the register 0.1.1 indicates a number of billing periods for which metering data are available in the meter.

## 15.1. Types of billing resets

The following billing resets can be executed:

- automatically by the internal tariff device,
- by communication interfaces,
- by inputs,
- manually by the reset button.

### 15.1.1. Internal tariff device

Billing reset is performed automatically with the internal real-time clock.

A variety of billing reset can be programmed with a MeterView software. Up to 20 billing dates can be entered. On a special request this number can be increased.

The following billing reset options are available:

| Type | Description | Date |
|---|---|---|
| 0 | unique date | YY-MM-DD hh:mm |
| 1 | every year on the same month and day | MM-DD hh:mm |
| 10 | once a month on a date | DD hh:mm |

*Table 18: Billing reset options.*

### 15.1.2. Manual

The manual billing reset can be performed by pressing the reset button any time when the meter is in the automatic data displaying mode.

The manual billing reset is disabled when the meter communicates via a communication interface.

### 15.1.3. Communication interfaces

Billing reset can be performed by optical interface, or other communication interface.

### 15.1.4. MRa and MRb inputs

The meters can be equipped with inputs MRa and MRb for remote billing reset.

In normal state signal at the first input is high and on the other is low. In order to perform the billing reset, signals on both inputs should be changed from high to low and from low to high in an optional long time span.

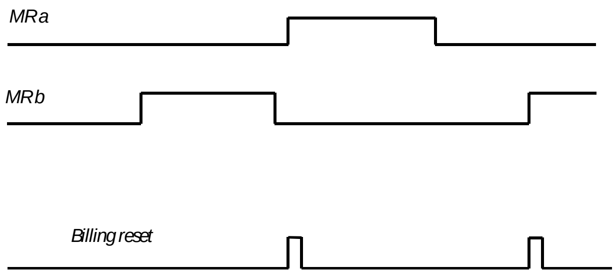



*Fig. 35: MRa and MRb signals perform billing reset.*

## 15.2. Billing reset blockade

When a billing reset is performed by pressing the reset button or via a communication interface a new billing reset by the same means is disabled for a certain time.
This time can be programmed in a range from 0 to 65535 minutes (45 days) in a register 0.0.128.0.18 for billing reset by reset button and 0.0.128.0.19 by communication. When this time elapses, the billing reset can be repeated by the same means.

Billing reset is not temporally disabled for inputs MRa and MRb or internal tariff device.

## 15.3. MRAa and MRAb outputs

Meters can be equipped with outputs MRAa and MRAb for billing reset of an external meter.
See also chapter 7.2.4 Billing reset.

## 15.4. Billing data

The following data is stored at billing reset:

- data on measured quantities,
- data on billing period completion.

Each billing period involves data on:

- cumulative energies,
- cumulative tariff energies,
- tariff maximum demands,
- cumulative tariff maximum demands.

All data, except cumulative maximum demands, are indexed with an index of previous values. The previous values are values registered in corresponding previous billing periods.

Cumulative maximum demands are unique data to which billing tariff maximum demands are added at every billing reset while values of previous billing periods are not stored.

Billing data on measured energy can be stored and listed as:

- absolute value, values of cumulative energy registers of individual energies are stored at the end of billing period.

- delta value, differences of cumulative energy registers of individual energies of two successive billing periods are stored.

Every billing period contains date and time when the billing occurred (timestamp).

### *15.4.1. Index of previous values*

In case of linear indexing data of the last billing period always have number 01, data of a billing period before that have a number 02, etc.

| | |
|---|---|
| 1.8.2(000004.28*kWh) | data of a current billing period |
| 1.8.2*01(000003.93*kWh) | data of the last billing period |
| 1.8.2*02(000003.18*kWh) | etc. |

*Example 3: Linear billing reset*

When a billing period obtain indexes of a maximum set value - e.g. 100 (=00), the next billing period gets again index 01. With next billing reset the index is incremented by 1 and the whole cycle of incrementing index at each reset is repeated. Therefore indexes of previous billing periods permanently circulate.

In register 0.1.2 one can see the timestamps of billing resets.

# *16. Protection*

Meters are well protected against attempts to tamper the measuring results and unauthorised access to the registers containing parameters that influence results of measurements. Protection measures are implemented as:

- hardware protection,
- software protection.

Hardware protection includes sealing of:

- meter cover  and so also parameterisation button,
- reset button,
- detection of meter cover opening (option),
- detection of terminal cover opening (option).

Software protection includes:

- software locks of registers and passwords,
- temporally meter programming blockade in case more wrong passwords were entered,
- billing resets counting,
- logbook records parameter changes,
- meter status registration,
- calculation of the neutral line current and phase symmetry.

## *16.1. Hardware protection*

The reset button can not be pressed without breaking its seal. Therefore it is not possible to perform a billing reset or set meter parameters via the pushbuttons.

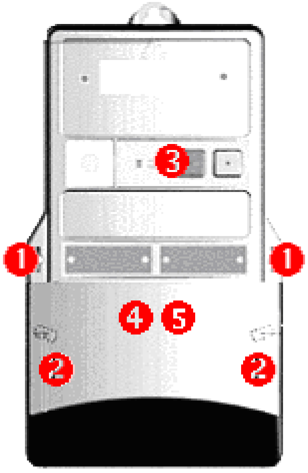



*Fig. 36: Hardware protection. Places of sealing: 1-meter cover, 2-terminal cover, 3-reset button. Optional detection of: 4- meter cover opening, 5- terminal cover opening.*

The parameterisation button can not be pressed without breaking the seals on the meter cover and removing it. Therefore parameters can not be changed in the meter parameterisation mode.

Access to the meter terminals and module terminals is not possible without breaking terminal cover seals.

### *16.1.1. Tamper protection*

For tamper protection, meter cover and terminal cover opening sensors are implemented. Statuses M (meter cover opened) and T (terminal cover opened) will be displayed on display for 10 min. or until reset button is pressed and held for time longer than 2 s.

## *16.2. Software protection*

### *16.2.1. Locks*

All registers that contains parameters, which influence or contains results of measurement, meter statuses or different counters of events are protected with up to 4 software locks. These locks should be unlocked first if content of the register is to be changed.

### *16.2.2. Passwords*

There are four passwords in the registers from 0.0.128.4.8 to 0.0.128.4.11 as well as a password with an encryption algorithm. These registers are protected with a password both against changing and reading.

| Register | Function |
|---|---|
| 0.0.128.4.8.255 | reading (READ) |
| 0.0.128.4.9.255 | setting (SET) |
| 0.0.128.4.10.255 | parameterisation (PARAM) |
| 0.0.128.4.11.255 | for command W5 (SET) |

*Table 19: List of passwords*

### *16.2.3. Communication blockade*

In case three wrong passwords have been entered into the meter via communication interface, meter programming via communication interfaces is temporally disabled for a certain time. Besides, every wrong password is counted by the wrong passwords counter. In this way the meter is protected against attempts to break the meter passwords.

### *16.2.4. Billing resets counting*

When a billing reset is performed, date and time as well as way of reset are recorded in the logbook. The counter of billing resets is incremented for one with each billing reset. In this way non-authorised billing resets are recorded.

### 16.2.5. Logbook

All significant events due to failures, interventions into the meter, settings, etc. are recorded into the logbook with a time stamp. The logbook can not be deleted except if the meter is re-configured. Therefore eventual unauthorised interventions into the meter are registered permanently.

### 16.2.6. Revenue protection

Different meter statuses or event counters are registered by the load profile recorder:

- reversed phase sequence,
- absence of phase voltages,
- voltage failures,
- detection of different incorrect operations of a meter, etc.

This enables registration of uncommon meter operation conditions, which might be caused by non-authorised intervention into the meter connection.

## 16.3. Settings and parameterisation

A customer can change meter settings, and can thus influence its operation. As certain changes of settings can essentially influence on the results of measurement and correct meter operation, each parameter should be set corresponding to the authorisation level.

Meter settings are protected with three levels:

- password,
- reset button,
- parameterisation button.

The lowest protection level is protection with a password. In the MeterView program it is necessary to enter only the password for the access to settings that can be modified in this way.

At protection with the reset button, the reset button seal should be removed. Go to the settings mode and change settings with buttons or by means of the MeterView program. Settings that can be changed are found in the setting sequence.

The highest level is the protection with a parameterisation button.
Remove meter cover seals. Open the cover and press the parameterisation button for parameter setting in the meter internal part.

Settings are changed only with a dedicated program and with software protection measures:

- password,
- encryption algorithm.

## 16.4. Software MeterView and MeterRead

Meters are supported by software MeterView for Microsoft Windows or MeterRead for Windows CE for palmtops (PDAs).

MeterView software has been designed specifically for meter specialists and technicians who need to configure meters. It offers intuitive graphical interface for meter setting, parameterisation, programming and data readout.

See details in MeterView and MeterRead related Iskraemeco documents.

## 17. Technical data

| | |
|---|---|
| **Accuracy class** | |
| Active energy | 0.2S or 0.5S (IEC 62053-22), C (EN 50470 - 3) |
| Reactive energy | class 2, 3 (IEC 62053-23), calibrated up to 0.5% |
| Apparent energy | calibrated up to 0.5% |
| **Measuring voltage (V)** | Multirange, 57-240 V ± 20% (phase to neutral)<br>3 x 57.7/100 3 x 100<br>3 x 63/110 3 x 110<br>3 x 115/200 3 x 200<br>3 x 127/220 3 x 220<br>3 x 220/380 3 x 380<br>3 x 230/400 3 x 400<br>3 x 240/415 3 x 415 |
| Voltage range | 0.8 - 1.15 $U_n$ |
| Rated frequency | 45-65 Hz |
| **Measuring current (A)** | 1(1.2), 1(2), 1(6), 5(6), 5(10) |
| Short-circuit current | 30 $I_{max}$ |
| Starting current | 0.001 $I_n$ |
| **Outputs** | |
| Type | PHOTO-MOS potential-free relay |
| Permitted load | 25 VA (100 mA, 250 V AC) |
| Isolation dielectric strength | make contact: 5000 $V_{rms}$ |
| Impulse length | from 10 to 2500 ms (programmable in steps of 10 ms) |
| Impulse frequency | max. 5 imp/s at impulse length 80 ms (shorter length, larger frequency is possible) |
| Transfer distance | 1 km |
| **Inputs** | 57.7 – 230 V AC |
| Voltage threshold | ON: U ≥ 50 V<br>OFF: U < 20 V |
| Current consumption | < 2 mA @ 57.7V<br>< 10 mA @ 230V |
| **Communication** | |
| IR | max. 9600 Baud |
| RS232 | max. 9600 Baud |
| RS485 | max. 9600 Baud |
| Protocols | IEC 62056-21, IEC 60870-102-5 |
| **Optical reading LED** | |
| Impulse frequency | ≤ 40 Hz |
| Impulse length | approx. 14 or 30 ms |
| **Real time clock** | |
| Accuracy | crystal 6 ppm = ≤ ±3 min./year (at Top= +25°C) |
| Super-Cap | 1F for minimal 250 h of back-up. |
| Li-battery | operation reserve 2 years, life span 20 years |
| **External power supply** | 50 - 230 V AC/DC |
| **EMC testing** | |
| Electrostatic discharge | 15 kV (IEC 60801-2) |
| HF Magnetic field | 10 V/m (IEC 60801-3) |
| Burst test | 4 kV (IEC 60801-4) |
| Dielectric strength | 4 $kV_{rms}$, 50 Hz, 1 min |
| Impulse voltage | 6 kV, 1.2/50 μs |

| | |
|---|---|
| **Temperature range**<br>Operation<br>Storage | In compliance with IEC62053-22<br>-40°C ... +70°C<br>-40°C ... +80°C |
| **Housing** | DIN 43857, 327 x 177 x 90 mm, 1.4 kg, UL94 (94V0), IP53 |
| **Self consumption**<br>Current circuits<br>Voltage circuits | <br><0,1 VA / phase<br><3 W / 10 VA |

*Table 20: Technical data*

# 18. Type designation

M T 8 6 0 S - A n m R n m S n m - E I V n 2 L n 1 - M n K 0 m

| | |
|---|---|
| MT860 | 3-element meter |
| | 19" version |
| S | Surface-mounted version |
| A | **Active energy** |
| n = 2 | class 0.2S (IEC 62053-22) |
| n = 3 | class 0.5S , C |
| m = 1 | one energy-flow direction |
| m = 2 | two energy-flow directions |
| R | **Reactive energy** |
| n = 3 | 0.5 % |
| n = 4 | 1 % |
| n = 5 | class 2 (IEC 62053-23) |
| n = 6 | class 3 (IEC 62053-23) |
| m = 1 | one energy-flow dir. (Q+) |
| m = 6 | 4-quadr. (Q+,Q-,Q1,Q2,Q3,Q4) |
| S | **Apparent energy** |
| n = 3 | 0.5 % |
| n = 4 | 1 % |
| n = 5 | 2 % |
| m = 2 | product $U_{RMS}$ x $I_{RMS}$ |
| m = 3 | $S^2 = P^2 + Q^2$ |
| E | **External supply** |
| I | **Internal supply** |
| V | **Inputs** |
| n = 1...3 | number of inputs |
| 2 | inputs - resistor type |
| L | **Outputs** |
| n = 1...8 | number of outputs |
| 1 | PHOTO-MOS make contact |
| M | **Additional device** |
| n = 2 | Super-Cap |
| n = 3 | Super-Cap + Li-battery |
| K | **Communication interface** |
| n = 0 | IR optical port |
| *m* | *Version of the 2nd interface* |
| m = 2 | RS-232 |
| m = 3 | RS-485 |

# 19. Input-output module marking

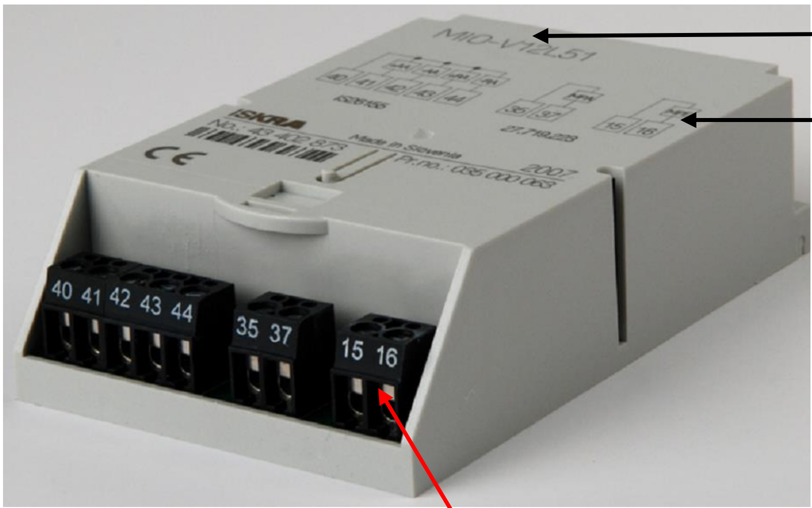
**MIO - Vn2 Ln1 B11**

| | |
|---|---|
| **MIO** | **Input output module** |
| **V** | **Control inputs** |
| n = 1..4 | a number of inputs |
| 2 | control voltage is phase voltage |
| **L** | **OptoMOS relay outputs** |
| n = 1..8 | a number of outputs |
| 1 | make contact |
| B | Relay outputs |
| n = 1 | 5A bistable relay |

**<u>Input/output module options:</u>**

**MIO – V12L51**
**MIO – V42L81**
**MIO – V12L41B11**

Input/output module MIO – V12L51

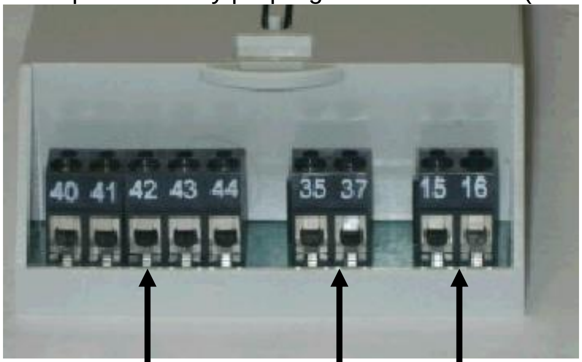



Module marking:

Connection diagram

Input/output module terminals

Example of factory preprogrammed module (function of the terminals are defined in the module) :




| | | | |
|---|---|---|---|
| Common | | G | 15 |
| External synchronization (for clock/demand period) | Active | MPE | 16 |

| | | | |
|---|---|---|---|
| Common | | G | 35 |
| Measuring period | make contact | MPA | 37 |

| | | | |
|---|---|---|---|
| Common | | G | 40 |
| Pulse output for active energy +A | make contact | +AA | 41 |
| Pulse output for active energy -A | make contact | +AA | 42 |
| Pulse output for reactive energy +R | make contact | +RA | 43 |
| Pulse output for reactive energy -R | make contact | -AA | 44 |

## 20. Communication module marking

**MK – f3n - m**

| | |
|---|---|
| **MK** | **Communication module** |
| f | active CS- interface (20 mA current loop) – for multidrop communication |
| 1 | passive CS- interface (20 mA current loop) |
| 2 | RS-232 interface |
| 3 | RS-485 interface–for multidrop communication (module with modem) |
| **n = 7..9,a,e** | **the first communication interface (type of modem)** |
| n = 7 | PSTN modem |
| n = 8 | GSM modem |
| n = 9 | ISDN modem |
| n = a | GSM/GPRS modem |
| n = e | Ethernet |
| **m** | **the second communication interface** |
| m = 1 | passive CS - interface (20 mA current loop) |
| m = 2 | RS-232 interface |
| m = 3 | RS-485 interface |

**Communication module options:**

**MK – 2 – 3** (RS-232 & RS-485 interface)
**MK – 1 – 3** (CS interface & RS-485 interface)
**MK – 3 – 3** (RS-485 interface & RS-485 interface)
**MK – f37 – 3** (PSTN modem+CS+RS-485 interface & RS-485 interface) → module enables multidrop communication
**MK – f38 – 3** (GSM modem+CS+RS-485 interface & RS-485 interface) → module enables multidrop communication

**MK – f39 – 3** (ISDN modem+CS+RS-485 interface & RS-485 interface) → module enables multidrop communication
**MK – f38a – 3** (GSM/GPRS modem+CS+RS-485 interface & RS-485 interface) → module enables multidrop communication
**MK – 3e – 3** (Ethernet+RS-485 & RS-485 interface) → module enables multidrop communication

GSM/GPRS communication module MK – f3a – 3

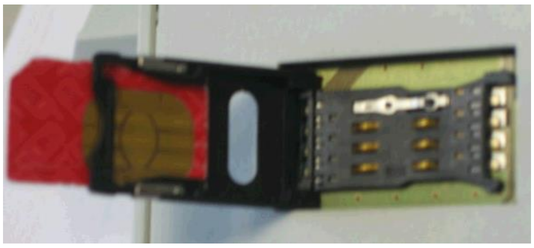


Installation of the SIM card (SIM card must be enabled for data transfer)

1. Remove the GSM/GPRS modem from the meter


2. SIM card must be without PIN code
3. Insert the SIM card into the SIM cardholder

Move lock to the left, to enable opening the SIM cardholder!



4. Insert the GSM modem back into the meter

5. Connect the antenna with the modem


6. With the **DIAG** menu on the meter (accessible with the black button), the following can be checked:

- C.C.3 → a signal level (should be higher than 17)
- C.C.4 → GSM provider (1 – home provider, 5 – roaming)
- C.C.5 → error code (should be 0)

## *Appendix A: OBIS codes and data names*

| OBIS code | Data name |
|---|---|
| **Three phases energy registers, t = TOU registers (1,..n)** | |
| 1-0:1.8.0 | A+, Active energy import, total register |
| 1-0:1.8.t | A+, Active energy import, TOU register |
| 1-0:1.9.0 | A+, Active energy import in the billing period, total register |
| 1-0:1.9.t | A+, Active energy import in the billing period, TOU register |
| 1-0:2.8.0 | A-, Active energy export, total register |
| 1-0:2.8.t | A-, Active energy export, TOU register |
| 1-0:2.9.0 | A-, Active energy export in the billing period, total register |
| 1-0:2.9.t | A-, Active energy export in the billing period, TOU register |
| 1-0:3.8.0 | Q+=Q1+ Q2, Reactive energy import, total register |
| 1-0:3.8.t | Q+=Q1+ Q2, Reactive energy import, TOU register |
| 1-0:3.9.0 | Q+=Q1+ Q2, Reactive energy import in the billing period, total register |
| 1-0:3.9.t | Q+=Q1+ Q2, Reactive energy import in the billing period, TOU register |
| 1-0:4.8.0 | Q-=Q3+ Q4, Reactive energy export, total register |
| 1-0:4.8.t | Q-=Q3+ Q4, Reactive energy export, TOU register |
| 1-0:4.9.0 | Q-=Q3+ Q4, Reactive energy export in the billing period, total register |
| 1-0:4.9.t | Q-=Q3+ Q4, Reactive energy export in the billing period, TOU register |
| 1-0:5.8.0 | Q1, Reactive energy, inductive import, total register |
| 1-0:5.8.t | Q1, Reactive energy, inductive import, TOU register |
| 1-0:5.9.0 | Q1, Reactive energy, inductive import in the billing period, total register |
| 1-0:5.9.t | Q1, Reactive energy, inductive import in the billing period, TOU register |
| 1-0:6.8.0 | Q2, Reactive energy, capacitive import, total register |
| 1-0:6.8.t | Q2, Reactive energy, capacitive import, TOU register |
| 1-0:6.9.0 | Q2, Reactive energy, capacitive import in the billing period, total register |
| 1-0:6.9.t | Q2, Reactive energy, capacitive import in the billing period, TOU register |
| 1-0:7.8.0 | Q3, Reactive energy, inductive export, total register |
| 1-0:7.8.t | Q3, Reactive energy, inductive export, TOU register |
| 1-0:7.9.0 | Q3, Reactive energy, inductive export in the billing period, total register |
| 1-0:7.9.t | Q3, Reactive energy, inductive export in the billing period, TOU register |
| 1-0:8.8.0 | Q4, Reactive energy, capacitive export, total register |
| 1-0:8.8.t | Q4, Reactive energy, capacitive export, TOU register |
| 1-0:8.9.0 | Q4, Reactive energy, capacitive export in the billing period, total register |
| 1-0:8.9.t | Q4, Reactive energy, capacitive export in the billing period, TOU register |
| 1-0:9.8.0 | S+, Apparent energy import, total register |
| 1-0:9.8.t | S+, Apparent energy import, TOU register |
| 1-0:9.9.0 | S+, Apparent energy import in the billing period, total register |
| 1-0:9.9.t | S+, Apparent energy import in the billing period, TOU register |
| 1-0:10.8.0 | S-, Apparent energy export, total register |
| 1-0:10.8.t | S-, Apparent energy export, TOU register |
| 1-0:10.9.0 | S-, Apparent energy export in the billing period, total register |
| 1-0:10.9.t | S-, Apparent energy export in the billing period, TOU register |
| **Three phases cumulative demand registers, t = TOU registers (1,..n)** | |
| 1-0:1.2.0 | P+ cumulative demand total register |
| 1-0:1.2.t | P+ cumulative demand TOU register |
| 1-0:2.2.0 | P- cumulative demand total register |
| 1-0:2.2.t | P- cumulative demand TOU register |
| 1-0:3.2.0 | Q+ cumulative demand total register |

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| 1-0:3.2.t | Q+ cumulative demand TOU register |
| 1-0:4.2.0 | Q- cumulative demand total register |
| 1-0:4.2.t | Q- cumulative demand TOU register |
| 1-0:5.2.0 | Q1 cumulative demand total register |
| 1-0:5.2.t | Q1 cumulative demand TOU register |
| 1-0:6.2.0 | Q2 cumulative demand total register |
| 1-0:6.2.t | Q2 cumulative demand TOU register |
| 1-0:7.2.0 | Q3 cumulative demand total register |
| 1-0:7.2.t | Q3 cumulative demand TOU register |
| 1-0:8.2.0 | Q4 cumulative demand total register |
| 1-0:8.2.t | Q4 cumulative demand TOU register |
| 1-0:9.2.0 | S+ cumulative demand total register |
| 1-0:9.2.t | S+ cumulative demand TOU register |
| 1-0:10.2.0 | S- cumulative demand total register |
| 1-0:10.2.t | S- cumulative demand TOU register |
| **Three phases momentary demand registers** | |
| 1-0:1.4.0 | P+ momentary demand register |
| 1-0:2.4.0 | P- momentary demand register |
| 1-0:3.4.0 | Q+ momentary demand register |
| 1-0:4.4.0 | Q- momentary demand register |
| 1-0:5.4.0 | Q1 momentary demand register |
| 1-0:6.4.0 | Q2 momentary demand register |
| 1-0:7.4.0 | Q3 momentary demand register |
| 1-0:8.4.0 | Q4 momentary demand register |
| 1-0:9.4.0 | S+ momentary demand register |
| 1-0:10.4.0 | S- momentary demand register |
| **Three phases last ended measurement period demand register** | |
| 1-0:1.5.0 | P+ last ended measurement period demand register |
| 1-0:2.5.0 | P- last ended measurement period demand register |
| 1-0:3.5.0 | Q+ last ended measurement period demand register |
| 1-0:4.5.0 | Q- last ended measurement period demand register |
| 1-0:5.5.0 | Q1 last ended measurement period demand register |
| 1-0:6.5.0 | Q2 last ended measurement period demand register |
| 1-0:7.5.0 | Q3 last ended measurement period demand register |
| 1-0:8.5.0 | Q4 last ended measurement period demand register |
| 1-0:9.5.0 | S+ last ended measurement period demand register |
| 1-0:10.5.0 | S- last ended measurement period demand register |
| **Three phases maximum demand registers, t = TOU registers (1,..n)** | |
| 1-0:1.6.0 | P+ maximum demand total register |
| 1-0:1.6.t | P+ maximum demand TOU register |
| 1-0:2.6.0 | P- maximum demand total register |
| 1-0:2.6.t | P- maximum demand TOU register |
| 1-0:3.6.0 | Q+ maximum demand total register |
| 1-0:3.6.t | Q+ maximum demand TOU register |
| 1-0:4.6.0 | Q- maximum demand total register |
| 1-0:4.6.t | Q- maximum demand TOU register |
| 1-0:5.6.0 | Q1 maximum demand total register |
| 1-0:5.6.t | Q1 maximum demand TOU register |
| 1-0:6.6.0 | Q2 maximum demand total register |
| 1-0:6.6.t | Q2 maximum demand TOU register |
| 1-0:7.6.0 | Q3 maximum demand total register |

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| 1-0:7.6.t | Q3 maximum demand TOU register |
| 1-0:8.6.0 | Q4 maximum demand total register |
| 1-0:8.6.t | Q4 maximum demand TOU register |
| 1-0:9.6.0 | S+ maximum demand total register |
| 1-0:9.6.t | S+ maximum demand TOU register |
| 1-0:10.6.0 | S- maximum demand total register |
| 1-0:10.6.t | S- maximum demand TOU register |
| **Three phases quality instantaneous registers** | |
| 1-0:11.7.0 | Average current RMS |
| 1-0:12.7.0 | Average voltage RMS |
| 1-0:13.7.0 | Average power factor |
| 1-0:14.7.0 | Average frequency |
| 1-0:11.7.h | Average harmonics component in current, h – harmonics component (1, ..,8) |
| 1-0:12.7.h | Average harmonics component in voltage, h – harmonics component (1, ..,8) |
| 1-0: 15.7.0 | Σ*L*i Active power (abs(QI+QIV)+(abs(QII+QIII)) |
| **Phase R energy registers, t = TOU registers (1,..n)** | |
| 1-0:21.8.0 | A+, Active energy import in phase R, total register |
| 1-0:21.8.t | A+, Active energy import in phase R, TOU register |
| 1-0:21.9.0 | A+, Active energy import in the billing period, phase R |
| 1-0:21.9.t | A+, Active energy import in the billing period TOU register, phase R |
| 1-0:22.8.0 | A-, Active energy export in phase R, total register |
| 1-0:22.8.t | A-, Active energy export in phase R, TOU register |
| 1-0:22.9.0 | A-, Active energy export in the billing period, phase R |
| 1-0:22.9.t | A-, Active energy export in the billing period TOU register, phase R |
| 1-0:23.8.0 | Q+=Q1+ Q2, Reactive energy import in phase R, total register |
| 1-0:23.8.t | Q+=Q1+ Q2, Reactive energy import in phase R, TOU register |
| 1-0:23.9.0 | Q+=Q1+ Q2, Reactive energy import in the billing period, phase R |
| 1-0:23.9.t | Q+=Q1+ Q2, Reactive energy import in the billing period TOU register, phase R |
| 1-0:24.8.0 | Q-=Q3+ Q4, Reactive energy export in phase R, total register |
| 1-0:24.8.t | Q-=Q3+ Q4, Reactive energy export in phase R, TOU register |
| 1-0:24.9.0 | Q-=Q3+ Q4, Reactive energy export in the billing period, phase R |
| 1-0:24.9.t | Q-=Q3+ Q4, Reactive energy export in the billing period TOU register, phase R |
| 1-0:25.8.0 | Q1, Reactive energy, inductive import in phase R, total register |
| 1-0:25.8.t | Q1, Reactive energy, inductive import in phase R, TOU register |
| 1-0:25.9.0 | Q1, Reactive energy, inductive import in the billing period, phase R |
| 1-0:25.9.t | Q1, Reactive energy, inductive import in the billing period TOU register, phase R |
| 1-0:26.8.0 | Q2, Reactive energy, capacitive import in phase R, total register |
| 1-0:26.8.t | Q2, Reactive energy, capacitive import in phase R, TOU register |
| 1-0:26.9.0 | Q2, Reactive energy, capacitive import in the billing period, phase R |
| 1-0:26.9.t | Q2, Reactive energy, capacitive import in the billing period TOU register, phase R |
| 1-0:27.8.0 | Q3, Reactive energy, inductive export in phase R, total register |
| 1-0:27.8.t | Q3, Reactive energy, inductive export in phase R, TOU register |
| 1-0:27.9.0 | Q3, Reactive energy, inductive export in the billing period, phase R |
| 1-0:27.9.t | Q3, Reactive energy, inductive export in the billing period TOU register, phase R |
| 1-0:28.8.0 | Q4, Reactive energy, capacitive export in phase R, total register |
| 1-0:28.8.t | Q4, Reactive energy, capacitive export in phase R, TOU register |
| 1-0:28.9.0 | Q4, Reactive energy, capacitive export in the billing period, phase R |
| 1-0:28.9.t | Q4, Reactive energy, capacitive export in the billing period TOU register, phase R |
| 1-0:29.8.0 | S+, Apparent energy import in phase R, total register |
| 1-0:29.8.t | S+, Apparent energy import in phase R, TOU register |
| 1-0:29.9.0 | S+, Apparent energy import in the billing period, phase R |

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| 1-0:29.9.t | S+, Apparent energy import in the billing period TOU register, phase R |
| 1-0:30.8.0 | S- Apparent energy export in phase R, total register |
| 1-0:30.8.t | S- Apparent energy export in phase R, TOU register |
| 1-0:30.9.0 | S-, Apparent energy export in the billing period, phase R |
| 1-0:30.9.t | S-, Apparent energy export in the billing period TOU register, phase R |
| **Phase R cumulative demand register, t = TOU registers (1,..n)** | |
| 1-0:21.2.0 | P+ cumulative demand in phase R total register |
| 1-0:21.2.t | P+ cumulative demand in phase R TOU register |
| 1-0:22.2.0 | P- cumulative demand in phase R total register |
| 1-0:22.2.t | P- cumulative demand in phase R TOU register |
| 1-0:23.2.0 | Q+ cumulative demand in phase R total register |
| 1-0:23.2.t | Q+ cumulative demand in phase R TOU register |
| 1-0:24.2.0 | Q- cumulative demand in phase R total register |
| 1-0:24.2.t | Q- cumulative demand in phase R TOU register |
| 1-0:25.2.0 | Q1 cumulative demand in phase R total register |
| 1-0:25.2.t | Q1 cumulative demand in phase R TOU register |
| 1-0:26.2.0 | Q2 cumulative demand in phase R total register |
| 1-0:26.2.t | Q2 cumulative demand in phase R TOU register |
| 1-0:27.2.0 | Q3 cumulative demand in phase R total register |
| 1-0:2.2.t | Q3 cumulative demand in phase R TOU register |
| 1-0:28.2.0 | Q4 cumulative demand in phase R total register |
| 1-0:28.2.t | Q4 cumulative demand in phase R TOU register |
| 1-0:29.2.0 | S+ cumulative demand in phase R total register |
| 1-0:29.2.t | S+ cumulative demand in phase R TOU register |
| 1-0:30.2.0 | S- cumulative demand in phase R total register |
| 1-0:30.2.t | S- cumulative demand in phase R TOU register |
| **Phase R momentary demand register** | |
| 1-0:21.4.0 | P+ momentary demand in phase R register |
| 1-0:22.4.0 | P- momentary demand in phase R register |
| 1-0:23.4.0 | Q+ momentary demand in phase R register |
| 1-0:24.4.0 | Q- momentary demand in phase R register |
| 1-0:25.4.0 | Q1 momentary demand in phase R register |
| 1-0:26.4.0 | Q2 momentary demand in phase R register |
| 1-0:27.4.0 | Q3 momentary demand in phase R register |
| 1-0:28.4.0 | Q4 momentary demand in phase R register |
| 1-0:29.4.0 | S+ momentary demand in phase R register |
| 1-0:30.4.0 | S- momentary demand in phase R register |
| **Phase R last ended measurement period demand register** | |
| 1-0:21.5.0 | P+ last ended measurement period in phase R demand register |
| 1-0:22.5.0 | P- last ended measurement period in phase R demand register |
| 1-0:23.5.0 | Q+ last ended measurement period in phase R demand register |
| 1-0:24.5.0 | Q- last ended measurement period in phase R demand register |
| 1-0:25.5.0 | Q1 last ended measurement period in phase R demand register |
| 1-0:26.5.0 | Q2 last ended measurement period in phase R demand register |
| 1-0:27.5.0 | Q3 last ended measurement period in phase R demand register |
| 1-0:28.5.0 | Q4 last ended measurement period in phase R demand register |
| 1-0:29.5.0 | S+ last ended measurement period in phase R demand register |
| 1-0:30.5.0 | S- last ended measurement period in phase R demand register |
| **Phase R maximum demand registers, t = TOU registers (1,..n)** | |
| 1-0:21.6.0 | P+ maximum demand in phase R register |
| 1-0:21.6.t | P+ maximum demand in phase R TOU register |

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| 1-0:22.6.0 | P- maximum demand in phase R register |
| 1-0:22.6.t | P- maximum demand in phase R TOU register |
| 1-0:23.6.0 | Q+ maximum demand in phase R register |
| 1-0:23.6.t | Q+ maximum demand in phase R TOU register |
| 1-0:24.6.0 | Q- maximum demand in phase R register |
| 1-0:24.6.t | Q- maximum demand in phase R TOU register |
| 1-0:25.6.0 | Q1 maximum demand in phase R register |
| 1-0:25.6.t | Q1 maximum demand in phase R TOU register |
| 1-0:26.6.0 | Q2 maximum demand in phase R register |
| 1-0:26.6.t | Q2 maximum demand in phase R TOU register |
| 1-0:27.6.0 | Q3 maximum demand in phase R register |
| 1-0:27.6.t | Q3 maximum demand in phase R TOU register |
| 1-0:28.6.0 | Q4 maximum demand in phase R register |
| 1-0:28.6.t | Q4 maximum demand in phase R TOU register |
| 1-0:29.6.0 | S+ maximum demand in phase R register |
| 1-0:29.6.t | S+ maximum demand in phase R TOU register |
| 1-0:30.6.0 | S- maximum demand in phase R register |
| 1-0:30.6.t | S- maximum demand in phase R TOU register |
| **Phase R quality instantaneous registers** | |
| 1-0:31.7.0 | Average current RMS in phase R |
| 1-0:32.7.0 | Average voltage RMS in phase R |
| 1-0:33.7.0 | Average power factor in phase R |
| 1-0:34.7.0 | Average frequency in phase R |
| 1-0:31.7.h | Average harmonics component in current, h – harmonics component (1, ..,8) in phase R |
| 1-0:32.7.h | Average harmonics component in voltage, h – harmonics component (1, ..,8) in phase R |
| 1-0:81.7.40 | Phase angle in phase R |
| **Phase S energy registers, t = TOU registers (1,..n)** | |
| 1-0:41.8.0 | A+, Active energy import in phase S, total register |
| 1-0:41.8.t | A+, Active energy import in phase S, total register |
| 1-0:41.9.0 | A+, Active energy import in the billing period, phase S |
| 1-0:41.9.t | A+, Active energy import in the billing period, phase S |
| 1-0:42.8.0 | A-, Active energy export in phase S, total register |
| 1-0:42.8.t | A-, Active energy export in phase S, total register |
| 1-0:42.9.0 | A-, Active energy export in the billing period, phase S |
| 1-0:42.9.t | A-, Active energy export in the billing period, phase S |
| 1-0:43.8.0 | Q+=Q1+ Q2, Reactive energy import in phase S, total register |
| 1-0:43.8.t | Q+=Q1+ Q2, Reactive energy import in phase S, total register |
| 1-0:43.9.0 | Q+=Q1+ Q2, Reactive energy import in the billing period, phase S |
| 1-0:43.9.t | Q+=Q1+ Q2, Reactive energy import in the billing period, phase S |
| 1-0:44.8.0 | Q-=Q3+ Q4, Reactive energy export in phase S, total register |
| 1-0:44.8.t | Q-=Q3+ Q4, Reactive energy export in phase S, total register |
| 1-0:44.9.0 | Q-=Q3+ Q4, Reactive energy export in the billing period, phase S |
| 1-0:44.9.t | Q-=Q3+ Q4, Reactive energy export in the billing period, phase S |
| 1-0:45.8.0 | Q1, Reactive energy, inductive import in phase S, total register |
| 1-0:45.8.t | Q1, Reactive energy, inductive import in phase S, total register |
| 1-0:45.9.0 | Q1, Reactive energy, inductive import in the billing period, phase S |
| 1-0:45.9.t | Q1, Reactive energy, inductive import in the billing period, phase S |
| 1-0:46.8.0 | Q2, Reactive energy, capacitive import in phase S, total register |
| 1-0:46.8.t | Q2, Reactive energy, capacitive import in phase S, total register |

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| 1-0:46.9.0 | Q2, Reactive energy, capacitive import in the billing period, phase S |
| 1-0:46.9.t | Q2, Reactive energy, capacitive import in the billing period, phase S |
| 1-0:47.8.0 | Q3, Reactive energy, inductive export in phase S, total register |
| 1-0:47.8.t | Q3, Reactive energy, inductive export in phase S, total register |
| 1-0:47.9.0 | Q3, Reactive energy, inductive export in the billing period, phase S |
| 1-0:47.9.t | Q3, Reactive energy, inductive export in the billing period, phase S |
| 1-0:48.8.0 | Q4, Reactive energy, capacitive export in phase S, total register |
| 1-0:48.8.t | Q4, Reactive energy, capacitive export in phase S, total register |
| 1-0:48.9.0 | Q4, Reactive energy, capacitive export in the billing period, phase S |
| 1-0:48.9.t | Q4, Reactive energy, capacitive export in the billing period, phase S |
| 1-0:49.8.0 | S+, Apparent energy import in phase S, total register |
| 1-0:49.8.t | S+, Apparent energy import in phase S, total register |
| 1-0:49.9.0 | S+, Apparent energy import in the billing period, phase S |
| 1-0:49.9.t | S+, Apparent energy import in the billing period, phase S |
| 1-0:50.8.0 | S-, Apparent energy export in phase S, total register |
| 1-0:50.8.t | S-, Apparent energy export in phase S, total register |
| 1-0:50.9.0 | S-, Apparent energy export in the billing period, phase S |
| 1-0:50.9.t | S-, Apparent energy export in the billing period, phase S |
| **Phase S momentary demand register** | |
| 1-0:41.4.0 | P+ momentary demand in phase S register |
| 1-0:42.4.0 | P- momentary demand in phase S register |
| 1-0:43.4.0 | Q+ momentary demand in phase S register |
| 1-0:44.4.0 | Q- momentary demand in phase S register |
| 1-0:45.4.0 | Q1 momentary demand in phase S register |
| 1-0:46.4.0 | Q2 momentary demand in phase S register |
| 1-0:47.4.0 | Q3 momentary demand in phase S register |
| 1-0:48.4.0 | Q4 momentary demand in phase S register |
| 1-0:49.4.0 | S+ momentary demand in phase S register |
| 1-0:50.4.0 | S- momentary demand in phase S register |
| **Phase S last ended measurement period demand register** | |
| 1-0:41.5.0 | P+ last ended measurement period in phase S demand register |
| 1-0:42.5.0 | P- last ended measurement period in phase S demand register |
| 1-0:43.5.0 | Q+ last ended measurement period in phase S demand register |
| 1-0:44.5.0 | Q- last ended measurement period in phase S demand register |
| 1-0:45.5.0 | Q1 last ended measurement period in phase S demand register |
| 1-0:46.5.0 | Q2 last ended measurement period in phase S demand register |
| 1-0:47.5.0 | Q3 last ended measurement period in phase S demand register |
| 1-0:48.5.0 | Q4 last ended measurement period in phase S demand register |
| 1-0:49.5.0 | S+ last ended measurement period in phase S demand register |
| 1-0:50.5.0 | S- last ended measurement period in phase S demand register |
| **Phase S maximum demand registers, t = TOU registers (1,..n)** | |
| 1-0:41.6.0 | P+ maximum demand in phase S register |
| 1-0:41.6.t | P+ maximum demand in phase S TOU register |
| 1-0:42.6.0 | P- maximum demand in phase S register |
| 1-0:42.6.t | P- maximum demand in phase S TOU register |
| 1-0:43.6.0 | Q+ maximum demand in phase S register |
| 1-0:43.6.t | Q+ maximum demand in phase S TOU register |
| 1-0:44.6.0 | Q- maximum demand in phase S register |
| 1-0:44.6.t | Q- maximum demand in phase S TOU register |
| 1-0:45.6.0 | Q1 maximum demand in phase S register |
| 1-0:45.6.t | Q1 maximum demand in phase S TOU register |

| | |
|---|---|
| 1-0:46.6.0 | Q2 maximum demand in phase S register |
| 1-0:46.6.t | Q2 maximum demand in phase S TOU register |
| 1-0:47.6.0 | Q3 maximum demand in phase S register |
| 1-0:47.6.t | Q3 maximum demand in phase S TOU register |
| 1-0:48.6.0 | Q4 maximum demand in phase S register |
| 1-0:48.6.t | Q4 maximum demand in phase S TOU register |
| 1-0:49.6.0 | S+ maximum demand in phase S register |
| 1-0:49.6.t | S+ maximum demand in phase S TOU register |
| 1-0:50.6.0 | S- maximum demand in phase S register |
| 1-0:50.6.t | S- maximum demand in phase S TOU register |
| **Phase S quality instantaneous registers** | |
| 1-0:51.7.0 | Average current RMS in phase S |
| 1-0:52.7.0 | Average voltage RMS in phase S |
| 1-0:53.7.0 | Average power factor in phase S |
| 1-0:54.7.0 | Average frequency in phase S |
| 1-0:51.7.h | Average harmonics component in current, h – harmonics component (1, ..,8) in phase S |
| 1-0:52.7.h | Average harmonics component in voltage, h – harmonics component (1, ..,8) in phase S |
| 1-0:81.7.51 | Phase angle in phase S |
| **Phase T energy registers, t = TOU registers (1,..n)** | |
| 1-0:61.8.0 | A+, Active energy import in phase T, total register |
| 1-0:61.8.t | A+, Active energy import in phase T, total register |
| 1-0:61.9.0 | A+, Active energy import in the billing period, phase T |
| 1-0:61.9.t | A+, Active energy import in the billing period, phase T |
| 1-0:62.8.0 | A-, Active energy export in phase T, total register |
| 1-0:62.8.t | A-, Active energy export in phase T, total register |
| 1-0:62.9.0 | A-, Active energy export in the billing period, phase T |
| 1-0:62.9.t | A-, Active energy export in the billing period, phase T |
| 1-0:63.8.0 | Q+=Q1+ Q2, Reactive energy import in phase T, total register |
| 1-0:63.8.t | Q+=Q1+ Q2, Reactive energy import in phase T, total register |
| 1-0:63.9.0 | Q+=Q1+ Q2, Reactive energy import in the billing period, phase T |
| 1-0:63.9.t | Q+=Q1+ Q2, Reactive energy import in the billing period, phase T |
| 1-0:64.8.0 | Q-=Q3+ Q4, Reactive energy export in phase T, total register |
| 1-0:64.8.t | Q-=Q3+ Q4, Reactive energy export in phase T, total register |
| 1-0:64.9.0 | Q-=Q3+ Q4, Reactive energy export in the billing period, phase T |
| 1-0:64.9.t | Q-=Q3+ Q4, Reactive energy export in the billing period, phase T |
| 1-0:65.8.0 | Q1, Reactive energy, inductive import in phase T, total register |
| 1-0:65.8.t | Q1, Reactive energy, inductive import in phase T, total register |
| 1-0:65.9.0 | Q1, Reactive energy, inductive import in the billing period, phase T |
| 1-0:65.9.t | Q1, Reactive energy, inductive import in the billing period, phase T |
| 1-0:66.8.0 | Q2, Reactive energy, capacitive import in phase T, total register |
| 1-0:66.8.t | Q2, Reactive energy, capacitive import in phase T, total register |
| 1-0:66.9.0 | Q2, Reactive energy, capacitive import in the billing period, phase T |
| 1-0:66.9.t | Q2, Reactive energy, capacitive import in the billing period, phase T |
| 1-0:67.8.0 | Q3, Reactive energy, inductive export in phase T, total register |
| 1-0:67.8.t | Q3, Reactive energy, inductive export in phase T, total register |
| 1-0:67.9.0 | Q3, Reactive energy, inductive export in the billing period, phase T |
| 1-0:67.9.t | Q3, Reactive energy, inductive export in the billing period, phase T |
| 1-0:68.8.0 | Q4, Reactive energy, capacitive export in phase T, total register |
| 1-0:68.8.t | Q4, Reactive energy, capacitive export in phase T, total register |

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| 1-0:68.9.0 | Q4, Reactive energy, capacitive export in the billing period, phase T |
| 1-0:68.9.t | Q4, Reactive energy, capacitive export in the billing period, phase T |
| 1-0:69.8.0 | S+, Apparent energy import in phase T, total register |
| 1-0:69.8.t | S+, Apparent energy import in phase T, total register |
| 1-0:69.9.0 | S+, Apparent energy import in the billing period, phase T |
| 1-0:69.9.t | S+, Apparent energy import in the billing period, phase T |
| 1-0:70.8.0 | S-, Apparent energy export in phase T, total register |
| 1-0:70.8.t | S-, Apparent energy export in phase T, total register |
| 1-0:70.9.0 | S-, Apparent energy export in the billing period, phase T |
| 1-0:70.9.t | S-, Apparent energy export in the billing period, phase T |
| **Phase T momentary demand register** | |
| 1-0:61.4.0 | P+ momentary demand in phase T register |
| 1-0:62.4.0 | P- momentary demand in phase T register |
| 1-0:63.4.0 | Q+ momentary demand in phase T register |
| 1-0:64.4.0 | Q- momentary demand in phase T register |
| 1-0:65.4.0 | Q1 momentary demand in phase T register |
| 1-0:66.4.0 | Q2 momentary demand in phase T register |
| 1-0:67.4.0 | Q3 momentary demand in phase T register |
| 1-0:68.4.0 | Q4 momentary demand in phase T register |
| 1-0:69.4.0 | S+ momentary demand in phase T register |
| 1-0:70.4.0 | S- momentary demand in phase T register |
| **Phase T last ended measurement period demand register** | |
| 1-0:61.5.0 | P+ last ended measurement period in phase T demand register |
| 1-0:62.5.0 | P- last ended measurement period in phase T demand register |
| 1-0:63.5.0 | Q+ last ended measurement period in phase T demand register |
| 1-0:64.5.0 | Q- last ended measurement period in phase T demand register |
| 1-0:65.5.0 | Q1 last ended measurement period in phase T demand register |
| 1-0:66.5.0 | Q2 last ended measurement period in phase T demand register |
| 1-0:67.5.0 | Q3 last ended measurement period in phase T demand register |
| 1-0:68.5.0 | Q4 last ended measurement period in phase T demand register |
| 1-0:69.5.0 | S+ last ended measurement period in phase T demand register |
| 1-0:70.5.0 | S- last ended measurement period in phase T demand register |
| **Phase T maximum demand registers, t = TOU registers (1,..n)** | |
| 1-0:61.6.0 | P+ maximum demand in phase T register |
| 1-0:61.6.t | P+ maximum demand in phase T TOU register |
| 1-0:62.6.0 | P+ maximum demand in phase T register |
| 1-0:62.6.t | P- maximum demand in phase T TOU register |
| 1-0:63.6.0 | Q+ maximum demand in phase T register |
| 1-0:63.6.t | Q+ maximum demand in phase T TOU register |
| 1-0:64.6.0 | Q- maximum demand in phase T register |
| 1-0:64.6.t | Q- maximum demand in phase T TOU register |
| 1-0:65.6.0 | Q1 maximum demand in phase T register |
| 1-0:65.6.t | Q1 maximum demand in phase T TOU register |
| 1-0:66.6.0 | Q2 maximum demand in phase T register |
| 1-0:66.6.t | Q2 maximum demand in phase T TOU register |
| 1-0:67.6.0 | Q3 maximum demand in phase T register |
| 1-0:67.6.t | Q3 maximum demand in phase T TOU register |
| 1-0:68.6.0 | Q4 maximum demand in phase T register |
| 1-0:68.6.t | Q4 maximum demand in phase T TOU register |
| 1-0:69.6.0 | S+ maximum demand in phase T register |
| 1-0:69.6.t | S+ maximum demand in phase T TOU register |

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| 1-0:70.6.0 | S- maximum demand in phase T register |
| 1-0:70.6.t | S- maximum demand in phase T TOU register |
| **Phase T quality instantaneous registers** | |
| 1-0:71.7.0 | Average current RMS in phase T |
| 1-0:72.7.0 | Average voltage RMS in phase T |
| 1-0:73.7.0 | Average power factor in phase T |
| 1-0:74.7.0 | Average frequency in phase T |
| 1-0:71.7.h | Average harmonics component in current, h – harmonics component (1, ..,8) in phase T |
| 1-0:72.7.h | Average harmonics component in voltage, h – harmonics component (1, ..,8) in phase T |
| 1-0:81.7.62 | Phase angle in phase T |

## Appendix B: Log book events

| LB code | Data name |
|---|---|
| LB.0080 | Power down |
| LB.0040 | Power up |
| LB.8102 | Voltage down phase L1 |
| LB.8103 | Voltage down phase L2 |
| LB.8104 | Voltage down phase L3 |
| LB.8105 | Under-voltage phase L1 |
| LB.8106 | Under-voltage phase L2 |
| LB.8107 | Under-voltage phase L3 |
| LB.8108 | Voltage normal phase L1 |
| LB.8109 | Voltage normal phase L2 |
| LB.810A | Voltage normal phase L3 |
| LB.810B | Over-voltage phase L1 |
| LB.810C | Over-voltage phase L2 |
| LB.810D | Over-voltage phase L3 |
| LB.810E | Billing reset |
| LB.810F | RTC sync start |
| LB.8110 | RTC sync end |
| LB.0020 | RTC Set |
| LB.0008 | DST |
| LB.2000 | Log-Book erased |
| LB.4000 | Load-Profile erased |
| LB.0001 | Device disturbance |
| LB.8117 | Parameters changed |
| LB.8118 | Watch dog |
| LB.8119 | Fraud start |
| LB.811A | Fraud end |
| LB.811B | Terminal cover opened |
| LB.811C | Terminal cover closed |
| LB.811D | Main cover opened |
| LB.811E | Main cover closed |
| LB.811F | Master reset |
| LB.8120 | Parameter changed via remote comm. |
| LB.8121 | Scheduled parameter change |
| LB.8122 | Private key changed |

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|---|---|
| LB.8123 | Local communication started |
| LB.8124 | Local communication ended |
| LB.8125 | Remote communication started |
| LB.8126 | Remote communication ended |
| LB.8127 | GPS communication established |
| LB.8128 | GPS communication lost |
| LB.8129 | Contract1 communication started |
| LB.812A | Contract1 parameter changed |
| LB.812B | Contract1 parameter changed |
| LB.812C | Contract1 parameter changed |
| LB.812D | Contract1 parameter changed |
| LB.812E | Contract1 billing reset |
| LB.812F | Contract2 communication started |
| LB.8130 | Contract2 parameter changed |
| LB.8131 | Contract2 parameter changed |
| LB.8131 | Contract2 parameter changed |
| LB.8133 | Contract2 parameter changed |
| LB.8134 | Contract2 billing reset |
| LB.8135 | Contract3 communication started |
| LB.8136 | Contract3 parameter changed |
| LB.8137 | Contract3 parameter changed |
| LB.8138 | Contract3 parameter changed |
| LB.8139 | Contract3 parameter changed |
| LB.813A | Contract3 billing reset |
| LB.813B | Contract4 communication started |
| LB.813C | Contract4 parameter changed |
| LB.813D | Contract4 parameter changed |
| LB.813E | Contract4 parameter changed |
| LB.813F | Contract4 parameter changed |
| LB.8140 | Contract4 billing reset |
| LB.8141 | Reverse power flow |
| LB.8142 | Breaker failure |
| LB.8143 | Invalid password |
| LB.8144 | Corrupted SMS |
| LB.8145 | Incorrect credit code |
| LB.8146 | Keypad locked |
| LB.8147 | GSM network failure |
| LB.8148 | Programming failed |
| LB.8149 | Invalid SMS source |
| LB.814A | All code entered |
| LB.814B | Valid code time |
| LB.814C | Customer purchase request |
| LB.814D | Meter removal |
| LB.814E | Full Technical Log Book |
| LB.814F | Unable to send SMS alarm |
| LB.8150 | Intrusion reset |
| LB.8151 | Previous values reset |
| LB.8152 | Current without Voltage phase L1 - start |
| LB.8153 | Current without Voltage phase L2 – start |
| LB.8154 | Current without Voltage phase L3 - start |
| LB.8155 | Current without Voltage phase L1 - end |

| | |
|---|---|
| LB.8156 | Current without Voltage phase L2 – end |
| LB.8157 | Current without Voltage phase L3 - end |
| LB.815E | Wrong password login |
| LB.815F | Password changed |



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