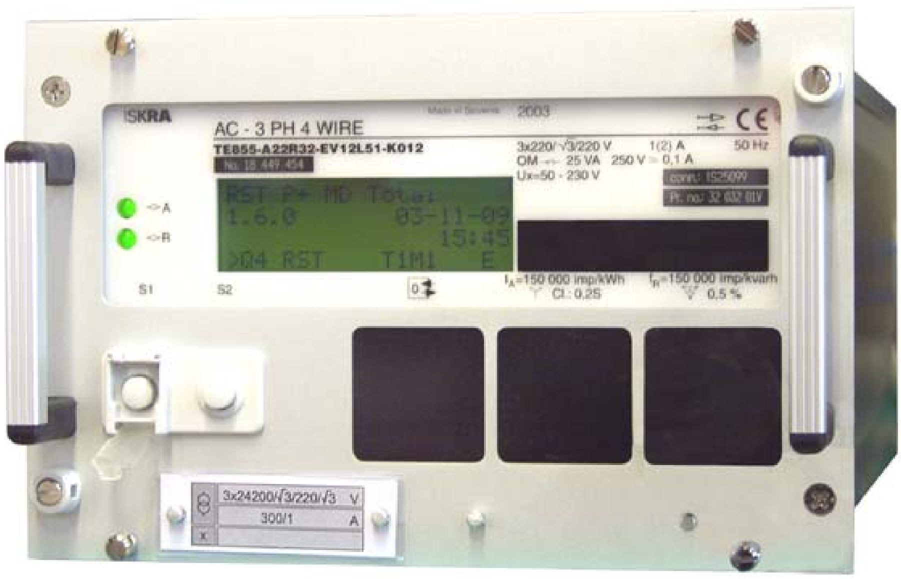
TE855

Technical description



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High precision multifunction meter TE855

1. Overview

TE855 is an electronic four-quadrant transformer rated electricity meter, for measurement and registration of active and reactive energy as well as active and reactive demand.
High precision multifunction static transformer meters TE855 are intended for large and medium size commercial and industrial customers.

The main meter features are:

- high accuracy and long-term measurement stability,
- three-phase active energy measurement (import, export) in compliance with the IEC 62053-22 standard, class 0.2S or 0.5S,
- three-phase reactive energy measurement (four quadrants and combined quadrants) in compliance with IEC 62053-23 standard, class 2 or 3 (calibrated up to 0.2%),
- current average, maximal and cumulative demand measurement,
- Time Of Use (TOU), on-line registration of energy and demand,
- two independent Load Profiles (LP), registration of energy absolute values, demands and other quantities,
- event Log book,
- display of various data, alarms and statuses on LCD,
- possibility of three inputs and eight outputs,
- three independent communication channels,
- security of the meter and meter data,
- supply from external supply, measuring voltages or a combination of both,
- connection via current or current and voltage measuring transformer in three-phase three or four-wire networks,
- meter design complies with VDEW-Lastenheft Elektronische Elektrizitätszähler, Version 2.0 (12.97).

Each meter is a unique design and is made according to a customer’s specification. Meters are manufactured in compliance with ISO 9001 standard.

2. Meter parts

Meter consists of the following parts:

- central processing unit (CPU),
- measuring system Time Division Multiplication (TDM),
- real time clock (RTC),
- display (LCD),
- infra-red optical interface (IR),
- CS interface (CS),
- RS 232 interface (RS 232),
- RS 485 interface (RS 485),
- inputs/outputs,
- power supply.

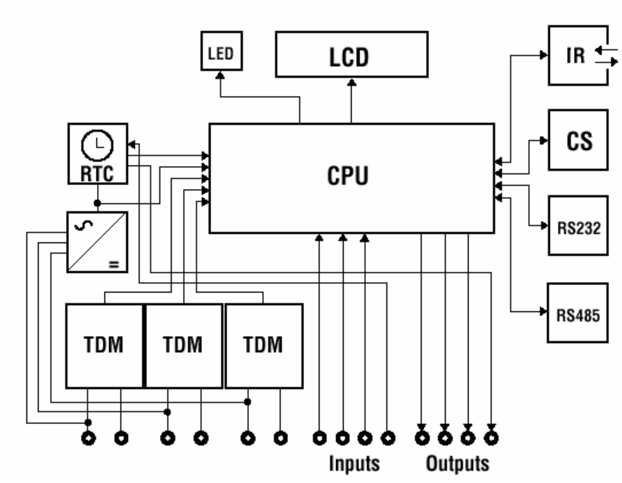

Fig. 1: Meter block scheme

3. Housing

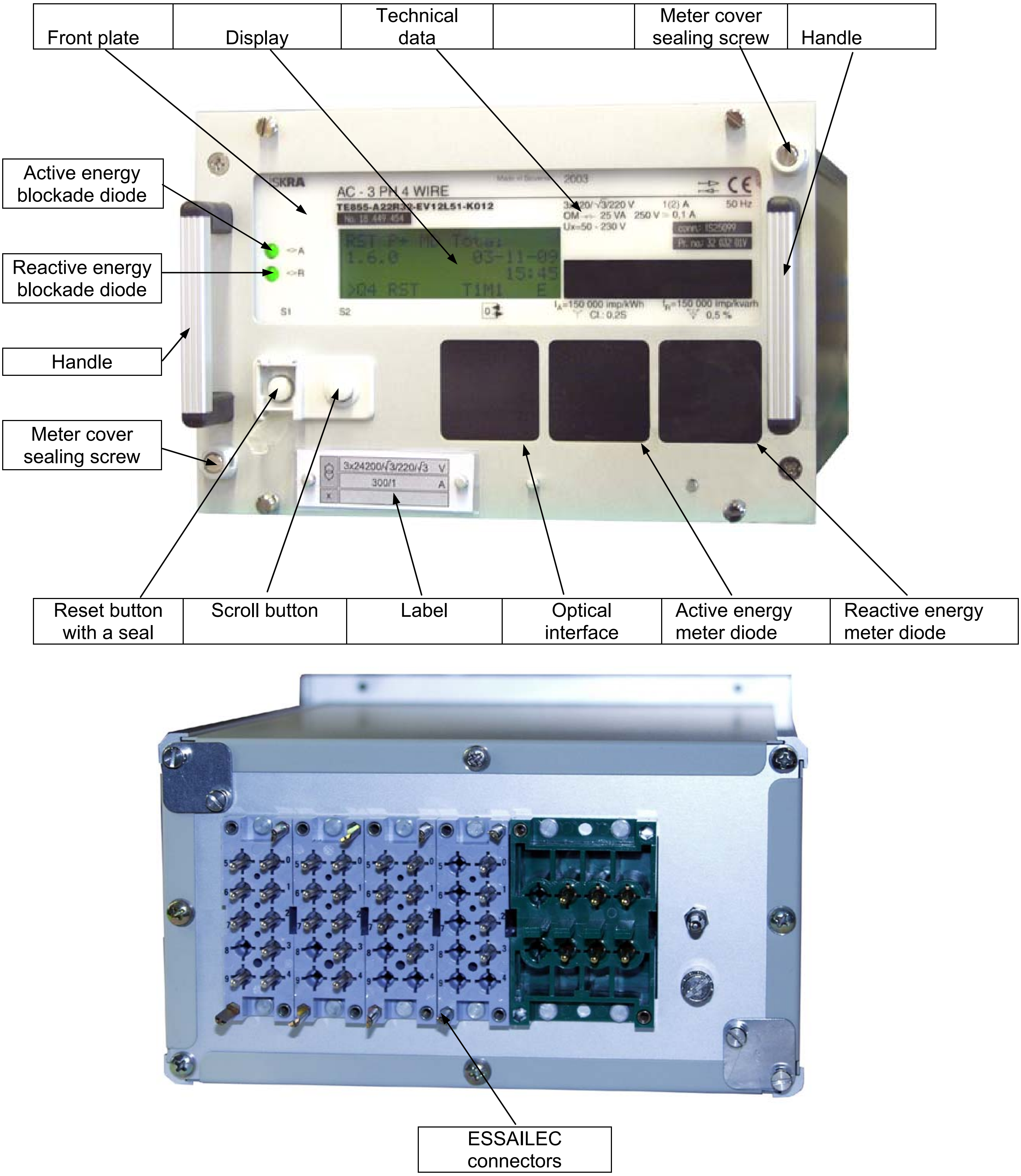

Fig. 2: Meter parts

3.1. Dimensions

Meter TE855 is built into a standard half 19" housing and can be thus mounted in a 19" cabinet by means of a carrying casing. The casing is made of metal. The meter fixing dimensions comply with the DIN 43862 standard.

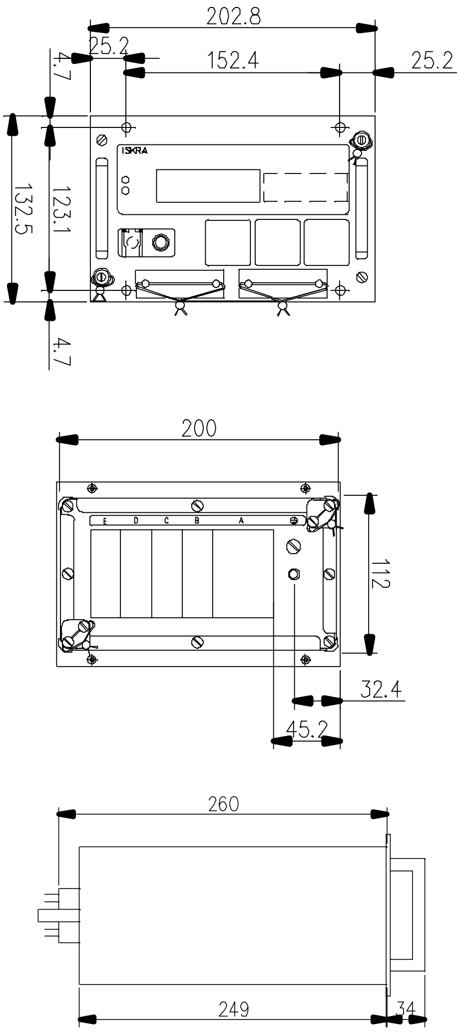

Fig. 3: Meter housing dimensions

3.2. ESSAILEC connector

ESSAILEC connector enables simple replacement of the meter on the measuring place. It automatically short circuits a secondary winding of the current transformer when the meter is removed from the measuring cabinet. The connectors are fixed to the meter with two screws that can also be sealed.

The meters are connected to the ESSAILEC connector (plug-in & plug-out) from the rear side. Measuring, input and output circuits as well as communication conductors are connected to ESSAILEC connectors according to the connection diagram that is stuck on the meter external side.

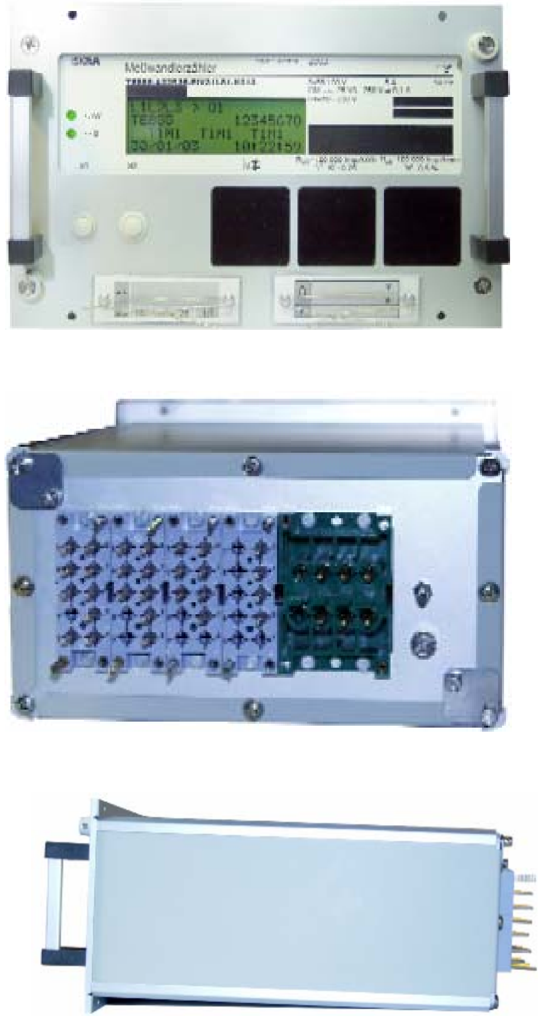

Fig. 4: Front, back, side view

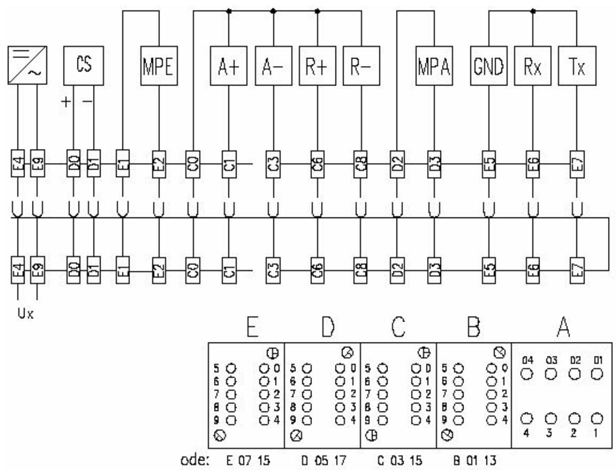

Fig. 5: ESSAILEC connector scheme

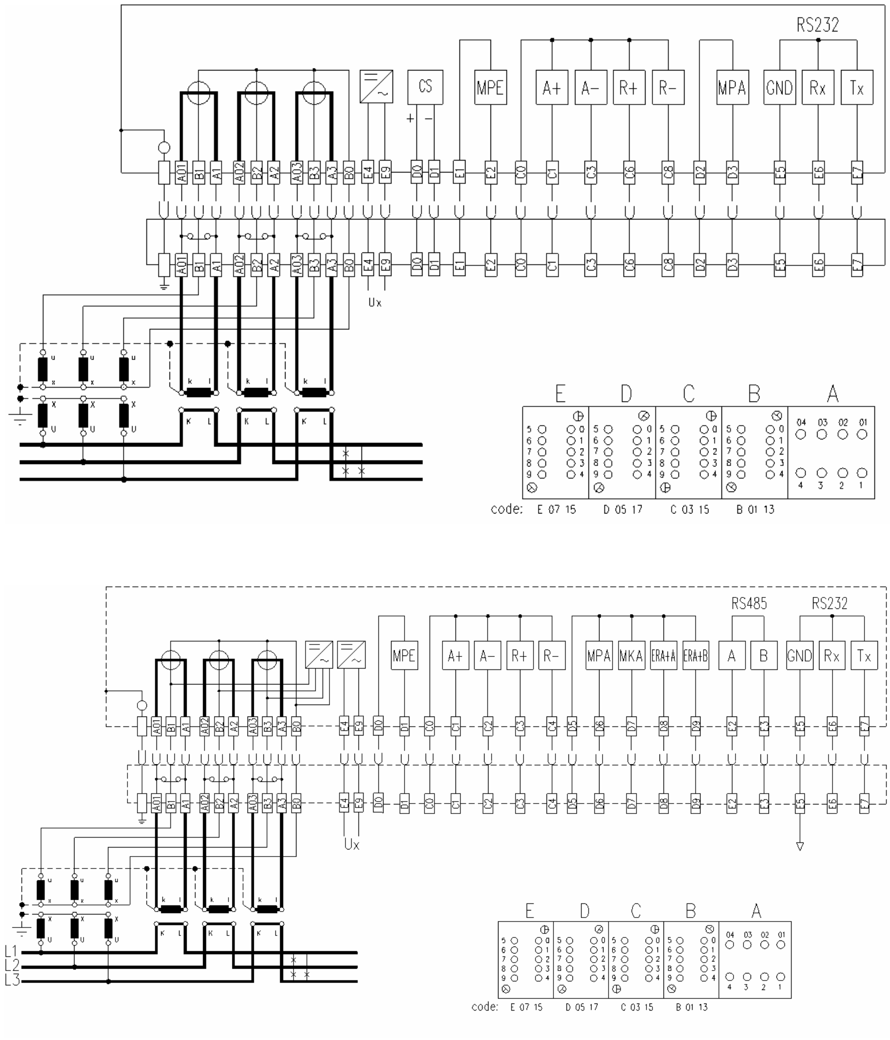

Fig. 6: Wiring diagrams

3.3. Wiring diagrams

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.

3.4. Front plate

The following data is printed on the meter nameplate:

- 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 at meter testing,
- software version,
- owner’s name or logo,
- bar code,
- code of connection diagram and program number.

4. Measuring system

A measuring system is based on the Time Division Multiplication measuring method. The TE meters are provided with three measuring systems, and the DE meters with two.
The measuring system presents a long-term stable and the most precise measuring technique as it is used also in the meters of class 0.05% (Iskraemeco TEMP 100). The metering elements are protected against over-voltage and high frequency disturbances.
Recalibration of the meter is thus not required during its life span.

The figure below shows a simplified example of a circuit for single-phase conditions. Basic modules of the measuring system are:

1. resistor dividers,
2. voltage/time converter,
3. delta voltage generator,
4. current transformers,
5. inverter,
6. multiplier,
7. voltage/frequency converter.

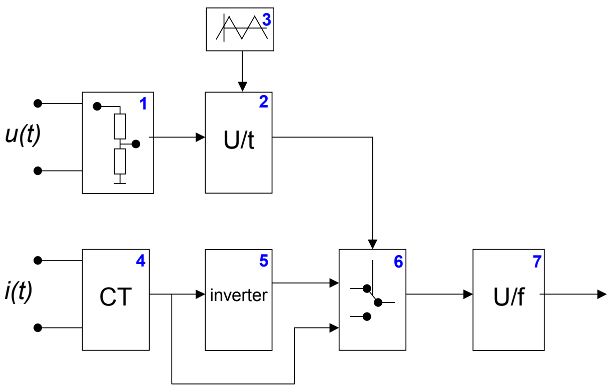

Fig. 7: TDM measuring system

For reactive energy measurement modules for either artificial or natural connections can be used. In case of natural connection, three phase shifters are mounted, of which each module for one phase.

4.1. Time Division Multiplication

Time Division Multiplication (TDM) is an electronic measuring technique, which produces an output signal proportional to two inputs, in our case voltage and current. The width or duration of the output signal is proportional to voltage and the height is proportional to the current. The area of the signal is then proportional to the product of the two inputs, power.

Measuring voltage is dropped down to the level, which is convenient for electronics by means of resistor voltage dividers (1).

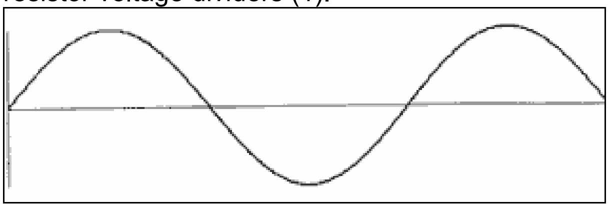

Fig. 8: Voltage signal

Voltage/time (U/t) conversion is performed in a converter (2) by means of delta voltage (3). The impulse width is proportional to the input voltage.

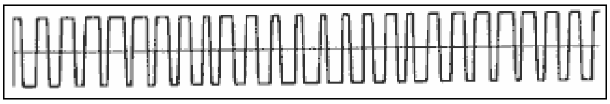

Fig. 9: Voltage signal pulse-width modulation

Measuring currents are converted to voltage signals, convenient for electronics, by means of electronically compensated current transformers (4). They are electrically isolated from mains network and limit secondary voltage in case of primary short circuit.

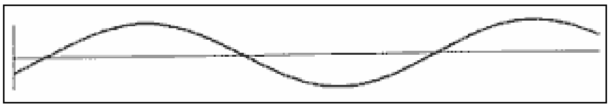

Fig. 10: Current signal

Instantaneous values of voltages and currents, obtained via voltage dividers and current transformers are multiplied (6).

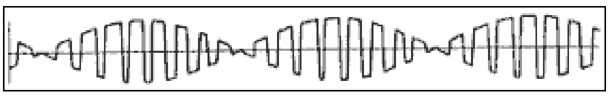

Fig. 11: Time Division Multiplication output signal

Multiplier voltage is converted to frequency (a string of successive impulses suitable for further processing) by a method of balance charges (7), which is proportional to energy.

Fig. 12: Electrical power after filtering output signal

For measurement of reactive energy artificial connection is used. On request it is possible to use natural connection.

4.2. Artificial / natural connection

Artificial and natural connection is used for reactive energy measurement.
In most cases, artificial connection is used which is based on symmetric three-phase system.
Current of the first phase is multiplied with a voltage difference of the second and the third phase voltage. The result of a multiplication is reactive energy. The same is for other two-phase currents.

Drawback of the artificial connection is that it requires all three phases and precision depends on a symmetric of the three-phase system.

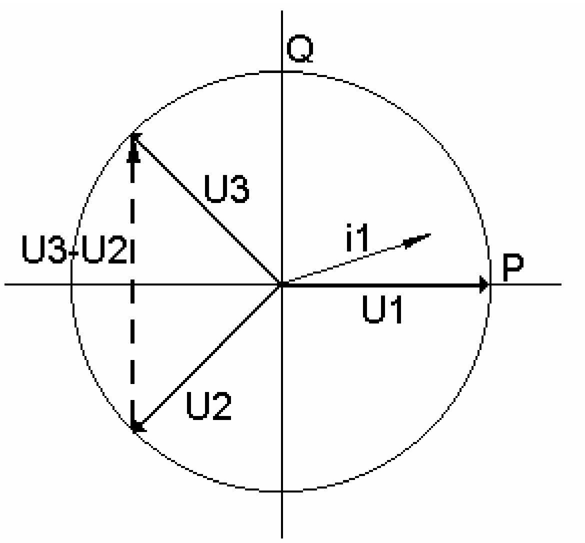

Fig. 13: Artificial connection voltage vector diagram

With a natural connection, there is a single-phase reactive energy measurement. For each phase the current and 90º-shifted voltage are multiplied.
Phase voltage (U) is shifted for angle 90º by controlled filter. Control loop includes multiplier and integrator. Phase voltage (U) is multiplied with a shifted voltage (U_{90}) from filter output and sent to integrator. Filter is corrected by output from integrator. If voltages are shifted for 90º the result of integration must be null.

In a case of the phase failure or asymmetric voltage system, information about reactive energy is still correct for each phase.

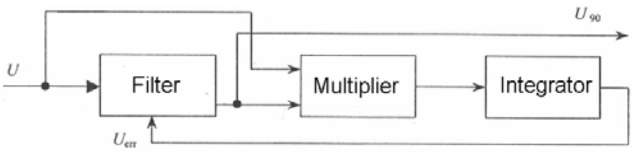

Fig. 14: Natural connection block diagram

5. Real time clock

Real time clock (RTC) performs all time related meter functions. It performs:

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

Next registers contains time and date:

	Format	Register
Time	hhmmss	0.9.1
Date	YYMMDD	0.9.2
Date and time	YYMMDDhhmmss	0.9.4

Table 1: 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, by mains frequency synchronisation (50/60 Hz) or corrected by input signal MPE. The RTC version is defined with a parameter set in the register C.59.0 during meter configuration.

Version	C.59.0
Quartz crystal	0
Synchronisation by mains frequency	1
Quartz crystal and MPE correction	2
Synchronisation by mains frequency and MPE correction	3

Table 2: RTC versions

The RTC power supply is backed-up with a super capacitor or a super capacitor and a Li-battery[1].

5.1. Quartz crystal

The quartz crystal is digitally trimmed during manufacturing. A value of the trimming constant in a range from 0 to 255 is stored in register C.55.9.
The crystal controlled RTC complies with the IEC 61038 standard. Its accuracy is ±3 min/year at room temperature. The error is cumulative.

5.2. Mains synchronisation

If mains are present RTC is synchronized by mains frequency. Otherwise the RTC is controlled with a quartz crystal.

The RTC accuracy depends on mains frequency accuracy. If frequency is strictly controlled long-term accuracy is ±30 sec/year. The error is not cumulative.

5.3. MPE correction

Besides quartz crystal and mains synchronisation 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 1:MPE time correction

5.4. Back-up power supply

The RTC is backed-up with a super capacitor or a super capacitor (smaller capacity is used) 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 10 years. There is a counter (C.6.0) of elapsed time when RTC was backed-up with the Li-battery. Cursor on a LCD indicates that battery was discharged and has to be replaced. As option also output is set for remote alarming.
In case of power shortage lasting up to 25 hours, the RTC is backed-up with the super capacitor (0.22F). If power shortage is lasting longer than 25 hours, the Li-battery starts to back-up the RTC.
In case of discharge of back-up power supply the meter clock will be set at next power-up with date and time of the latest power-down. Also the status “Battery back-up discharged” will be set.

5.5. Setting

The RTC can be set to current time and date by user with buttons 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.

[1] Surface mounted meter version only.

5.6. Daylight saving time

RTC enables automatic changing to daylight saving time (DST) and back to the standard time, also known as a summer and winter time.
Daylight saving time is indicated with value 1 in the register 0.9.5, otherwise the value is 0. Daylight saving time beginning and end are defined in register ID_438 in a form of a table. First 4 bytes define the beginning and next 4 bytes define the end of DST.

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.

5.7. Time validity verification

The default date is the oldest one in the device and used for verification. The time validity is verified at each reset of the meter. At the same time status of eventual error is set and a corresponding action for eliminating the error is activated. The meters have two statuses of the RTC:

- Operation status register ID_133 - is a status that occurs at testing the RTC time after the microcomputer reset. It is the most recent information on the RTC status. Value 0 means OK.
- History status register ID_134 - permanently stores the status of the RTC errors irrespective of how many resets back they occurred. This status is reset only at a regular setting of the RTC time. Value 0 means OK.

6. Display

The liquid crystal matrix-dot display with 4x20 characters enables complex and clear display of different data, messages and events. Depending to meter mode different information is shown. Displayed data is identified with EDIS code by DIN 43863-3.

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.

6.1. Handling

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

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

- scroll,
- reset.

Each button has three activation times:

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

The scroll button is on the right and the reset button is on the left and sealed.

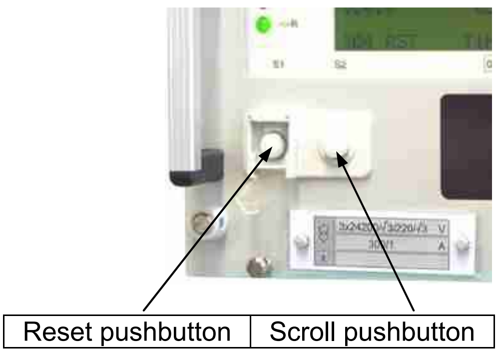

Fig. 15: Meter buttons

6.2. Modes of LCD operation

There are the following LCD modes:

- start logo (at power-up only),
- LCD test,
- auto-scroll,
- standard data,
- load profile,
- setting,
- parameterisation,
- special messages.

In each mode different data is shown on a display. There are 4 modes with data displaying sequences:

- auto,
- standard data,
- load profile,
- setting.

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

In auto mode, data from the auto sequence are cyclically displayed for 10 seconds. In standard data mode it is possible to list all data from the standard data sequence with a scroll button. Setting sequence contains the list of parameters to set in setting mode.

6.3. Menu system

Principles of the meter handling and data displaying described in this chapter are shown in Fig. 23: Meter push-button handling flow-chart diagram

6.4. Auto-scroll

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

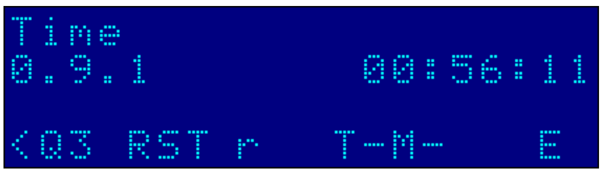

Fig. 16: Auto mode, time item displayed

The following four lines are displayed:

1. line: information text on displayed data,
2. line: EDIS identification code and value,
3. line: unit,
4. line: meter status indicators.

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

6.4.1. Status indicators

Standard meter status indicators are:

- <, > Active energy direction, blinking: below start-up energy.
- Qx Reactive energy quadrant, blinking: below start-up energy.
- R,S,T Phase voltage detection, blinking incorrect phase sequence.
- r,s,t Phase current detection, blinking: current without voltage.
- Ty Valid tariff for energy.
- Mz Valid tariff for demand.
- C Communication
- F Fatal error
- R RTC controls tariff program
- S Setting mode
- B Billing reset blockade
- T Test mode
- E External supply
- P Parameterisation mode

6.5. LCD test

LCD test mode is used to check if all LCD dots are displayed.
When scroll button is depressed in auto mode, display is illuminated and all segments (dots) of the LCD blink. LCD illumination time is set in register C.55.10.

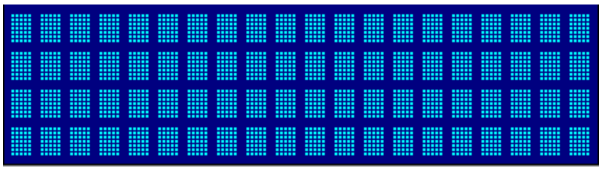

Fig. 17: LCD test, all dots are displayed

6.6. Standard data

The first data item displayed in the standard data sequence list is usually the identification code and data on function errors. Each following depress of the scroll button displays next data item from the sequence.

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

Standard data sequence can be also scrolled by illuminating the photo-transistor of the IR optical port with a torch for a time longer than the communication time. This feature is useful when the meter is built in a locked cabinet with a glass window and scroll button can not be pressed.

Fig. 18: Standard data

6.7. Load profile

There are 4 lines on LCD in load profile mode:

1. line: text "Oldest Period Time",
2. line: the oldest period timestamp,
3. line: defined interval,
4. line: defined start time.

Fig. 19: Initial load profile screen

It is possible to view load profile by selecting date and time and type of scrolling interval:

- period - displaying periodical values,
- hour - hourly values on each full hour,
- day - daily values on each full day after selected time.

To select time and interval and to move between months, days, hours, etc. a scroll button must be pressed for a long time. To set time or interval scroll button is pressed for short time.

After defining desired date, time and interval with short presses on scroll button you will get values of a load profile.
On every screen there are 3 quantities displayed. After displaying all quantities for a specific period next period is shown.
To move back to load profile initial screen to set time and interval again, scroll button is pressed for long time.

Fig. 20: Load profile – energy absolute values

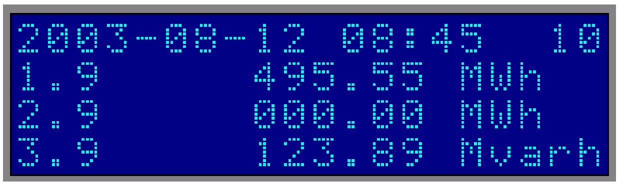

Fig. 21: Load profile – energy delta values

Displayed load profile record has the following fields:

- timestamp when period ended,
- status in hexadecimal (upper right corner),
- register name,
- value,
- unit.

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	Measurement value error
2	Set time	Clock battery discharged
1	MD reset	Device disturbance

Example 2: Load profile bits. C0 (hex) = 1100 0000 (bin). Power-up and power-down event occurred

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.

Register ID_284 bits 5 and 8 defines how LP will be formatted.

ID_284/ bit 5	ID_284/ bit 8	Description
0	0	Demand – x.5
0	1	Energy – x.9
1	0	Energy – x.8
1	1	Pulses

Table 3: LP formatting

6.8. Setting

To enter “SET” mode seal from “Reset” button must be removed and “Reset” button must be pressed. In this mode programmable parameters can be set either via communication interfaces (after first short press of Reset button – on LCD is text “SET LOCK OPEN”) or by buttons (after second short press of Reset button).
When setting is done by communication interface, setting by buttons is disabled. While parameters are set by buttons (digits blink) setting by communication interfaces is disabled.

6.9. Parameterisation

To set the meter into the parameterisation mode, the meter cover should be removed. Seal from setting button and from meter cover must be removed.
When meter is in the setting mode parameterisation button under the meter cover should be pressed.

When the parameterisation button has been pressed, the cursor P on the display starts to blink indicating that the meter is in the parameterisation mode.
The meter is now ready to be programmed via 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
- after power-down.

6.10. Billing reset

When reset button is pressed in the auto-scroll mode, the meter carries out a billing reset. The message “MD Reset Done” indicates that billing reset has been performed. Status B indicates billing reset blockade period when new billing reset can not performed.

Fig. 22: Billing reset message

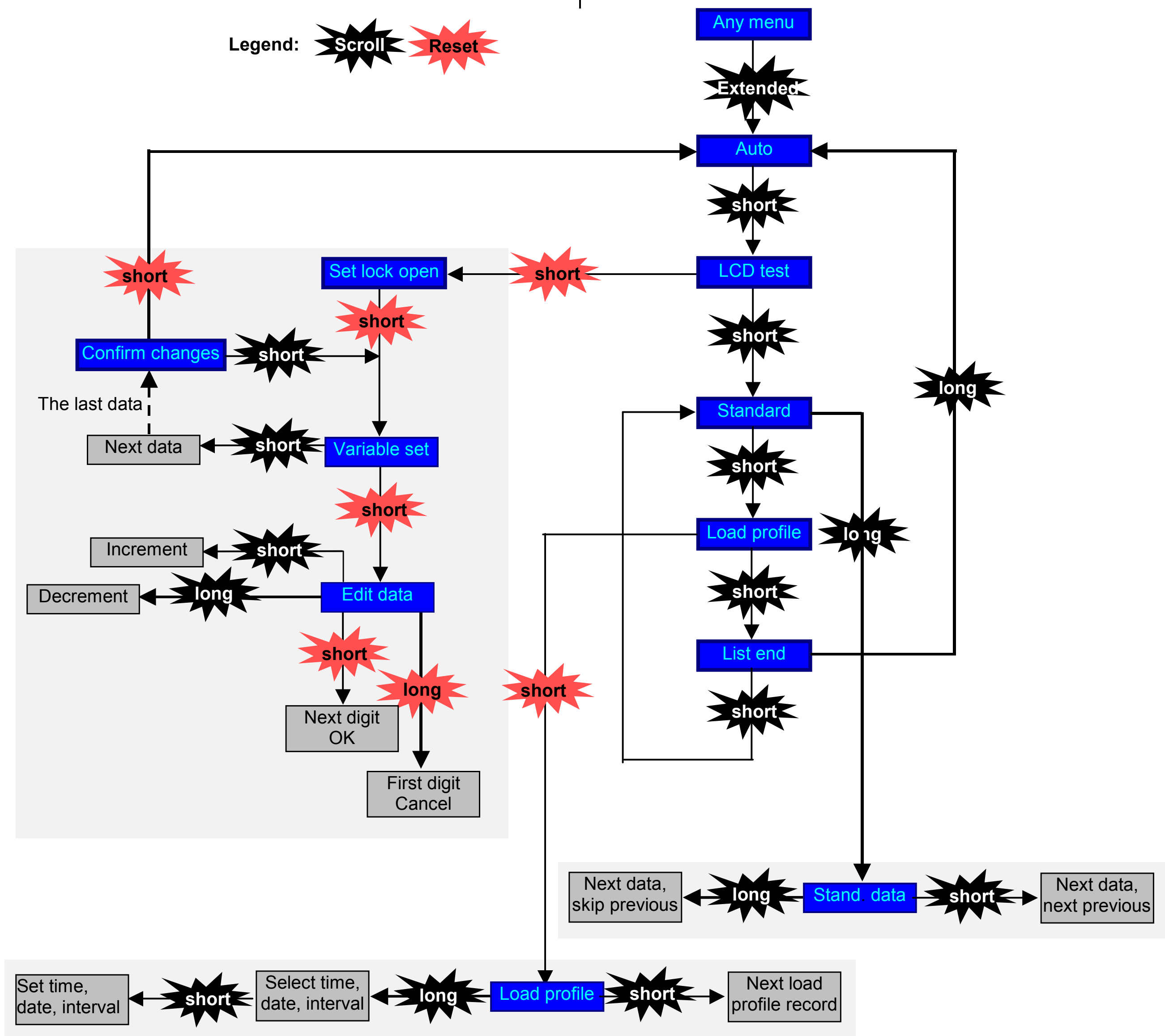

Fig. 23: Meter push-button handling flow-chart diagram

7. Communication

The meter is provided with three serial asynchronous communication channels that are completely independent concerning the format, rate and data.
It is possible to read data from all three communication interfaces simultaneously. If there are more requests to write data to a meter, communication interface where first request occurred has priority.

The following types of interfaces are available:

- IR,
- CS,
- RS 232,
- RS 485.

An optical interface is built in. Other two channels are optional but they should not be of the same type.

Next registers defines communication rates:

- C.57.1, COM 0, IR interface,
- C.57.2, COM 1,
- C.57.3, COM 2.

C.57.1, C.57.2, C.57.3	Rate (Baud)
0	disabled
1	300
2	600
3	1200
4	2400
5	4800
6	9600
7	19200

Fig. 24: Communication settings

Two communication protocols are available in compliance with the standards:

- IEC 61107, mode C with password,
- IEC 60870-5-102.

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

	IR	CS	RS 232	RS 485
Wires	-	2	3	2
IEC 61107	✓	✓	✓	✓
IEC 60870	✓	✓	✓	✓
Max. baud rate	9600	9600	19200	9600

Table 4: Communication interface properties

7.1. IR interface

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 61107 protocol, C mode.
Maximal communication rate is 9600 Baud.

7.2. CS interface

The CS interface complies with the DIN 66348 standard and is a two-wire 20 mA current loop communication. Maximum transmission rate 9600 Baud.

7.3. RS 232 interface

Three-wire RS 232 interface is used for point-to-point communication in accordance with standard IEC 61107 mode C and IEC 60870-5-102. An external device can be connected to the RS 232 terminals. Maximum transmission rate 19200 Baud.

7.4. RS 485 interface

Two-wire RS 485 interface is used for multi-drop communication in accordance with standard IEC 61107 mode C or IEC 60870-5-102. Maximum transmission rate 9600 Baud.

7.5. IEC 61107 mode C[1]

The IEC 61107 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 5: IEC 61107 communication settings

A protocol diagram flow is shown in Fig. 25. The following steps of communication are shown:

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

[1] Only protocol basics are described. For more information see standard IEC 61107 or newer IEC 62056-21.

7.5.1. 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.

7.5.2. 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 61107 standard is quite inconvenient, the Iskraemeco meters enable a non-standard additional possibility of communication with only one specified rate (fixed baud rate).

7.5.3. 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.

7.5.4. 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.

7.5.5. 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

7.5.6. 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

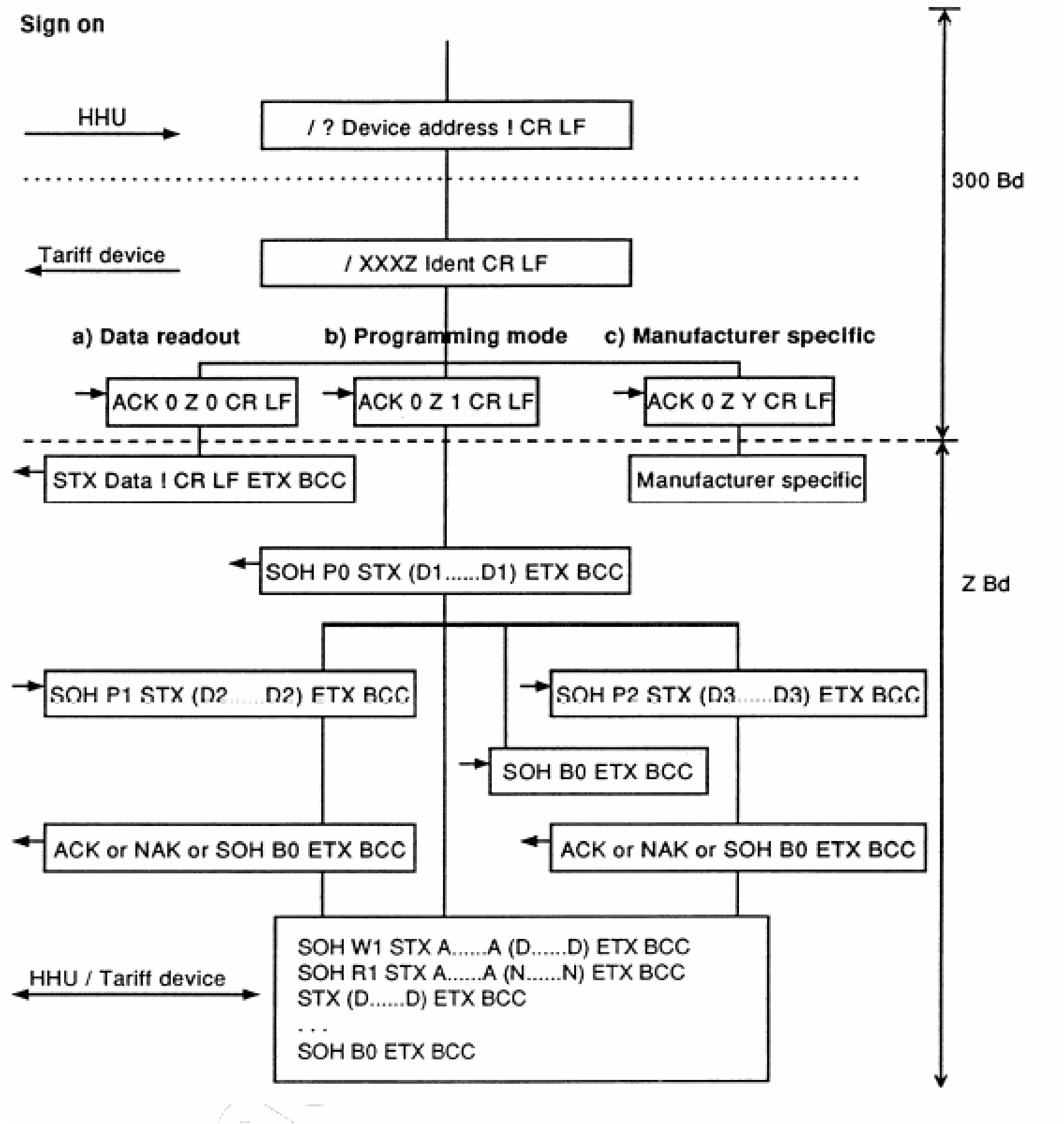

Fig. 25: IEC 61107 mode C protocol diagram

7.5.7. Error messages

Next table shows list of communication error codes and description.

ERxy	Explanation
01	Unknown command
02	Invalid command
03	Command format error
04	Read-only code
05	Write-only code
06	Command => no R/W allowed
07	Access denied
08	Non R3 variable
09	Variable is not command
10	Command not executed
11	Code format error
12	Non Data-read-out variable
13	Variable without unit
14	Wrong previous values index
15	Code without offset
16	Wrong offset or number of elements
17	No value for write
18	Array index too high
19	Wrong offset format or field length
20	No response from master
21	Invalid character in R3 blocks
22	Variable without previous values
23	Code does not exists
24	Invalid variable sub tag
25	Non-existing register
26	FLASH write failed
27	Invalid value
28	Invalid time
29	Previous value not valid
30	Previous value empty
36	MD Reset lockout active – comm.
37	LP value not valid
38	LP is empty (no values)
39	No LP function in the meter
40	Non-existing channel of LP
41	LP Start time > End time
43	Error in time format
44	Invalid Data-read-out
47	Meter not in auto-scroll mode
49	Error on cumulative maximum
53	Non R5 variable

Table 6: List of error messages on communication

7.6. IEC 60870-5-102[1]

IEC 60870-5 is a general protocol definition developed by the International Electrotechnical Commission (IEC) Technical Committee 57. It is an outline for the structure of a protocol and can only be implemented with a companion standard to specify options such as one of five link layer formats.

[1] Only protocol basics are described. For more information see standard IEC 60870-5-102 and companion standards.

In order to support additional functions apart from those considered as basic, the procedure described in the standard has been followed:

- object definition in the foreseen range and
- utilization according to the standard.

The protocol structure follows the layers specified:

- Physical layer: Based on ITU-T recommendations,
- Data link layer: data link transmission procedures and frames supporting application messages,
- Application layer: application functions that imply transmission of ASDUs (Application Services Data Units) between two points.

7.6.1. Physical layer

In remote mode the following standards will be supported:

- ITU-T V.24/V28 with baud rates up to 38.400 bps,
- ITU-T V.32, V.32 bis and V.34 with baud rates up to 28.800 bps.

Start bit	1
Data bits	8
Parity	Even
Stop bit	1

Table 7: IEC 60870-5-102 communication settings

7.6.2. Link layer

Used is basically REQUEST/RESPOND service with function code 11, for requesting class 2 user data. These data is requested by means of read type ASDUs.

Data link address field of fixed and variable length frames (field A) is a parameter. Every meter has unique data link address. In multi-point configurations, involved meters have different data link addresses. Data link addresses length is 2 bytes.

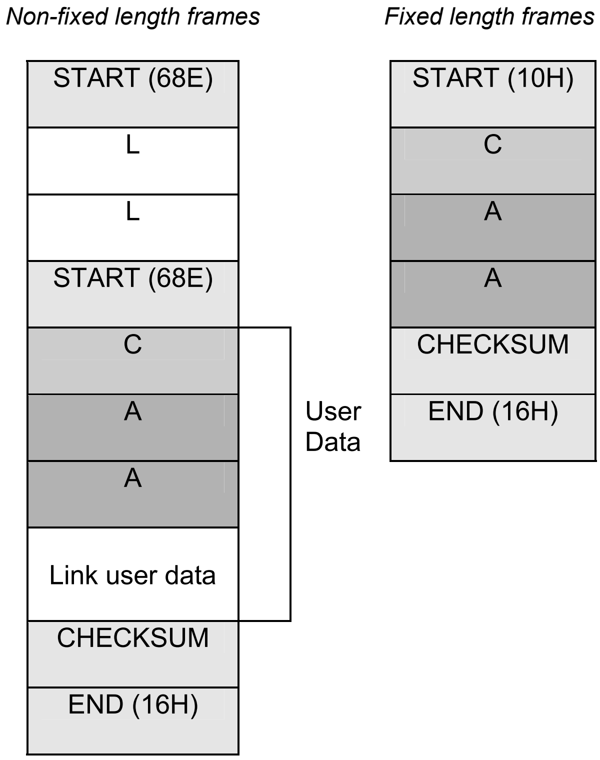

Fig. 26: IEC 60870-5-102 protocol format

RES	PRM	FCB	FCV	Function Code
Bit 8	Bit 7	Bit 6	Bit 5	Bits 4 to 1

RES: reserve = 0
PRM: primary message from primary station (1)
FCB: frame count bit
FCV: FCB bit validation

RES	PRM	ACD	DFC	Function Code
Bit 8	Bit 7	Bit 6	Bit 5	Bits 4 to 1

RES: reserve = 0
PRM: primary message from secondary station (0)
ACD: access demand
DFC: data flow control

Fig. 27: C field format

Maximum user data length (L) is 255 bytes. Because field A length is 2 bytes and field C length is 1 byte, data link user data is 252 bytes.
Function codes for control field (field C) supported for messages sent by control station (PRM=1) are the following:

- 0: remote link restart, send/confirm, FCV=0,
- 3: user data sent with confirmation, send/confirm, FCV=1,
- 9: link status request, request/respond, FCV=0,
- 11: class 2 data request, request/respond, FCV=1.

Function codes for control field (field C) supported for messages sent by meters (PRM=0) are the following:

- 0: ACK: positive acknowledge, confirm,
- 1: NACK: message not accepted, line occupied, confirm,
- 8: USER DATA, respond,
- 9: NACK: requested data not available, respond,
- 11: link status or access demand, respond.

In order to avoid ambiguity and to not limit functionality, the “unique character” (E5 H) frame format will not be used. Instead fixed length frame with proper field C will be used.

7.6.3. Application Layer

A data link layer frame may contain one application service data unit (ASDU) in the data link layer user data. An ASDU is composed of a data unit identifier, one or more information objects and depending on the type of ASDU, a common time stamp.
The data unit identifier of an ASDU is made up of:

- a type identifier (1 byte),
- a variable structure identifier (1 byte),
- a cause of transmission (1 byte),
- an ASDU common address (3 bytes).

The ASDU common address is composed of a metering point address (2 bytes: between 1 and 65535) and a record address. The metering point address corresponds to the term “DTE total integrated address”.
Each information object consists of:

- an information object address (optional),
- a group of information objects,
- an information object time stamp (optional).

An information object group may be a sole information element, a combination of elements, or a sequence of information elements.

8. Inputs and outputs

There are up to 3 inputs and 8 outputs.

8.1. Inputs

There are up to 3 non-programmable inputs with a common ground. The inputs are performed as semiconductor resistor type inputs electrically isolated from the metering part. Available inputs:

Input	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 8: Inputs

8.1.1. 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 $2^3 = 8$.

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

Table 9: Number of tariff inputs and number of tariffs

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

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

Table 10: Multiple tariff control by inputs

8.1.2. Billing reset

Inputs MRa and MRb enable remote resetting of the meter at the end of billing periods. See chapter 16 Billing reset.

8.1.3. Demand measurement disabling

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

8.1.4. 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 shifted to the nearest minute. Executed actions depend on RTC time correction thresholds. There are two in registers ID_677 and ID_785:

- < 3 s.: synchronisation is done,
- 3 - 5 s.: synchronisation is done, logbook event, communication message is sent.
- > 5 s.: no synchronisation.

Register ID_786 (in ms) is used to compensate transmission delays.

8.2. Outputs

Outputs are programmable potential-free PHOTO-MOS relays with:

- make contact,
- change-over contact.

The maximum number of outputs is 8. The maximum number of change-over contacts is 4. In this case other 4 outputs are make contacts only. There are at least two groups (4+4) and maximum six groups (1+1+1+1+2+2) of outputs with a separate ground terminal.

Output	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	MZA

Output	Marking
disabling	
Energy reading pulses	+AA, -AA, +RA, -RA, RA1, RA2, RA3, RA4
Alarm	MKA
Modem reset	RES

Table 11: Outputs

The polarity is defined in register ID_644 (0 – break, 1 – make contact). Form of pulse output is defined in ID_835 (0 – make, 255 – change-over contacts; useful only in case that such contacts are installed). In case of make contact the duration is defined in ID_236 (in steps of 10 ms, max. 2,5 sec).

8.2.1. 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 voltage and current of the meter. Output constants are obtained by division of LED constants by integer divisor N. See Table 12: LED and output constants

8.2.2. 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.

8.2.3. 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. The polarity is defined in register ID_641 (0 – break, 1 – make contact).

8.2.4. 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.

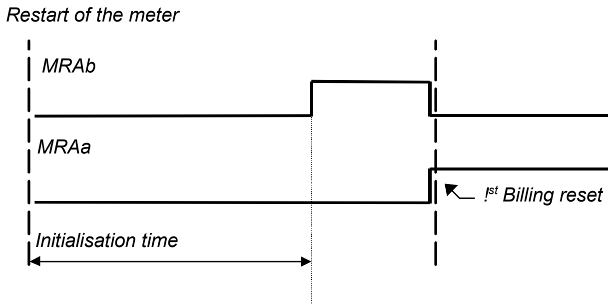

Fig. 28: MRAa MRAb outputs at restart and first billing reset

8.2.5. Demand measurement disabling

MZA output indicates forgiveness period - demand is not measured. The polarity is defined in register ID_642 (0 – break, 1 – make contact).

8.2.6. 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 ID_828 defines duration of MPA output activity. If set to 0 it means 1% of MP. Values from 1 to 60 represents number of seconds. The polarity is defined in register ID_643 (0 – break, 1 – make contact).

8.2.7. 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.

8.3. LED pulse indicators

Two red LEDs on the front plate are used for meter testing and checking. Blinking rate of the LEDs depend 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 are OFF.

Un (V)	In (A)	LED (imp/kWh, imp/kvarh)	Output (imp/kWh, imp/kvarh)
3x57.7/100 3x63/110	1	600.000	Output = LED / N
	1(2)	300.000	
	5	120.000	
	5(10)	60.000	
	5||1	120.000	
3x115/200 3x127/220	1	300.000	
	1(2)	150.000	
	5	60.000	
	5(10)	30.000	
	5||1	60.000	
3x220/380 3x230/400	1	150.000	
	1(2)	75.000	
	5	30.000	
	5(10)	15.000	
	5||1	30.000	

Table 12: LED and output constants

Possible values for N (= ID_235) are: 1,2,3,4,5,6,10,12,15,20,30,60,…
In case of make contact the output frequency and pulse length must be considered (<50% duty-cycle).
In case of change-over contact maximum frequency can be 40 Hz.

8.4. LED power indicators

Two green LEDs on the right side of the front plate are used for active and reactive power blockade indication. If LED is off metering is blocked.
Meters have implemented blockade in accordance with a following table:

I_{max}	Active power	Reactive power
120% I_n	0.05% P_n	0.1% Q_n
200% I_n	0.1% P_n	0.2% Q_n

Table 13: Metering start regarding nominal power

Active power metering		
I_n (A)	Start (mA)	Stop (mA)
1	0,5	0,15
1(2)	1	0,3
5	2,5	0,75
5(10)	5	1,5
5//1	0,5	0,15

Reactive power metering		
I_n (A)	Start (mA)	Stop (mA)
1	1	0,3
1(2)	2	0,6
5	5	1,5
5(10)	10	3
5//1	1	0,3

Table 14: Blockade limits

9. Power supply

The meter can have three types of supply: internal, external or internal and external at the same time.

9.1. Internal supply

The meter is supplied from three-phase switching supply unit that functions on measuring voltages.

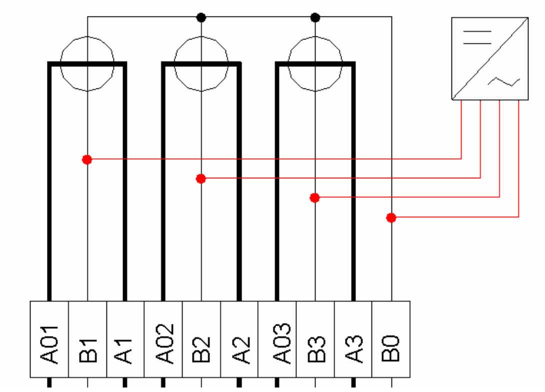

Fig. 29: Internal power supply

9.2. External supply

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

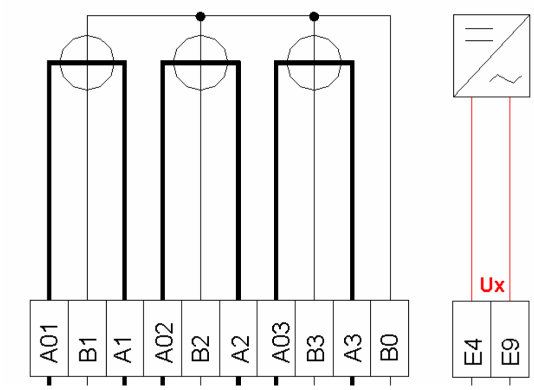

Fig. 30: External power supply Ux

9.3. Internal and external supply

The meter has two supply units: internal three-phase and external single-phase switching supply unit. Until the external supply source is present, the meter is supplied from the external supply unit. In case of failure of the external supply, it immediately switches to the internal supply.

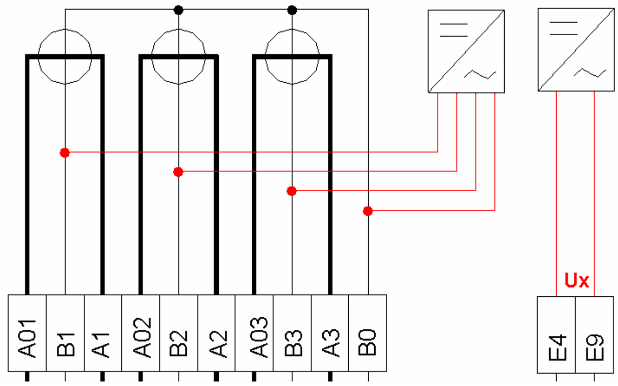

Fig. 31: Internal and external power supply

9.4. Phase voltages detection

The meter enables detection and alarming of the presence of phase voltages and currents. Presence of voltage and phase sequence is marked by R, S and T characters in the bottom line of the LCD. If character is off, it means absence of a certain phase.

If cursors are blinking, phase sequence is not correct. Measurement of active energy is correct, but reactive energy is in wrong quadrants (e.g. instead of Q1 is Q4).

Register ID_184 (bits 2,1,0) shows presence of phase L1, L2 and L3 voltages.

Power shortage is recorded for each phase separately in registers C.7.1, C.7.2 and C.7.3. The registers count from 0 to 65535. An alarm can be generated on output in case of power shortage.

9.5. Current without voltage

Special hardware module detects current without voltage. The threshold I_{th} is set to approximately 2% of I_n.

If the meter detects current in a phase without voltage, "a current without voltage“ signal is generated for each phase separately.

“Current without voltage” is marked by “r, s and t” characters in the bottom line of the LCD.

If $I < I_{th}$, voltage is present, character is OFF.
If $I > I_{th}$, voltage is present, character is ON.
If $I > I_{th}$, voltage not present, character is blinking.

Also status in event log-book is generated when this situation appears and also when it disappears.

Status can be also sent as an alarm to the output.

10. 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: R+, R- or R1, R2 , R3 and R4,
- combined quadrants e.g. R_p= R1 + R4 and R_n= R2 + R3.

All energies are measured three-phase. Above mentioned energies can be registered as:

- Total energies, up to 8 registers,
- Tariff rated energies, up to 255 registers,
- Calculated quantities, up to 32 registers.

10.1. 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.

10.2. 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}.

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

Moreover, 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}:

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

where:

k_{ct} - a current transformer ratio,
k_{vt} - a product of a voltage transformer ratio and voltage transformer error compensation.

A current transformer ratio k_{ct} is an integer in a range from 1 to 30,000 (register 0.4.2). A product of voltage transformer ratio and error compensation of voltage transformer k_{vt} is a floating point number (register 0.4.3). If no voltage transformer error compensation is required, the k_{vt} is equal to voltage transformer ratio.

11. 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).

11.1. 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.

11.2. 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 reactive energy in four quadrants Q1, Q2, Q3 and Q4,
- demand of reactive energy in combined quadrants Q_p=Q1+Q2 and Q_n=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.

11.3. 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.

11.4. 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.

11.5. Modes

The modes of demand measurement differ regarding:

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

There are two basic demand period types:

- fixed demand period,
- rolling demand period.

Table 15 shows different modes of demand measurement regarding the way of triggering the demand period. They can be selected by a parameter setting in the register C.59.2.

Mode	C.59.2	MPE triggering
Asynchronous - fixed	0	-
Asynchronous - rolling	1	-
Synchronous	2	-
Asynchronous - fixed	3	✓
Asynchronous - rolling	4	✓
Synchronous	5	✓

Table 15: Demand period modes regarding triggering

The states of the meter demand measurement are indicated with a parameter in the register ID_260:

260	MODE
0	Asynchronous - fixed demand period
1	Asynchronous - rolling demand period
2	Synchronous mode
3	MPE starts demand measurement

Table 16: Demand measurement status

The following events cause demand period interruption: power shortage, time setting, parameter setting, billing reset, watchdog reset, etc.

The percentage of elapsed time of demand period in register C.55.0 indicates how much time has elapsed till the moment when the demand measurement was started.

11.5.1. Fixed demand period

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

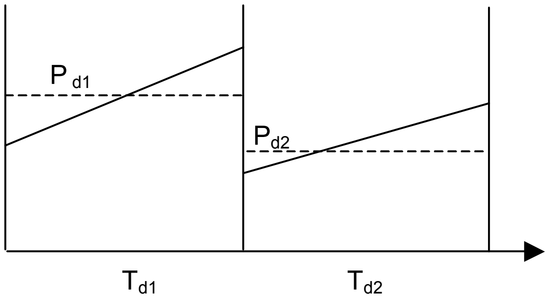

Fig. 32: Fixed demand period mode

11.5.2. Rolling demand period

At rolling demand measurement a demand period T_{dp} is divided into subintervals T_S, so that the demand period is a multiple of the subintervals. At the end of each subinterval starts a new demand period.

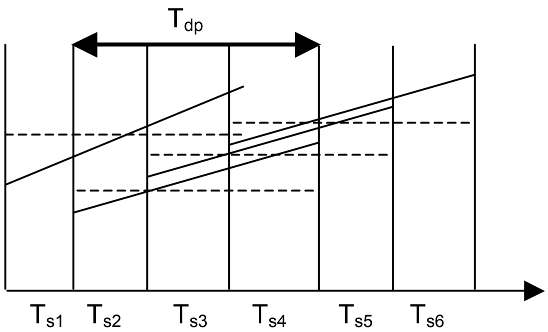

Fig. 33: Rolling demand period mode

11.5.3. Demand period type settings

Demand period type is set by defining lengths of:

- a demand period in a register 0.8.0 and
- a subinterval in a register 0.8.2

both expressed in minutes. Both a demand period and a subinterval can be set in a range from 1 to 60 minutes, with step of 1 minute.

In fixed demand period subinterval should be of the same length as the demand period.
If demand in rolling demand period is to be measured, length of a subinterval should be chosen so that subintervals are contained in the demand period without a residual and a number of subintervals should not be larger than 15.

If such a length of a subinterval is chosen that a number of subintervals is larger than 15, the meter itself will enter 1 minute both into the register 0.8.0 and the register 0.8.2. Consequently fixed demand will be measured.

11.5.4. Asynchronous mode

In the asynchronous mode both demand period and registration period start independently of each other. Every demand and registration period last as it is defined regardless of their start time. The start of the period is triggered:

- after watchdog reset,
- power-up,
- time setting,
- parameter setting.

The end of a billing period and tariff changeover may or may not interrupt the demand period.

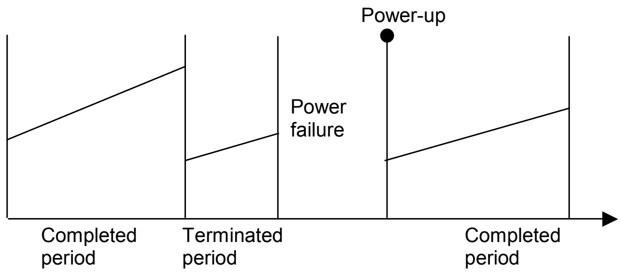

Fig. 34: The start and length of demand period under different circumstances

11.5.5. 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.

11.5.6. 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.

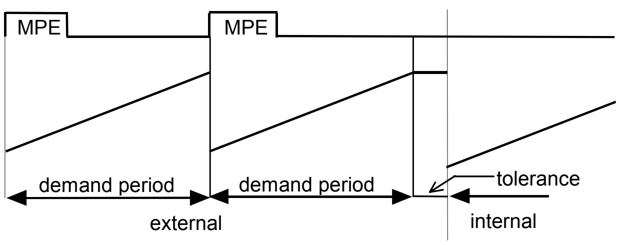

Fig. 35: Demand not measured in a tolerance time

11.6. Billing reset and tariff change-over influence

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 change-over 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:

- both billing reset and tariff changeover interrupts the current demand period,
- billing reset does not interrupt the demand period but tariff changeover does,
- billing reset is delayed up to the end of the demand period, tariff changeover interrupts the demand period,
- billing reset does not interrupt the demand period, tariff changeover is delayed up to the end of the demand period,
- both billing reset and tariff changeover are delayed up to the end of the current demand period.

C.59.4	Billing reset	Tariff changeover
0	interrupts the demand period	interrupts the demand period
1	does not interrupt the demand period	
2	is delayed up to the end of the demand period	
3	interrupts the demand period	is delayed up to the end of the demand period
4	does not interrupt the demand period	
5	is delayed up to the end of the demand period	

Table 17: MD Reset and tariff change influence on MP

11.6.1. Billing reset interrupts demand period

Billing reset is executed during a current demand period and interrupts it. Demand of interrupted period is considered in the just ended billing period.

If the demand exceeds the maximum demand of the just ended billing period, it will be considered as a maximum demand of that billing.

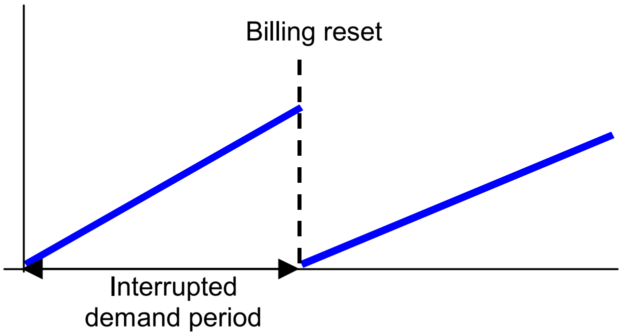

Fig. 36: Billing reset interrupts demand period

After the billing reset, the demand registers of a current billing period are cleared and measurement of maximum demand for a new billing period is started.

11.6.2. 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.

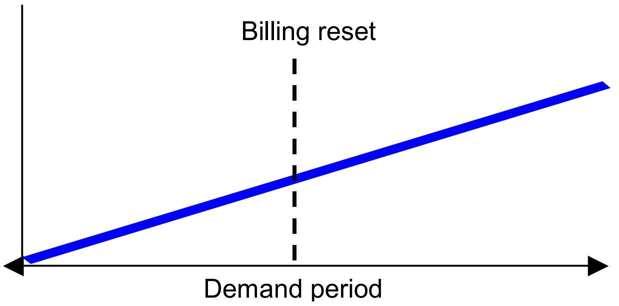

Fig. 37: Billing reset does not interrupt demand period

11.6.3. 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 the billing reset was requested and not when it was actually performed.

11.6.4. Tariff changeover interrupts demand period

Tariff changeover is executed during the current demand period and interrupts it.
The meter changeover the tariff at the moment when it was requested. Consequently the current demand period is interrupted and a demand measurement is started in a new demand period.

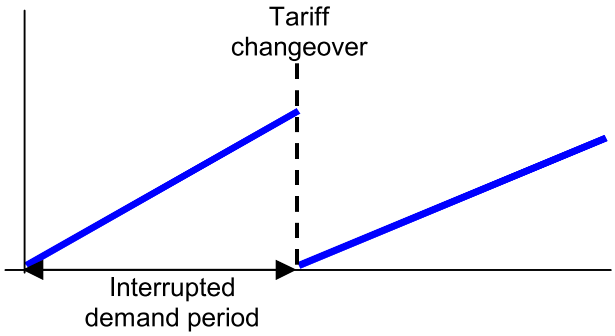

Fig. 38: Tariff change-over interrupts demand period

If demand in the interrupted demand period is the largest one in the billing period, it is considered as the maximum demand and is accompanied with time and date of the tariff changeover.

11.6.5. Delayed tariff changeover

Execution of tariff changeover is delayed up to the end of the current demand period.

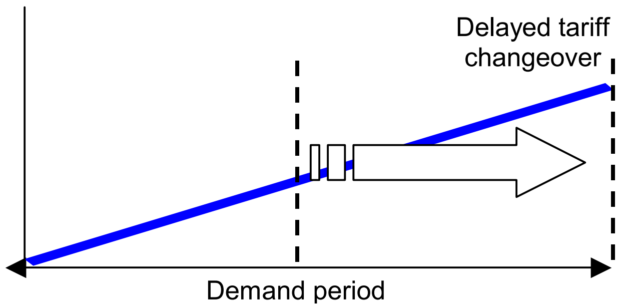

Fig. 39: Delayed tariff changeover

In this mode the meter does not execute a command for tariff changeover immediately.
Instead of that it delays the tariff changeover command up to the end of the current demand period. Consequently the current demand period is not interrupted.

A special case in the synchronous mode with delayed tariff changeover is when either a command for reset (e.g. billing reset, watchdog reset) was received or a power shortage was appeared when the tariff was changing-over.

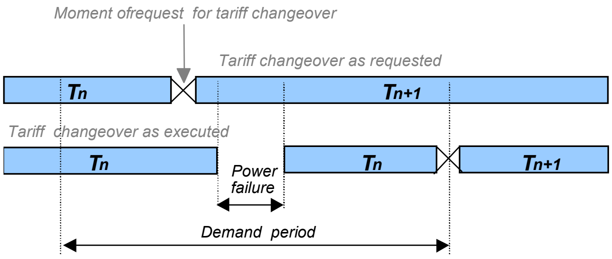

Fig. 40: Tariff changeover delay in case of a power shortage

During a current demand period a command for changing-over tariff from T_n to T_{n+1} was received. Power failure occurred after that. As both data on valid tariff and requested tariff change-over command are stored in a non-volatile memory, the tariff valid before the power shortage (T_n) will be valid till the end of the first demand period after the power supply restoration. At its end the tariff will be changed-over to the requested tariff (T_{n+1}).
This will happen regardless if the tariff changeover is controlled by the internal real-time clock, external time-switch or other tariff controlling device.

11.7. Forgiveness period

Electric utilities can forgive their customers to measure maximum demand for a time span called forgiveness period in a case of power shortage that lasted longer than a certain time.

This means that electric utility allows to its customers to exceed the contractual maximum demand for some time after power shortage without paying penalty.

It can be controlled either by:

- the internal real-time clock,
- externally by MZE input signal.

For RTC control next registers must be set.

Description	Register
Forgiveness period (min.)	C.55.7
Power shortage (min.)	C.55.8

Table 18: RTC control forgiveness period settings

If forgiveness time is controlled by MZE input no values should be set in above registers. As long as MZE input is active forgiveness period is running and demand measurement is disabled.

Null value is stored in demand registers that relates to time during forgiveness period.

12. Multi-rate revenue metering

Meters enable multiple rate registration separately for energy and demand. Also, several tariffs can be valid at the same time.
The considerable amount of tariffs and tariff registers enable flexible and complex tariff systems.

	Max. no.
Tariff registers	255
Tariffs	16

Table 19: Tariffs and tariff registers

Default value for number of tariffs is 8. In register ID_834 is defined how many are actually used (for e.g. in sequences – for all sequences there is same number of tariffs).
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,
- externally by communication interfaces.

Tariff control source	Priority
Internal tariff device	high
Tariff inputs	medium
Communication interface	low

Table 20: Control sources priority

12.1. Tariff device

Powerful memory and an adaptive tariff device enable to perform various tariff programs (Time of use - TOU). A number of tariff registers, tariffs, programs, seasons, 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 21: 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 where one or more tariffs are valid at the same time.
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 22: 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 23: 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 24: 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.),
- every year on the 1st selected day of week (Monday, Tuesday, etc.) after the date (MM.DD.),
- every year on selected date (MM.DD.) but not on Sunday (transferred to Monday),
- a shift forward regarding the Easter day,
- a shift backward regarding the Easter day.

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 8.1.1 Tariff change-over.

12.3. Excess demand (optional)

Special function of the meter is calculation of excess demand (special firmware version). This is done for each tariff according to following formula:

$$X = \sqrt{\sum (P - Pc)^2}$$

if $P > Pc$

where:

X = excess demand

P = actual demand in previous measuring period (=MP)

Pc = contracted demand

At the end of the MP the value of excess demand is updated in case that actual demand was greater than contracted demand.

If contracted demand Pc is defined with value 0 it means that this function for a specific tariff is disabled.

13. Load profile (LP)

There are two independent load profiles. Each load profile is defined with:

- number of channels,
- registration period,
- quantities to register,
- capacity - number of records.

Each load profile registers in registration period energy absolute values or demands, meter statuses, events as well as other quantities. Each record is accompanied with date and time of the end of a registration period to which it relates.

On LCD in load profile mode only the first load profile (i.e. P.01) is displayed.

13.1. Channels

Each load profile has up to 10 channels and 8 status bits. A channel represents one measured quantity.

13.2. Registration period (RP)

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 RPs are: 1, 2, 3, 5, 10, 15, 30 or 60 minutes

Default value for first load profile RP1 is 15 minutes and for a second RP2 is 1 minute.

13.3. Quantities

The LP 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.
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. Data registration

Data can be registered by a load profile:

- every second,
- at the end of the LP period.

Demands of active and reactive energies are registered every second. By entering data every second into the LP recorder an accurate recording is assured also in case of power shortages.
All other quantities are registered at the end of registration period.

13.5. 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.

LP capacity examples:

	Minutes	No. of ch.	Capacity (day)
RP1	15	4	173,5
RP2	1	4	3
RP1	15	6	109
RP2	1	6	3
RP1	15	4	158,5
RP2	1	4	4
RP1	15	6	94,2
RP2	1	6	4

Table 25: LP capacity examples

Capacity (if all records are dedicated to a single load profile) depending on registration period and number of channels illustrates table bellow:

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

Table 26: Maximum LP capacity

13.6. LP format

LP format as it is sent via communication and also represented on LCD can be 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.

14. Event Log-book (LB)

Event Log-book is a special kind of recorder. It holds the information of all important events that occurred to the meter. By default event LB has 800 events (max. 30.000) recorded as a FIFO buffer. Due to security reasons data recorded in the LB can not be deleted without opening 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.

There are two types of event log-book.

1. "Iskraemeco" custom type
   - with expanded set of informations
   - "enumerated" type – up to 4 nibbles of information i.e. from 0000 to FFFF = 65535 different events can be reported.
2. According to VDEW requirements
   - with reduced set of informations – see column "VDEW statuses" in table below
   - "bitstring" type with – up to 8 nibbles of information i.e. up to 32 differents events can be reported.

Value	Explanation	VDEW statuses
0001	Device disturbance	✓
0002	Battery discharged	✓
0008	DST	✓
0010	MD reset	✓
0020	Set RTC	✓
0040	Power-up	✓
0041	Power restored for L1	
0042	Power restored for L2	
0043	Power restored for L3	
0080	Power-down	✓
0081	Power-down phase L1	
0082	Power-down phase L2	
0083	Power-down phase L3	
0100	Variable changed in set mode	✓
0101	Correct phase sequence	
0102	Incorrect phase sequence	
0104	External power supply on	
0105	External power supply off	
0131	Current without voltage for L1	
0132	Current without voltage for L2	
0133	Current without voltage for L3	
0141	Current without voltage for L1 off	
0142	Current without voltage for L2 off	
0143	Current without voltage for L3 off	
0400	CPU error	
0600	Watchdog	
2000	Logbook reset	✓
4000	Load profile reset	✓
D000	Alarm request	
D100	Alarm done	
D200	Alarm input active	
D300	Alarm failed	
E000	Parameter change via comm. port	
EF00	Setting with buttons	
FE00	Previous values reset	
FF00	Master reset	

Table 27: Event Log-Book status values interpretation.

15. 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,
- ESSAILEC connectors.

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.

15.1. Hardware protection

Meter cover at front and back is sealed against meter intrusion and so also against access to parameterisation button inside a meter.

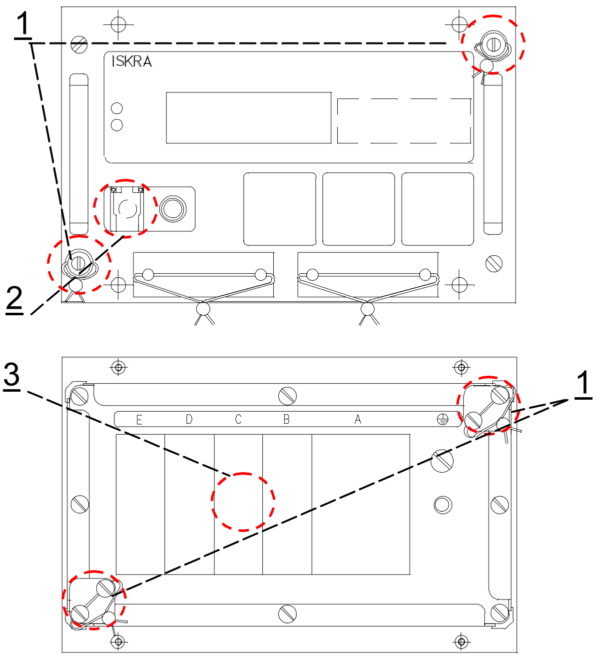

Fig. 41: Places of sealing: 1-meter cover, 2-reset button, 3- ESSAILEC connectors.

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.

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.

Access to the main and auxiliary terminals is not possible without breaking the seals on the ESSAILEC connectors. Therefore fraud via meter terminals is not possible.

15.2. Software protection

15.2.1. 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.

15.2.2. Passwords

There are two passwords in the registers C.58.3 and C.58.4 as well as a password with an encryption algorithm. The registers C.58.3 and C.58.4 are protected with a password both against changing and reading.
In case of a password with an algorithm, one should have a key for encoding/decoding the password, otherwise access to the registers is disabled.

15.2.3. 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.

15.2.4. 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.

15.2.5. 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.

15.2.6. 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.

15.3. 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 Reset 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 the reset button and the 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.

See also chapter 6.1 Handling.

Setting
Device address(-es)
Transformer ratios
Communication settings
Tariff change-over program
Holidays
Date of billing reset
Date and time settings
LCD illumination
Pushbutton settings
Parameterisation
Passwords
Setting sequence
Display sequences
Data-Read-Out sequence
Load profile recorder data and period
Registration period
Forgiveness time
Reset of registers with metering data
Reset of the billing reset counter

Table 28: List of programmable parameters groups

15.3.1. 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.

16. 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,
- generate and register data on origin and status of billing.

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 counter in the register 0.1.1 indicates a number of billing periods for which metering data are available in the meter. This counter increments with each billing reset until it reach a number of previous billing periods provided in the meter and than keeps that value.

16.1. 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.

16.1.1. 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
2	every year on the 1st Monday after the date	MM-DD hh:mm
3	every year on the 1st Tuesday after the date	MM-DD hh:mm
4	every year on the 1st Wednesday after the date	MM-DD hh:mm
5	every year on the 1st Thursday after the date	MM-DD hh:mm
6	every year on the 1st Friday after the date	MM-DD hh:mm
7	every year on the 1st Saturday after the date	MM-DD hh:mm
8	every year on the 1st Sunday after the date	MM-DD hh:mm
9	every year not on Sunday, transfer to Monday	MM-DD hh:mm
10	once a month on a date	DD hh:mm
11	every month on 1st Monday after the day	DD hh:mm
12	every month on 1st Tuesday after the day	DD hh:mm
13	every month on 1st Wednesday after the day	DD hh:mm
14	every month on 1st Thursday after the day	DD hh:mm
15	every month on 1st Friday after the day	DD hh:mm
16	every month on 1st Saturday after the day	DD hh:mm
17	every month on 1st Sunday after the day	DD hh:mm
18	every day	hh:mm
18	every Monday	hh:mm
18	every Tuesday	hh:mm
18	every Wednesday	hh:mm
18	every Thursday	hh:mm
18	every Friday	hh:mm
18	every Saturday	hh:mm
18	every Sunday	hh:mm

Table 29: Billing reset options.

16.1.2. Manual

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

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

16.1.3. Communication interfaces

Billing reset can be performed by IR optical interface, CS or RS232/485 interface.

16.1.4. 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.

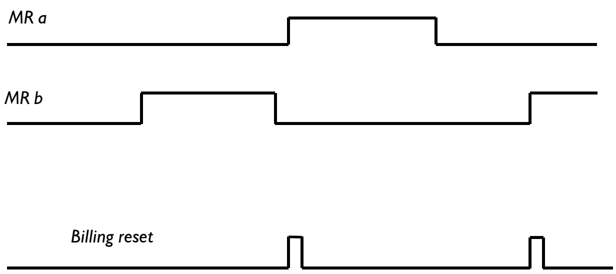

Fig. 42: MRa and MRb signals perform billing reset.

16.2. 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 C.55.1. 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.

16.3. MRAa and MRAb outputs

Meters can be equipped with outputs MRAa and MRAb for billing reset of an external meter.
See also chapter 8.2.4 Billing reset.

16.4. 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), how was performed the billing reset and status of a billing validity.

16.4.1. Index of previous values

The index of previous values can be linear or circular and is programmable in the register C.59.3 as follows:

Index of previous values	C.59.3
Linear	0
Circular	1

Table 30: Billing rates types

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

By circular index each billing period gets its characteristic number and keeps it during the storage procedure. Each new billing period gets an index, which is incremented by 1 regarding the previous billing period.

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.

1.8.0(000005.16*kWh)	current billing period
1.8.0*12(000004.71*kWh)	last billing period
1.8.0*11(000003.93*kWh)	
1.8.0*10(000003.18*kWh)	
1.8.0&09(000003.04*kWh)	
1.8.0*08(000002.38*kWh)	
1.8.0*07(000002.14*kWh)	
1.8.0&06(000001.63*kWh)	
1.8.0*05(000001.59*kWh)	
1.8.0*04(000000.80*kWh)	
1.8.0*03(000000.65*kWh)	
1.8.0&02(000000.55*kWh)	
1.8.0*01(000000.00*kWh)	
1.8.0*00(000000.00*kWh)	
1.8.0*99(000000.00*kWh)	
1.8.0*98(000000.00*kWh)	

Example 4: Circular billing reset

Note:
* - means billing reset performed automatically by the internal tariff device or by communication interfaces or via inputs,

& - means billing reset performed manually by the reset button.

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

17. Used standards

IEC 62053-22 *(2003-01)*
Electricity metering equipment (a.c.) - Particular Requirements - Part 22: Static meters for active energy (classes 0,2 S and 0,5 S)

IEC 62053-23 *(2003-01)*
Electricity metering equipment (a.c.) - Particular requirements - Part 23: Static meters for reactive energy (classes 2 and 3)

ISO 9001:2000*, Quality management systems - Requirements.*

DIN 43862*, Ausgabe:1996-12*
Elektrizitätszähler - Einschubzähler mit statischem Meßwerk - Hauptmaße.

IEC 61038 *(1998-11) Ed. 1.2 Consolidated Edition*
Electricity metering - Tariff and load control - Particular requirements for time switches

DIN 43863-3*, Ausgabe:1997-02*
Elektrizitätszähler - Teil 3: Tarifgeräte als Zusatzeinrichtung zum Elektrizitätszähler; EDIS - Energie-Daten-Identifikations-System

IEC 61107[1] *Ed.2.0 (1996)*
Electricity metering - Data exchange for meter reading, tariff and load control -Part 21: Direct local data exchange

IEC 62056-21 *(2002-05)*
Electricity metering - Data exchange for meter reading, tariff and load control - Part 21: Direct local data exchange

IEC 60870-5-102 *(1996-06)*
Telecontrol equipment and systems - Part 5: Transmission protocols - Section 102: Companion standard for the transmission of integrated totals in electric power systems

DIN 66348-1*, Ausgabe:1986-09*
Schnittstellen und Steuerungsverfahren für die serielle Meßdatenübermittlung; Start-Stop-Übertragung, Punkt-zu-Punkt-Verbindung

ISO 1177:1985
Information processing - Character structure for start/stop and synchronous character oriented transmission

[1] This first edition IEC 62056-21 cancels and replaces the second edition of IEC 61107 published in 1996 and constitutes a technical revision.

18. Technical data

Accuracy class	
Active energy	0.2S or 0.5S (IEC 62053-22)
Reactive energy	class 2, 3 (IEC 62053-23), calibrated up to 0.2%, 0.5%, 1%.
Measuring voltage (V)	3 x 57.7/100 3 x 100 3 x 63/110 3 x 110 3 x 115/200 3 x 200 3 x 127/220 3 x 220 3 x 220/380 3 x 380 3 x 230/400 3 x 400
Voltage range	0.8 - 1.15 U_n
Rated frequency	45 - 55 Hz
Measuring current (A)	1(1) 1(2) 5(6) 5(10) 5//1
Nominal	1 1 5 5 1
Maximal	1.2 2 6 10 6
Thermal	2 3 8 15 8
Short-circuit current	30 I_n
Outputs	
Type	PHOTO-MOS potential-free relay
Contact	make or change-over contact
Permitted load	25 VA (100 mA, 250 V AC)
Isolation dielectric strength	make contact: 5000 V_{rms}, change-over contact: 3750 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 (at a shorter impulse a larger impulse frequency is possible), change-over max. frequency: 40 Hz
Transfer distance	1 km
Inputs	57.7 – 230 V AC
Voltage threshold	ON: U ≥ 50 V OFF: U 20 V
Current consumption	< 2 mA @ 57.7V < 10 mA @ 230V
Communication	
IR	max. 9600 Baud
CS	max. 9600 Baud, passive, CL0 in compliance with DIN 66348, Part 1.
RS232	max. 19200 Baud
RS485	max. 9600 Baud
Protocols	IEC 61107 mode C with encrypted or non-encrypted password. IEC 60870-102-5
Optical reading LED	
Impulse frequency	□40 Hz
Impulse length	approx. 8 ms
Real time clock	
Accuracy	crystal: 6 ppm = ≤ ±3 min./year (at T_{op}= +25°C)
Power back-up	super-Cap: 1F for minimal 250 h of back-up.
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	2 kV_{rms}, 50 Hz, 1 min
Impulse voltage	6 kV, 1.2/50

Temperature range Operation Operation (limit) Storage	In compliance with IEC62053-22 -25°C ... +55°C -25°C ... +60°C (IEC 61036 outdoor) -25°C ... +70°C
Relative humidity	In compliance with IEC 62053-22 Tab. 5
Housing	Half 19" for rack mounting according to DIN 43862.
Mass	approx. 3.1 kg

Table 31: Technical data

Tables below show meter consumption with nominal voltage and current U_n = 3x57.7/100V and I_n = 5A. (Note: Actual values can vary from the ones stated in tables for ±10% due to component tolerances.)

Phase	Current (mA)	Consumption	Incl. illumination
R	26,44	1,078 W	
S	26,04	1,086 W	
T	26,50	1,090 W	
	Total active	3,269 W	3,47 W
	Total apparent	4,56 VA	4,79 VA

Table 32: Internal power supply consumption

	Consumption		Incl. illumination	
U_x (V)	Active(W)	Apparent (VA)	Active(W)	Apparent (VA)
50	3,37	4,77	3,60	5,12
70	3,18	5,00	3,40	5,35
100	3,13	5,65	-	-
230	3,48	8,26	3,68	8,37

Table 33: External power supply consumption at different voltages Ux

19. Type designation

T E 8 5 5 S - A n m R n m - E I V n 2 L n 1 L n 2 - M 2 K 0 n m

TE855	3-element meter
DE855	2-element meter
S	Surface-mounted version
A	**Active energy**
n = 2	class 0.2S (IEC 62053-22)
n = 3	class 0.5S (IEC 62053-22)
m = 1	one energy-flow direction
m = 2	two energy-flow directions
R	**Reactive energy**
n = 2	0.2 %
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 direction (Q+ = Q1 + Q2)
m = 6	4-quadrant, imp./exp. (Q+, Q-, Q1, Q2, Q3, Q4)
E	**External supply**
I	**Internal supply**
V	**Control inputs**
n = 1...3	number of inputs
2	inputs - resistor type
L	**Outputs**
n = 1...8	number of outputs
1	PHOTO-MOS make contact
L	**Outputs**
n = 1...4	number of outputs
2	PHOTO-MOS change-over contact[1]
M	**Additional device**
2	2 – RTC + Super-Cap
3	3 – RTC + Li-battery (not in rack version)
K	**Communication interface**
0	1st interface, IR optical port
n = 2	2nd interface, RS-232
n = 3	2nd interface, RS-485
m = 1	3rd interface, CS-20 mA
m = 3	3rd interface, RS-485[2]

TE855-A22R36-EIV22L21L42-M2K023
Rack mounted meter, active class 0,2S, reactive calibrated to 0,5% 4-quadrant, external + internal supply, two inputs resistor type, two outputs make contact, four outputs change-over contact, RTC + Super-Cap, IR optical interface, RS-232, RS-485

TE855-A22R36-IV32L81-M2K021
Rack mounted meter, active class 0,2S, reactive calibrated to 0,5% 4-quadrant, internal supply, three inputs resistor type, eight outputs make contact, RTC + Super-Cap, IR optical interface, RS-232, CS-20 mA

Example 5: Meter type designation

[1] It is possible to have up to 8 outputs of any of both types. But the maximum number of change-over contacts is limited to 4.
[2] Only one RS485 can be built in the meter

20. Registers, statuses and events

EDIS	Description
F.0.0	Error Status
F.F.	Function Error
C.1.0	Factory ID
C.3	Status I/O
C.4	Status tariff
C.5	Status mode
C.6.0	Time of the RTC backed-up by Li-battery
C.7.0	Total phase failure counter
C.7.1	R Phase Failure Counter
C.7.2	S Phase Failure Counter
C.7.3	T Phase Failure Counter
C.50.0	WDOG Counter
C.50.1	Meter parameterisation counter
C.53	Status info ISK
C.55.0	Elapsed time of current demand period
C.55.1	Time of disabled billing reset
C.55.2	Date of the last meter parameterisation
C.55.3	Active season - energy
C.55.4	Active season - demand
C.55.5	Part of a day - energy
C.55.6	Part of a day - demand
C.55.7	Forgiveness period
C.55.8	Shortage time for forgiveness activation
C.55.9	Tuning factor for quartz crystal frequency
C.55.10	Duration of the LCD illumination
C.55.11	Time tolerance for MPE
C.57.1	COM 0 Baud-rate (IR)
C.57.2	COM 1 Baud-rate (RS-232 or RS-485)
C.57.3	COM 2 Baud-rate (RS485 or CS)
C.58.1	Meter Type
C.58.2	Communication string
C.58.3	Password 1 (P1)
C.58.4	Password 2 (P1)
C.59.0	External RTC synchronisation
C.59.1	Test mode / standard resolution
C.59.2	Demand period mode
C.59.3	Index of historical registers
C.59.4	Influence of billing reset and tariff change-over to demand period
C.91.0	RST R_p=R1+R4

EDIS	Description
C.92.0	RST R_n=R2+R3
0.0.0	Device Address 0
0.0.1	Device address 1
0.0.2	Owners number
0.0.3	Product ID
0.0.4	Year of production
0.1.0	Reset counter
0.1.1	Number of previous billing periods
0.1.2	Time stamp of billing resets
0.2.0	Software version number
0.2.1.01	Software version
0.2.1.02	Parameterisation check sum
0.2.1.03	Time switch program check sum
0.2.1.50	Program time stamp
0.2.1.51	Loader check sum
0.2.1.52	Data format check sum
0.2.1.53	Program check sum
0.2.1.54	Common check sum
0.4.2	Current transformer ratio
0.4.3	Voltage transformer ratio & compensation
0.8.0	Demand Period
0.8.2	Subinterval of the demand period
0.8.4	Registration period 1
0.8.5	Registration period 2
0.9.1	Current time
0.9.2	Current date
0.9.3	Weekday
0.9.4	Current date and time
0.9.5	Day-light saving period/standard time
1.4.0	RST +P current average total
2.4.0	RST -P current average total
1.5.0	RST +P last average total
2.5.0	RST -P last average total
1.6.0	RST +P MD total
2.6.0	RST -P MD total
1.4.x	RST +P current average tariff x

EDIS	Description
2.4.x	RST -P current average tariff x
3.4.x	RST +Q current average tariff x
4.4.x	RST -Q current average tariff x
5.4.x	RST Q1 current average tariff x
6.4.x	RST Q2 current average tariff x
7.4.x	RST Q3 current average tariff x
8.4.x	RST Q4 current average tariff x
1.5.x	RST +P last average tariff x
2.5.x	RST -P last average tariff x
3.5.x	RST +Q last average tariff x
4.5.x	RST -Q last average tariff x
5.5.x	RST Q1 last average tariff x
6.5.x	RST Q2 last average tariff x
7.5.x	RST Q3 last average tariff x
8.5.x	RST Q4 last average tariff x
1.6.x	RST +P MD tariff x
2.6.x	RST -P MD tariff x
3.6.x	RST +Q MD tariff x
4.6.x	RST -Q MD tariff x
5.6.x	RST Q1 MD tariff x
6.6.x	RST Q2 MD tariff x
7.6.x	RST Q3 MD tariff x
8.6.x	RST Q4 MD tariff x
1.8.0	RST +A energy total
2.8.0	RST -A energy total
3.8.0	RST +R energy total
4.8.0	RST -R energy total
5.8.0	RST R1 energy total
6.8.0	RST R2 energy total
7.8.0	RST R3 energy total
8.8.0	RST R4 energy total
1.8.x	RST +A energy tariff x
2.8.x	RST -A energy tariff x
3.8.x	RST +R energy tariff x
4.8.x	RST -R energy tariff x
5.8.x	RST R1 energy tariff x
6.8.x	RST R2 energy tariff x
7.8.x	RST R3 energy tariff x
8.8.x	RST R4 energy tariff x
90.4.0	RST active demand
90.4.1	RST reactive demand

EDIS	Description
P.01	LP recorder 1
P.02	LP recorder 2
ID_284	Format register
P.98	Logbook
ID_833	Event Logbook Mask (optional)
ID_133	RTC status
ID_134	RTC historical status
ID_184	Voltage presence status
ID_260	Status of demand measurement mode
ID_438	DST table
ID_677	RTC synchr. lower limit
ID_785	RTC synchr. upper limit
ID_786	Comm. transmission compensation
ID_235	Output pulse divider
ID_236	Output pulse duration
ID_641	Polarity – tariff outputs
ID_642	Polarity – MZA output
ID_643	Polarity – MPA output
ID_644	Polarity – pulse outputs
ID_828	Duration of MP output activity
ID_835	Pulse outputs form
ID_829	Number of PVs in auto-scroll
ID_830	Number of PVs in manual-scroll
ID_831	Number of PVs in readout
ID_834	Actual number of tariffs

Table 34: Meter registers

Status
Tariff input TEx for energy (x=1..3)
Tariff input MEx for demand (x=1..3)
Tariff output TAx for energy (x=1..3)
Tariff output MAx for demand (x=1..3)
MPE active
MZE active
MRE-a active
MRE-b active
MP1 impulse of power measuring interval
+P energy flow-direction
-P energy flow-direction
MZA
MRAa
MRAb
Tariff for energy Tx active (x=tariff no.)
Tariff for demand Mx active (x=tariff no.)
Active energy flow
Reactive energy flow
Phase Lx ON (x=1..3)
Phase Lx OFF (x=1..3)
Presence of all phase voltages
Absence of one or two phase voltages
Reversed phase sequence connection
Phase sequence connection OK
1st quadrant
2nd quadrant
3rd quadrant
4th quadrant
1st or 2nd quadrant
2nd or 3rd quadrant
3rd or 4th quadrant
1st or 4th quadrant
1st or 3rd quadrant
2nd or 4th quadrant
Flow-direction for P or S (total) □ 2nd or 3rd quad.
Flow-direction for Q (total) □ 3rd or 4th quadrant
Parameters setting with the pushbuttons
Meter setting mode
Lock for meter setting
Meter parameterisation communication
Lock for meter parameterisation
Unlocked the password 1 software lock
Unlocked the password 2 software lock
Disabled billing reset with a pushbutton
Disabled billing via communication
Billing reset is not disabled
Error on meter vital data
Meter vital data OK
Error on meter configuration data
Meter configuration data OK
Error on Format Constant Units (FCU)
FCU OK
Error on sequences
Sequences OK
Error in tariff change-over program
Tariff change-over program OK
Error in calendar for time of billing resets
Calendar for time of billing resets OK
Battery (SuperCap) back-up discharged
Current time of RTC OK
LP recorder in operation
LP recorder not in operation
A day is a holiday
Fixed demand period, asynchronous mode
Rolling demand period, asynchronous mode
Fixed demand period, asynchronous with MPE
Rolling demand period, asynchronous with MPE
Fixed demand period, synchronous mode
Rolling demand period, synchronous mode
Meter programming disabled due to wrong passwords
Communication status
Successful
Programming mode
Manufacturer specific mode
Tariff change-over for energy controlled
by tariff device
by inputs TEx
Tariff change-over for demand controlled
by tariff device
by inputs MEx (x=1..3)
Disabled demand measurement
Enabled demand measurement
Daylight-Saving-Time
Standard time

Table 35: Meter statuses

Events
Logbook initialisation
Master reset
WDOG reset
Power-down
Power-up
Time before time change
Time after time change
Time synchronisation
Initialisation of load profile 1
Initialisation of load profile 2
Reset previous values
Data readout
Processor error
Variable changed in set mode
Parameterisation by communication
MD reset contract 1
MD reset contract 2
MD reset contract 3
Communication for contract 1
Communication for contract 2
Communication for contract 3
Parameterisation for contract 1
Parameterisation for contract 2
Parameterisation for contract 3
Session on IR-interface
Session on COM1-interface
Alarm request
Sending of alarm failed

Events
Sending of alarm successful
Power-up on phase L1
Power-up on phase L2
Power-up on phase L3
Power-down on phase L1
Power-down on phase L2
Power-down on phase L3
External power supply on
External power supply off
Current without voltage – phase L1
Current without voltage – phase L2
Current without voltage – phase L3
Current without voltage off – phase L1
Current without voltage off – phase L2
Current without voltage off – phase L3
Correct phase sequence
Incorrect phase sequence
Write of private key
Write of parameters ASDU 143
Write ASDU 146 contract 1
Write ASDU 146 contract 2
Write ASDU 146 contract 3
Write ASDU 149 contract 1
Write ASDU 149 contract 2
Write ASDU 149 contract 3
Daylight saving time - season change

Table 36: Meter events

21. Quick order form

Customer:____________________________
Quantity:_____________________________

Nominal values

Secondary Voltage [V]:_________________
Primary Voltage [V]:___________________

Rated current [A]:_____________________
Maximum current [A]:__________________

Frequency [Hz]:_______________________
Accuracy class active/reactive:____________

Inputs (check maximum 3)

☐ Energy tariff 1 (TE1) ☐ Demand tariff 1 (ME1)
☐ Energy tariff 2 (TE2) ☐ Demand tariff 2 (ME2)
☐ Energy tariff 3 (TE3) ☐ Demand tariff 3 (ME3)

☐ Alarm (MKE)
☐ Synchronization (MPE)
☐ Maximum demand disable (MZE)
☐ Billing reset signal a (MREa)
☐ Billing reset signal b (MREb)

Outputs (check maximum 8)

Pulse output as:
☐ make contact ☐ change-over contact
(Up to 4 change-over outputs possible!)

☐ Active energy +A ☐ Reactive energy R1
☐ Active energy -A ☐ Reactive energy R2
☐ Reactive energy +R ☐ Reactive energy R3
☐ Reactive energy -R ☐ Reactive energy R4

Make contact outputs:

☐ Direction of active energy (ERA+A)
☐ Direction of reactive energy (ERA+R)

☐ Energy tariff 1 (TA1) ☐ Demand tariff 1 (MA1)
☐ Energy tariff 2 (TA2) ☐ Demand tariff 2 (MA2)
☐ Energy tariff 3 (TA3) ☐ Demand tariff 3 (MA3)

☐ Alarm (MKA)
☐ Measuring period (MPA)
☐ Maximum demand disable (MZA)
☐ Billing reset signal a (MRAa)
☐ Billing reset signal b (MRAb)
☐ Modem reset (RES)

Power supply

☐ Internal ☐ External

Communication (check maximum 2)

☐ CS ○ IEC 61107 ○ IEC 60870
☐ RS232 ○ IEC 61107 ○ IEC 60870
☐ RS485 ○ IEC 61107 ○ IEC 60870

Output pulses values

○ Primary ○ Secondary
Constant output [imp/kW(var)h] :_______________

Tariff quantities

Number of tariffs (max. 8):__________

Energy	Demand
☐ +A	☐ +P
☐ -A	☐ -P
☐ +R	☐ +Q
☐ -R	☐ -Q
☐ R1	☐ Q1
☐ R2	☐ Q2
☐ R3	☐ Q3
☐ R4	☐ Q4

Load profile

As: ○ Energy ○ Demand ○ Pulses

If energy, energy values as:
○ total ○ delta

Load profile 1

☐ +A (or +P) Period (1-60 min):______
☐ -A (or -P) Channels: (max. 10) :______
☐ +R (or +Q)
☐ -R (or -Q)
☐ R1 (or Q1)
☐ R2 (or Q2)
☐ R3 (or Q3)
☐ R4 (or Q4)

Load profile 2

☐ +A (or +P) Period (1-60 min):______
☐ -A (or -P) Channels: (max. 10) :______
☐ +R (or +Q)
☐ -R (or -Q)
☐ R1 (or Q1)
☐ R2 (or Q2)
☐ R3 (or Q3)
☐ R4 (or Q4)

Additional requests

____
____
____

Instructions

Where __ write in value.
Where ☐ **multiple** choice is possible.
Where ○ **single** choice is possible.

22. Appendix A: Time related specifications

This paragraph will clarify some details about the use of time information and some related matters.

All the time labels used in the communications between the concentrators and the recorders, in both directions, will contain the official time. Today, this implies a 1-hour advance during some months of the year (summer time). The SU bit set to 1 (summer time) will be used in the time labels corresponding to instants and periods in the summer time.

Concerning the number of records in the load curve, all the days have the official number of hours. This means in the winter to summer DST day, only 23 registers will be transmitted, while in the summer to winter DST day, 25 registers will be transmitted. As a consequence, if the integration period is 1 hour, the request of a complete day load curve will return 24 registers with the exception of the DST days with 23 or 25 registers:

- In the summer to winter DST day, the energy in the periods affected by the change of hour and belonging to the summer time (now, from 2:00 to 3:00) will be marked with the SU bit (summer time) set to 1. The same hour in the wintertime will be marked with the SU bit (summer time) reset to 0. The load curve of this day (25 registers) will repeat the hour of change, distinguishing both through the SU bit.

  For the DST days of 1999, 28/03/1999 02:00:00-winter and 31/10/1999 03:00:00-summer, the time stamps used in the load curve are following:

  28/03/1999 01:00:00-winter
  28/03/1999 03:00:00-summer
  28/03/1999 04:00:00-summer
  28/03/1999 05:00:00-summer

  and

  31/10/1999 01:00:00-summer
  31/10/1999 02:00:00-summer
  31/10/1999 02:00:00-winter
  31/10/1999 03:00:00-winter
  31/10/1999 04:00:00-winter
  31/10/1999 05:00:00-winter

- Moving forward or setting back the time, according to the official date for summer/winter time change, will only be made on the date and time of the official time change kept in the memory of the data logger. When the dates of the official time change are updated in the data logger (as a consequence of a DST update command by the concentrator), the data logger must check to see if its actual date and time coincides with the time which is determined by the newly received date and time. If they do not coincide, the data logger will set or clear the bit SU, depending on the new period it finds itself in, for all time stamps used in communications and in the integrated total records and events), but the data logger will not execute a time change (move forward or set back the clock in one hour).

With the aim of accepting the DST change automatically, the meter has to be programmed with the days and time of the mentioned change, as well as recovering this information (see messages type 131, 185 and 186).

In each session of the SAPR with a metering point of a data logger, the first will send to the second a synchronization message, with resolution up to seconds. If the difference between the time in the meter and the new one is higher than a threshold (T1 seconds), the meter will change the time immediately, an event will be generated, and all the integrated totals acquired by the meter corresponding to the period affected by the time change, will be marked with the CA bit set to 1.

- As a consequence of the synchronization, 2 time change events will be generated in the data logger. The first with SPA=7 and SPQ=9 (record address 53) with the time in the data logger previous to the synchronization. The second will have SPA=7 and SPQ=11 (record address 53) with the new data logger time resulting from the synchronization.

- If the time change changes the data logger clock to a future hour, and this provokes a hole in the integrated total log, the data logger will fill in the hole with zeros and set the IV and CA quality bits to one for each one of the operational and periodically reset integrated totals. The values for the operational and periodically reset integrated totals of the first closed period after the synchronization will have the bit CA set.

- If the time change changes the data logger clock to a past hour, the operational and periodically reset integrated totals of the first closed period after the synchronization will be kept in its corresponding period with the bit CA set.

- If the time difference in less than or equal to threshold T1, the data logger will change its time immediately although it will not produce a synchronization event. All the integrated totals (operational and periodically reset) acquired by the data logger corresponding to the affected hour will have the bit VH set.

In the case that the meters associated to the metering points of a data loggers allow it, the data loggers can synchronize them with its own time (the time of the data loggers). In case a meter does not allow it, or when the synchronization is not wanted because any reason, the recorders will check the meters not to drift too much with regard to the time in the data loggers. With this objective, if a meter is not synchronized with regards to its data loggers with a difference larger that a certain threshold (T2 seconds), an event of synchronization information will be created. The integrated totals obtained through the measurements of this meter will have a special mark (IV, lack of synchronization event, during the periods when the lack of synchronization remains.

23. Appendix B: DIN EN 60870-5-102 specialties

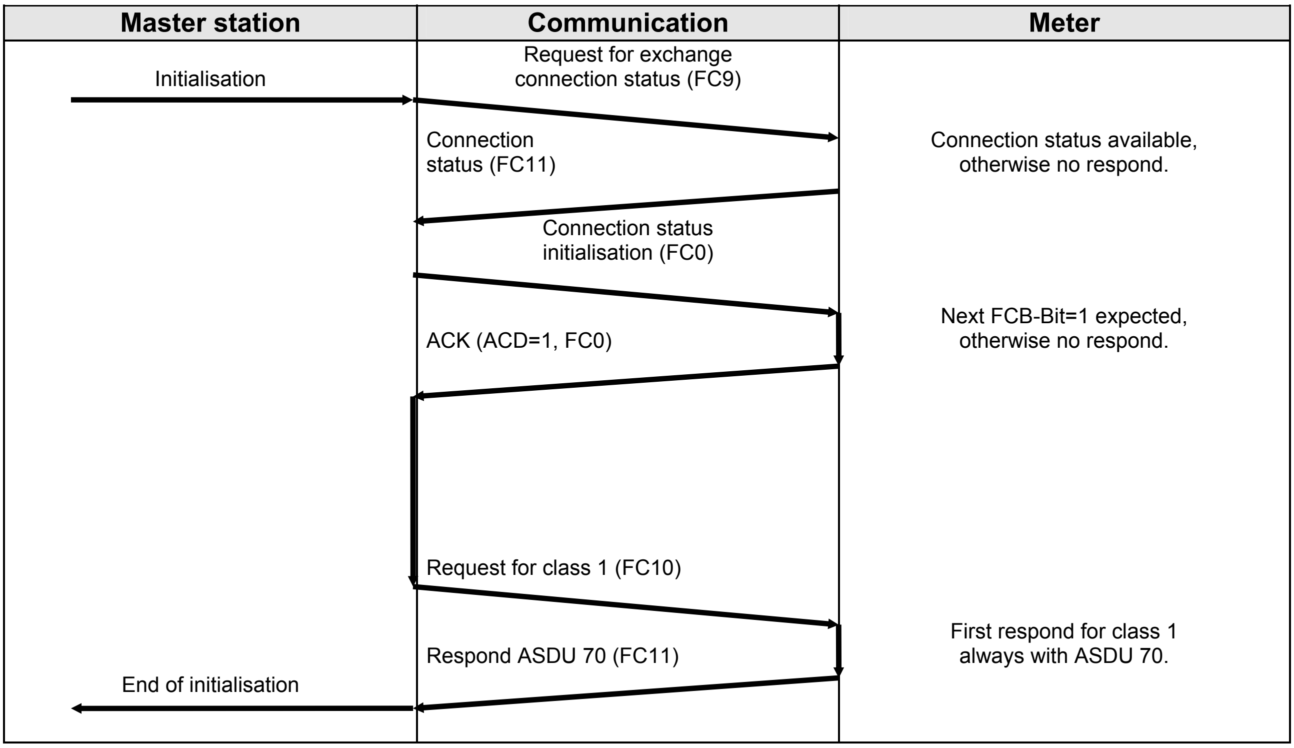

Fig. 43: Initialisation

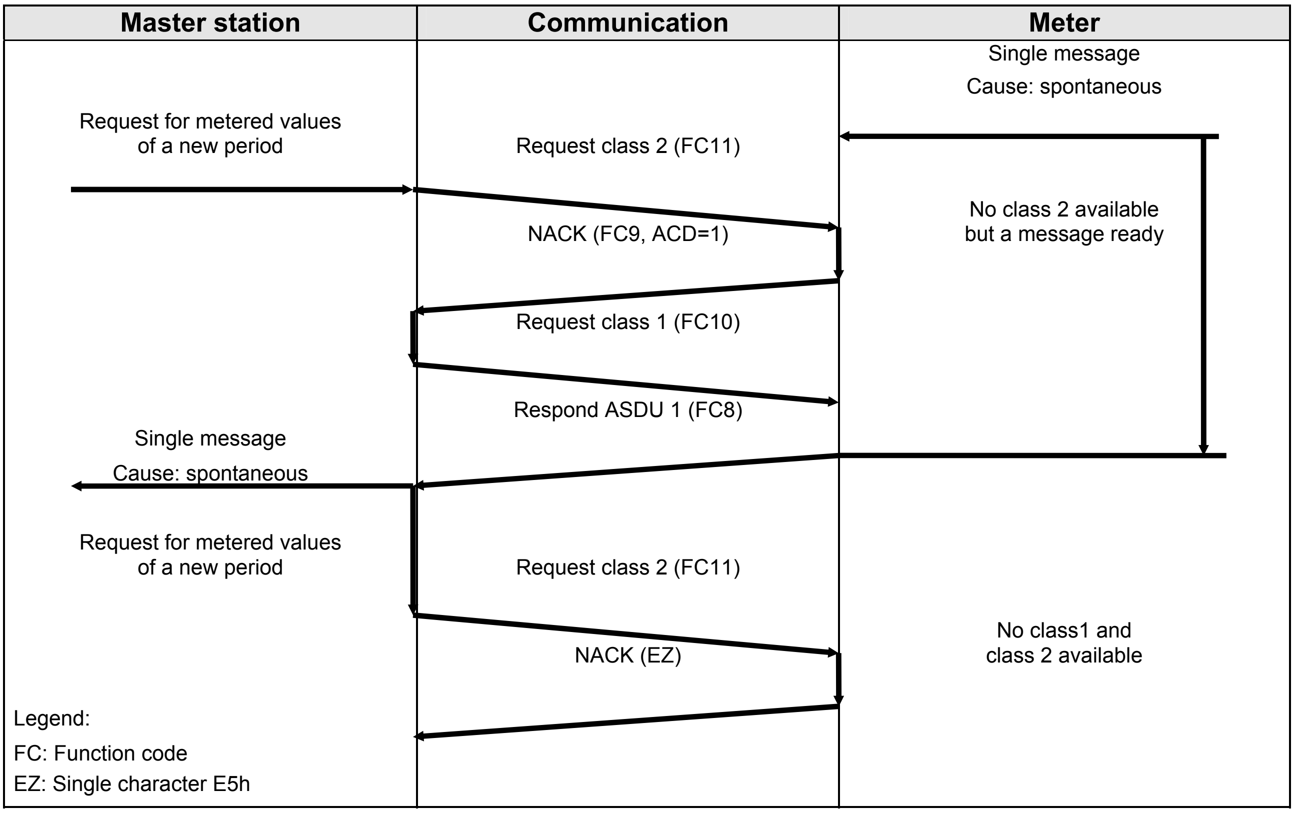

Fig. 44: Spontaneous messages

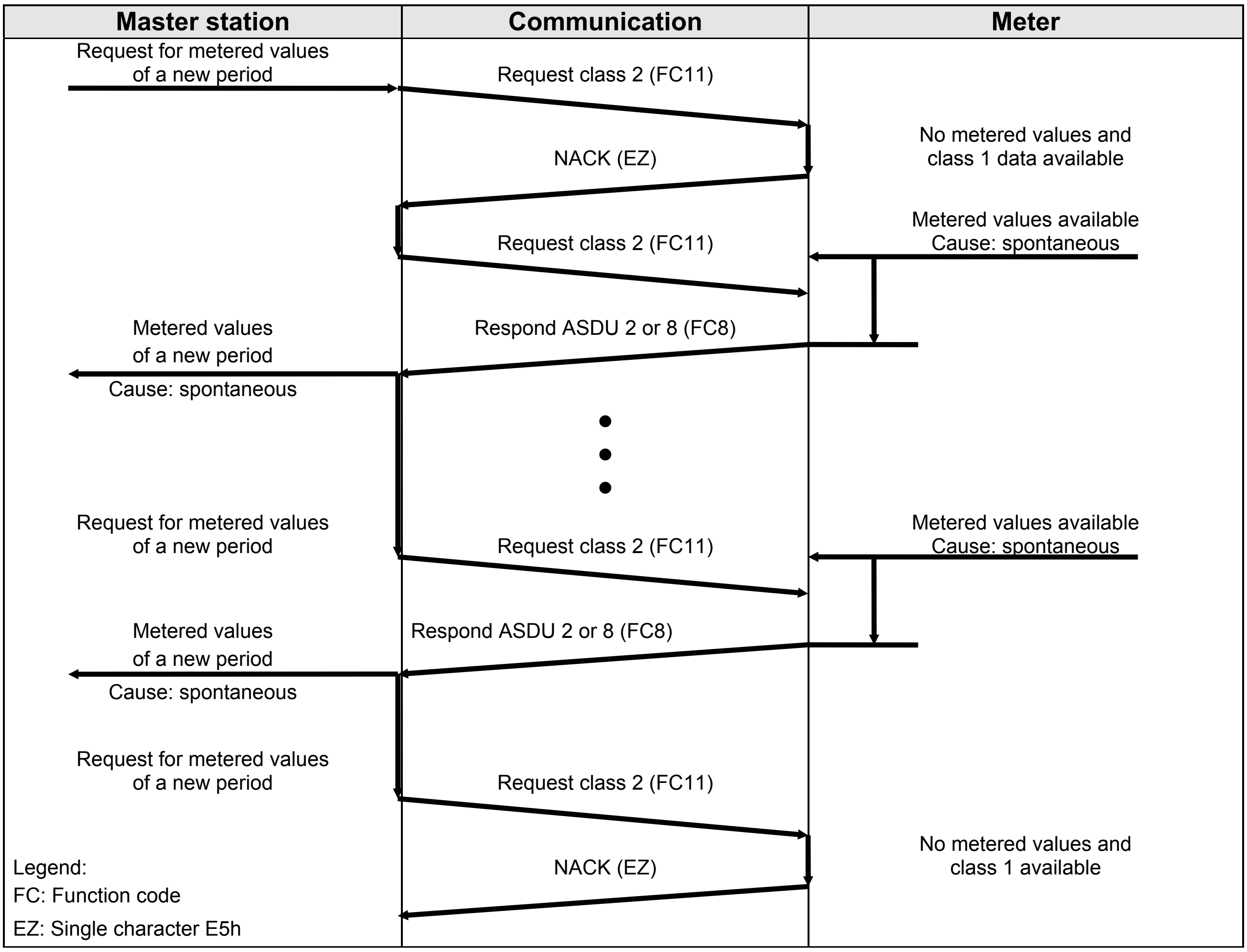

Fig. 45: Cyclic polling for metered values

To establish a session of information interchange with the metering point, a specific ASDU will be used. The session can be terminated sending another specific ASDU or when the data link layer detects the absence of received valid frames during a time interval of the order of various seconds.

List of supported ASDUs (default version of firmware):

ASDU	Description
1	Event information with time tag
2	Accounting integrated totals
5	Periodically reset accounting integrated totals
70	End of initialisation
71	Manufacturer and equipment identifier
72	Current date and time
100	Read manufacturer/equipment identifier
102	Read event information record of a range of time
103	Read current date and time
120	Read accounting integrated totals of a time range and a range of address
121	Read periodically reset accounting integrated totals of a time range and a range of address

Table 37: Supported ASDU types (default version of firmware)

24. Appendix C: IEC 60870 special

ASDU	Description	Access in MeterView
1	Event information with time tag	read log book
11	Periodically reset integrated totals	read load profile
71	Manufacturer and equipment identifier	read/write parameters, monitoring, commands, resets
72	Current date and time	monitoring
100	Read manufacturer/equipment identifier	read/write parameters, monitoring, commands, resets
102	Read event information record of a range of time	read log book
103	Read current date and time	monitoring
123	Read periodically reset integrated totals of a time range and a range of address	read load profile
129	metering point parameters	read parameters
130	digital signature	read load profile
131	DST times	read parameters
132	Load private key	write parameters
133	Read current values of tariff information	monitoring
134	Read previous values of tariff information	monitoring
135	Current values of tariff information	monitoring
136	Previous values of tariff information	monitoring
137	Close billing period	commands
141	Read configuration	read parameters
142	Configuration	read parameters
143	Modify configuration	write parameters
144	Read contracted maximum	read parameters
145	Contracted maximums	read parameters
146	Modify contracted maximums	write parameters
147	Read holidays	read parameters
148	Holidays	read parameters
149	Modify parameters	write parameters
150	Contracts configuration	read parameters
151	Modify contracts configuration	write parameters
152	Read tariff seasons	read parameters
153	Tariff seasons	read parameters
154	Modify tariff seasons	write parameters
155	Read daily discrimination table	read parameters
156	Daily discrimination table	read parameters
157	Modify daily discrimination table	write parameters
158	Read passwords	read parameters
159	Passwords	read parameters
160	Modify passwords and addresses	write parameters
169	Read contracts configuration	read parameters
181	Change date and time	set time
183	Start session	any access
184	Read digital signature	read load profile
185	Read DST times	read parameters
186	Modify DST times	write parameters
187	End session	any access
200	Manufacturer specific[1]	

Table 38: Supported ASDU types (Spanish version of firmware)

Identifiers with numbers greater than 127 (grey background) are new proposals and belong to the private class foreseen.

[1] ASDU 200 covers several functions of the meter, which are not covered in other ASDUs.

Logbook is read with command ASDU 1 in accordance with a standard IEC 60870-5-102.
Reading device requests "Record address", meter responds with status SPA and SPQ as shown in a table below. With each event meter also sends a timestamp (7 bytes).

Event description	Rec., SPQ, SPA
Master reset	52, 1, 1
Power-down	52, 0, 3
Power-up	52, 2, 1
Time before time change	53, 9, 7
Time after time change	53, 11, 7
Time synchronisation	53, 2, 7
Intrusiveness detected	128, 1, 18
Parameterisation by comm.	54, 0, 15
MD reset contract 1	131, 21, 7
MD reset contract 2	132, 22, 7
MD reset contract 3	133, 23, 7
Communication for contract 1	131, 21, 18
Communication for contract 2	132, 22, 18
Communication for contract 3	133, 23, 18
Parameterisation for contract 1	131, 21, 15
Parameterisation for contract 2	132, 22, 15
Parameterisation for contract 3	133, 23, 15
Session on IR-interface	129, 3, 18
Session on COM1-interface	129, 2, 18
Power-down on phase L1	52, 1, 3
Power-down on phase L2	52, 2, 3
Power-down on phase L3	52, 3, 3
Write of private key	130, 0, 16
Write of parameters ASDU 143	54, 1, 15
Write ASDU 146 contract 1	131, 24, 15
Write ASDU 146 contract 2	132, 25, 15
Write ASDU 146 contract 3	133, 26, 15
Write ASDU 149 contract 1	131, 27, 15
Write ASDU 149 contract 2	132, 28, 15
Write ASDU 149 contract 3	133, 29, 15

Table 39: Events defined in logbook

25. Appendix D: Event Logbook mask

There is an optional feature for enabling or disabling events that appears in event Logbook. This feature is configurable (i.e. requires special version of meter firmware) and applicable only to Iskraemeco custom type of Logbook (see also Chapter 14).
Register ID_833 defines how specific event listed in Logbook will be treated. List of available events is part of a Technical configuration checklist. It is specific for different versions of the meter. Number of characters in register ID_833 defines number of available events.
Each event can be:

- recorded in logbook – character L in ID_833
- sent as a spontaneous message – character M in ID_833
- recorded in logbook and sent as a spontaneous message – character B in ID_833
- not recorded, neither sent – character 0 in ID_833.

An example: ID_833 = (BLLLLL000L000L0L00MMM000LLLL0000LLLL)

LB event description	Logbook Event	Message	ID_833
Device disturbance	✓	✓	B
Battery discharged	✓		L
DST	✓		L
MD reset	✓		L
Set RTC	✓		L
Power-up	✓		L
Power restored for L1			0
Power restored for L2			0
Power restored for L3			0
Power-down	✓		L
Power-down phase L1			0
Power-down phase L2			0
Power-down phase L3			0
Variable changed in set mode	✓		L
Correct phase sequence			0
Incorrect phase sequence	✓		L
External power supply on			0
External power supply off			0
Current without voltage for L1		✓	M
Current without voltage for L2		✓	M
Current without voltage for L3		✓	M
Current without voltage for L1 off			0
Current without voltage for L2 off			0
Current without voltage for L3 off			0
CPU error	✓		L
Watchdog	✓		L
Logbook reset	✓		L
Load profile reset	✓		L
Alarm request			0
Alarm done			0
Alarm input active			0
Alarm failed			0
Parameter change via comm. port	✓		L
Setting with buttons	✓		L
Previous values reset	✓		L
Master reset	✓		L

Table 40: Event logbook mask example

Owing to periodical improvements of our products the supplied products can differ in some details from data stated in the Technical Description.

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