ISKRAEMECO

Energy Measurement and Management

ME381 and MT381 User manual

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i. About the User manual

- User manual is intended to present the Mx381 meters (x stands for E (single phase meters) or T (three phase meters).
- The User manual represents the purpose of the Mx381 meters, meter construction, the way of deriving the measured quantities and meter functionalities.
- The User manual is intended for technically qualified personnel at energy supply companies, responsible for system planning and system operation.

ii. Reference documents

- Functional description
- Installation and maintenance manual

iii. Versioning

Date	Version	Update
04.07.2013	1.00	First version of document
29.10.2013	1.01	Annex 1 (MT381 object list) added at the end of the document

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Disclaimer

1. Safety information

Safety information used in this user manual is described with the following symbols and pictographs:

DANGER: for a possibly dangerous situation, which could result in severe physical injury or fatality – attention to a high risk hazards.

CAUTION: for a possibly dangerous situation, which could result in minor physical injury or material damage - attention to a medium risk hazards.

Operating instruction: for general details and other useful information.

All safety information in this user manual describes the type and source of danger, its possible consequences and measures to avoid the danger.

Responsibilities

The owner of the meter is responsible to assure that all authorized persons who work with the meter read and understand the parts of the User manual that explains the safe handling with the meter.

The personnel must be sufficiently qualified for the work that will be performed.

The personnel must strictly follow the safety regulations and operating instructions, written in the individual chapters in this User manual.

The owner of the meter respond specially for the protection of the persons, for prevention of material damage and for training of personnel.

Safety measures should be observed at all times. Do not break the seals or open the meter at any time!

1.1. Safety instructions

CAUTION: At the beginning of handling with the meter, the meter should be carefully taken out of the box where it was packed. This should prevent the meter from falling as well as any other external or internal damage to the device and personal injuries. Should such an incident occur despite all precautions, the meter may not be installed at the metering point as such damage may result in different hazards. In such case the meter needs to be sent back to the manufacturer for examination and testing.

CAUTION: The edges of the seal wires are sharp.

CAUTION: The temperature of the terminal block of the connected and operating meter may rise, therefore the temperature of the terminal cover may rise as well.

DANGER: In case of any damage inside the meter (fire, explosion...) do not open the meter.

CAUTION: The meter may be used only for the purpose of measurement for which it was produced. Any misuse of the meter will lead to potential hazards.

WARNING: Safety measures should be observed at all times. Do not break the seals or open the meter at any time!

The content of this User manual provides all information necessary for safe selection of Mx381 meter.

See the complete User manual for detailed technical features of Mx381 and its intended use.

It must be consulted in all cases where symbol ⚠ is marked in order to find out the nature of the potential hazards and any actions which have to be taken to avoid them.

The meter installation procedure is described in the Installation and maintenance manual. For safety reasons the following instructions should be followed.

Only the properly connected meter can measure correctly. Every connecting error results in a financial loss for the power company.

DANGER: The Mx381 electricity meter is the device, connected to the power supply. Any unauthorized manipulation of the device is dangerous for life and prohibited according to the applicable legislation. Any attempt to damage the seals as well as any unauthorized opening of the terminal or meter cover is strictly forbidden.

DANGER: Breaking the seals and removing the terminal cover or meter cover will lead to potential hazards because there are live electrical parts inside.

DANGER: When switching on the power beware of the risk of electric shock at all times!

No maintenance is required during the meter's life-time. The implemented metering technique, built-in components and manufacturing process ensure high long-term stability of meters, so that there is no need for their recalibration during their life-time.

If a battery is built into the meter, its capacity is sufficient to backup all meter functions like RTC and tampering functions for its entire life-time.

In case the service of the meter is needed, the requirements from the Installation, operation and naintenance manual must be observed and followed.

CAUTION: Cleaning of the meter is allowed only with a soft dry cloth. Cleaning is allowed only in upper part of the meter – in region of the LCD. Cleaning is forbidden in the region of terminal cover. Cleaning can be performed only by the personnel, responsible for meter maintenance.

CAUTION: Do not try to erase the markings, laser printed on the name plate.

DANGER: Never clean soiled meters under running water or with high pressure devices. Penetrating water can cause short circuits. A damp cleaning cloth is sufficient to remove normal dirt such as dust. If the meter is more heavily soiled, it should be dismounted and sent to the responsible service or repair centre.

CAUTION: While dismounting the meter observe and follow the same safety regulations and instructions as for installation of the meter.

CAUTION: Visible signs of fraud attempt (mechanical damages, presence of a liquid, etc.) must be regularly checked. The quality of seals and the state of the terminals and connecting cables must be regularly checked. If there exist a suspicion of incorrect operation of the meter, the local utility must be informed immediatelly.

After the end of the meter's lifetime, the meter should be treated according to the Waste Electric and Electronic Directive (WEEE).

2. Energy metering and Mx381 meters

Mx381 family meters are designed for up to eight tariff measuring of active, reactive and apparent energy in one or two energy flow directions. The meter measures consumed energy in single-phase two-wire networks or three-phase four-wire network for direct or indirect connection.

Measuring and technical characteristics of the meter comply with the IEC 62052-11 and IEC 62053-21 international standards for electronic active energy meters, class 1 and 2, and reactive energy meters, classes 2 or 3 in compliance with IEC 62053-23 as well as a standard for time switches IEC 62052-21.

Meters are designed and manufactured in compliance with the standards and ISO 9001 as well as more severe Iskraemeco standards.

Meter utilizes the DLMS communication protocol in compliance with the IEC 62056-46 standard as well as IEC 62056-21, mode C protocol.

The Mx381 meters are members of the third generation of Iskraemeco electronic single and three-phase meters for a deregulated market of electric power, with the following common functional properties:

- Time-of-use measurement of active energy and maximum demand (in up to 8 tariffs),
- Load-profile registration,
- LCD in compliance with the VDEW specification, with two modes of data display,
- Internal real-time clock,
- Two keys: **Reset** and **Scroll** key,
- Optical port (IEC 62056-21 standard) for local meter programming and data downloading,
- Built-in interface (IR) for a remote two-way communication, meter programming and data downloading,
- Wired M-Bus,
- Alarm input,
- Non-potential key input,
- Opto-MOS
    - switching functionality (for low current loads (max. 100mA, 250V)),
    - metropulse functionality (configurable energy pulses),
- Bi-stabile relay
    - switching external loads up to 6A (max.250V),
    - external disconnector functionality,
- Integrated disconnector with 1-phase meters,
- External disconnector with 3-phase meters (option).

Further to the Mx381 meters functionality they also enable:

- Detectors of the meter and the terminal block covers opening,
- Disconnector for remote disconnection / reconnection of the customer premises,
- M-Bus for reading other meters (heat, gas, water),
- Remote display ON/OFF configuration,
- Two different console type (reduced and normal),
- Third party disconnector driven through rele.

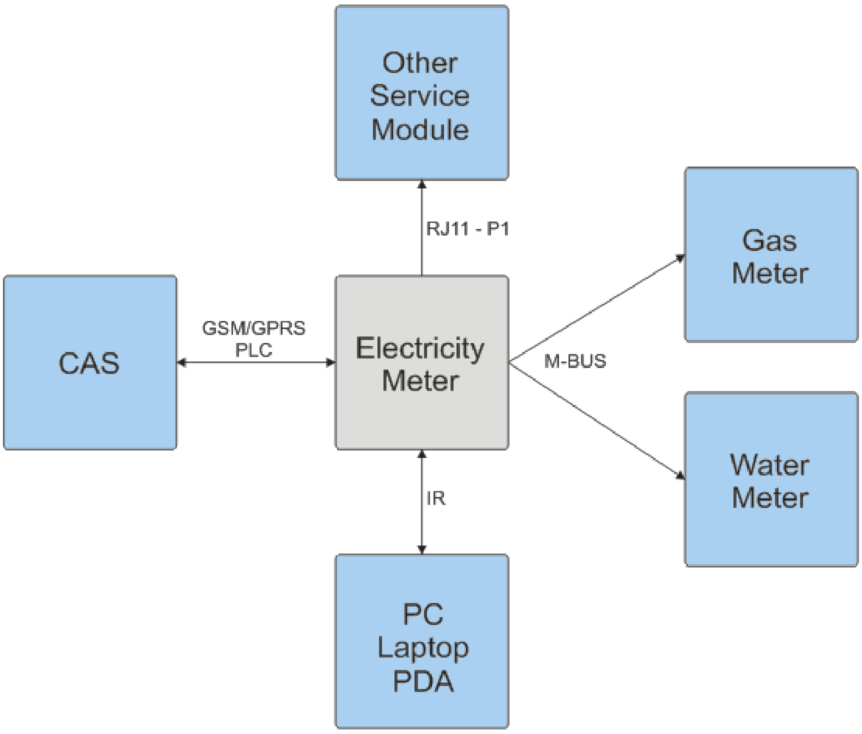


Figure 1: Smart metering system

3. Mx381 meters introduction

3.1. Standards and references

EN 13757-1	Communication systems for meters and remote reading of meters Part 7: Data exchange.
EN 13757-2	Communication systems for meters and remote reading of meters Part 2: Physical and link Layer
EN 13757-3	Communication systems for meters and remote reading of meters Part 3: Dedicated application Layer
EN 13757-4	Communication systems for meters and remote reading of meters Part 4: Wireless meter readout (Radio Meter reading for operation in the 868-870 MHz SRD band)
IEC 62056–21	Data exchange for meter reading, tariff and load control - Direct local connection (3rd edition of IEC 61107)
IEC 62056-46	Electricity metering; Data exchange for meter reading, tariff and load control; Data link layer using HDLC-Protocol
IEC 62056-47	Electricity metering; Data exchange for meter reading, tariff and load control; COSEM transport layers for IPv4 networks
IEC 62056-53	Electricity metering; Data exchange for meter reading, tariff and load control COSEM Application Layer
IEC 62056-61	Electricity metering; Data exchange for meter reading, tariff and load control obis object identification system (OBIS)
IEC 62053-21	Electricity metering equipment; Particular requirements; Electronic meters for active energy (classes 1 and 2)
IEC 62053-23	Electricity metering equipment (AC.); Particular requirements; Static meters for reactive energy (classes 2 and 3)
IEC 62052-11	Electricity metering equipment (AC.): General requirements, tests and test conditions - Metering equipment
IEC 62052-21	Electricity metering equipment (AC.) General requirements, tests and test conditions - Tariff and load control equipment
IEC 61334-4-32	Distribution automation using distribution line carrier systems - Data communication protocols - Data link layer - Logical link control (LLC)
IEC 61334-4-512	Distribution automation using distribution line carrier systems - Data communication protocols - System management using profile 61334-5-1 - Management Information Base (MIB)
IEC 61334-5-1	Distribution automation using distribution line carrier systems - Lower layer profiles - The spread frequency shift keying (S-FSK) profile

ISO/IEC 8802.2	Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements; Logical link control
RFC 1321	MD5 Message-Digest Algorithm
RFC 1332	The Internet Protocol Control Protocol (IPCP)
RFC 1570	PPP Link Control Protocol (LCP) Extensions
RFC 1661	Standard 51, The Point-to-Point Protocol (PPP)
RFC 1662	Standard 51, PPP in HDLC-like Framing
RFC 1700	Assigned Numbers
RFC 2507	IP Header Compression
RFC 3241	Robust Header Compression
FIPS PUB 180-1	Secure Hash Algorithm
IEC 60529	Degrees of protection provided by enclosures (IP code)

COSEM Blue Book 10th Edition, DLMS UA 1000-1:2010, Ed. 10.0, 2010-08-26

COSEM Green Book 7th Edition, DLMS UA 1000-2:2010, Ed. 7.0, 209-12-22

IDIS Package 2 IP Profile ed. 1.0.docx

Iskraemeco technical notes

IDIS - object model - V2.10 (20120823).xlsx

VDEW- specification for “Electronic Meters with load curve“ Version 2.1.2 i7th November 2003

IP Header Compression over PPP

Dutch Smart Meter Requirements v3.0 final P1

3.2. Mx381 meter appearance

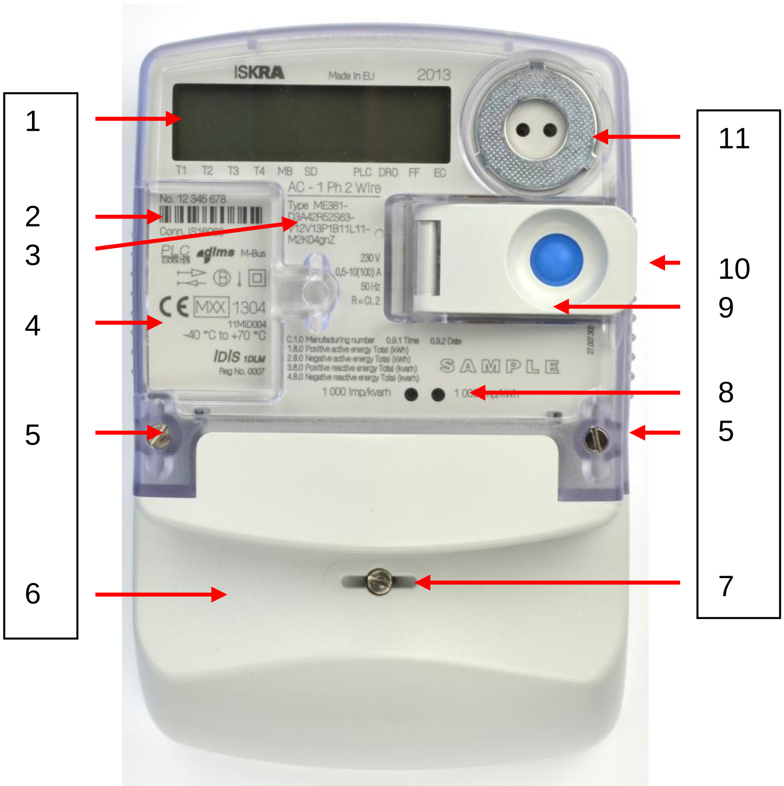


Figure 2: ME381 meter appearance – front view

Item	Description
1	Liquid crystal display (LCD)
2	Meter serial number
3	Meter technical data
4	Coupling circuit
5	Meter cover sealing screw
6	Terminal cover
7	Terminal cover sealing screw
8	Right side – Active energy Impulse LED Left side – Reactive energy Impulse LED
9	**Scroll** and **Reset** keys
10	Lid sealing screw
11	IR optical interface

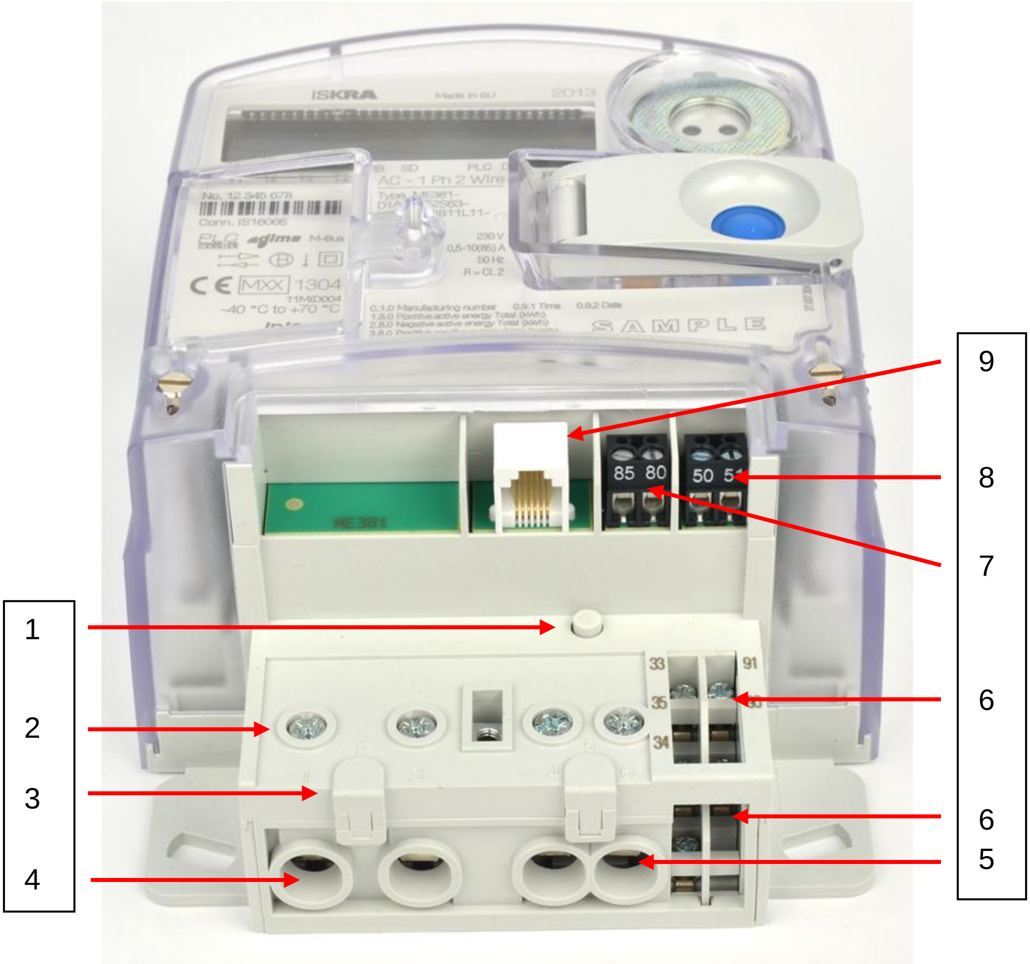


Figure 3: ME381 meter appearance – bottom view

Item	Description
1	Switch for detection of terminal cover opening
2	Screw for fitting current cables
3	Additional voltage terminals (option)
4	Current terminals
5	Neutral terminals
6	Auxiliary terminals (Load control output, M-Bus communication interface)
7	Alarm input
8	Non-potential key input
9	Port P1

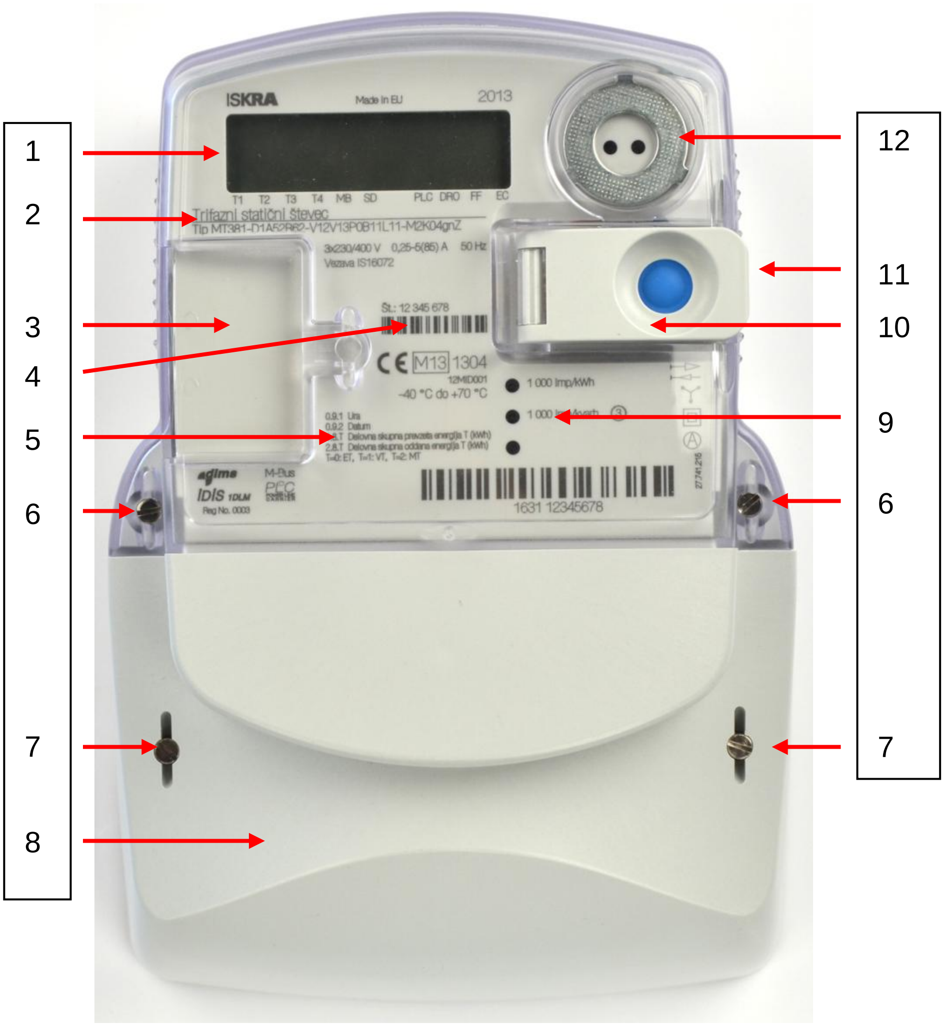


Figure 4: MT381 meter appearance – front view

Item	Description
1	LCD display
2	Meter technical data
3	Coupling circuit
4	Meter serial number
5	Legend of registers displayed on LCD
6	Meter cover sealing screws
7	Terminal cover sealing screws
8	Terminal cover
9	Upper – Active energy Impulse LED
	Middle – Reactive energy Impulse LED
	Lower – not active
10	Scroll and Reset keys
11	Lid sealing screw
12	IR optical interface

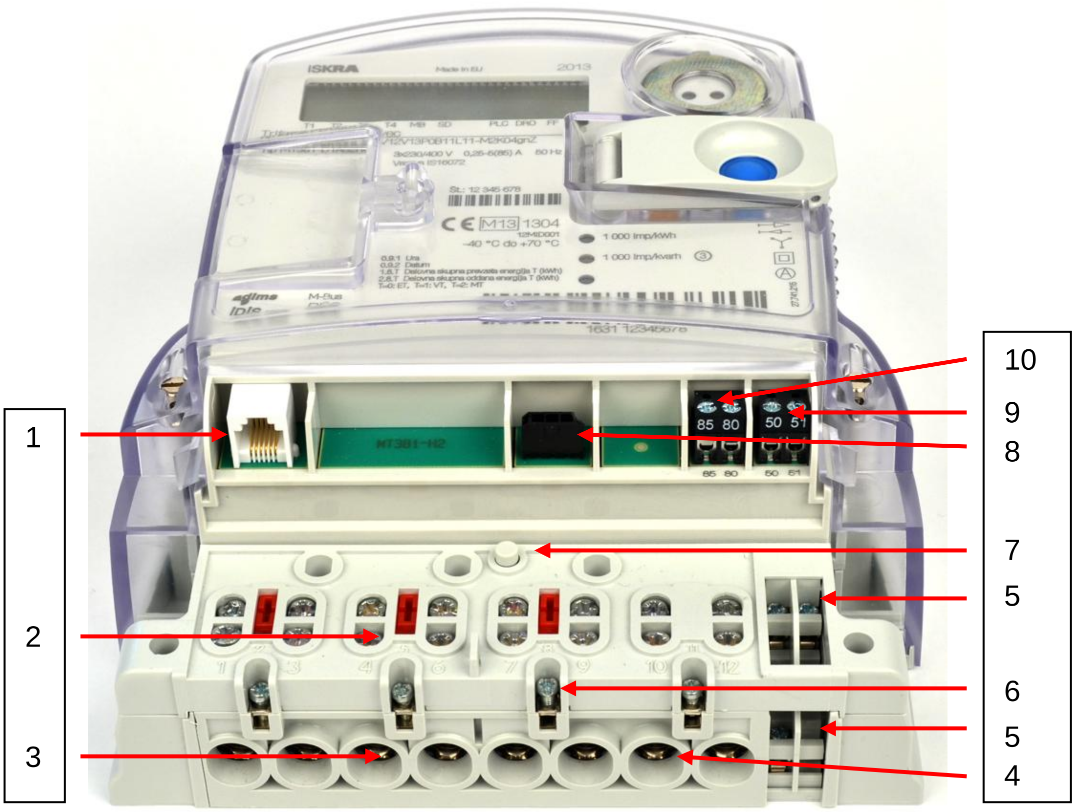


Figure 5: MT381 meter appearance – bottom view

Item	Description
1	Port P1
2	Screw for fitting current cables
3	Current terminals
4	Neutral terminals
5	Auxiliary terminals (Load control output, M-Bus communication interface)
6	Additional voltage terminals
7	Switch for detection of terminal cover opening
8	Connector for disconector unit
9	Non-potential key
10	Alarm input

3.3. Main meter properties

- Active energy and demand meter of accuracy class 1 or 2 (in compliance with IEC 62053-21).
- Reactive energy and demand meter of accuracy class 2 or 3 (in compliance with IEC 62053-23).
- Apparent energy meter of accuracy class 2 or 3.
- Modes of energy measurement and registration (single-phase meters):
  - For one-way energy flow direction,
  - For two-way energy flow direction,
  - For two-way energy flow direction but registered in one (absolute) register.
- Modes of energy measurement and registration (three-phase meters):
  - For one-way energy flow direction, three-phase energy is algebraic (arithmetical) sum of energies registered, in each of the phases – meters are equipped with an electronic reverse running stop,
  - For two-way energy flow direction, three-phase energy is algebraic (arithmetical) sum of energies registered in each of the phases,
  - For one-way energy flow direction, three-phase energy is sum of absolute values of energies registered in each of the phases.
- Meter quality:
  - Due to high accuracy and long term stability of metering elements no meter re-calibration over its life-time is required,
  - High meter reliability,
  - High immunity to EMC.
- Additional meter functions:
  - Detection of missing/broken neutral conductor,
  - Detection of phase and voltage unbalance,
  - Measurement and registration of under- and over-voltage,
  - Daily peak and minimum value.
- Time-of-use registration (up to 8 tariffs): Tariffs change-over; internal RTC (by IEC 61038).
- Two Load-profile recorders.
- Communication channels:
  - Infrared optical port (IEC 62056-21) for local meter programming and data downloading,
  - Built-in M-Bus communication interface,
  - Built-in RJ11 communication interface (one way).
- LCD: In compliance with the VDEW specification.
- Data display modes (configurable):
  - Reduced type:
    - Automatic cyclic data display (10 sec display time),
    - Manual data display mode (by pressing the Scroll key).
  - Normal type (according to VDEW):
    - Automatic cyclic data display mode,
    - Manual data display mode,
    - Load profile 1 (configurable),
    - Load profile 2 (configurable).
- Indicators:
  - LCD:
    - Presence of phase voltages L1, L2, L3,
    - Phase currents flow direction,
    - Active tariff at the moment,
    - Status of a disconnector,
    - Communication status,
    - Meter network status
    - Critical error status (Fatal Fault),
    - Status of at least one M-Bus device installed in meter,

- Status of DRO in progress.
  - LED1: Imp/kWh.
  - LED2: Imp/kVArh or Imp/kVAh.
- Communication protocols:
  - Optical port: IEC 62056 – 21, mode C or DLMS (in compliance with IEC 62056 – 46),
  - Identification system; IEC 62056 – 61,
  - COSEM organization of data: IEC 62056-53,
  - M-Bus: EN 13757-2 and EN 13757-3.
- OBIS data identification code: IEC 62056–61.
- Auxiliary inputs / outputs:
  - Output for load control with a 6A relay,
  - Output for load control with an OptoMOS relay,
  - Alarm input,
  - External key input,
  - M-Bus interface to which up to 4 gas, heat or water meters can be connected,
  - Active disconnector output (MT381).
- Automatic configuration of an AMR system: Meters are registered automatically into an AMR system.
- Programming of the meter as well as FW upgrade can be done locally (via an optical port) or remotely in compliance with the predefined security levels.
- Detection of opening meter and terminal block covers.
- Simple and fast meter installation.
- Current terminals:
  - Make good contact with current conductors regardless of their design and material,
  - Do not damage conductors.
- Voltage terminals:
  - Internal and/or external connection,
  - A sliding bridge (for simple separation of a voltage part from a current part) (only at direct connected meters). The sliding bridges can be accessible when terminal cover is removed, or they can be hidden under the meter cover.
- Compact plastic meter case:
  - Made of high quality self-distinguishing UV stabilized material that can be recycled,
  - IP54 protection against dust and water penetration (by IEC 60529).

3.4. Mx381 meter connection into the network

The meter connection diagrams for Mx381 meters are shown on the following four Figures:

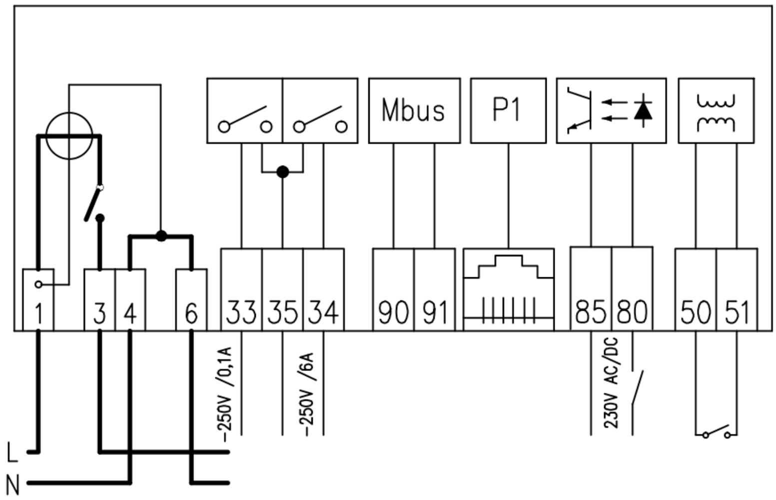


Figure 6: ME381 meter connection diagram – DIN connection

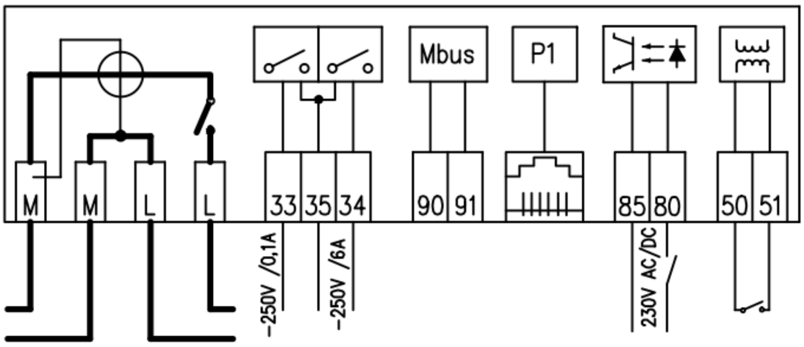


Figure 7: ME381 meter connection diagram – BS connection

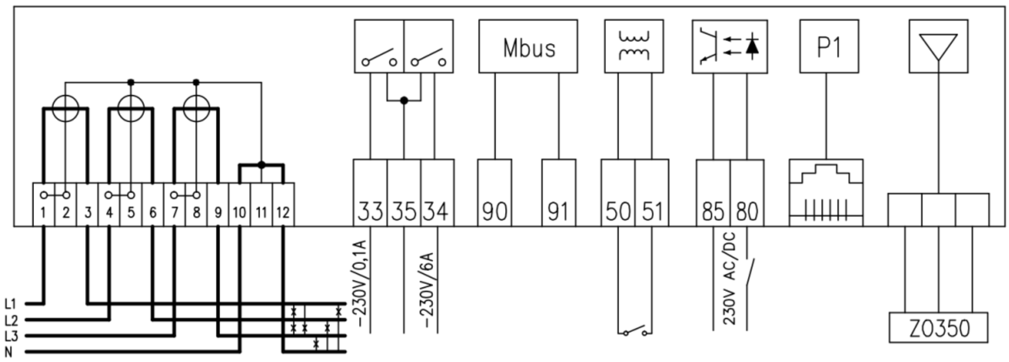


Figure 8: MT381 meter connection diagram – direct connection

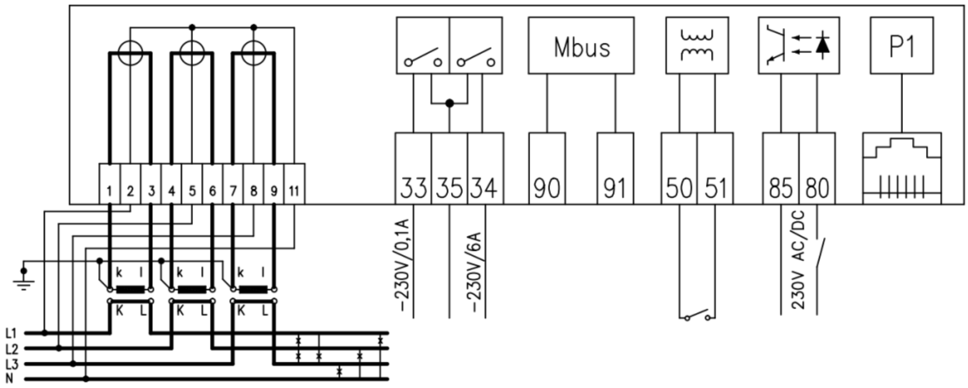


Figure 9: MT381 meter connection diagram – transformer operated meter

3.5. Energy and demand registration

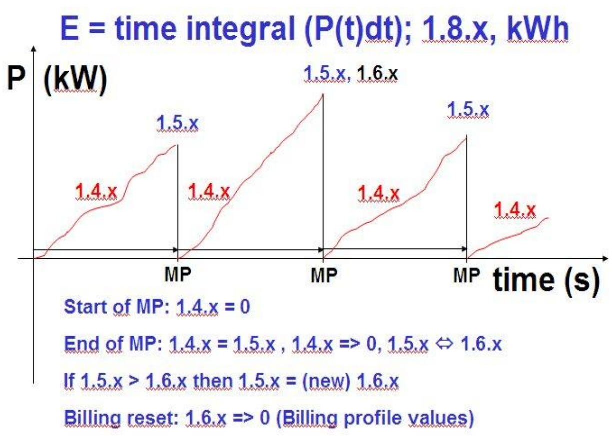
The meter measures and records electric energy:

- Single-phase two wire,
- Three-phase four-wire networks:
  - total (∑ Li),
  - positive and negative active energy (A+, A-) separately,
  - reactive energy per quadrants (QI, QII, QIII, QIV),
  - positive and negative reactive energy (Q+, Q-) separately (Q+=QI+QII, Q-=QIII+QIV),
  - positive and negative apparent energy (S+, S-) separately,
  - absolute active energy│A│.

Meters are provided with two LEDs on the front plate. They are intended for checking the meter accuracy. Impulse constant depends on the meter version.

Power is measured inside a measuring period. The measuring period is a meter parameter and can be set. Values that can be set are 1, 5, 10, 15, 30 and 60 minutes. After termination of the measuring period, the measured meter value is transferred from current measuring period registers to registers for previous measuring period that can be later used for the formation of billing values.

Values are recorded for each tariff and stored in corresponding tariff register from 1 to 8.



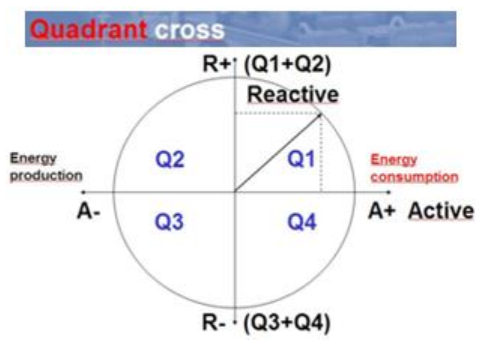


Figure 10: Measuring principle

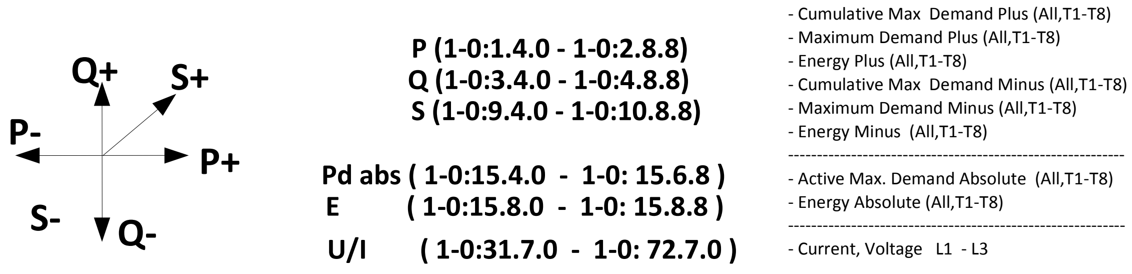


Figure 11: Measured energy and demand

3.5.1 Energy

Electrical meter energy is accumulated in respective registers (A+ or A-) until 1 Wh is reached thus energy measurement is carried out in latter unit. Default representation of the energy values on display is in kWh with 6 digits without decimals. This representation can be changed via communication interfaces writing appropriate string in COSEM objects as shown console description (see console section). Nevertheless full value with each Wh counted could be obtained through communication interfaces in form of value, unit and scaler.

The micro-computer records different types of energy (active, reactive, apparent) for all phases in one or more tariffs (rates) and stores these values in various registers according to energy direction and active tariff (rates).

Several energy types (A+, A-, Q+, Q-, QI, QII, QIII, QIV, S+, S-, ABS and NET) are registered as total register value and rate ragister values.

	total	tariff
A+	1.8.0	1.8.e
A-	2.8.0	2.8.e
Q+	3.8.0	3.8.e
Q-	4.8.0	4.8.e
QI	5.8.0	5.8.e
QII	6.8.0	6.8.e
QIII	7.8.0	7.8.e
QIV	8.8.0	8.8.e
S+	9.8.0	9.8.e
S-	10.8.0	10.8.e
ABS = IA+I + IA-I	15.8.0	15.8.e
NET = IA+I - IA-I	16.8.0	/

<e> is used as tariff index from 1 to 8

Table 1: All total and rate energy registers

3.5.2 Demand

Meter calculates an average demand in a time interval as a quotient of registered energy during measurement period and elapsed time Td:

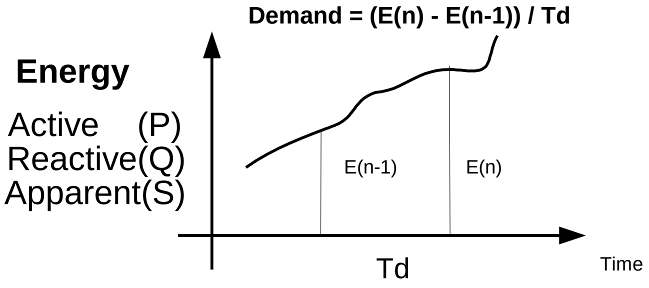


Figure 12: Demand calculation sample

After completion of the measuring period, average value is stored to the register for previous measuring period and compared with highest maximum value stored in the relevant register (x.6.y). If new value is larger it is stored as new maximum value at corresponding position. At the same time, timestamp is stored representing the time conclusion of measuring period.

At the end of billing period demand registers (x.4.0, x.5.0, and x.6.y) are recorded and stored prior to being set back to zero when new period starts.

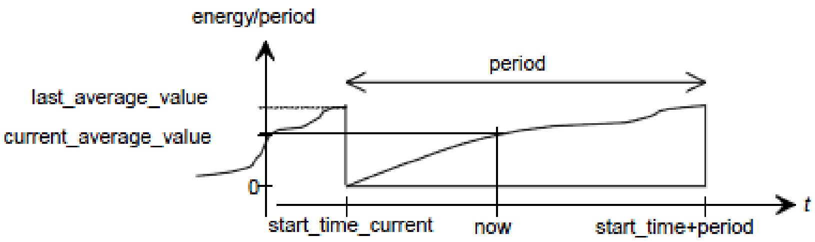


Figure 13: Attributes in the case of block demand (1 period)

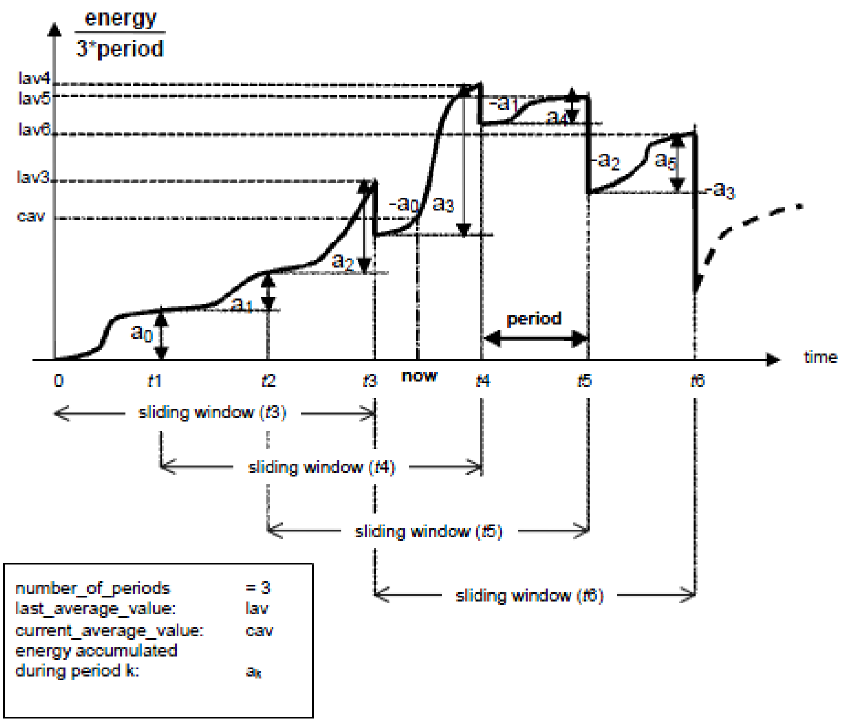


Figure 14: Attributes in case of sliding demand

3.5.2.1. Demand according to averaging scheme 3

Averaging scheme 3 is realized with sliding window of known size. The size is determined with two parameters. First is the number of periods considered while the second is the duration of the period.

Interface consists of two distinctive registers. First represents current average while the second resembles last average.

Last average
Provides the value of the energy accumulated over the last time interval divided by duration of the time interval. The energy of the current (not terminated) period is not considered by the calculation.

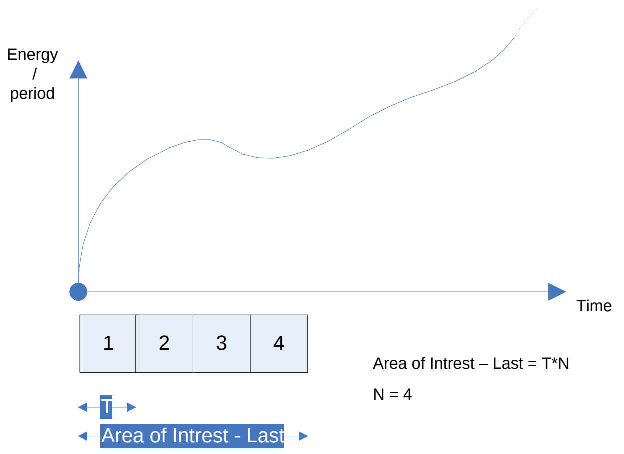


Figure 15: Calculation of demand over a known period with sliding window

Current Average

This attribute provides the current value (running demand) of the energy accumulated over area of interest – Current time interval.

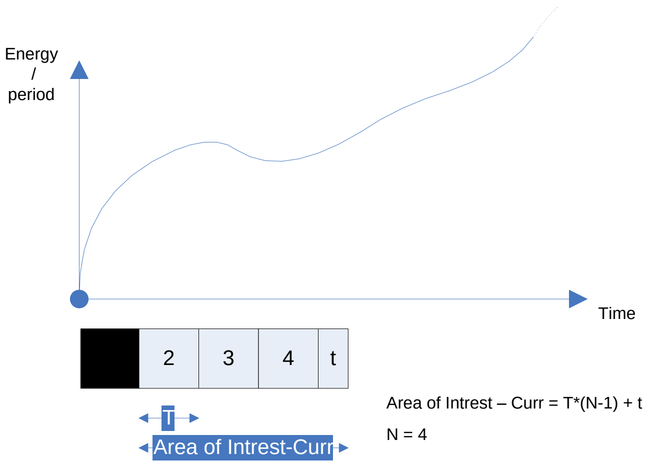


Figure 16: Calculation of demand over a known period with sliding window

3.5.2.2. Sliding demand registers

COSEM Demand Register class allows modeling values, with its associated scaler, unit, status and time information.

A “Demand register” object measures and computes a current_average_value periodically, and stores last_average_value. The time interval T over which the demand is measured or computed is defined by specifying number_of_periods and period attributes. The figure below presents how time attributes are ment to be used with the Demand register class.

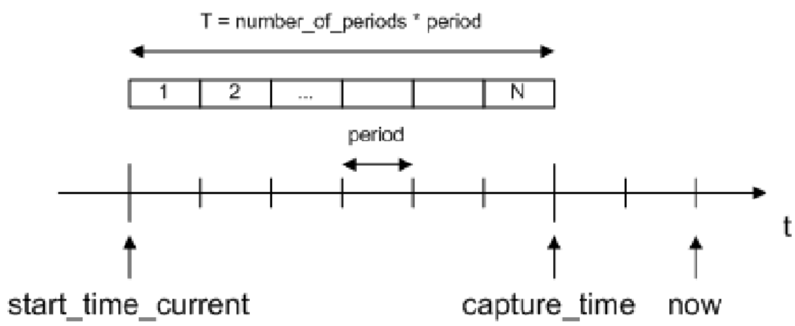


Figure 17: Time attributes when measuring sliding demand

3.5.2.3. Other demand registers

In addition to sliding demand registers Mx381 meter also has other demand measuring registers.

Last average Demand Registers
Last demand registers (x.5.0) represent same values as attribute 3 of average demand registers. They are stored as separate registers for possible display on LCD.

	SUM	tariff
A+	1.5.0	x
A-	2.5.0	x
Q+	3.5.0	x
Q-	4.5.0	x
S+	9.5.0	x
S-	10.5.0	x
ABS = IA+I + IA-I	15.5.0	x

Table 2: Last average demand registers

Maximum Demand Registers (total)
Maximum demand registers represent the biggest CAV (Current Average Value) from average demand registers, measured in one period. At the end of each measurement period, CAV from x.4.0 register (attribute 2) is compared to maximum demand value – if CAV is bigger, it replaces the value stored in maximum demand register. Maximum demand values are set to 0 at the end of billing period. COSEM Extended register class is used for maximum demand registers. Houdini meter provides 63 total demand registers:

	SUM	tariff
A+	1.6.0	1.6.e
A-	2.6.0	2.6.e
Q+	3.6.0	3.6.e
Q-	4.6.0	4.6.e
S+	9.6.0	9.6.e
S-	10.6.0	10.6.e
ABS = IA+I + IA-I	15.6.0	15.6.e

<e> is used as tariff index from 1 to 8

Table 3: Maximum demand registers – total

3.5.2.4. Time management

Whenever time in meter (meter clock) is changed it comes to one of two possible events – time change or time synchronization.
Time synchronization is treated whenever the difference between new and old time does not exceed certain thresholds. For demand registers those thresholds are:

- time_set_threshold in object Clock time shift limit (1-0:0.9.11.255),
- time shift is smaller than 1% of respective measurement period but no bigger than 9s (VDEW).

Time synchronization event has no effect on demand registers, because time change is too small. Nevertheless if more than one time synchronization per measurement period occurs, every second synchronization is treated as appropriate time change (second time synchronization forward/backward is treated as time change forward/backward).

If the above mentioned thresholds are exceeded, time change is treated by meter. All time change use cases are presented in next chapter.

3.6. Measurement principle

One (ME381) or three (MT381) metering elements can be built in the meter. The current sensor for MT381 meters is Rogowsky coil (a current transformer with an air core) and shunt for ME381 meter, while voltage sensor is a resistive voltage divider. Signals of currents and voltages are fed into the A/D converters and there further processed.

3.6.1 Energy LED impulse output

There are two metrological LED’s on the meter (See Chapter: 4.4.1)

- Active LED,
- Reactive LED / Apparent LED.

LED pulse blink duration is 30ms.

3.6.2 Energy METRO pulse output

OptoMOS output can be used as metrological output. To enable metrological output there is the service control functionality object used.

These objects are used to configure energy constants for metrological outputs.

Metrological output constants are used for the following energies:

- Absolute active energy output,
- Absolute reactive energy output,
- Absolute apparent energy output.

If the value in the register is 0 or higher than 1000000 the metropulse output is disabled otherwise the metropulse output is enabled and switching (connected/disconnected) according to the constant selected and energy consumption (impulse/unit).

Metropulse output functions enumeration:

Enumeration	IO Function	Description
0	NONE	No function is assigned to the metropulse output
23	absAA	Pulse output for absolute A
26	absRA	Pulse output for absolute R
33	absSA	Pulse output for absolute S

Table 4: List of metropulse output function enumeration

Only above specified metropulse output functions are allowed, maximal pulse duration value is 200 ms while minimal pulse duration value is 30ms.

For effective use of functionalities, meter must be properly configured.

3.6.2.1. Transformer measurement type

This object defines if current transformer ratios will be used in measuring process or not (only for transformer type MT381 meters). Options are:

- Transformer ratio is not used (for direct connection) – secondary measurement – (0),
- Transformer ratio is used (for transformer connection) – primary measurement – (1).

3.6.2.2. Transformer ratio

1-0:4.0.e
<e>: 2 – Current (numerator),
5 – Current (denominator).

Transformer ratios are used to configure meter where results on the secondary side need to be different (lower) than on the primary side (only for transformer type MT381 meters). For correct results constant K on the secondary side must be also considered. Constant K is the correction factor between secondary side and primary side.

K = Current Numerator / Current Denominator
Primary current = Secondary current * K

For effective use of functionalities, meter must be properly configured.

3.6.3 Measured quantities

Quantities that can be measured by Mx381 meter are:

- Active energy/demand: instantaneous values,
- Reactive energy/demand: instantaneous values, values per quadrant,
- Apparent energy/demand: instantaneous values,
- Last average demand – active, reactive, apparent,
- Maximum demand register – active, reactive, apparent,
- Average import, net and total power,
- Average voltage daily peak/minimum,
- Average voltage,
- Voltage levels per phase,
- Magnitude of last voltage sag and swell per phase,
- Instantaneous voltage,
- Instantaneous current,
- Sliding average current per phase,
- Daily peak/minimum voltage per phase,
- Instantaneous network frequency,
- Instantaneous power factor, per phase,
- Last average power factor.

3.6.3.1. Measurement period

There are two measurement periods in use. Measurement period 1 (MP1) is used for demand measurements (recommended periods are 300s, 900s, 1800s and 3600s), measurement period 3 (MP3) is used for energy and power limits.

For effective use of functionalities, meter must be properly configured.

3.6.3.2. Average values

- Average voltage,
- Average daily peak and minimum voltage,
- Voltage levels,
- Voltage sags and swells,
- Sliding average current,
- Last average power factor,
- Total energy values,
- Tariff energy values,
- Average power,
- Average demand,
- Last average demand,
- Maximum demand.

3.6.3.3. Instantaneous values

- Instantaneous voltage,
- Daily peak and minimum voltage,
- Instantaneous current,
- Instantaneous current – sum of all three phases,
- Instantaneous net frequency,
- Instantaneous power,
- Instantaneous power factor.

3.6.4 Voltage

3.6.4.1. Instantaneous voltage

Instantaneous voltage is measured in the meter every 100ms.

	L1	L2	L3
Instantaneous voltage	32.7.0	52.7.0	72.7.0

Table 5: Instantaneous voltage objects in the Mx381 meter

3.6.4.2. Daily peak and minimum values

	L1	L2	L3
Daily peak voltage (current)	128.8.10	128.8.20	128.8.30
Daily peak voltage (previous)	128.8.11	128.8.21	128.8.31
Daily minimum voltage (current)	128.8.12	128.8.22	128.8.32
Daily minimum voltage (previous)	128.8.13	128.8.23	128.8.33

Table 6: Peak and minimum values of voltage

3.6.4.3. Average voltage

	ALL	L1	L2	L3
Average voltage		32.24.0	52.24.0	72.24.0
Average voltage daily peak (current)	128.8.0	x	x	x
Average voltage daily peak (previous)	128.8.1	x	x	x
Average voltage daily minimum (current)	128.8.2	x	x	x
Average voltage daily minimum (previous)	128.8.3	x	x	x

Table 7: Average values of voltage

3.6.4.4. Voltage levels

	ANY	L1	L2	L3
Level 1: U > +10%	128.7.41	128.7.11	128.7.21	128.7.31
Level 2: +5% < U < +10%	128.7.42	128.7.12	128.7.22	128.7.32
Level 3: 0% < U < +5%	128.7.43	128.7.13	128.7.23	128.7.33
Level 4: -5% < U < 0%	128.7.44	128.7.14	128.7.24	128.7.34
Level 5: -10% < U < -5%	128.7.45	128.7.15	128.7.25	128.7.35
Level 6: -15% < U < -10%	128.7.46	128.7.16	128.7.26	128.7.36
Level 7: U < -15%	128.7.47	128.7.17	128.7.27	128.7.37

Table 8: Voltage levels

3.6.4.5. Voltage sags and swells

	ANY
Magnitude for voltage sag	12.34.0
Magnitude for voltage swell	12.38.0

Table 9: Magnitude for voltage sags and swells

	L1	L2	L3
Magnitude of last voltage sag	32.34.0	52.34.0	72.34.0
Magnitude of last voltage swell	32.38.0	52.38.0	72.38.0

Table 10: Magnitude of last voltage sag and swell

3.6.5 Current

3.6.5.1. Instantaneous current

Instantaneous current is measured in the meter every 100ms.

	SUM	L1	L2	L3
Instantaneous current	90.7.0	31.7.0	51.7.0	71.7.0

Table 11: Instantaneous current objects

3.6.5.2. Sliding average current

	L1	L2	L3
Sliding average current	31.4.0	51.4.0	71.4.0

Table 12: Sliding average current

3.6.6 Net frequency

3.6.6.1. Instantaneous net frequency

	Any phase
Instantaneous net frequency	14.7.0

Table 13: Instantaneous net frequency object

3.6.7 Power

3.6.7.1. Instantaneous power

	SUM
A+	1.7.0
A-	2.7.0
Q+	3.7.0
Q-	4.7.0
S+	9.7.0
S-	10.7.0
ABS = IA+I + IA-I	15.7.0

Table 14: Instantaneous power objects

3.6.7.2. Average power

	SUM
A+	1.24.0
ABS = IA+I + IA-I	15.24.0
NET = IA+I - IA-I	16.24.0

Table 15: Average power

3.6.8 Power factor

3.6.8.1. Instantaneous power factor

	SUM	L1	L2	L3
Instantaneous power factor +	13.7.0	33.7.0	53.7.0	73.7.0

Table 16: Instantaneous power factor objects

3.6.8.2. Last average power factor

	SUM
Last average power factor +	13.5.0

Table 17: Last average power factor

3.6.9 Energy

In all connection variants meter provides following energy values:

- positive and negative active energy (A+, A-), sum of all phases,
- positive and negative reactive energy (R+, R-), sum of all phases,
- quadrant reactive energy (QI, QII, QIII, QIV), sum of all phases,
- positive and negative apparent energy (S+, S-), sum of all phases,
- absolute active energy (|A+| + |A-|), sum of all phases,
- net active energy (|A+| - |A-|), sum of all phases.

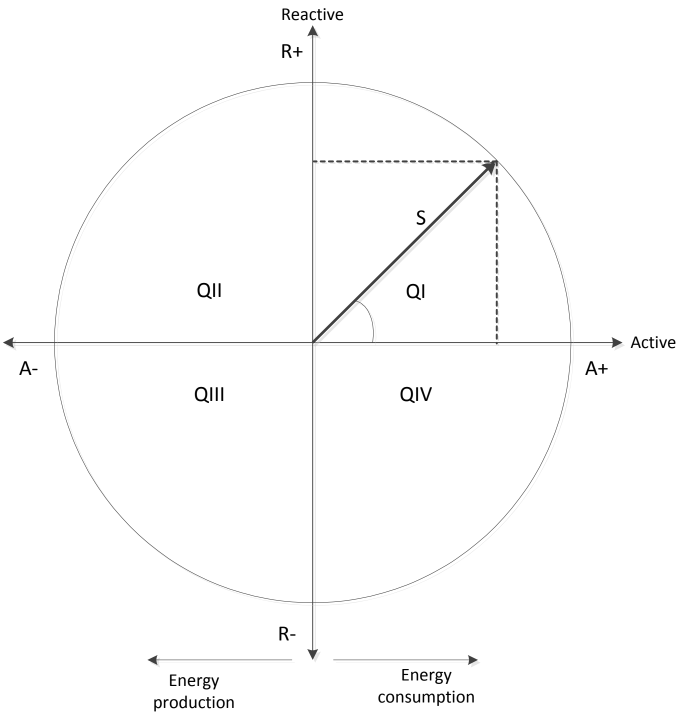


Figure 18: Quadrant cross

Positive and negative reactive energy/power can be registered as Q+=QI+QII and Q-=QIII+QIV.

Besides total registration, Mx381 meter provides up to 8 tariffs for energy and demand registration.

Related to energy accumulation in time, Mx381 meter provides the following energy values:

- total values,
- tariff values.

3.6.9.1. Total energy values

	SUM
A+	1.8.0
A-	2.8.0
Q+	3.8.0
Q-	4.8.0
QI	5.8.0
QII	6.8.0
QIII	7.8.0
QIV	8.8.0
S+	9.8.0
S-	10.8.0
ABS = IA+I + IA-I	15.8.0
NET = IA+I - IA-I	16.8.0

Table 18: Total energy objects

3.6.9.2. Tariff energy values

	Total tariff
A+	1.8.e
A-	2.8.e
Q+	3.8.e
Q-	4.8.e
QI	5.8.e
QII	6.8.e
QIII	7.8.e
QIV	8.8.e
S+	9.8.e
S-	10.8.e
ABS = IA+I + IA-I	15.8.e

<e> is used as tariff index from 1 to 8

Table 19: Tariff energy registers

3.6.9.3. Average demand

	SUM
A+	1.4.0
A-	2.4.0
Q+	3.4.0
Q-	4.4.0
S+	9.4.0
S-	10.4.0
ABS = IA+I + IA-I	15.4.0

Table 20: Average demand objects

3.6.9.4. Last average demand

	SUM
A+	1.5.0
A-	2.5.0
Q+	3.5.0
Q-	4.5.0
S+	9.5.0
S-	10.5.0
ABS = IA+I + IA-I	15.5.0

Table 21: Last demand objects

3.6.9.5. Maximum demand

	SUM	Tariff
A+	1.6.0	1.6.e
A-	2.6.0	2.6.e
Q+	3.6.0	3.6.e
Q-	4.6.0	4.6.e
S+	9.6.0	9.6.e
S-	10.6.0	10.6.e
ABS = IA+I + IA-I	15.6.0	15.6.e

<e> is used as tariff index from 1 to 8

Table 22: Maximum demand objects

3.6.10 Measurement period parameterization

Measurement period can be manipulated with settings in measurement period parameterization objects:

Measurement period 1	0.8.0
Measurement period 3	0.8.2

Table 23: MP configuration objects

4. Meter construction

4.1. Technical figures and dimensions

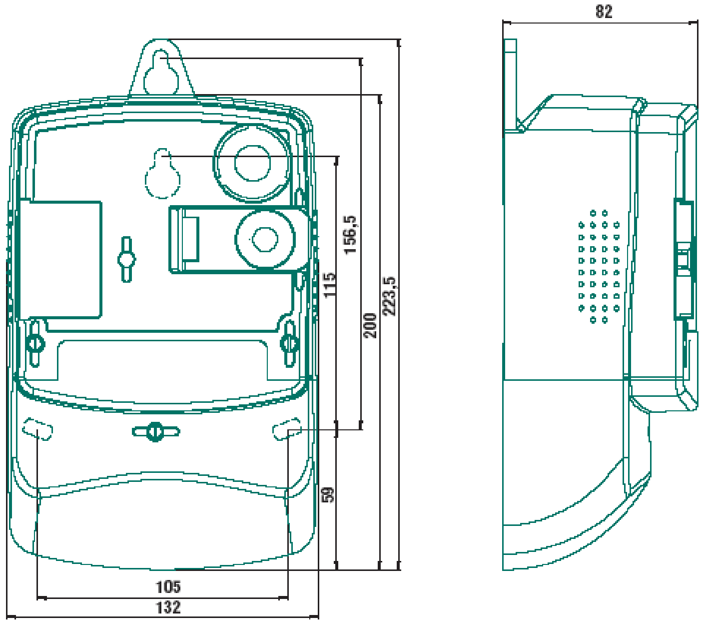


Figure 19: Overall and fixing dimensions of the ME381 meter fitted with a long terminal cover

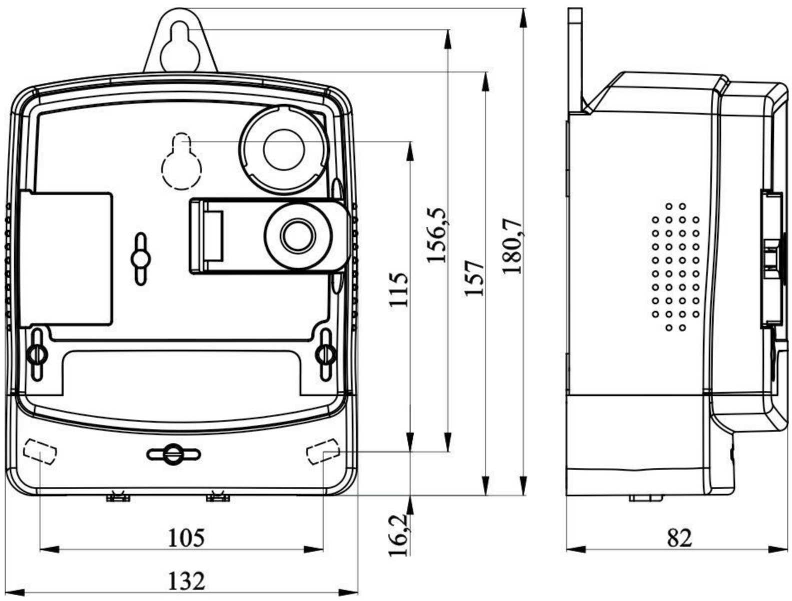


Figure 20: Overall and fixing dimensions of the ME381 meter fitted with a short terminal cover

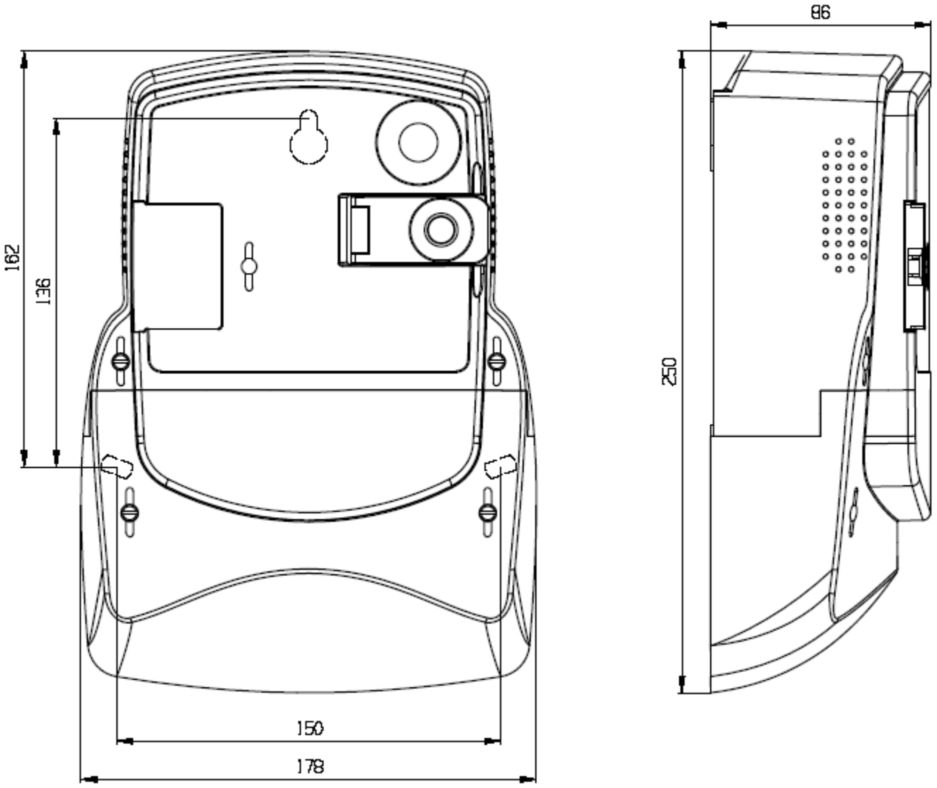


Figure 21: Overall and fixing dimensions of an MT381 meter fitted with a long terminal cover

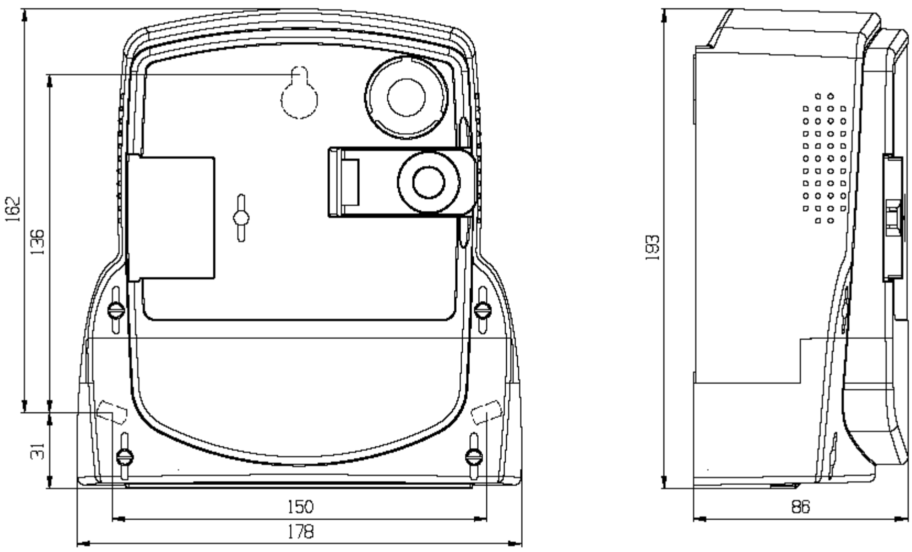


Figure 22: Overall and fixing dimensions of an MT381 meter fitted with a short terminal cover

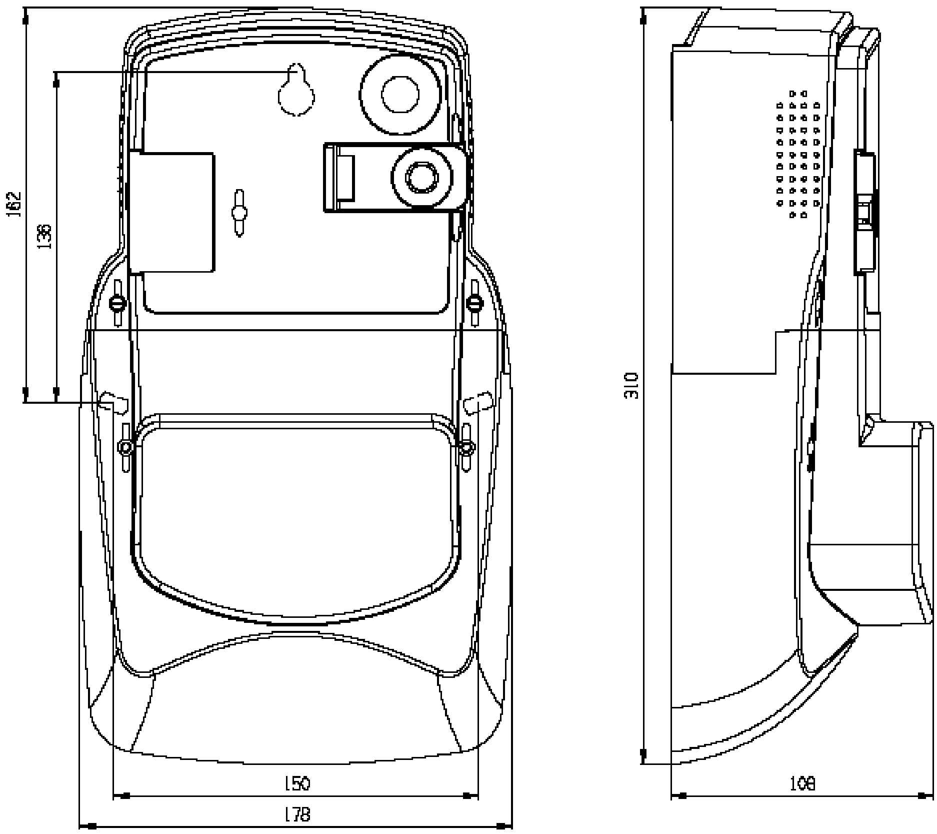


Figure 23: Overall and fixing dimensions of the MT381 meter fitted with a disconnector and a long terminal cover

4.2. Meter case

A compact meter case consists of a meter base with a terminal block and fixing elements for mounting the meter, a meter cover and a terminal cover. The meter case is made of high quality self-extinguishing UV stabilized polycarbonate that can be recycled. The case ensures double insulation and IP54 protection level against dust and water penetration.

The movable top hanger is provided on the back side of the meter base under the top edge. The top hanger ensures the upper fixing hole height of 156,5mm (ME381) and 136mm (MT381) above the line connecting the bottom fixing holes (DIN 43857).

On the front side of the meter there is a lid which is fixed to the meter cover with a hinge. The lid covers the SET key and can be sealed in the closed position. The optical port is utilized for attaching an optical probe. The optical port is designed in accordance with standards.

The meter connection diagram is in the form of label and is placed on the inner side of the terminal cover.

4.2.1 Terminal block

A terminal block complies with the DIN 43857 standard. It is made of self-extinguishing high quality polycarbonate. Terminal cover is made in the color of the meter - light grey.

At single phase meters ME381-D1 terminal block the current terminals are made of nickel plated steel, screws are made of zinc plated steel, pozidrive nr. 2 head type. The conductors can be fixed with one screw per terminal and Iskraemeco's design of cage clamps.

At ME381-D3 terminal block current terminals are made of brass. The surface of terminals can be additionally protected with nickel for the areas with extreme climatic conditions (e.g. tropical area). Screws are made of zinc plated steel with pozidrive nr. 2 head type. The conductors can be fixed with two screws per terminal.

At three phase meters MT381-D1 with 85A terminal block the current terminals are made of nickel plated steel. Screws can be made of zinc plated steel with pozidrive nr. 2 head type. The conductors can be fixed with one screw per terminal and Iskraemeco's design of cage clamps.

At MT381-D2 with 120A terminal block the current terminals are made of nickel plated steel. Screws can be made of zinc plated steel with pozidrive nr. 2 head type or can be made of nickel plated brass with slot head type. The conductors can be fixed with two screws per terminal and Iskraemeco's design of cage clamps.

At MT381-T1 meters the current terminals are made of brass. The surface of terminals can be additionally protected with nickel for the areas with extreme climatic conditions (e.g. tropical area). Screws can be made of nickel plated brass with slot head type, or can be made of zinc plated steel with pozidrive nr. 1 head type. The conductors can be fixed with two screws per terminal.

An universal clamping terminals at direct connected meters assure the same quality of the contact irrespective of the shape of the connection conductor (a compact wire, a stranded wire, of greater or smaller cross-sections). They also assure faster meter assembly.

Current terminals:

- current terminals for direct connected have 8,5mm hole diameter for 85A terminal block and 9,5mm hole diameter for 120A terminal block,
- current terminals for MT381-T1 meters have 5mm hole diameter.

The meter is equipped with max. four additional voltage terminals - 2 (L1), 5 (L2), 8 (L3) and 11 (N). They enable simple connection of additional external devices. See Figure 3 and Figure 5.

At ME381 and direct connected MT381 meters the voltage terminals and screws are made of zinc plated steel. AT MT381-T1 meters voltage terminals are made of brass, which can be protected with nickel for the areas with extreme climatic conditions (e.g. tropical area) while screws are made of zinc plated steel.

4.2.2 Meter cover

Meter cover is made of transparent high quality self-extinguishing UV stabilized polycarbonate that can be recycled. Mx381 meter is equipped with meter cover opening detector.

4.2.3 Terminal cover

The meter terminal cover covers the meter terminal block. It is made of non-transparent high quality self-extinguishing UV stabilized polycarbonate that can be recycled. The Mx381 meter is equipped with terminal cover opening detector. On the inner side of the terminal cover there is the place for the connection diagram, which is in the form of the label. For meter connection diagrams see Chapter 3.4.

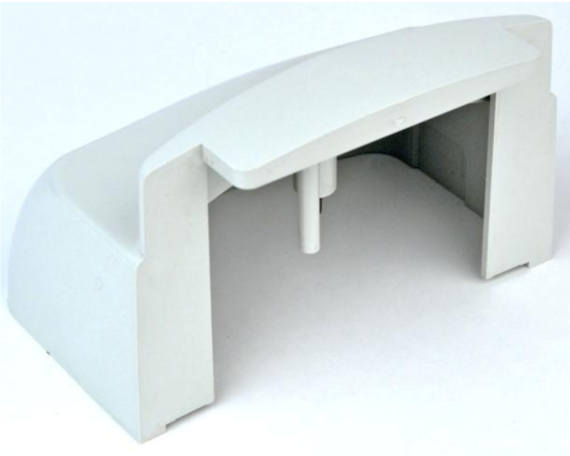


Figure 24: Terminal cover for ME381 meter

Figure 25: Short terminal cover for MT381 meter

Figure 26: Long terminal cover for MT381 meter

Figure 27: Terminal cover for MT381 meter with disconnector unit

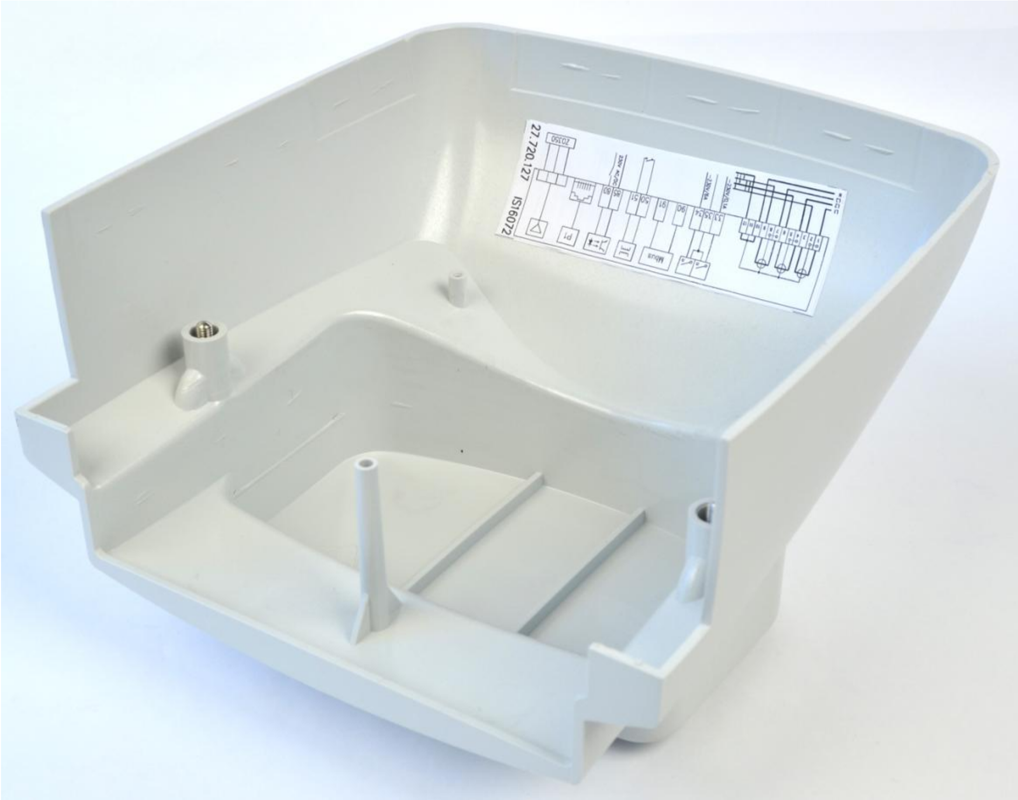


Figure 28: Meter connection diagram on the inner side of the terminal cover

4.2.4 Sealing

The meter cover can be sealed with two sealing screws. The lid on the front side, which covers set key, can be sealed separatelly. The terminal cover can also be sealed: with one sealing screw at ME381 meter and two sealing screws at MT381 meter.

Figure 29: Positions of the seals at ME381 meter

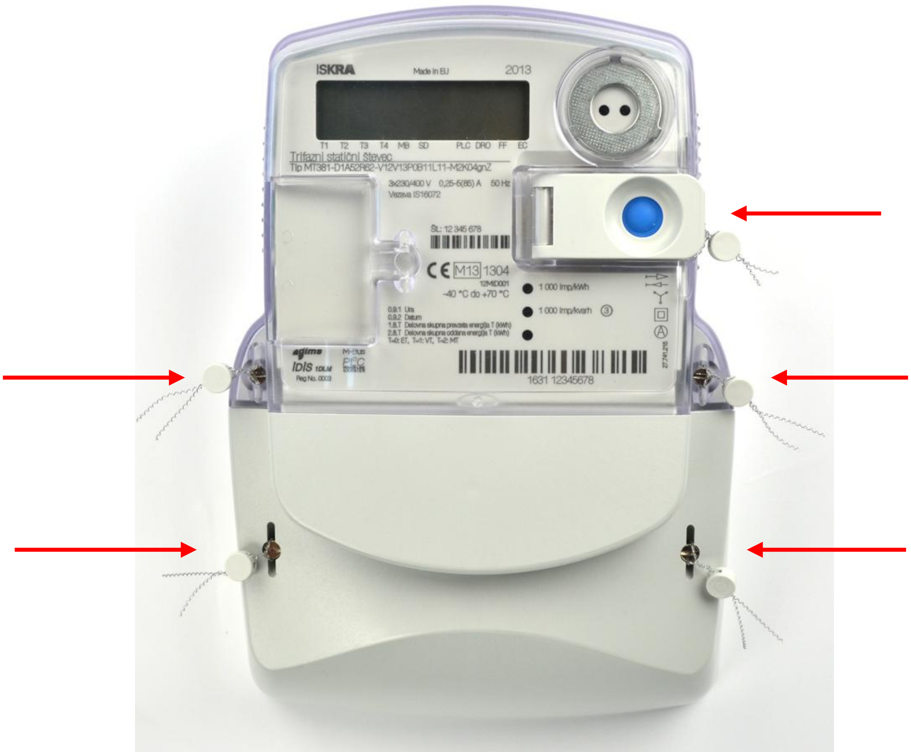


Figure 30: Positions of the seals at MT381 meter

4.3. Front plate

The front plate of ME381 meter is shown on the following two figures:

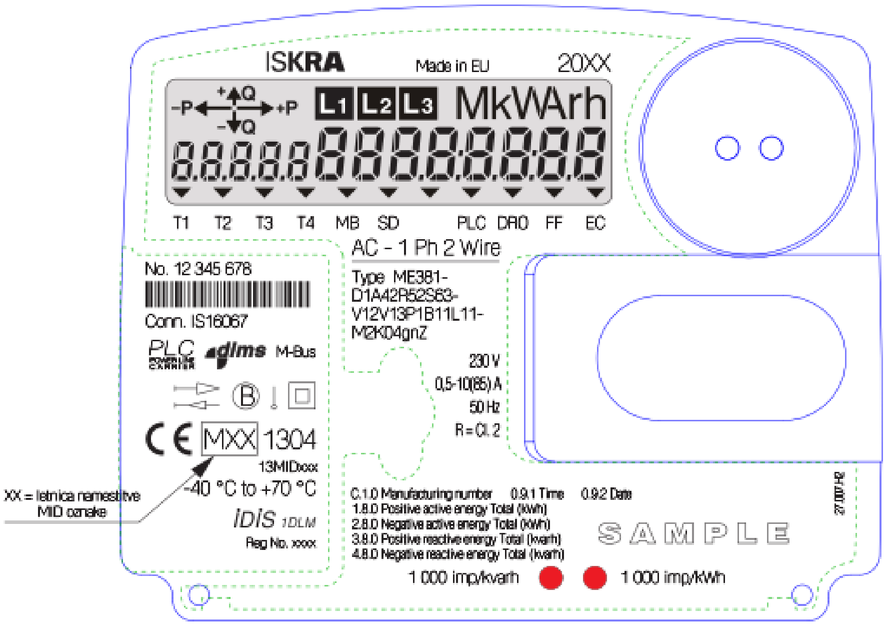


Figure 31: ME382 – DIN front plate

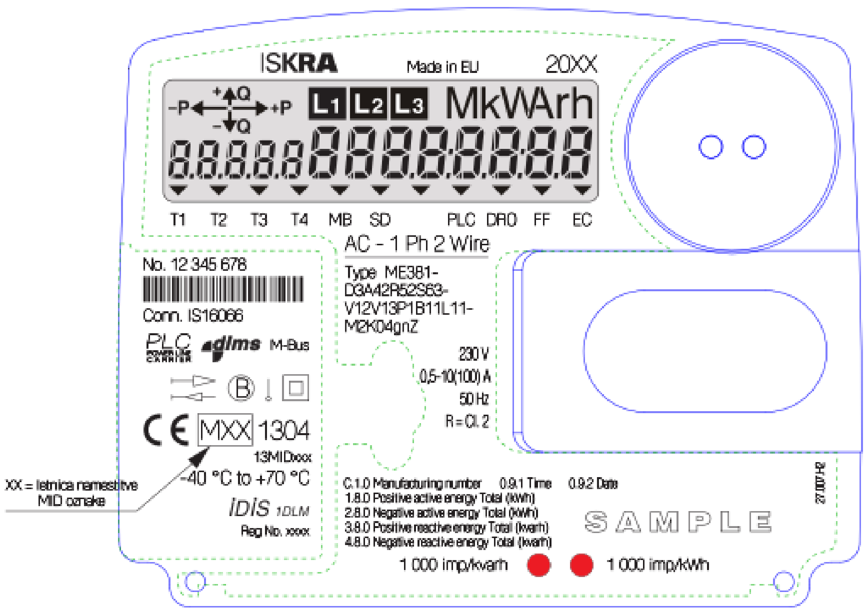


Figure 32: ME381 – BS front plate

The following three figures show the name plate of three different variants of MT381 meters:

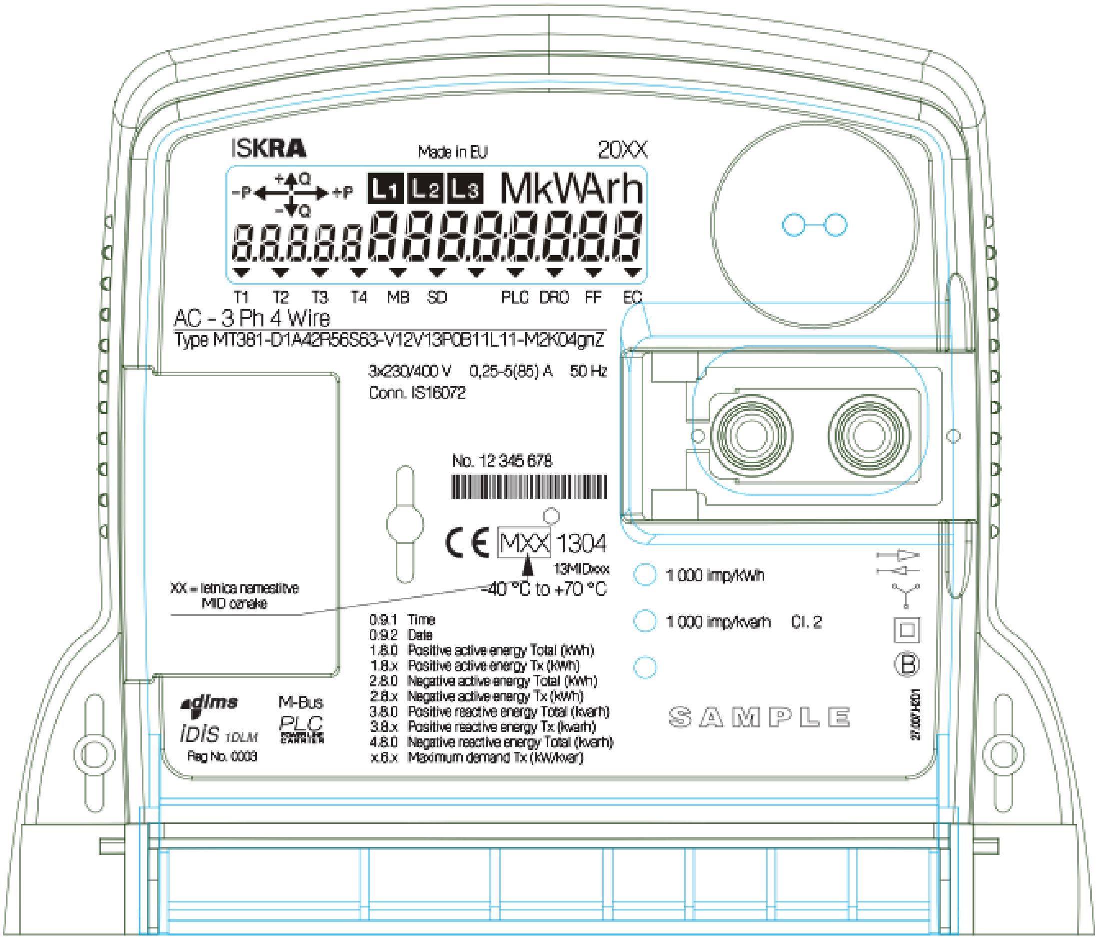


Figure 33: MT381-D1 front plate

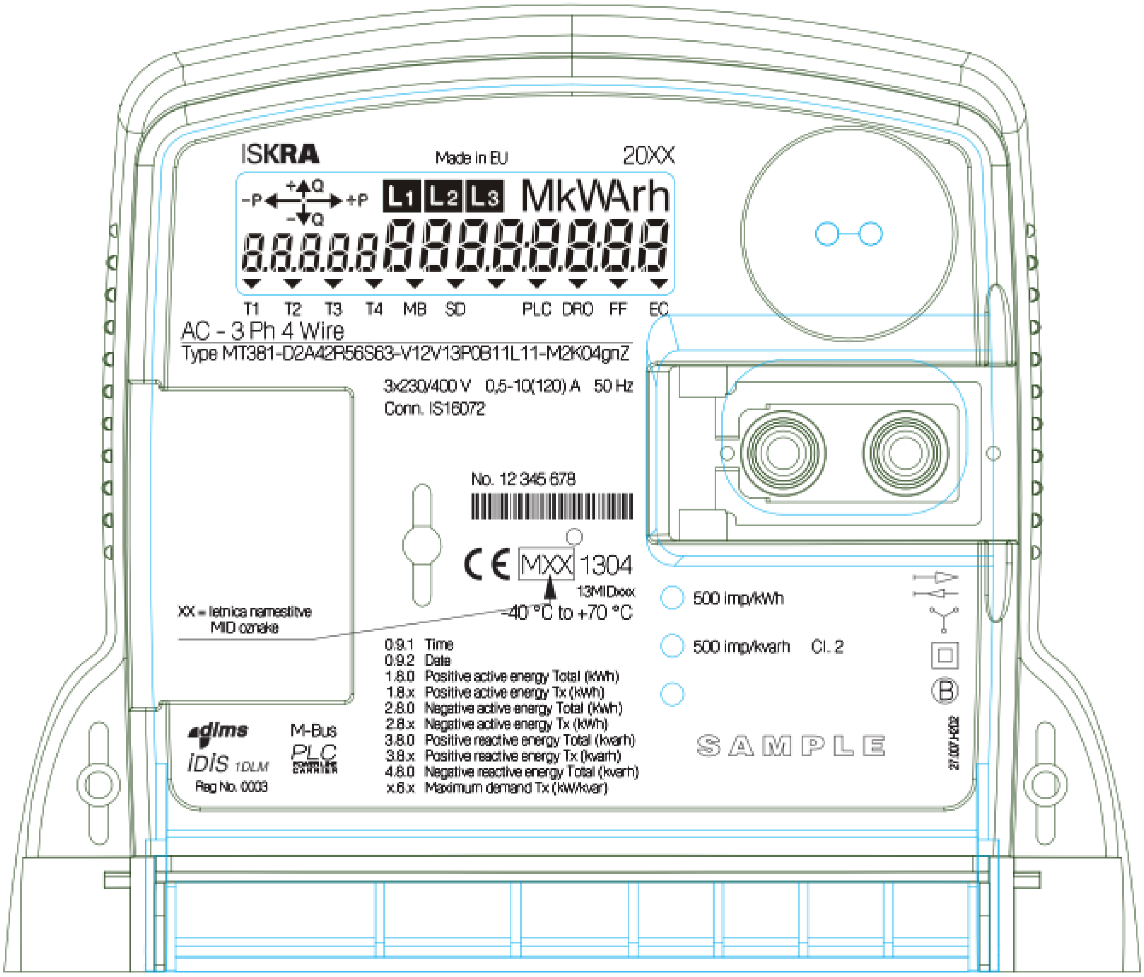


Figure 34: MT381-D2 front plate

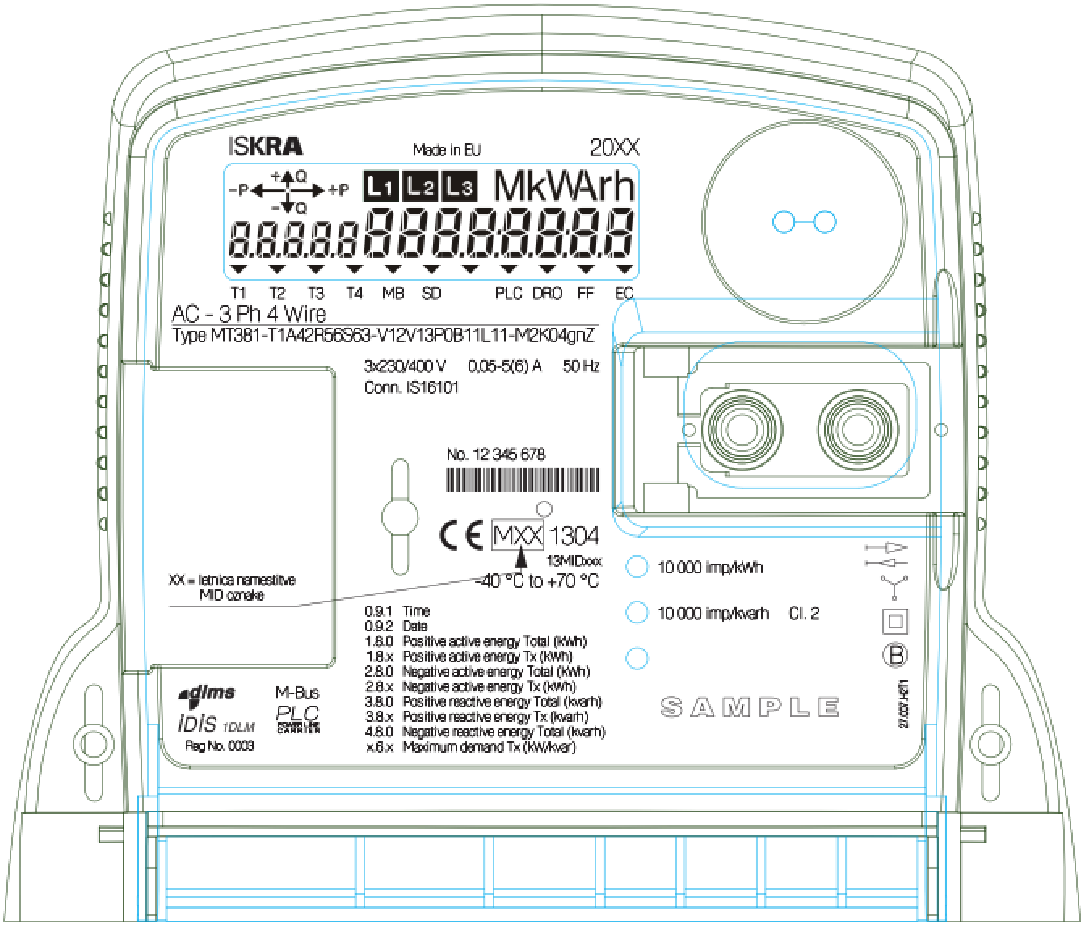


Figure 35: MT381-T1 front plate

4.4. Console keys

Main features on the meters console are LCD, two LED's and two keys. Every meter has them integrated.

4.4.1 LCD

The seven-segment liquid crystal display (LCD) complies with the VDEW requirements.

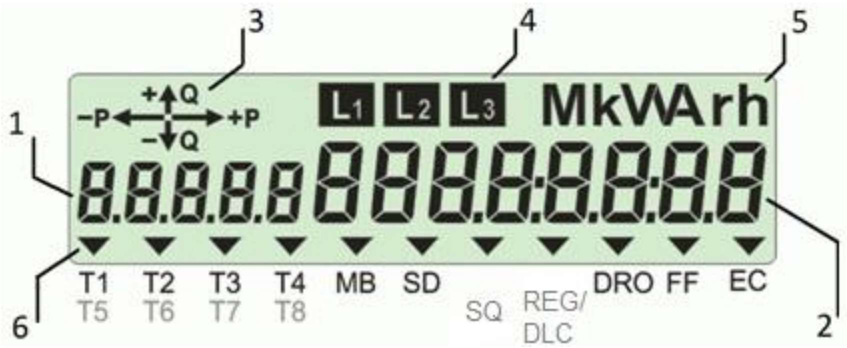


Figure 36: Full Mx381 LCD – display fields

Item	Description
1	Alphanumeric field 1 – Small five 7-segment digits – OBIS identification code presentation
2	Alphanumeric field 2 – Large eight 7-segment digits – Data value presentation.
3	Power flow direction cursors
4	Voltage presence by phases indicators
5	Physical unit field of the currently displayed data
6	Cursors

4.4.1.1. Alphanumeric fields

Alphanumeric field 1 is used for presentation the OBIS identification codes of the displayed data (in accordance with DIN 43863-3). The hight of characters is 6mm and width is 3mm.

Alphanumeric field 2 is used for presentation the data value. The hight of characters is 8mm and width is 4mm.

4.4.1.2. Display test state

In display test state all segments are displayed.

Figure 35 shows the display in the test state.

4.4.1.3. Power flow direction cursors

There are four power flow direction cursors on the display:

- Positive reactive power flow (+Q),
- Positive active power flow (+P),
- Negative reactive power flow (-Q),
- Negative active power flow (-P).

4.4.1.4. Phase indicators

Segments L1, L2 and L3 show indicated phases on meter. Blinking segments represents wrong phase sequence connection.

4.4.1.5. Physical unit field

Physical unit field shows units of currently displayed data.

4.4.1.6. Characters

Characters, which can be represented on a display, are listed below. Alphanumeric fields have a 7-segment display shape. There are also some additional dot fields. Alphanumeric characters are used to display values, tariff name, consumer message, signatures, etc.

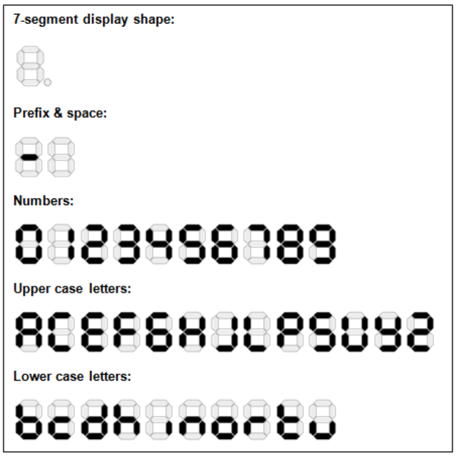


Figure 37: Characters represented on a display

Available characters, which can be represented on a display:

“-”, “ ”

“0”, “1”, “2”, “3”, “4”, “5”, “6”, “7”, “8”, “9”,

“A”, “B”, “C”, “D”, “E”, “F”, “G”, “H”, “I”, “J”, “L”, “N”, “O”, “P”, “R”, “S”, “T”, “U”, “Y”, “Z”
(Letters B, D, I, N, O, R, T, will be displayed as b, d, i, n, o, r, t)

“a”, “b”, ”c”, “d”, “e”, “f”, “g”, “h”, “i”, “j”, “l”, “n”, “o”, “p”, “r”, “s”, “t”, “u”, “y”, “z”
(Letters a, c, e, f, g, j, l, p, s, y, z will be displayed as A, C, E, F, G, J, L, P, S, Y. Z)

4.4.1.7. Cursors

On the front plate below the LCD display meter has laser printed markings that belong to the cursors on the LCD. The cursor shows the state of certain function that it represents e.g. tariff, registration, disconnector status, meter fault...

Flags (cursors) in the lower bar readout have the following meaning (from left to right):

Flag	Name	Not displayed	Displayed	Blinking
1	T1/5		Active first tariff	Active fifth tariff / param switch off *
2	T2/6		Active second tariff	Active sixth tariff / param switch off *
3	T3/7		Active third tariff	Active seventh tariff / param switch off *
4	T4/8		Active fourth tariff	Active eighth tariff / param switch off *
5	MB	No M-Bus device installed	At least one M-Bus device installed	
6	SD	Disconnector inactive (connection)	Disconnector active (disconnection)	
7	-			
8	DLC	Meter not logged in the DLC network	Meter logged in the DLC network	
9	DRO		Meter data down-loading is in progress	Data package is present in the AMR communication network
10	FF	No fault	“Fatal“ fault	
11	SET	Normal operation mode		
	EC		Emergency Credit active	Emergency Credit threshold limit expired

Table 24: LCD cursors

Figure 38: LCD cursors

4.4.1.8. Display format

Two objects are used to configure format for energy and demand values on display. Up to eight digits are used to display a value and up to three of them can be used for decimal precision. On display active energy is represented in (kWh), reactive energy in (kvar), apparent energy in (var) and demand in (kW).

Format is a single octet value where first nibble of value (upper half of byte) represents the width of the value (a number of digits for value presentation on display), and last nibble of value (lower half of byte) represents the precision of the value (a number of decimal digits for energy presentation on display). See examples below.

For effective use of functionalities, meter must be properly configured.

Display format examples:

- 60 – 6 digits, 0 decimals

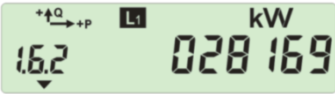


Figure 39: Displaying value with format “60“

- 82 – 8 digits, 2 decimals

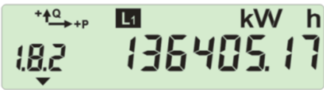


Figure 40: Dislpaying value with format “82“

Also negative registers can be presented on display. For those values the minus is attached in front of the most significant digit, if width of displayed value is smaller than 8 (digits < 8).

- 42 – 4 digits, 2 decimals

Figure 41: Displaying negative value with format “42“

If all digits are used (digits = 8), the minus sign is attached on a place of the most significant digit. Therefore this digit is cut off, which may result in the loss of data.

- 80 – 8 digits, 0 decimals

Figure 42: Displaying negative value with format “80“

If configured format width is smaller than register value it results in the loss of data on display.

- 42 – 4 digits, 2 decimals.
- register value: -35790 W……….displayed value is OK.
- register value: -1435790 W……displayed value is limited to format width (two most significant digits are missing).

Figure 43: Displaying negative value with improper format “42“ according to register value

The objects, that are not intended to show on the display, will not be displayed, if they are included in General display readout list (0-0:21.0.1) or in Alternate display readout list (0-0:21.0.2). The message code Error 11 (Ident format failed) will be displayed instead.

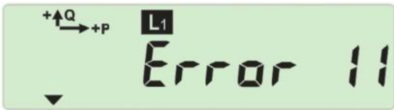


Figure 44: Ident format failed message

4.4.1.9. OBIS name on display

There are 5 digits reserved for OBIS name presentation on the left side of the display. OBIS name is always displayed from the first digit on the left.

In general there are two types of OBIS name format:
- Short OBIS name format: C.D.E
- Full OBIS name format: A.B.C.D.E

For presentation on the display the short OBIS name format is used: C.D.E. There are some exceptions, when extended OBIS name is displayed:
- A.B.C.D.E format is used for presentation of the following objects:
  - Core identification (1.0.0.2.0)
  - Module identification (1.1.0.2.0)
  - Core signature (1.0.0.2.8)
  - Module signature (1.1.0.2.8)
- B.C.D.E format is used for presentation of the objects with field B ≠ 0.

Up to 5 characters of OBIS name can be displayed. There are some abbreviation characters used for the specific multi-character fields of OBIS name:

Multi-character field	Abbreviation character
96	C
97	F
98	L
99	P
128	U

Table 25: OBIS name abbreviation characters

4.4.1.10. Error codes on display

In certain cases an error message can appear on display. The error codes that can be seen on display are listed in a table below:

Error code	Error description
Error 11	Ident format failed
Error 23	Ident not existing
Error 31	Value format failed

Table 26: Error codes on display

4.4.1.11. Console period

Three console period timings are defined in meter which are all fixed and cannot be changed:

- exit period after last pressed key (default is 120s),
- auto scroll period (default is 10s),
- backlight lit time after pressed key (default is 30s).

4.4.1.12. Horizontal scroll

Presentation of strings on display is performed with horizontal scroll, if the size of string is larger than the size of alphanumeric field for value on display (8 characters). Horizontal scroll shift period is one second. When the horizontal scroll is performed in Auto scroll mode, the auto scroll period (10s) is extended until end of the string is reached.

4.4.1.13. Tariff on display

Active tariff is indicated on display by an appropriate cursor, as it is defined above. For details see Chapter 4.4.1.7.

Active tariff can also be displayed with a dedicated name. For this purpose the Currently active energy tariff object (0-0:96.14.0) needs to be set in:

- General display readout list (0-0:21.0.1) for use in Auto-scroll mode sequence or
- Alternate display readout list (0-0:21.0.2) for use in Manual-scroll mode sequence.

Active tariff name can be constructed with the characters that are supported for presentation on display.

Limitations:

- Maximum number of characters used for tariff name is 8. If more than 8 characters are used, the meter will reject the entry.
- Characters that are not supported for presentation on LCD, will be shown as blank segments.
- Value of Currently active energy tariff object (0-0:96.14.0) is seen in hex format.
- Active tariff name has to be set in dedicated objects with setting file (.ncs):
  - Register activation object (0-0:14.0.1) – Active mask.
  - Tariffication script table object (0-0:10.0.100) – Parameter.
- Active tariff name has to be set in ASCII format to be presented on display. Otherwise the value is ignored for presentation on display and is shown as blank digits.
- Default value of the Active tariff name (0001, 0002, …, 0008) is not set in ASCII format, therefore are not suitable for presentation on display.

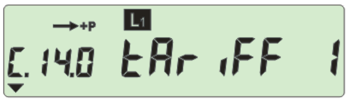


Figure 45: Tariff on display

For effective use of functionalities, meter must be properly configured.

4.4.1.14. Signature on display

- Active firmware module signature object: 1-1:0.2.8,
- Active firmware core signature object: 1-0:0.2.8,
- Full OBIS code presentation is used for Active firmware module/core signature objects.
- Firmware module/core signature presentation on display is performed with horizontal scroll, if the size of signature string is larger than the size of alphanumeric field for value on display (8 characters).
- Horizontal scroll shift period is one second.

Figure 46: Signature on display

4.4.2 Metrological LEDs

The meter is provided with two red colored LEDs on the front plate. They are intended for checking the meter accuracy. Impulse constant depends on the meter version.

MT381

- upper LED indicates active energy flow,
- middle LED indicates reactive / apparent energy flow.

ME381

- right LED indicates active energy flow,
- left LED indicates reactive / apparent energy flow.

In normal meter operation mode LEDs emit pulses with frequency that is proportional to the measured power and is intended for the meter calibration and testing. The LEDs are turned-on and glows steadily if load is lower than the meter starting current.

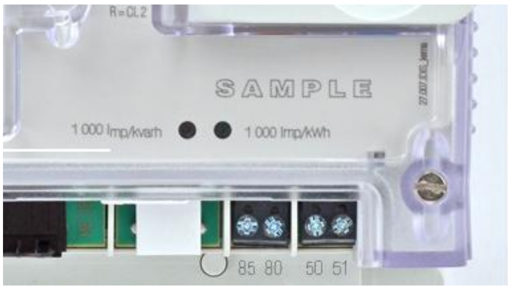


Figure 47: LEDs at ME381 meter

Figure 48: LEDs at MT381 meter

4.4.3 Keys

There are two keys on every meters front side:

- **Scroll** key – the blue key that is always accessible. Its primary function is to scroll data from the Manual scroll sequence on the LCD.

- **Reset** key – the orange key that is under the lid with a hinge and can be sealed independently from the meter cover.

Figure 49: **Reset** and **Scroll** key

Depending on the time of releasing the keys and a combination of released keys, the different actions can be made by the console:

- menu navigation,
- scrolling of metering results and other data,
- starting procedure to searching connected M-Bus devices,
- testing the LCD,
- meter reset execution to reset the meter parameters.

The **Scroll** key (blue) is sensitive to key press duration, therefore the key action is depended on key release time. There are also some differences in key press actions, either Reduced or Normal console menu type is active.

4.4.3.1. Reduced console menu type

Reduce console menu type is activated by the Display configuration object (0-0:196.1.3).

For effective use of functionalities, meter must be properly configured.

Use of Scroll Key
The **Scroll** key enables three different types of key press, depending on duration:

- Short press → time of key depression shorter than 2s:
  Next data in the manual sequence is displayed.
- Long press → time of key depression longer than 5s:
  Displayed submenu or function is selected,
- Extended press → time of key depression longer than 8s:
  Enter to menu.

The **Scroll** key functions are:

- LCD display test performing,
- displayed list data view,
- switching to the meter test operation mode,
- disconnector disconnection or reconnection,
- short time press scrolls the display,
- long time press enables to perform different function such as disconnector connection / disconnection or emergency credit selection.

Use of Reset Key

The **Reset** key is locked up by a seal. It is used to execute the reset of parameters, by the specific procedure under specific conditions.

Menu navigation

When the Reduced console menu type is active, the user interface has only two modes: Auto-scroll mode and Manual-scroll mode. The first one shows data stated in a list in the 'General display readout' object (0-0:21.0.1). Transition between the displays of individual data from a list is performed automatically. By short pressing the **Scroll** key the program goes to the Manual-scroll mode, where data are listed by successive pressing the **Scroll** key. A data list that can be checked in the Manual-scroll mode is stored in the 'Alternate display readout' object (0-0:21.0.2). A disconnector connection / disconnection or emergency credit selection can be done with the **Scroll** key.

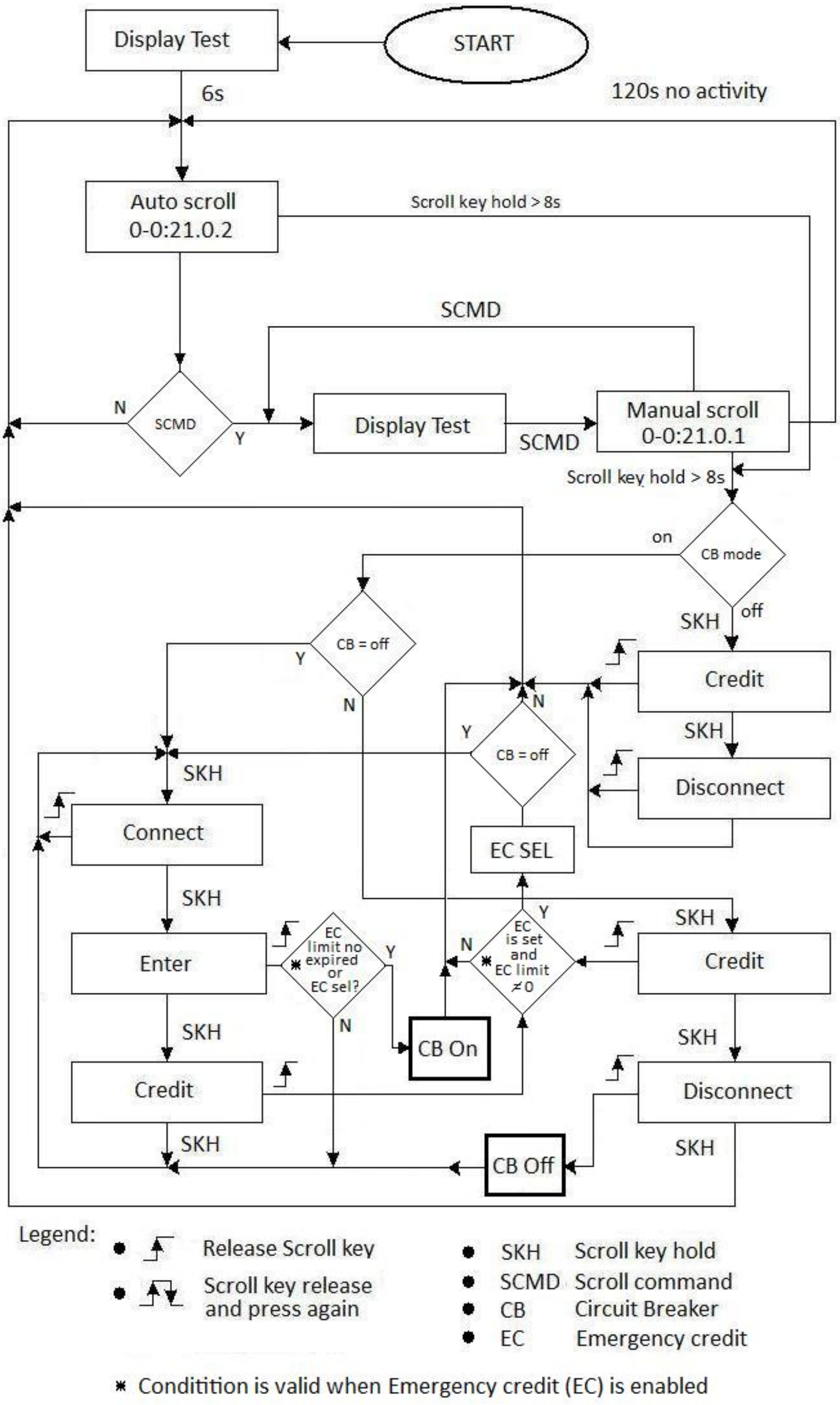


Figure 50: Menu navigation diagram for reduced console

4.4.3.2. Normal console menu type

Normal console menu type is activated by the Display configuration object (0-0:196.1.3).

For effective use of functionalities, meter must be properly configured.

Use of Scroll key and Reset key

Key press	Press duration	Triggering event	Tip on display
Scroll key			
Short press	Tp < 2s	Scroll forward / Go to the next item	/
Long press	2s ≤ Tp < 5s	Enter to the current item / Go to the lower layer	EntEr
		Return to the upper layer at the End of list / Return to the upper layer from the lowest layer	LAYEr UP
		Return to the Auto-scroll mode at the End of list in Set menu / Data menu	ESC
Extended press	Tp ≥ 5s	Escape to the Auto-scroll mode from any mode	ESC
Reset key			
Short press	/	Enter to the Set menu from the Display test state	/

Table 27: Use of keys – normal console menu type

Key	Key press	Press duration	Key label
Scroll key	**S**hort press	Tp < 2s	SS
	Long press	2s ≤ Tp < 5s	SL
	Extended press	Tp ≥ 5s	SE
Reset key	**S**hort press	Tp < 2s	RS
	Extended press	Tp ≥ 5s	RE

Table 28: Key labels

Menu navigation

When the Normal console menu type is active, the user interface has two menus that are accessed from the Display test state. The Display test state is entered from the Auto-scroll mode by a short press on Scroll key (see figure below):

- Data menu (general use),
- Set menu (limited use).

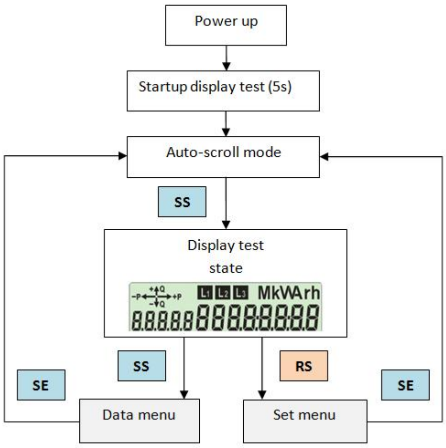


Figure 51: Entering the Data/Set menu

4.4.3.3. Data menu

Data menu is accessed from the Display test state by a short press on **Scroll** key. There are several items supported for presentation in Data menu on display. The first item is Manual-scroll mode (Std data). It is fixed and can not be disabled. Other items are optional and can be configured by the Display configuration object (0-0:196.1.3). In Data menu the following items are listed in order:

- Std data – Manual-scroll mode,
- P.01 – Load profile with period 1 (optional),
- P.02 – Load profile with period 2 (optional),
- End – end of list.

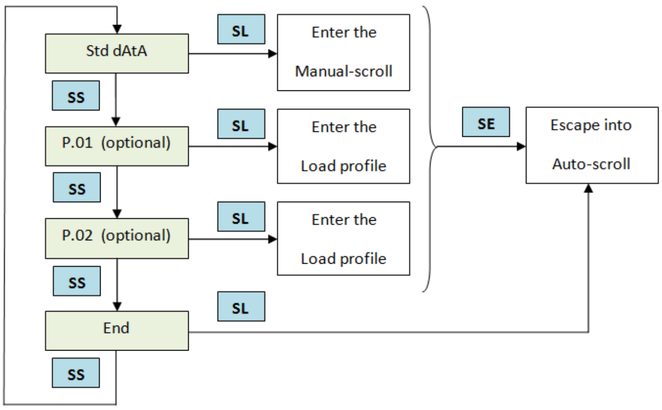


Figure 52: Data menu navigation

4.4.3.4. Set menu

Set menu is accessed from the Display test state by a short press on **Reset** key, which is protected with a seal. In Set menu the following items are listed in order:

- Reset – Reset mode – reset of parameters, by the specific procedure under specific conditions,

- Lcd test – Lcd test mode – display unit test,
- End – end of list.

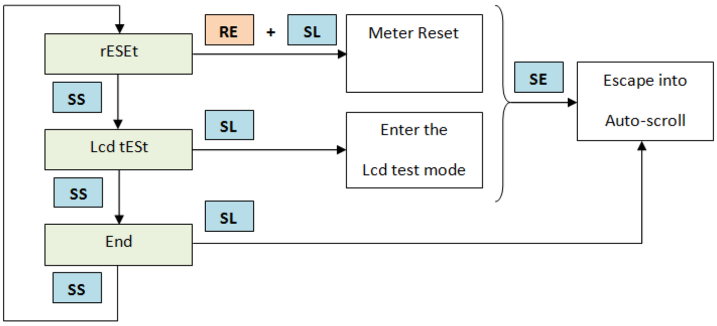


Figure 53: Set menu navigation

4.4.3.5. Auto-scroll mode

Auto-Scroll mode is implemented in the following way:

- Auto-scroll mode is general meter mode, where the items listed in General display readout object (0-0:21.0.1) are cyclically displayed on LCD.
- Auto-scroll time is a compile-time parameter and is set to 10 seconds.

General display readout object (0-0:21.0.1) is an instance of COSEM Profile Generic class, where only Capture Objects attribute is relevant (or other attributes are not used).

For effective use of functionalities, meter must be properly configured.

4.4.3.6. Manual scroll mode

Manual-Scroll mode is implemented in the following way:

- Manual-scroll mode is used for manual data review on display.
- Displayed items are listed in Manual-scroll mode sequence list, defined by Alternate display readout object (0-0:21.0.2).
- Manual-scroll mode is accessible from the Data menu by a long press on **Scroll** key at the Std data item, when tip Enter is shown. Then the first item from the sequence list is displayed.
- The next item from the sequence list is displayed by a short press on Scroll key.
- At the end of sequence the End notice is displayed.
- Return to the Data menu is performed by a long press on **Scroll** key, when tip Layer up is shown.
- Escape in Auto-scroll mode is performed by an extended press on **Scroll** key, when tip Esc is shown.

Alternate display readout object (0-0:21.0.2) is an instance of COSEM Profile Generic class, where only Capture Objects attribute is relevant (or other attributes are no used).

For effective use of functionalities, meter must be properly configured.

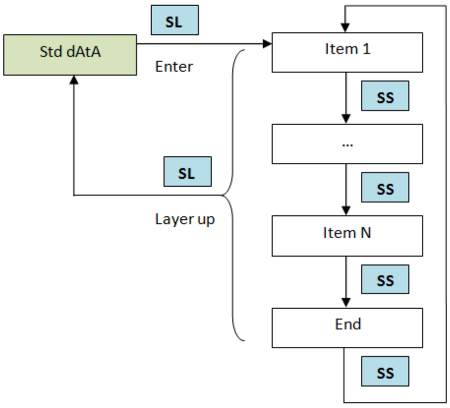


Figure 54: Manual-scroll mode navigation

4.4.3.7. Load profile on display (P.01, P.02)

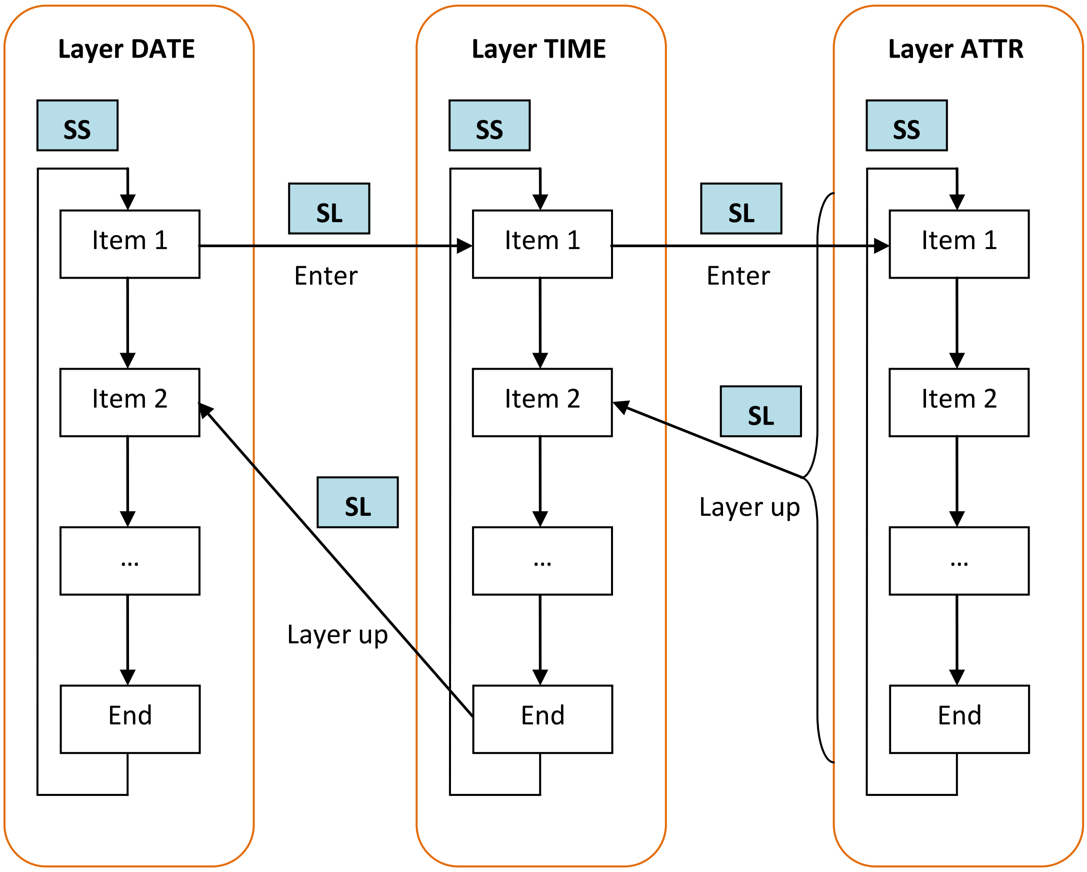
Presentation of Load profile on display is optional and can be enabled by a bit–parameter in the Display configuration object (0-0:196.1.3). Load profile presentation is accessible from the Data menu by a long press on **Scroll** key at the P.01 / P.02 item, when tip Enter is shown. There are two types of Load profile supported:

- P.01 – Load profile with period 1,
- P.02 – Load profile with period 2.

Load profile presentation on display follows VDEW specifications in general. Load profile is presented on display in three layers:

- layer DATE (upper layer),
- layer TIME (middle layer),
- layer ATTR (attribute) (lower layer).

For effective use of functionalities, meter must be properly configured.



Display forms by layers:

P.0X	YY.MM.DD

P.0X	DD.hh:mm

C.10.1	1
1.8.0	000000

Legend:

YY	→	Year	hh	→	hours
MM	→	Month	mm	→	minutes

Figure 55: Load profile on display navigation

4.4.3.8. LCD test mode

LCD test mode is used for testing purposes to perform LCD unit test. LCD test mode is accessed from the Set menu by a long press on **Scroll** key at the Lcd test item, when tip Enter is shown.

- There are four LCD test conditions (all, odd, even, none segments), which can be scrolled by a short press on **Scroll** key.
- Return to the Set menu is performed, when all LCD test conditions are scrolled.
- It is also possible to return to the Set menu from any LCD test condition, by a long press on **Scroll** key, when tip Layer up is shown.
- Escape into the Auto-scroll mode is performed by an extended press on **Scroll** key, when tip Esc is shown.

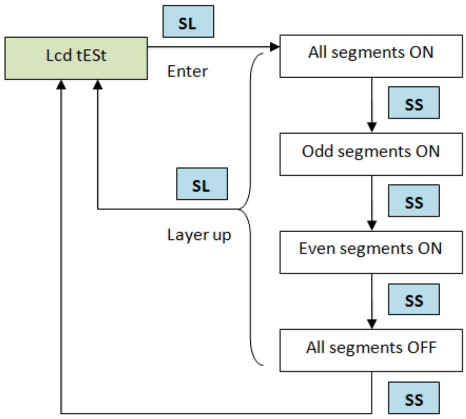


Figure 56: LCD test mode navigation

4.4.3.9. Meter reset

Sealed reset key cover must be opened to access the reset key.

Reset and **Scroll** keys are used to reset the meter by pressing appropriate keys, following predefined time sequences. The meter has to be unlocked (param switch on). The pressing keys are tracked by messages on display.

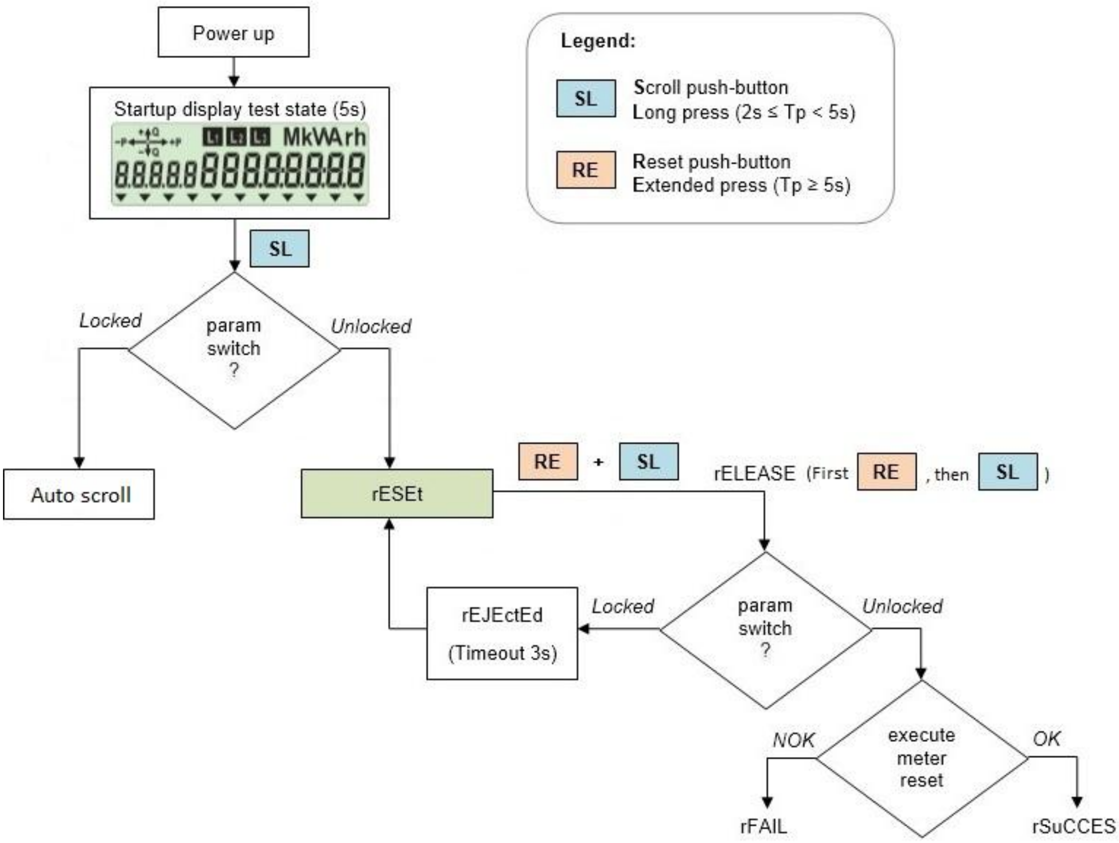


Figure 57: Meter reset procedure

Meter reset is performed by the following procedure:

- Power-up the meter.
- Within 5 seconds after power-up, when the Startup display test is performing, long press the **Scroll** key (2s ≤ Tp < 5s) to enter the Reset mode. The display indicates rESEt.
- Press the **Reset** key and hold it, then simultaneously press and hold the **Scroll** key.
- Wait until the display indicates rELEASE, that is approximately 5 seconds after pressing the **Reset** key.
- Release the **Reset** key first and then the **Scroll** l key, to execute the meter reset.
- The parameter switch has to be open. Otherwise the meter reset execution is rejected and the display indicates rEJEctEd for 3 seconds. Then the meter returns to Reset mode.

If the meter reset was successfully executed, the display indicates rSuCCESS, otherwise it indicates rFAIL.

4.4.4 Display data codes

Basic data that can be displayed are listed in the table below. OBIS identification for those data registers are presented on display in reduced format because the display has only five digits available for code presentation. Which of the registers will be displayed depends on the meter type. Some examples of the registers are listed in following table.

Code	Data description
0.0.0	Meter serial number
C.1.0	Meter manufacturer number
0.9.1	Time
0.9.2	Date
1.8.0	Total imported active energy (A+)
1.8.1	Imported active energy in the 1st tariff (T1)
1.8.2	Imported active energy in the 2nd tariff (T2)
1.8.3	Imported active energy in the 3rd tariff (T3)
1.8.4	Imported active energy in the 4th tariff (T4)
15.8.0	Total absolute active energy |A|
15.8.1	Absolute active energy in the 1st tariff |T1|
15.8.2	Absolute active energy in the 2nd tariff |T2|
15.8.3	Absolute active energy in the 3rd tariff |T3|
15.8.4	Absolute active energy in the 4th tariff |T4|
2.8.0	Total exported active energy (A-)
2.8.1	Exported active energy in the 1st tariff (T1)
2.8.2	Exported active energy in the 2nd tariff (T2)
2.8.3	Exported active energy in the 3rd tariff (T3)
2.8.4	Exported active energy in the 4th tariff (T4)
1.6.0	Total A+ imported maximum demand
2.6.0	Total A- exported maximum demand
F.F.0	Meter fatal error

Table 29: Display register codes

For effective use of functionalities, meter must be properly configured.

4.5. Voltage bridge

A sliding voltage bridge (only on MT381 direct connected meters) is intended for fast and simple separation of meter current and voltage circuit used for calibration or accuracy testing. A special slider is built in each phase of the connection terminal. It can be shifted up and down with a screwdriver.

When a voltage bridge is in “0” position, it means that the voltage part is separated from the current part. During the meter testing and calibration the sliding voltage bridges should be in position “0”.

When a voltage bridge is in position “1” the voltage part is not separated from the current part. During the normal meter operation the potential links should be closed (position “1”). Upon request, the potential links can be built under the meter cover.

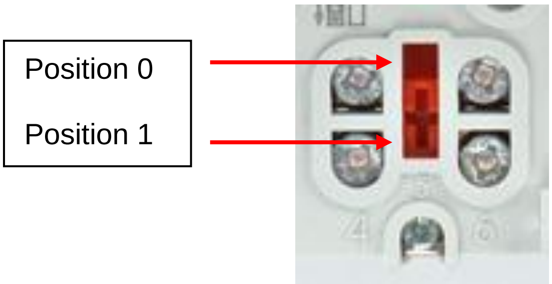


Figure 58: Sliding voltage bridge

5. Mx381 meter constituent parts

5.1. Mx381 meter type designation

ME381 - D1A42R56S63 - V12V13P1B11L11 - M2K04gnZ

ME																Single-phase electronic meter
MT																Three-phase three-system electronic meter
	381															With built-in DLC modem
		-														Separator
			D1													Terminal block: Imax=85A
			D2													Terminal block: Imax=120A (MT381 only)
			D3													Terminal block: Imax=100A (ME381 only)
			T1													Terminal block up to 6 A (MT381 only)
				A4												Active energy measurement, accuracy class 1
				A5												Active energy measurement, accuracy class 2
					1											Energy measurement in one direction
					2											Energy measurement in two directions
					4											Absolute energy measurement
				R5												Reactive energy measurement, accuracy cl. 2
				R6												Reactive energy measurement, accuracy cl. 3
					1											Energy measurement in one direction
					2											Energy measurement in two directions
					6											Energy measurement in all 4 quadrants in both directions
				S5												Apparent energy measurement, accuracy cl. 2
				S6												Apparent energy measurement, accuracy cl. 3
					3											Energy calculated as SQR (P^2+Q^2)
						-										Separator
							V									Control inputs
								1								No. of inputs
									2							High voltage control - 230V
									3							No voltage control - transformer
							P									Integrated disconnector
								0								Three phase disconnection - external
								1								One phase disconnection - internal
							B									High voltage output – relay type
								1								One relay contact output
									1							Relay contact output with make contact
							L									High voltage output – OptoMOS type
								1								One control output
									1							Control output with make contact
										-						Separator
											M					Internal clock
												2				Back-up power supply – super capacitor
												3				Back-up power supply – battery
													K			Communication interface
														0		Optical interface (IEC62056-21)

														4		**PLC communication**
														g		**M-Bus comm. interface – master**
														n		**P1 port**
															Z	**Load profile**

Table 30: Meter type designation

5.2. Inputs and outputs

Every meter has built in input/output terminals. They are driven through the meter firmware functionality and can have different shared functions on the same pin through the specific configuration. Some functions (for hardware reasons) are not available on all meters. Functions can be used to operate with:

- Relay output,
- OptoMOS output,
- Outputs for active disconnector (SD),
- Alarm input,
- External key input / No voltage external key input.

For effective use of functionalities, meter must be properly configured.

5.2.1 Relay output - load

Load Control registers are used to configure bi-stable relay output with maximum capability of 6A at 250V. Load control terminals are:

- 34 – Relay output,
- 35 – Common.

Figure 59: Load control terminal

This output can also be triggered via tariff program. Tariffication script table needs to be configured accordingly.

Note!
When power-down occurs and relay state is on with power on delay mode enabled, power-up will cause the relay to switch off for the time set in load control power on delay before it switches back to on state!

5.2.1.1. Load control delay mode

With Load Control Mode different types of switching can be set. Available mode options are:

- (0) – Normal,
- (1) – Switch on Delayed,
- (2) – Switch on Random Delayed,
- (3) – Switch On Delayed with Power on Delay,
- (4) – Switch On Delayed with Power on Random Delay,
- (5) – Switch On Random Delayed with Power on Delay,
- (6) – Switch On Random Delayed with Power on Random Delay.

5.2.1.2. Load control power on delay

This register defines relay power up delay time, before it is switched on. Delay time is set in seconds. Used for grid power balance, when power returns.

5.2.1.3. Load control switch on delay

This register defines relay switch on delay time, before relay is switched on. Delay time is set in seconds. Used for grid power balance on tariff action relay on.

5.2.1.4. Load management relay control 1

This object controls relay state machine. By default outputs are in disconnected state.

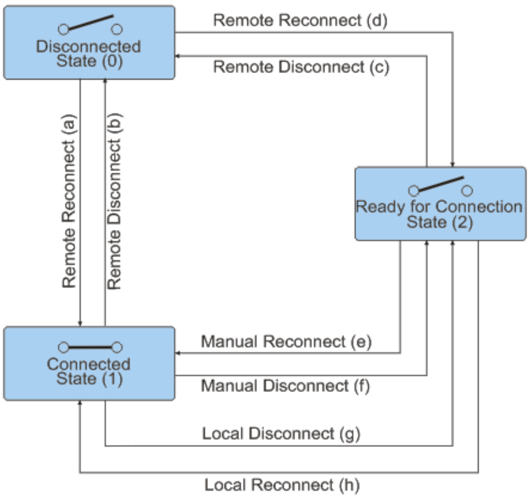


Figure 60: Relay state transitions

Mode	Description	
0	None. The disconnect control object is always in ‘connected’ state	
2	Disconnection:	Remote (b, c) Local (g)
	Reconnection:	Remote (a)
4	Disconnection:	Remote (b, c) Local (g)
	Reconnection:	Remote (a)
5	Disconnection:	Remote (b, c) Local (g)
	Reconnection:	Remote (d) local (h)
6	Disconnection:	Remote (b, c) Local (g)
	Reconnection:	Remote (d) Local (h)

Table 31: Disconnect modes

Note!
To perform the switchover, methods described below should be executed (remotely or locally). Manual transitions are not possible on relay object.

5.2.2 OptoMOS output - service

Service Control registers are used to configure OptoMOS output with maximum capability of 0,1A at 250V. Service control terminals are:

- 33 – OptoMOS output,
- 35 – Common.

Figure 61: Service control terminal

To configure service control function an object of COSEM Class Data is introduced. Service Control Functionality object define a function of service control. If metropulse output function is selected other service control parameters have no influence on behavior of OptoMOS output.

This output can also be triggered via tariff program. Tariffication script table needs to be configured accordingly.

5.2.2.1. Service control functionality

With Service Control Functionality different types of functions can be selected. Available function options are:

- (0) – Switching,
- (1) – Metropulse output (see Chapter 3.6.2),
- (otherwise) – Reserved.

5.2.2.2. Service control delay mode

With Service Control Mode different types of switching can be set. Available mode options are:

- (0) – Normal,
- (1) – Switch on Delayed,
- (2) – Switch on Random Delayed,
- (3) – Switch On Delayed with Power on Delay,
- (4) – Switch On Delayed with Power on Random Delay,
- (5) – Switch On Random Delayed with Power on Delay,
- (6) – Switch On Random Delayed with Power on Random Delay.

5.2.2.3. Service control power on delay

With this register OptoMOS switch delay at power up can be set and is used when OptoMOS state should be switched on. Delay time is set in seconds.

5.2.2.4. Service control switch on delay

With this register relay switch delay at state switch can be set and is used when OptoMOS state should be switched on. Delay time is set in seconds.

5.2.2.5. Load management relay control 2

This object controls the connection and disconnection of the relay. Switching of either of the outputs can be controlled via build in time of use by setting the switching times for corresponding tariffs. See also TOU settings. By default outputs are active when the low tariff is active.

For effective use of functionalities, meter must be properly configured.

5.2.3 Inputs

Inputs are simple passive inputs with capability to detect a presence of voltage level on dedicated terminals. There is one variation of input type:

- High Voltage 230V AC inputs.

Up to two inputs can be used on the meter, however only one type can be chosen (low voltage or high voltage input). Inputs can be configured for alarm or external key use only. To be able to use inputs, I/O Control register needs to be configured according to desired needs. There is a maximum of four input terminals (two functional inputs) intended for alarm or external key function use. Terminal labels are the same for all system meter types.

Terminals are labeled as:

- 85 – Common,
- 80 – Alarm input 2,
- 50 – Passive External key,
- 51 – Passive External key.

Figure 62: Mx381 input terminals

5.2.4 Active SD outputs

This output is low voltage transistor output. There are three output pins on the terminal block which serve these outputs (only on MT381 meters) and are intended for disconnector.

For more info on disconnector see Chapter 6.18.

5.2.5 Input/output status

This is read only information of I/O status. I/O Status is represented as a decimal number which is a result of all input or output function statuses. Each input or output function has its own designated bit in 16 bit input or output register. This bit can be enabled (logical 1) or disabled (logical 0). According to that, HEX number is a result of the whole binary register word. Not all bits in the register are used and some are reserved for future functions.

```
           x x x x x x x x x x x x x x x x
Bit        15 . . . . . . . . . . . . 0
```

5.2.5.1. State of the input control signals

Input control status register (0-0:96.3.1) includes this input function bits:

Bit	HEX (when bit set)	Bit name	Remarks
0-5			
6	0x0040	ALARM IN 1	20/15 or 50/51
7	0x0080	ALARM IN 2	85/80
8-12			
13	0x2000	SCROLL KEY	Key pressed
14	0x4000	RESET KEY	Key pressed
15	0x8000	PARAM LOCK SWITCH	Locked

Table 32: Input state control register

5.2.5.2. State of the output control signals

Output control status register (0-0:96.3.2) includes this output function bits:

For 1-phase meter:

Bit	HEX (when bit set)	Bit name	Remarks
0	0x0001	RELAY OUTPUT	Relay ON
1	0x0002	RELAY OUTPUT	Relay OFF
2-3			
4	0x0010	BREAKER OUTPUT	Breaker ON
5	0x0020	BREAKER OUTPUT	Breaker OFF
6-7			
8	0x0100	SERVICE OUTPUT	OptoMOS ON
9-15			

Table 33: Output state control register

For 3-phase meter:

Bit	HEX (when bit set)	Bit name	Remarks
0	0x0001	RELAY OUTPUT	Relay ON
1	0x0002	RELAY OUTPUT	Relay OFF
2-3			
4	0x0010	BREAKER OUTPUT	Breaker OFF
5	0x0020	BREAKER OUTPUT	Breaker ON
6-7			
8	0x0100	SERVICE OUTPUT	OptoMOS ON
9-15			

Table 34: Output state control register

5.3. Real time clock

Depending on customer needs meters have three options of power storage devices which guaranty operation of Real Time Clock and Tamper functionality during power loss.

Option 1 : One SuperCap
Enables operation for 7 days, when meter is previously charged for 24h continuosly. Data is valid for ambient temperature 25°C.

Option 2 : Two SuperCaps
Enables operation for 20 days, when meter is previously charged for 168h continuosly. Data is valid for ambient temperature 25°C.

Option 3 : Lithium battery
Enables operation of RTC and Tamper for longer periods. Battery has 20 years life time and provides enough energy to enable 10 years operation.

For effective use of functionalities, meter must be properly configured.

Clock object consists of several time/date related attributes. These attributes are divided into:

- Local time/date,
- Time zone,
- Daylight savings time (DST).

5.3.1 Time

Contains the meter's local date and time, its deviation to UTC and the status.

OCTET1	OCTET2	OCTET3	OCTET4	OCTET5	OCTET6	OCTET7	OCTET8	OCTET9	OCTET10	OCTET11	OCTET12
YYYY		MM	DD	WD	hh	mm	ss	hd	dddd		CS
Year		Month	Day	Week Day	Hour	Minute	Second	Hund-redths	Deviation		Clock Status

Figure 63: Time and Date Data Format

Time zone attribute holds the deviation of local, normal time to UTC in minutes.

5.3.2 Status

The status is equal to the status read in time.

Clock status shows if DST is currently active or not

- 128 (DST is currently active – current time/date is in DST boundaries),
- 0 (DST is currently not active – current time/date is outside DST boundaries).

5.3.3 Daylight Savings

Daylight saving begin/end defines the local switch date and time when the local time has to be deviated from the normal time. DST start and end date needs to be entered where specific values for "day in a week" are:

- FD = 2nd last day of month,
- FE = last day of month,
- FF = not specified.

For repetitive dates, the unused parts must be set to "not specified".

Daylight savings deviation contains the number of minutes by which the deviation in generalized time must be corrected at daylight savings begin. Deviation (in minutes shows the difference from GMT time and clock status active/inactive DST. Deviation range of up to ± 120 min.

Daylight savings enabled
To use DST, DST needs to be enabled with start and end date set also. DST Status can be:

- TRUE = DST enabled - (1),
- FALSE = DST disabled - (0).

5.3.4 Local time and date

These two objects are part of clock object and show only date or time. Date and time are represented on the meter display like this:

- Time:
  hh:mm:ss (hours:minutes:seconds),
- Date:
  yy.mm.dd (year.month.day),
  dd.mm.yy (day.month.year).

The easiest way and also the most common way to set local time and date is via MeterView application (this action writes date and time in main clock object 0-0:1.0.0 attr. 2).

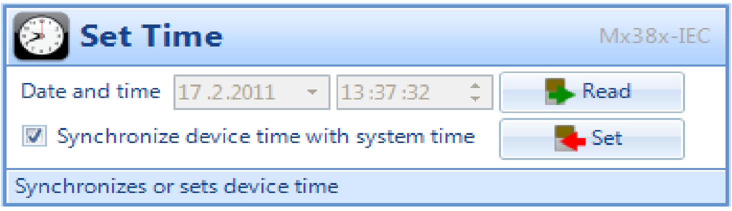


Figure 64: Set date and time

5.3.5 Clock time shift limit

Clock time shift limit is the maximum allowed time shift (in seconds) without registration of a time shift event. If the time synchronization is larger than the clock shift limit the meter will record the synchronization as time setting.

5.3.6 RTC Mode

RTC (Real Time Clock) mode object determines RTC operation function:

- (0) – Normal (for normal use),
- (1) – Test (for calibration).

5.3.7 Battery Use Time Counter

This attribute shows battery use time. The value is a sum of meter power-down and power-up time in seconds.

5.3.8 Battery Estimated Remaining Use Time Counter

It shows remaining battery use time in seconds. It measures power time length and detracts it from battery default life time (determined according to datasheets and tests – approx. 20 years).

When this counter reaches 0, replace battery event (event 7) is triggered. Battery low (event 8) is triggered when voltage on companion circuit reaches certain threshold.

5.4. Activity calendar and TOU registration

Tariff program is implemented with set of objects that are used to configure different seasons or weekly and daily programs, to define which certain tariffs should be active. Also different actions can be performed with tariff switching like for example registering energy values in different tariffs or switching on/off bi-stable relay. Graphical tariff program illustration can be seen on figure below.

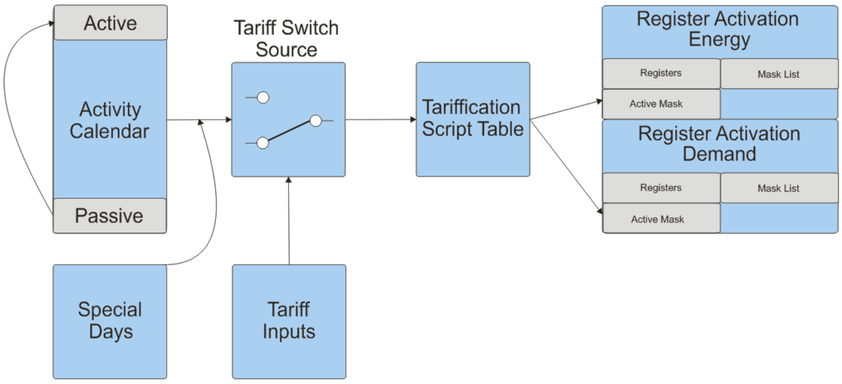


Figure 65: Graphical tariff program

TOU capabilities:

- Up to 8 tariffs,
- Up to 8 masks for configuring different combinations of tariff registers,
- Up to 12 seasons tariff programs,
- Up to 12 week tariff programs,
- Up to 12 day tariff programs,
- Up to 16 actions per day tariff program,
- Up 64 special day date definitions.

Possible ways of tariff switching are:

- Separate energy and demand tariff switching,
- Tariff switching via internal RTC (by IEC 61038),

5.4.1 Tariff program

Tariff program configures different seasons or weekly and daily programs to define, which certain tariffs should be active. Different actions can be performed with tariff switching like registering energy values in different tariffs or switching on and off the bi-stable relay.

For effective use of functionalities, meter must be properly configured.

5.4.2 Activity calendar

Activity calendar is time of use (TOU) object for tariff control. It allows modeling and handling of various tariff structures in the meter.

To handle different tariff structures an instance of the COSEM class “Activity calendar” is used. It is used to store energy and demand according to tariff rate schedule.

It is a definition of scheduled actions inside the meter, which follow the classical way of calendar based schedules by defining seasons, weeks and days.

After a power failure, only the “last action” missed from “Activity calendar” is executed (delayed). This is to ensure proper tariff after power up.

Activity calendar consists of two calendars, active and passive, and an attribute for activation of passive calendar. Changes can be made only to passive calendar and then activated to become active calendar. Each calendar has following attributes:

- Calendar name,
- Season profile,
- Week profile table,
- Day profile table.

5.4.2.1. Calendar Name

Calendar name typically contains an identifier, which describes calendar parameter set. With Calendar name the calendar can be identified.

5.4.2.2. Season Profile

The season table can be divided into 12 periods (seasons), during which different week tables are applicable. FF value is used for not specified fields. Season profile consists of:

- Season name,
- Season start date & time,
- Week name.

5.4.2.3. Week Profile Table

The week table determines the day profile table applicable for particular week. 12 week tables are available – one week profile per season. Since week tables are only divided into days, Monday to Sunday without time data, they are repeated every week while they are valid according to season profile. Value FF is used for not specified field. Week profile consists of:

- Week name,
- Weekdays.

5.4.2.4. Day Profile Tables

Up to 12 day profile tables are available in the meter to cover weekdays and special days. Day profile tables are divided into day actions, which define individual tariff switching times for energy and power. Each of these day actions is defined by the entry of start time. Up to 16 daily actions (switching points) can be defined per one day profile table. FF values are used for not specified fields. Day profile consists of:

- Weekday name,
- Day start time,
- Script table,
- Script names.

5.4.2.5. Change Over to New Switching Program

New tariff program structure is entered to passive calendar and change over time and date are entered to attribute activate passive calendar time of the class “Activity calendar”. On entered time and date content of active calendar will be replaced by tariff structure stored in passive calendar.

5.4.2.6. Specific Method

Immediate activation can be done by setting the activation date to the current date or with invoking the method active passive calendar. For not specified use FF (e.g. FFFFFFFFFFFFFFFFFF8000FF).

5.4.3 Special days

Special day object is used for defining dates with special tariff programs. According to COSEM object model special days are grouped in one object of COSEM class “special days”. Each entry in special days object contains date on which special day is used and “Day_id”. “Day_id” is reference to one day definition in day profile table of activity calendar object. In the meter one activity calendar object and one special days object are implemented. With these objects all the tariff rules (for energy and demand) must be defined.
Date definition in special days object can be:

- Fixed dates (occur only once),
- Periodic dates (recurring algorithms according to definition in COSEM blue book).

Special days object implementation in meter allows to sets 64 special day dates.

If two or more special days with same index or same time are entered only first one will be taken into account.

- FF and 255 values are used for not specified,
- FE – last day,
- FD – 2nd last day.

5.4.4 Register activation

With this object registers which values should be recorded and stored are determined. Selection of registers depends on meter type and configuration. Attribute 2 of this object shows which registers are available in the meter to register. Each register has its own index number and this index is used to identify the register which should be selected. There is a separate energy and maximum demand object where data to register can be set. Energy or demand objects can therefore be set separately with 16 different masks.

The complete set consists of

- 11 energy types (A+, A-, Q+, Q-, QI, QII, QIII, QIV, S+, S- and |A+|+|A-|), each having 8 tariff registers,
- 7 demand types (DA+, DA-, Abs(DA+), DQ+, DQ-, DS+ and DS-), each having 8 tariff registers.

For effective use of functionalities, meter must be properly configured.

5.4.4.1. Register Assignment

In total 88 objects are included in register assignment attribute of energy register activation object.

5.4.4.2. Mask List

For these objects in register assignment, 16 masks are available.

5.4.4.3. Active Mask

The attribute defines the currently active mask. The mask is defined by its mask name.

Energy
Register assignment includes all 88 rated energy objects from the meter.

Maximum demand
Register assignment includes all 56 rated maximum demand objects from the meter.

5.4.5 Tariff synchronization

This is the object where different tariff switching modes can be selected. There are two options:

- Tariff not synchronized with measuring period – Asynchronous (0),
- Tariff synchronized with measuring period – Synchronize (1).

If internal tariffication scheme via activity calendar is used, "0" (asynchronous) value should be used in object 0-0:128.10.1.255.

If tariff switching must be synchronous with the measuring period, activity calendar must be set up in such a way that this is achieved.

Explicitly setting value "1" (synchronize) to object 0-0:128.10.1.255 and using internal tariffication scheme via activity calendar will produce discrepancies between active mask attribute of register activation object and Currently active tariff object #1 on one side and cursor of active tariff on display and registration of energy in corresponding energy register on the other side. Therefore explicitly setting value "1" is feasible only if external tariffication scheme is used.

For effective use of functionalities, meter must be properly configured.

5.4.6 Currently active tariff

Currently active tariff is active mask of register activation object. It shows the tariff that is currently active.

This object is used to get information about which tariff is currently active. Information in the register is represented with a number or name that represents certain tariff. Table below shows this.

Register Value / Name x	Tariff	Display Flag
00 00	No Tariff	None
00 01 / name 1	1	Flag 1 lit
00 02 / name 2	2	Flag 2 lit
00 03 / name 3	3	Flag 3 lit
00 04 / name 4	4	Flag 4 lit
00 05 / name 5	5	Flag 1 flashing
00 06 / name 6	6	Flag 2 flashing
00 07 / name 7	7	Flag 3 flashing
00 08 / name 8	8	Flag 4 flashing

Table 35: Active tariff register

5.5. Communication

5.5.1 Optical interface

Optical interface operates according to IEC 62056–21 standard: Electricity metering: Data exchange for meter reading, tariff and load control, Part 21: Direct local data exchange (for remote data exchange see other standards of the IEC 62056 series). In such systems a hand-held unit (HHU) or a unit with equivalent functions is connected to a tariff device or a group of devices. The connection can be permanent or disconnectable using an optical or electrical coupling. The optical coupler is easily disconnectable to enable data collection via HHU.

The protocol permits reading and programming of tariff devices. It is designed to be particularly suitable for the environment of electricity metering, especially as regards electrical isolation and data security.

Optical interface is based on the reference model for communication in open systems. It is enhanced by further elements such as protocol controlled baud rate switchover, data transmission without acknowledgement of receipt. The protocol offers several modes for implementation in the tariff device. The HHU or equivalent unit acts as a master while the tariff device acts as a slave in protocol modes A to D. In protocol mode E the HHU acts as a client and the tariff device acts as a server.

Every meter has build-in optical communication. It is used for local meter data readouts and settings via PC, laptops or PDA devices.

Figure 66: Optical interface

5.5.1.1. IEC 62056-21 optical port communication profile

This communication profile is intended to be used by older HHU devices which are not able to use DLMS protocol. As in previous communication profiles the application layer provides same services to access COSEM interface objects.

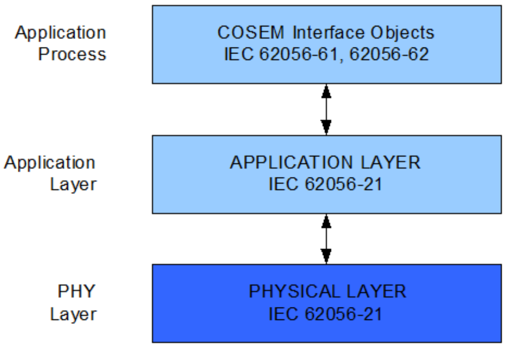


Figure 67: IEC optical port communication profile

5.5.1.2. COSEM/DLMS over IEC 62056-21 optical port

This communication profile is added to meter to ensure using of the same protocol on different communication media.

The implementation provides mode “E” according to the IEC 62056-21 standard (formerly IEC 1107). During the opening sequence the meter (server) is able to advise the HHU (client), that the advanced mode “E” is available. If the HHU acknowledges it, they will continue the data exchange using HDLC-based protocol. If the information exchange takes place then COSEM object model is used. If not data exchange continues in the conventional mode “C”.

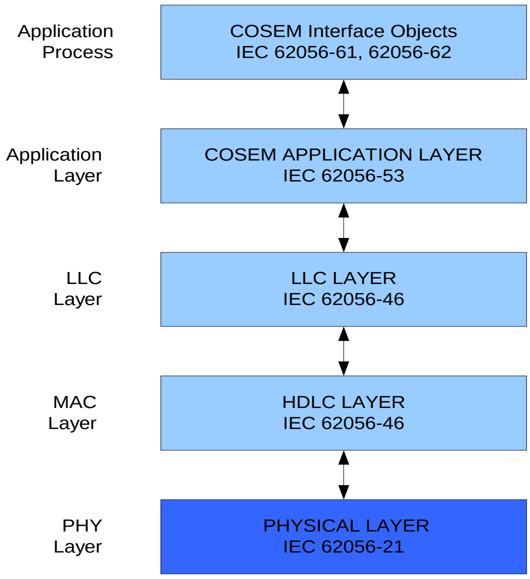


Figure 68: COSEM/DLMS optical port communication profile

5.5.1.3. IEC optical port setup

COSEM object includes several attributes, described as follows.

Communication Mode
Defines the protocol used by the meter on the port. It can be selected between these three modes:

- (0) - Protocol according to IEC 62056-21 (IEC 1107),
- (1) - Protocol according to IEC 62056-46 (DLMS UA),
- (2) - Protocol not specified; proposed baud rate is used for setting the communication speed.

Communication Speed
Default baud rate defines baud rate for the opening sequence. Proposed baud rate defines baud rate to be proposed by the meter (relevant only for communication type 0 – (1107, modes A to E). Communication speed up to 115200 baud is possible (recommended is 38400 baud). Selection for Default and Proposed baud rate can be made between these rates:

- (0) - 300 baud
- (1) - 600 baud
- (2) - 1200 baud
- (3) - 2400 baud
- (4) - 4800 baud
- (5) - 9600 baud
- (6) - 19200 baud
- (7) - 38400 baud
- (8) - 57600 baud
- (9) - 115200 baud

Response Time
Response time defines the minimum time between the reception of a request (end of request telegram) and the transmission of the response (begin of response telegram). These two options are available:

- (0) – 20 ms,
- (1) – 200 ms.

Device Address
Device address is intended to identify a meter in the group of meters. Each meter in one group must therefore have a unique number. Eight digits (1 to 9) should be used.

Passwords
There is a password for communication channels:

- settings password (used in IEC 1107 where entrance password needs to match this password and one of four authentication keys); eight digits (1 to 9) should be used,

5.5.1.4. IEC HDLC setup

COSEM object includes several attributes, described as follows.

Communication Speed
Selection can be made between these rates:

- (0) - 300 baud,
- (1) - 600 baud,
- (2) - 1200 baud,
- (3) - 2400 baud,
- (4) - 4800 baud,
- (5) - 9600 baud,
- (6) - 19200 baud,
- (7) - 38400 baud,
- (8) - 57600 baud,
- (9) - 115200 baud.

Window Size Transmit
Attribute defines the maximum number of frames that a device or system can transmit before it needs to receive an acknowledgement from a corresponding station. During logon, other values can be negotiated.

Window Size Receive
Attribute defines the maximum number of frames that a device or system can receive before it needs to transmit an acknowledgement to the corresponding station.

Maximum Info Length Transmit
Attribute defines the maximum information field length that a device can transmit.

Maximum Info Length Receive
Attribute defines the maximum information field length that a device can receive.

Inter Octet Time Out
Attribute defines the time, expressed in milliseconds, over which, when any character is received from the primary station, the device will treat the already received data as a complete frame.

Inactivity Time Out
Attribute defines the time, expressed in seconds over which, when any frame is received from the primary station, the device will process a disconnection. When set to 0, this means that the inactivity time out is not operational.

Device Address
Attribute contains the physical device address of a device.

In the case of single byte addressing:

- 0x00 No Station Address,
- 0x01…0x0F Reserved for future use,
- 0x10...0x7D Usable address space,
- 0x7E 'Calling' device address,
- 0x7F Broadcast address.

For effective use of functionalities, meter must be properly configured.

5.5.2 P1 interface

Port P1 is a read only interface. The meter has only one port P1. It is possible to connect more than one device (OSM – Other Service Module) via splitter. Diagram for connecting one or more devices to port P1 is shown in figure below.

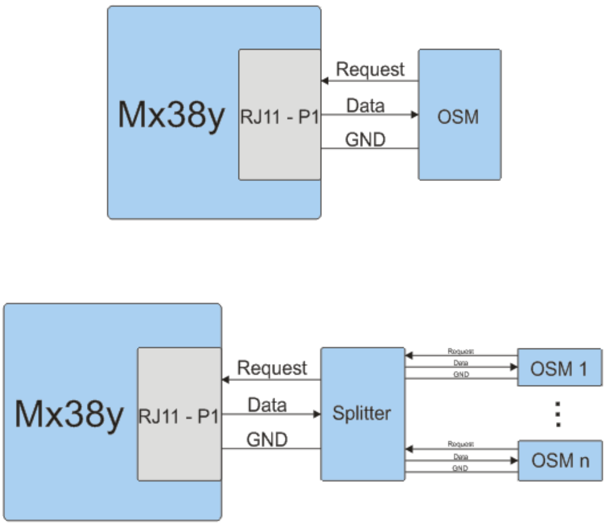


Figure 69: Diagram for connecting device to P1 port

To protect the meter and to lower the possibility of influencing the meter through the P1 port, it is equipped with an opto-coupler. The interface is protected against reversed connection and necessary over-voltage protection.

To ensure a safe, stable solution the connection consists of three signals:

- request signal,

- data signal,
- ground signal.

The port is activated by activating (raising) the request signal (~5V). While receiving data the requesting device must keep the request port activated (high). The meter sends data to the P1 port every 10 seconds after raising request in order to receive frequent and up to date results.

When more than one OSM is connected to the meter, each OSM may request data input and all OSM will receive the same data sent by the meter.

There is no address for P1 devices and more than one OSM can be connected, activated or not. Dropping the request line by connecting to ground is not allowed, to prevent short circuit. Modulating the request signal is not allowed. Data transfer will stop immediately after the request signal is dropped.

The meter completes the data transfer within 8 seconds.

All signals are compliant with TTL levels with max current Ih(max) = 30mA and voltage 30V. TTL signal level is +/-5mA and 5V.

5.5.2.1. P1 port settings

Parameters for P1 interface are set as:

- communication type is set to IEC 62056-21 (IEC 1107),
- communication speed is set to fixed 9600 baud,
- response time is set to 200ms,
- no addressing is necessary for this port,
- no passwords are used for this port,
- energy format is set to 8.2 (8 digits including 2 decimals) and with units
  Example: 1-0:1.8.0(000000.00*kWh),
- demand format is set to 6.3 (6 digits including 3 decimals) and with units
  Example: 1-0:1.4.0(000.000*kW).

5.5.2.2. P1 physical connector

The connector is RJ11. The metering system holds a female connector. The customer can plug in a standard RJ11 plug. Note that the connector in the metering system is physically accessible at all times and is not sealed or protected by a sealed cover.

Pin #	Signal name	Description
1		
2	Request	Input
3	GND	Ground
4		
5	Data	Output
6		

Table 36: RJ11 pins

Figure 70: P1 port connection

5.5.2.3. P1 port readout list

With this object data readout information can be set. This information can usually be retrieved locally over optical interface using IEC62056-21 mode C or remotely over P3 communication interface.

For effective use of functionalities, meter must be properly configured.

5.5.2.4. Consumer messages

If a device is connected, the meter will send the consumer message (code and/or text) over the P1 interface every 10 seconds.

The meter has storage capacity for one 64 character code message and one 1024 character text message. Both messages are handled independently, but in the same way.

Consumer message code
Consumer message code can be shown on P1 port and on the display. Maximum size value is 64. If more characters are written the last ones will be cut.

Message code can also be shown on general display (in visible string format) and stays there until message code is cleared (**Scroll** key pushed or empty value written). This message code has the priority above other display actions.

Only supported characters can be shown on display. If unsupported character is written in message code, it could not be formatted and message ”Error 31” is presented on the screen which means that message formatting has been failed. More details can be found in chapter Console.

For effective use of functionalities, meter must be properly configured.

Example:
ASCII message code presented on display as “tESt123” and message code presented on P1 port as “74 45 53 74 31 32 33”.

Display:

P1 port:
/ISk5\2ME381-1007
0-0:96.13.1(74455374313233)

Consumer message text
Consumer message text is sent to port P1 without any further interpretation, with maximum of 1024 characters in ASCII format.

For effective use of functionalities, meter must be properly configured.

Example:
ASCII message text is presented on P1 port as “30 31 32 33 34 35 36 37 38 39”.

P1 port:
/ISk5\2ME383-1007
0-0:96.13.0(303132333435363738 39)

5.5.2.5. Protocol description

The protocol is based on NEN-EN-IEC 62056-21 Mode D. Data transfer is requested with request line and automatically initiated every ten seconds until request line is released.

The interface will use a fixed transfer speed of 9600 baud. There are no options to switch the transmission speed. Note this is not conforming to EN-IEC 62056-21 Mode D.

The meter transmits the data message immediately following the activation through the Request signal. A series of blocks containing the following are sent:

/XXXZ Identification CR LF CR LF Data ! CR LF

The data transmission is complete after the data message has been transmitted by the meter. An acknowledgement signal is not provided for.

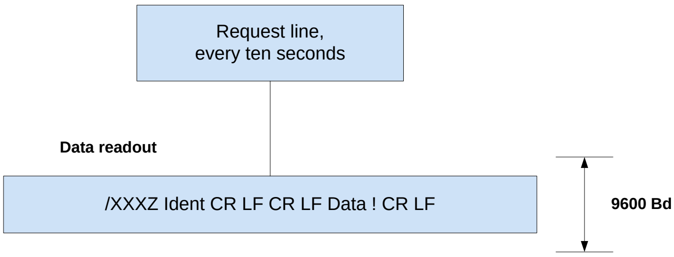


Figure 71: P1 port data string

For effective use of functionalities, meter must be properly configured.

5.5.3 M-Bus

M-Bus is an interface for gas meters (g-meter), gas valve, thermal (heat/cold) and water meters (w-meter). There is no separate interface for electricity meters (e-meter), since these meters are technically part of the metering system. It enables the communication between several types of meters and an e-meter, to which they are connected. The communication bus is based on the M-Bus standard.

The e-meter functions as the communication master, the other devices connected to the M-Bus function as slaves. M-Bus is a protocol that is described for remote reading of meters in the European standard EN 13757. It is a two wire system that provides power to the devices. The requirements for M-Bus are given in standard EN 13757 – 2. The bus interfaces of the slaves are polarity independent – the two bus lines can be interchanged without affecting the operation of the M-Bus devices. No physical access for P2 port is possible by customer. The connections to the M-Bus port are located behind a sealable lid.

Due to uniformity reasons and independency of used communication medium all data exchange over wired connection is encrypted. The Mx381 gathers and stores information from all connected meters or devices and forwards this information to the Central System. It also controls (e.g.) the gas valve. The maximum number of wired M-Bus devices associated with a single e-meter is four (each with current consumption of 1 unit load – 1,5mA; in total 6mA). Maximum current consumption of all connected M_Bus devices is 8 unit loads.

The Mx381 is the master device, meaning that all communication is initiated from it. The maximum number of slaves in a master/slave wired configuration is four.

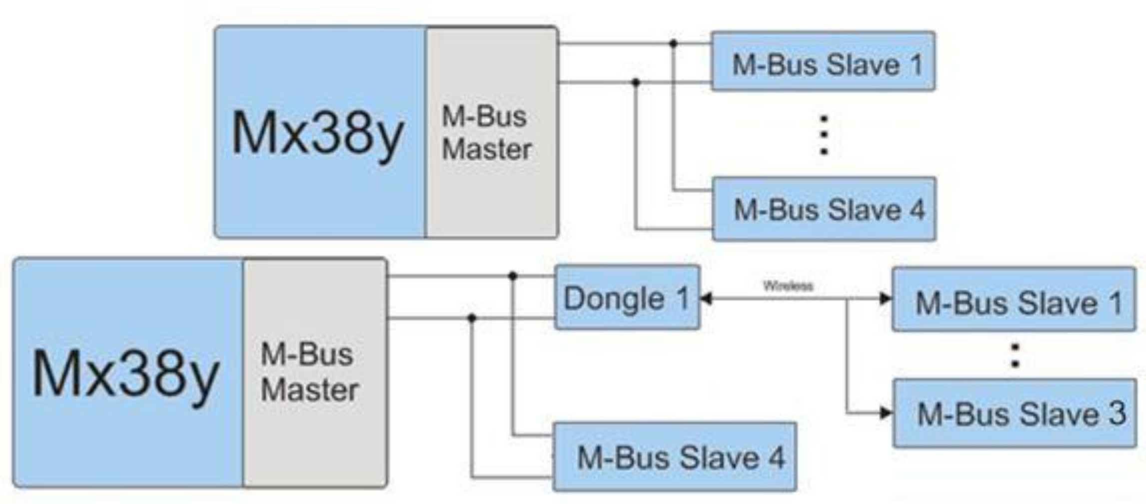


Figure 72: M-Bus master-slave configuration and dongle interface

As alternative solution for data exchange there is a combination of hardware or software paired meter-dongle interface. The dongle-master interface is confirming to the wired M-Bus specifications.

Wireless meter data are exchanged according to EN 13757–4 standard. Devices are connected through the wireless (RF) M-Bus connection according to the T1/T2 mode of this standard.

There is M-Bus communication interface integrated in all Mx381 meters according to EN 13757-2 and EN 13757-3 which enables connection of four slave devices (water, gas or/and heat meters) and maximum length of wiring 50 m.

Communication specification:

- The communication speed is 2400 baud.
- The e-meter act as an M-Bus master and the external device as an M-Bus slave. A maximum of four external slave devices is possible.
- The standard used for the application layer: EN 13757-3
- The standard used for the physical and link layer: EN 13757-2

During standard operation the e-meter will collect the consumption data by sequent polling the M-Bus by the available device addresses. A maximum four of the external M-Bus meters could be read. The retrieved data are organized in four measuring channels. One channel per each connected meter.

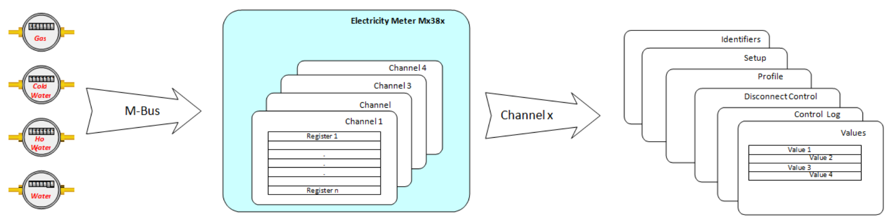


Figure 73: M-Bus channel model

Up to 4 values related to consumption data can be extracted from the M-Bus data frame and stored to the e-meter registers. Rule how to map data from the M-Bus data frame to the e-meter register could be defined by setting 4 DIF/VIF register for particular channel.

For effective use of functionalities, meter must be properly configured.

Read consumption values are represented forward to the system as COSEM extended register. Billing reads, data, could be retrieved daily, weekly, monthly at specified time or on request from the system.

5.5.3.1. M-Bus general installation procedures

During installation the M-Bus addresses of M-Bus devices will be registered in the e-meter. Note that there are two possibilities: that M-Bus device address is set to zero before installation or M-Bus device has already an address preset to the value different from 0.

M-Bus installation process is performed with three different actions:

- with Slave_install method of the M-Bus Client Setup object (locally or remotely over communication interface),
- with pressing the **Reset** key on the front plate of the e-meter,
- with power up of the e-meter.

When an installation procedure is started the e-meter scans for physically connected M-Bus devices for addresses from 1 to 6, and then also for address 0. After M-Bus device is registered in the e-meter regular communications can begin.

5.5.3.2. Installation process

The uniqueness of M-Bus device identification is guaranteed with following parameters: M-Bus equipment identifier (Fabrication number), Manufacturer id, Version and Medium.

Not all M-Bus devices include M-Bus equipment identifier in their M-Bus frame which causes the problem to identify the device completely. Beside that most of M-Bus devices include Serial number in their data header, but some also do not.

Therefore scenario for installing the M-Bus device and logging the installation event in M-Bus standard event log is as follows:

1. If Serial number is available in M-Bus data header frame then event “New M-Bus device installed ch x [1]” is logged after first successful reading of device regardless on M-Bus equipment identifier (no encryption key needed at the moment).
2. If Serial number is not available but the M-Bus equipment identifier is then event “New M-Bus device installed ch x [1]” is set after first successful decryption of the frame (valid encryption key needed or no key needed if the data are not encrypted).
3. If none of those identifications are available (Serial number and M-Bus equipment identifier), then device is not installed properly (event for installation is not set [1]).

5.5.3.3. Scan for M-Bus devices

The e-meter manages a list of device addresses connected to. The list can hold four M-Bus devices. During installation, the e-meter will scan for devices on the wired M-Bus. All responding devices will be registered in the list.

If, for some reason, communication is required between e-meter and an M-Bus device registered in the list, a request for the reading will be pushed to the queue and executed after scanning stops.
Two methods are supported to discover M-Bus devices connected to e-meter:

- Poll for device with address 0,
- Poll for devices with unregistered address.

5.5.3.4. Poll for Devices with Address 0

Address 0 is reserved for unconfigured M-Bus devices. Each unconfigured M-Bus device shall accept and answer all communication to this address (EN 13757-2 section 5.7.5).

The e-meter will select an unused device address and set M-Bus device address to it. Following this procedure the e-meter will request M-Bus data, set event “New M-Bus device installed ch x [1]” and raise alarm “M-Bus device installed ch x”.

5.5.3.5. Poll for Devices with Unregistered Address

Poll method is based on the procedure outlined in EN 13757-3 section 11.5. Addresses from 1 to 6 are scanned and if there is at least one channel still empty also address 0 is scanned, no matter if the address of the M-Bus device connected is included in the list of managed M-Bus devices or not.

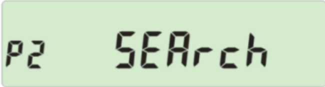
Secondary address searching is not used. Following this procedure the e-meter will poll for the device specific data.

While scanning, if a device answers on an address, the e-meter checks if the used address is in the list or not.

- If the used address is already in the list and answering M-Bus device is already in the list of managed M-Bus no action will follow.
- If the used address is already in the list and the answering M-Bus device is not same to device already stored in the list of managed M-Bus devices, old M-Bus device is replaced with answering M-Bus device, event “New M-Bus device installed ch x [1]” is set and alarm “M-Bus device installed ch x” is raised.
- If the used address is available and the answering M-Bus device is not in the list, a device is added to the list of managed M-Bus devices, event “New M-Bus device installed ch x [1]” is set and alarm “M-Bus device installed ch x” is raised.
- If the used address is available and the answering M-Bus device is already in the list, a device is set to new available address, event “New M-Bus device installed ch x [1]” is set and alarm “M-Bus device installed ch x” is raised.

5.5.3.6. Key Installation

An installation procedure for M-Bus devices can be triggered by pushing an **Reset** key located under a e-meter’s key cover (see figures below), ‘’P2 SEArch’’ is displayed first.



When a key is pressed e-meter starts to poll for device with an unregistered addresses from 1 to 6. After that it will start to poll for devices with address 0. After successful installation, at least one of the M-Bus devices on e-meter's display a flag designated with MB will be set on.

Figure 74: Keys

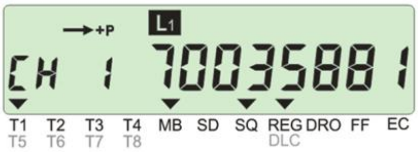
5.5.3.7. M-Bus display flag

MB flag is present on the display as long as if at least one M-Bus device is physically connected to the bus. If none of the devices are connected to the bus, then MB flag turns off after first capture even if the devices are correctly installed in the e-meter.

In addition to the MB flag on a scroll list with identification numbers (the sixth attribute of the M-Bus Client Setup class 72) of registered M-Bus devices which are able to communicate will pop-up on display.

The identification numbers are listed in following format: CH x 12345678.

The first 5 digits are used to display a number of the M-Bus channel and 8 last digits to display M-Bus device identification number. The display of the identification numbers will be exchanged with period of 10 seconds. After an interval of 120 seconds the pop-up list will disappear and display mode will be changed to normal auto scroll mode.



** DLC flag is present only on Mx381 meter*
*** SQ and REG flags are present only on Mx382 meter*

Figure 75: Example for channel

5.5.3.8. M-Bus client setup

An M-Bus master device may have one or more M-Bus interfaces, which can be configured using instances of the M-Bus client setup interface class (class ID 72). Each M-Bus client setup object controls one M-Bus slave device.

An M-Bus slave device is identified with its Primary Address, Identification Number, Manufacturer ID etc. as defined in EN 13757-3 Clause 5, Variable Data respond. These parameters are carried by the respective attributes of the M-Bus master setup IC.

Values to be captured from an M-Bus slave device are identified by the Capture definition attribute, containing a list of data identifiers (DIB – data information block, VIB – value information block) for the M-Bus slave device.

Values from a slave device can be captured into M-Bus master value objects and M-Bus master profile generic objects, periodically or on an appropriate trigger. It is also possible to perform operations like installing and de-installing devices, setting the clock, setting the encryption key to M-Bus master and slave.

Object includes setup parameters for M-Bus master for every M-Bus client. There is an object for each of four channels (b=1-4).

5.5.3.9. M-Bus identification numbers

Device ID1
Device ID1 is M-Bus Equipment identifier. There is one object for each of four channels (b=1-4).
M-Bus equipment identifier is one of the parameters which define uniqueness of the device. For successful reading of this identifier M-Bus device data must be unencrypted or successfully decrypted (the proper encryption key must be previously uploaded to e-meter and M-Bus device). After that binding process is completed.

Device ID2
Device ID2 is M-Bus Configurator data identifier. There is one object for each of four channels (b=1-4).

5.5.3.10. M-Bus result

M-Bus Master Value (result) holds last captured M-Bus value. There are four result objects for each of four channels (b=1-4; e=1-4).

5.5.3.11. M-Bus load profile

M-Bus Master Load profile has hourly interval readings of M-Bus devices. The buffer must be filled monotonously, i.e. no irregular entries are allowed. The profile is compressed type. Captured objects include clock, status and M-Bus value objects (maximum 4). There is one object for each of four channels (b=1-4).

Capture Objects
Up to 6 objects can be set as capture objects.

Capture Period
Capture period defines the time distance between two captured data (seconds). The period is synchronized with the hour (or minute); it always begins at completed hour (or minute). Value 0 of “capture period” means no registration. Following capture periods (in seconds) are recommended to choose from:

- No registration – (0),
- 5 minute recording period – (300),
- 15 minute recording period – (900),
- 30 minute recording period – (1800),
- 1 hour recording period – (3600),
- 1 day recording period – (86400).

Specific Methods
M-Bus master load profile has two methods implemented:

- Reset (erases captured values),
- Capture (performs capturing when executed) - not supported for M-Bus load profile.

For effective use of functionalities, meter must be properly configured.

5.5.3.12. M-Bus status

M-Bus status object shows the sum of status register bits set. Each bit has a different meaning as shown below. There is one status object for each of four channels.

5.5.3.13. M-Bus event log

M-Bus Event Log contains errors and alarms related to M-Bus devices (e.g. changes of the clock, communication errors, fraud attempt, etc). The buffer must be filled monotonously, i.e. no irregular entries are allowed. M-Bus Event Log structure consists of Timestamp and Event Code.

5.5.3.14. M-Bus event log status codes

M-Bus event code object holds the code from the last event triggered. These codes along with timestamps are then used in M-Bus event log.

5.5.3.15. M-Bus disconnector control

M-Bus master disconnect control
The object (0-b:24.4.0) controls the opening and closing of an M-Bus disconnector (e.g. gas valve). There is one object for each of four channels (b=1-4).

Disconnect control mode:

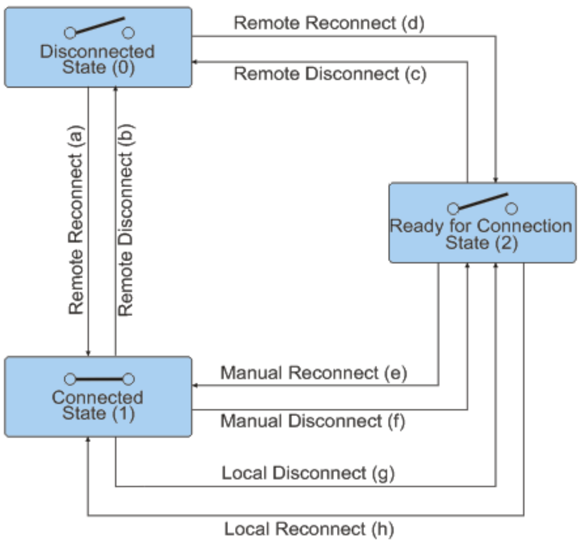


Figure 76: M-Bus disconnect state diagram

It defines the mode of operation of M-Bus Disconnect control. These are possible modes:

Mode	Description	
0	None	The disconnect control processes the command to go in ‘connected’ state
1	Disconnection:	Remote (b, c) Local (g)
	Reconnection:	Remote (d) Manual (e) – Press the key on M-Bus device
2	Disconnection:	Remote (b, c) Local (g)
	Reconnection:	Remote (a) Manual (e) – Press the key on M-Bus device
3	Disconnection:	Remote (b, c) Local (g)
	Reconnection:	Remote (d) Manual (e) – Press the key on M-Bus device
4	Disconnection:	Remote (b, c) Local (g)
	Reconnection:	Remote (a) Manual (e) – Press the key on M-Bus device
5	Disconnection:	Remote (b, c) Local (g)
	Reconnection:	Remote (d) Manual (e) – Press the key on M-Bus device Local (h)
6	Disconnection:	Remote (b, c) Local (g)
	Reconnection:	Remote (d) Manual (e) – Press the key on M-Bus device Local (h)

Table 37: M-Bus disconnector modes

Disconnect Output State:
Disconnect Output State shows the actual physical state of the disconnect unit.

- (0) – False,
- (1) – True.

Disconnect Control State:
Disconnect Control State defines the internal state of the disconnect unit. In the state Disconnected the meter disconnects the customer. In the state Connected the customer is connected to the network (gas, water...). In the state Ready to reconnection customer can perform reconnection manually on the meter. Possible Disconnect control states are:

- (0) - Disconnected – Customer is disconnected,
- (1) - Connected – Customer is connected,
- (2) - Ready for reconnection – Customer is disconnected. Reconnection needs to be performed manually on the meter.

Method Description:

- **Remote disconnect** forces the disconnector into 'disconnected' state if remote disconnection is enabled (control mode > 0).
- **Remote reconnect** forces the disconnect unit into the 'ready for reconnection' state if a direct remote reconnection is disabled (control mode = 1, 3, 5, 6), and forces it into the 'connected' state if a direct remote reconnection is enabled (control mode = 2, 4).

M-Bus disconnect control scheduler
M-Bus disconnect control scheduler (0-1:15.0.1) is dedicated time point for connection or disconnection. There is one object for all four M-Bus channels used.
Executed Script:
For executed script M-Bus Disconnect control script table (0-1:10.0.106) should be used. Selector needs to be selected according to the M-Bus channel used and according to selected command (connect/disconnect).

M-Bus disconnector script table
There are 8 scripts defined to control each of four channels with remote reconnect and remote disconnect service.

M-Bus master control log
Changes of the states (opened, closed, ready for reconnection) related to the M-Bus disconnect control are recorded. There is one object for each of four channels (b=1-4). Contains all events related to an M-Bus disconnector, e.g. a gas valve (open valve, close valve). M-Bus master control log structure consists of Timestamp and Event Code.

M-Bus control event codes
M-Bus control event code object holds the code from the last event triggered. These codes along with timestamps are then used in event log. There is one object for each of four channels (b=1-4).

M-Bus client configuration
Object (0-0:128.50.1) is intended for additional configuration for different kind of M-Bus functionality behavour. There are a lot of different scenarios of M-Bus functionality possible for some actions, for example transferring the encryption key to the M-Bus slave, handling the M-Bus value registers, profiles and logs in the case of decommissioning of the M-Bus slave, handling the capture actions in relation with M-Bus device id, etc.

5.5.3.16. M-Bus alarms

There are four different groups of alarms used for M-Bus events which are directly related to devices, connected to the e-meter:
- M-Bus communication error,
- M-Bus fraud attempt,
- M-Bus device installed,
- M-Bus valve alarm.

Each group consists of four different alarms, one per channel (1 - 4).

Alarm	Alarm set condition	Alarm reset condition
M-Bus communication error	After 3 unsuccessful readings of the M-Bus device (device is physically disconnected)	After first successful reading of the M-Bus device after communication error (device is physically connected again)
M-Bus fraud attempt	When the data is successfully received from the M-Bus device and bit 6 (Fraud attempt) in the Error status code of the Fixed data header is set	When the data is successfully received from the M-Bus device and bit 6 (Fraud attempt) in the Error status code of the Fixed data header is cleared
M-Bus device installed	After successful installation of the M-Bus device to the free channel	After successful de-installation of the M-Bus device from the channel (when Slave de-install method or M-Bus remove method are invoked)
M-Bus valve alarm	When M-Bus device sets the bit 7 in Status attribute of the M-Bus Client Setup object	When M-Bus device cleares the bit 7 in Status attribute of the M-Bus Client Setup object

Table 38: M-Bus alarms

5.5.4 PLC communication interface

PLC is power-line communication over the low-voltage grid, which has become more interesting for the utilities during the last decade, trying to achieve more reliable communication over the power lines. The main advantage of power-line communication is the fact that the existing infrastructure is used as a communication media. Wires connect every household with the power-line network. The power-line network is a large infrastructure covering most parts of the inhabited areas. In power distribution the power is typically generated by, e.g., a power plant and then transported on high-voltage (e.g., 400kV) cables to a medium-voltage substation, which transforms the voltage into, e.g., 10kV and distributes the power to a large number of low-voltage grids.

Each low-voltage grid has one substation, which transforms the voltage into 400 V and delivers it to the connected households via low-voltage lines. Typically several low-voltage lines are connected to the substation. Each low-voltage line consists of four wires, three phase wires and neutral wire. Coupled to the lines are cable-boxes, which are used to attach households to the grid.

PLC consists of three major parts:
- The DLC (Distribution Line Carrier)
- The Concentrator and Communication Node (CCN)
- The Operation and Management System (OMS)

Following figure shows how the parts are connected in a typical system.

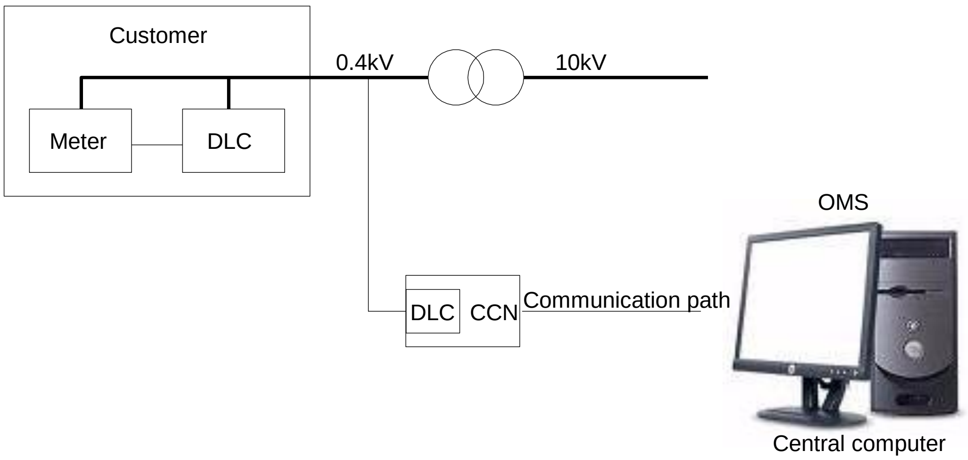


Figure 77: Typical PLC system

A DLC modem for remote two-way communication is built into the meter. The DLC modem is connected to the low-voltage network internally via L1 phase. For successful communication with the meter it is therefore necessary that L1 phase and neutral conductors are connected to the meter. If the MT381 meter is installed in a single-phase network, the phase conductor should be connected to its L1 phase terminal.

The DLC modem enables two-way communication with data concentrator built in the low-voltage side of a substation via low-voltage network and uses SFSK (Spread Frequency Shift Keying) modulation. Data transmission rate via low-voltage network can be up to 2,400 bit/sec. Data transmission between the microcontroller and the DLC modem is serial asynchronous with data transmission rate 4,800 bit/sec.

DLC metering system is based on Intelligent Network Management principle based on standard IEC 61334-4-511 (Discover, Register, Unregister, Ping and dynamic addressing).

Meter’s PLC system

- Coupler is LC filter with transformer preventing against high grid voltages.
- Modulator – demodulator are the couple, modulating and demodulating signals under choosing SFSK demodulating technique which means mark frequency (f_m) for digital value 1 and space frequency (f_s) for digital value 0. SFSK = $|f_m – f_s|$ > 10 kHz.
- Carrier frequencies are always in pair, means f_m&f_s. For the indoor system are defined as shows in figure below and are described as central frequencies. Meter system use band A. Systems with deferent frequency pair cannot hear each other.

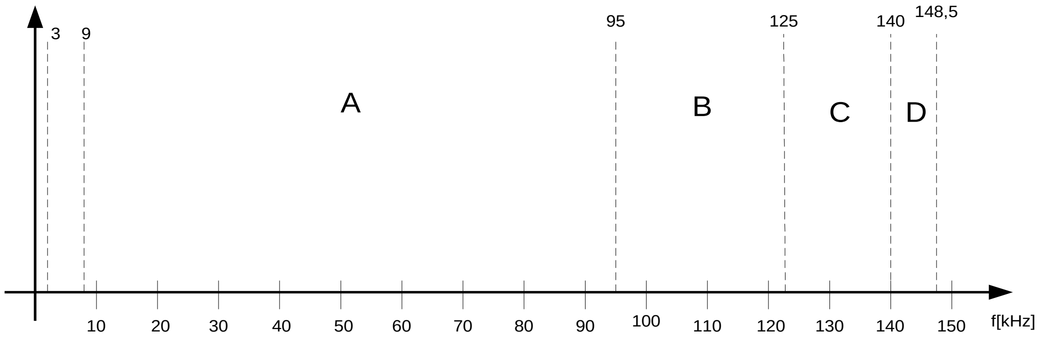


Figure 78: The frequency bands in the CENELEC standard

- MAC: the data goes and comes through the line in packet with MAC number in frame. When data goes, MAC number (address) identifies transmitter itself, when data comes, it identify receiver to which the packet belongs.
- DB: data base.
- LTC: local transfer and configuration

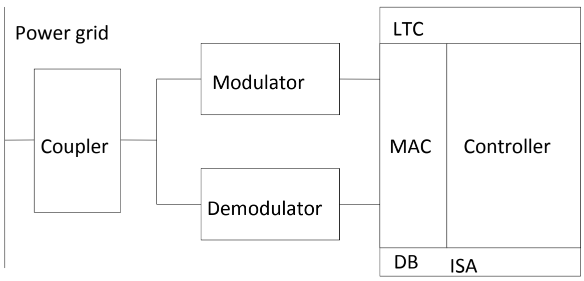


Figure 79: PLC system in the meter

Communication with meters via communication channels

The built-in communication channels enable:

- Data read out from the meter registers,
- Data read out from the load-profile recorder,
- Meter parameters read out,
- Setting meter parameters.

Communication with the meter in progress is indicated by displaying the DRO signal flag. Data block in the DLC network is indicating with a blinking DRO signal flag.

5.5.4.1. AMR readout

To establish the system for automatic meter readout (AMR) two basic components are required:

- A meter: ME381 or MT381 (Server)
- A concentrator P2LPC (Client)

Communication between the meter and the concentrator is performed via two DLC modems that are built in the meter and in the concentrator. For correct recognition of the meter by the concentrator, some identification numbers that are stated below should be written.

- Device number (1-0:0.0.0),
- Device factory number (0-0:96.1.0).

5.5.4.2. COSEM/DLMS S-FSK PLC communication profile

The DLMS/COSEM protocol uses a simplified OSI model, with just three layers, with an extension of DLMS, made suitable for communicating with the object oriented meter interface model.

COSEM/DLMS S-FSK PLC Communication Profile is based on 3-layer architecture. This comprises of COSEM Application Layer, the connectionless IEC 61334-4-32 HDLC based Data Link Layer and Physical Layer that uses PLC IEC 61334-5-1 S-FSK Profile. PLC Network Management is used for PLC system management including discovery and installation of network elements

The profile for meters using the PLC medium as defined in IEC 62056-47 or in DLMS UA Green Book edition 7 is pointed out in the Figure below.

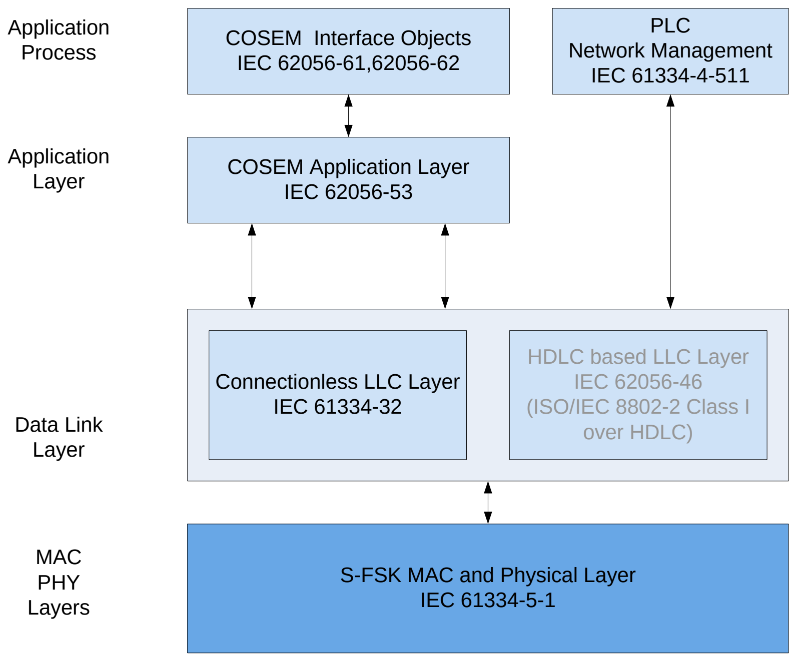


Figure 80: DLMS/COSEM S-FSK PLC communication profile

The PLC solution requires support of ISO/IEC 8802.2, allowing to plug in TCP/IP later. This can co-exist with the IEC 61334-4-32 LLC layer and the IEC 62056-46 data link layer used in existing implementations. The selected LLC layer is ISO/IEC 8802-2 LLC layer. The other two are only allowed for backwards compatibility reasons. The nine PLC setup objects are given below with their OBIS codes.

5.5.4.3. S-FSK profile

IEC 61334-5-1 – S-FSK Profile contains MAC and PHYSICAL layer which are managing

- S-FSK Modulation,
- MAC Frames Processing,
- Repetition with credit of frames,
- Alarm indication.

S-FSK modulation
The base principle of the S–FSK data coding technique is to assign data 0 to the carrier of one frequency, which is called the Space frequency (Fs) and data 1 to the carrier, which is called the Mark frequency (Fm). The main difference between a traditional FSK and S–FSK coding technique is that Fs and Fm are placed far from each other. The main advantage of this approach is that the quality of transmission of both carriers becomes independent from the strengths of the narrow band interferences signal sources and impulsive noise sources.

Spread frequency shift keying (S-FSK) principle is used with channels for “Mark” and “Space”. The channels for Mark and Space use the following frequencies:

- Fm (Mark Frequency): 63300 Hz,
- Fs (Space Frequency): 74000 Hz.

Transmission speed is 2400 baud.

MAC frames
Long MAC frames are composed with up to 7 sub-frames.

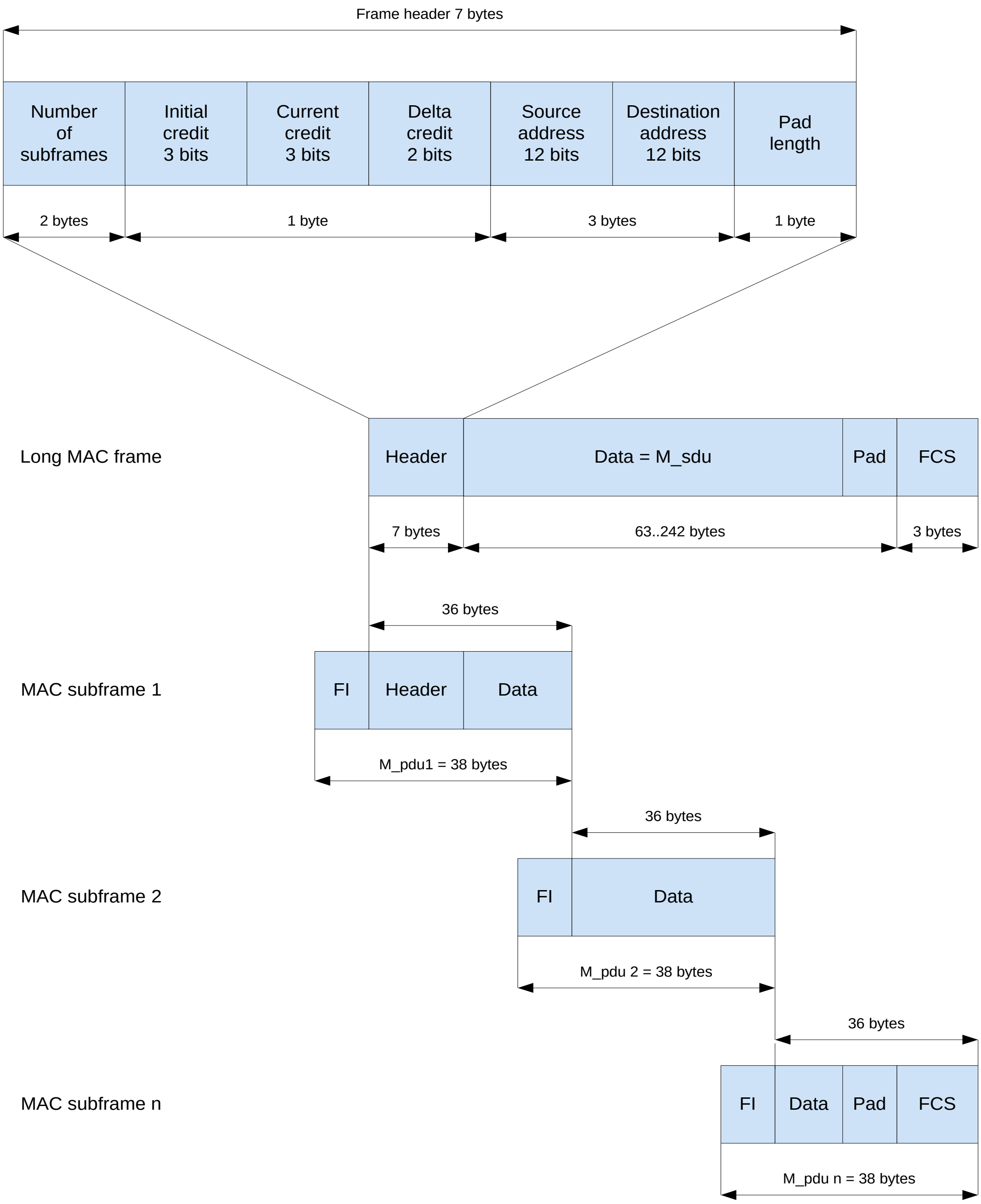


Figure 81: MAC frames

Number of sub-frames used depends on M-SDU Length.

M-SDU Length L (in bytes)	Number of sub frames	Pad length
L <= 26	1	26 – L
27 <= L <= 62	2	62 – L
63 <= L <= 98	3	98 – L
99 <= L <= 134	4	134 – L

135 <= L <= 170	5	170 – L
171 <= L <= 206	6	206 – L
207 <= L <= 242	7	242 – L

Table 39: Sub-frames

Up to 3 sub-frames should be used for optimal performance.

MAC addresses

These addresses are predefined values which are used by the IEC 61334-5-1 MAC sub layer.

MAC Address	Address (Hex)
All	FFF
New	FFE
All-Configured	FFC
All-Initiators	FFD
Nobody	000
Initiator Individual	C00...DFF
Individual	001..BFF
Multicast	E00...FEF
Reserved	FF0...FFB

Table 40: MAC addresses

Physical frames

The Physical frame has structure as described below:

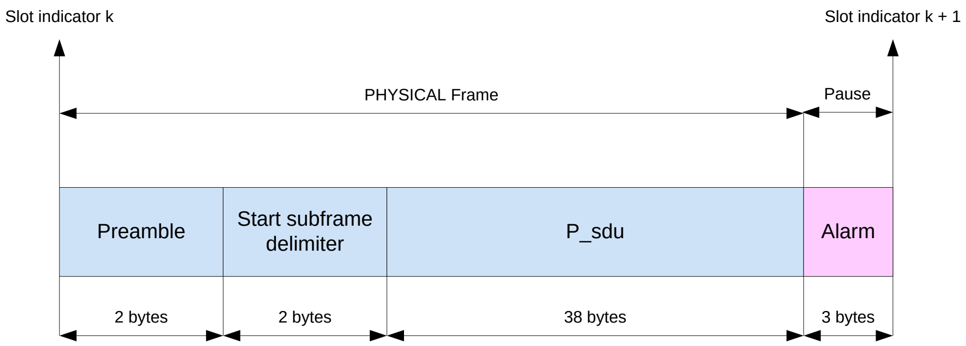


Figure 82: Physical frames

- Preamble is a 16-bit field equal to AAAA,
- Start sub frame delimiter is 16-bit field equal to 0x54C7,
- P SDU is equal to M PDU of the MAC sub-layer,
- Alarm is 24-bit field equal to 569E8A (when alarm state).

Preamble and Start sub-frame delimiter serve the purposes:

- Fine tuning of bit synchronization,
- Frame checking,
- Slot indicator resynchronization,

- Adaptation of automatic gain control,
- Reception signal quality measurement,
- Demodulation method decision FSK or ASK.

Repetition

The repeating performs the following characteristics:

- Repeating with credits,
- Each server can act as repeater,
- No topology information in servers,
- Broadcasting is supported,
- Repeaters setup in the network with Repeater Call service.

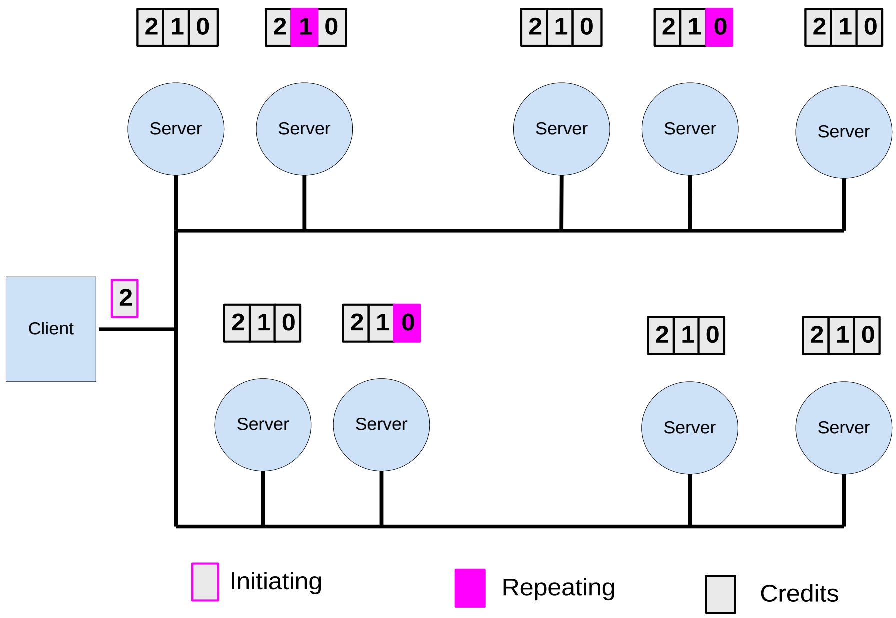


Figure 83: Repetition

5.5.4.4. PLC network management

PLC network management process includes management services for discovery and registration of network elements, service for detecting if network element responds (ping), service for clearing alarms (clear alarm) and service for repeater status update (repeater call).

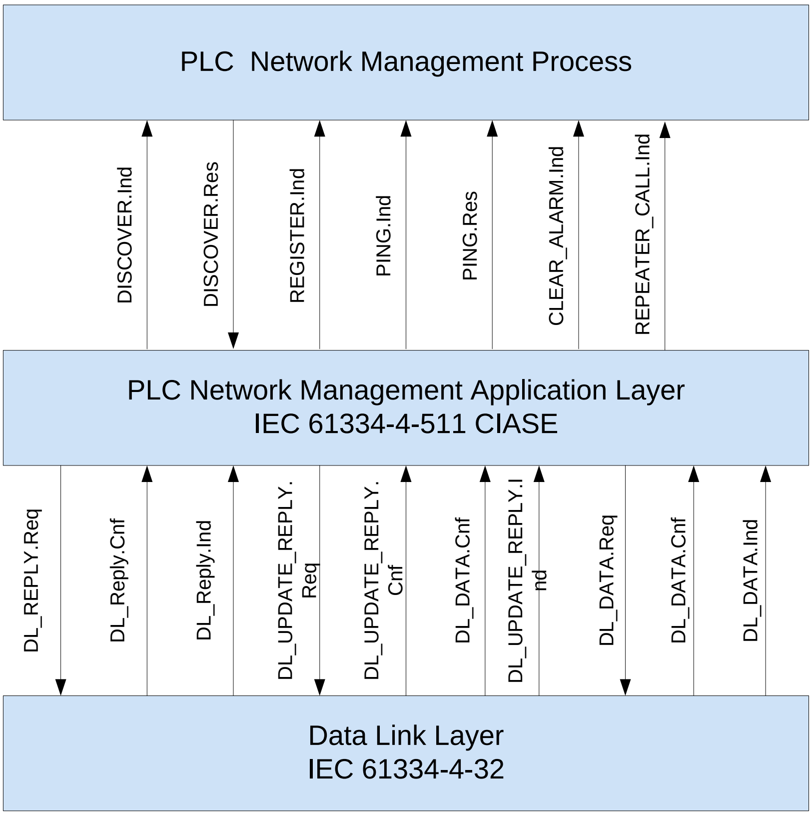


Figure 84: PLC network management

CIASE discover mechanism

The IEC 61334-5-511 CIASE discover mechanism uses discover and register services. Management services are used to discover new network elements (MAC address is set to NEW) or elements which are in alarm state. Management services also allow the assignment of an individual MAC address to unregistered network element.

CIASE discover service

Discover Service is used to discover new network elements or elements which are in alarm state.

- The discover process begins with a Discover request issued by the client. Discover request contains Discover CI-PDU and is broadcasted (sent to ALL-physical-address MAC address).
- The servers that have MAC address set to NEW or are in alarm state; get a chance to respond in next time slots.
- The servers that meet the reporting criteria respond with Discover Report CI-PDU. Discover Report is sent to ALL-physical-address MAC address.
- The servers calculate random time slot for response and respond only if random time slot is within response probability requested in Discover request.
- The servers that do not meet the reporting criteria do not send any respond.

Discover request arguments:

- Response Probability – this is unsigned integer between 0 and 100. It is the probability in per cent that the server that meets reporting criteria will respond.
- Allowed Time Slots – this is unsigned integer specifying the window in time slots that servers have available for response.
- Discover Report Credit – this is unsigned integer specifying the credit the servers have to use to set up the initial credit for Discover Report.

- IC Equal Credit – this is unsigned integer specifying the way how to compute the initial credit for Discover Report.

Discover Report arguments:

- Active Initiator System Title – is a system title of the client that issued Discover request.
- List of System Titles – is list of system titles made up with own system title followed by the content of its local-system-list local management variable.
- Alarm State – is signed integer with alarm state of the reporting network element.

CIASE register service

Register Service is used to configure new network elements. It specifies the MAC address to a new network element identified by its system title.

Register request arguments:

- New System Title(s) – is a list of system titles of the network elements that should be registered.
- MAC Address(es) – is list of MAC addresses of corresponding system titles of the network elements.

Register request is sent to ALL-physical-address MAC address.

CIASE ping service

Ping Service is used to check if network elements that have been registered are still present on the network.

Ping Service request arguments:

- System Title Server – is system title of the network element.

Ping Service respond arguments:

- System Title Server – is system title of the network element.

The CIASE Ping service allows:

- The concentrator to check that a registered meter is still present in the network,
- To verifying that the right physical device is linked to the right MAC address,
- To prevent the *time out not addressed* timer to expire.

CIASE repeater call service

Repeater Call Service is used to update repeater status of network elements. It is broadcasted (sent to ALL-physical-address MAC address) and therefore allows to update status of the whole network. This message is always equipped with initial credit set to the maximum value.

Repeater Call Service request arguments:

- Max Addr MAC – Maximal MAC Address number stored in Initiator,
- NbTslot For New – Number of Timeslots used for network elements in NEW state,
- Reception Threshold - Reception signal level threshold in dBuV.

Repeater Call Service has no respond.

IDIS is using the Repeater Call service to automatically configure (as “repeater” or as “no repeater”) those meters which are defined as “dynamic repeaters”. The corresponding parameters are attributes of the COSEM object "S-FSK Phy&MAC setup". The services involved in the repeater allocation process are displayed in figure below.

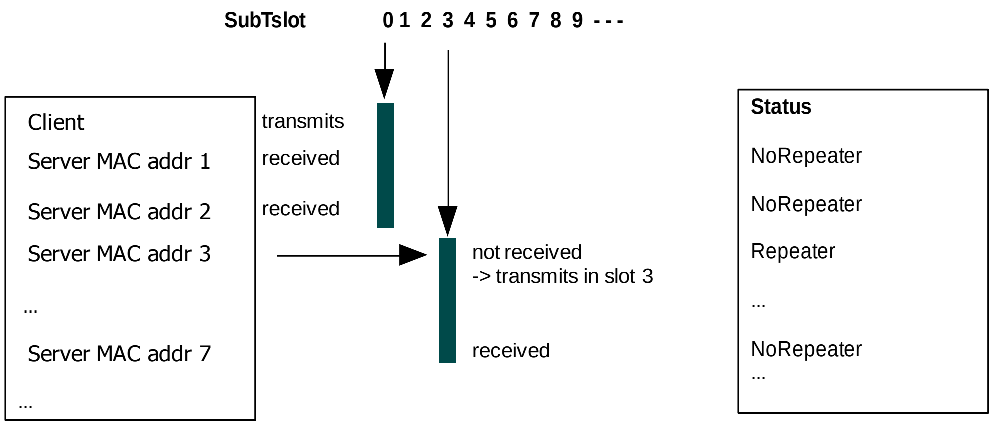


Figure 85: Server responses to a repeater call

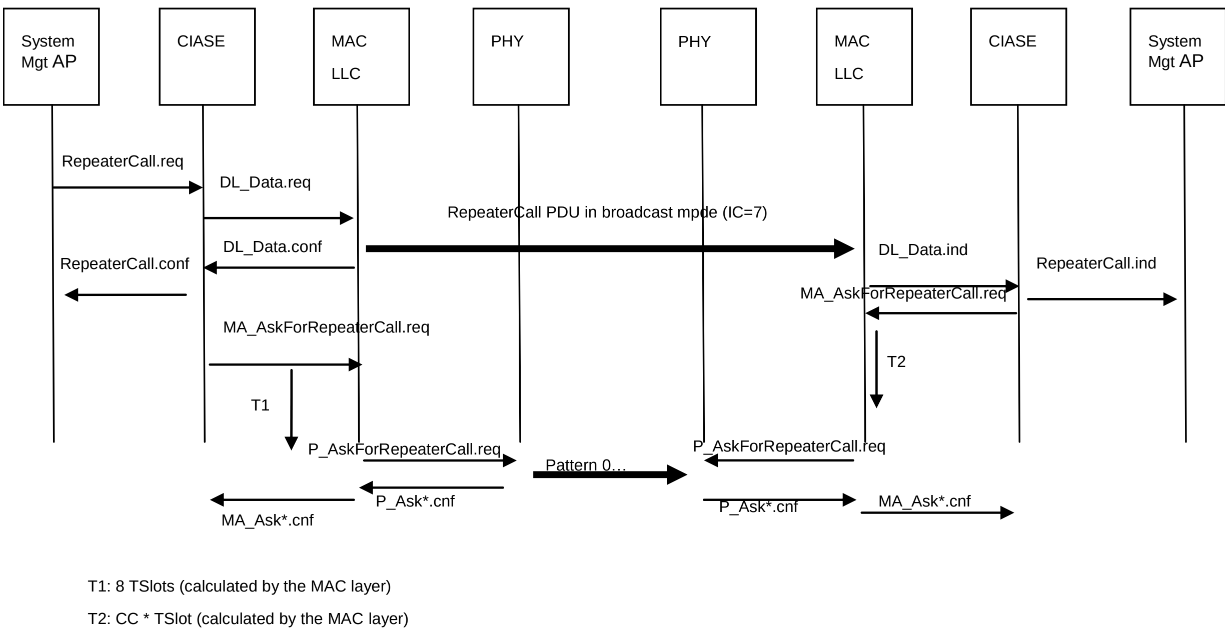


Figure 86: The repeater allocation services

CIASE clear alarm service

Clear Alarm Service is used to clear alarm state in network elements.

Clear Alarm Service request arguments:

- Alarm Descriptor – identify alarm to be cleared,
- Alarm Descriptor List – identify list of alarms to be cleared,
- Alarm Descriptor List And Server List – identify servers and alarms to be cleared,
- Alarm Descriptor by Server – identify servers and single alarm per server to be cleared.

Clear Alarm Service has no respond.

For the purpose of interoperability the following two Clear Alarm Service arguments must be supported:

- Alarm Descriptor,
- Alarm Descriptor List and Server List with the list of minimum one.

Search initiator service
The Search Initiator service objective is to improve plug&play installation of server systems, by ensuring that each server system is registered by the correct initiator.

When a new server system is placed in the network, it will be discovered and registered by the first initiator it hears talking. It remains registered by that initiator as long as it keeps receiving correct frames (the time out not addressed timer does not expire). If there is cross-talk on the network, the server system may be registered by the wrong initiator, i.e. one, which is “heard” by the server system due to cross-talk.

When the Intelligent Search Initiator process is implemented in the server system, it is capable to establish a list of all initiators it can “hear”, and to lock on the initiator with the best signal level.

IDIS uses the “Intelligent Search Initiator process” to bind the meter to the concentrator. The objective of the Intelligent Search Initiator process is to improve plug&play installation of the meter, by ensuring that every meter is registered at the correct initiator (concentrator).

If the Intelligent Search Initiator process is implemented, the meter does not bind to the first concentrator heard but it sets up a list of all concentrators in range and binds to the one with the best communication quality.

Alarm Management
When alarms are generated they are stored in the Alarm Register and are delivered to the Alarm Management System through the appropriate communication channel. Figure below shows the different services of the PLC channel supporting the alarm management.

Using PLC communication the alarms are raised by S-FSK Alarm delivery. The Alarm Management System - upon receipt of S-FSK Alarm - discovers the devices with Alarm Status using the CIASE Discover service. The Alarm Descriptors are sent to the Alarm Management System as part of the Discover Report PDUs. If an Extended Alarm Status is indicated the Alarm Management System reads the COSEM object Alarm Register to receive the complete Alarm status. Alarms are cleared with the CIASE Clear Alarm service or with writing to the Alarm Register.

CIASE Clear Alarm Service is used to clear alarm state in network elements.

Clear Alarm Service request arguments:

- Alarm Descriptor – identify alarm to be cleared,
- Alarm Descriptor List – identify list of alarms to be cleared,
- Alarm Descriptor List And Server List – identify servers and alarms to be cleared,
- Alarm Descriptor by Server – identify servers and single alarm per server to be cleared.

Clear Alarm Service has no respond.

For the purpose of interoperability the following two Clear Alarm Service arguments must be supported:

- Alarm Descriptor,
- Alarm Descriptor List and Server List with the list of minimum one.

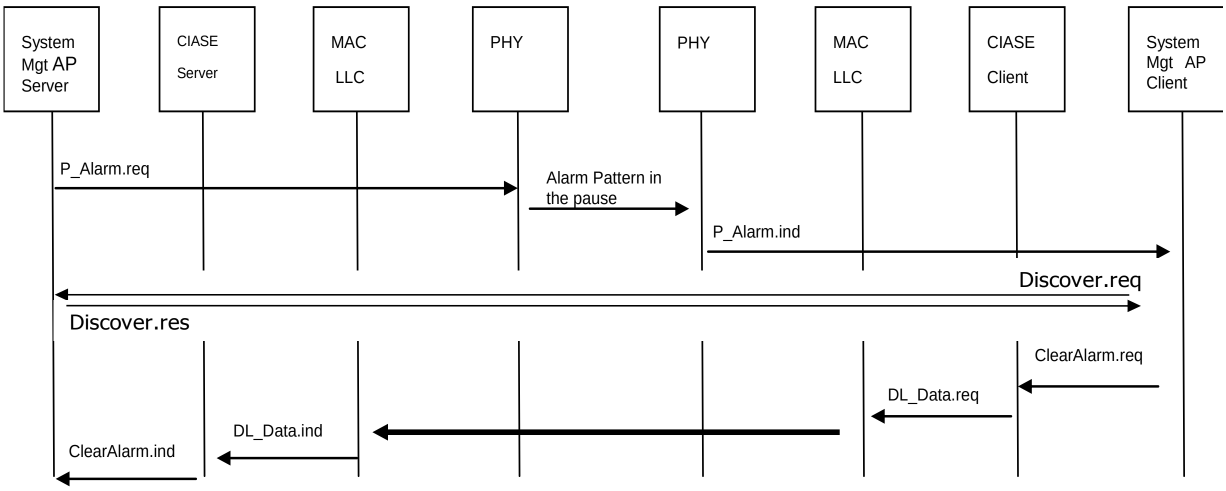


Figure 87: The alarm management services

5.5.4.5. S-FSK PHY&MAC setup

An instance of the "S-FSK Phy&MAC setup" class stores the data necessary to set up and manage the physical and the MAC layer of the PLC S-FSK lower layer profile.

Initiator Electrical Phase
Holds the MIB variable initiator-electrical-phase (variable 18) specified in IEC 61334-4-512 sub-clause 5.8. It is written by the client system to indicate the phase to which it is connected.

Delta Electrical Phase
Holds the MIB variable delta-electrical-phase (variable 1) specified in IEC 61334-4-512 sub-clause 5.2 and IEC 61334-5-1 sub-clause 3.5.5.3. It indicates the phase difference between the client's connecting phase and the server's connecting phase. The following values are predefined:

- 0 not defined: the server is temporarily not able to determine the phase difference,
- 1 the server system is connected to the same phase as the client system,
- 2 the phase difference between the server's connecting phase and the client's connecting phase is equal to 60 degrees,
- 3 the phase difference between the server's connecting phase and the client's connecting phase is equal to 120 degrees,
- 4 the phase difference between the server's connecting phase and the client's connecting phase is equal to 180 degrees,
- 5 the phase difference between the server's connecting phase and the client's connecting phase is equal to -120 degrees,

- 6 the phase difference between the server's connecting phase and the client's connecting
  phase is equal to −60 degrees.

Max Receiving Gain
Holds the MIB variable max-receiving-gain (variable 2) specified in IEC 61334-4-512 sub-clause 5.2 and IEC 61334-5-1 sub-clause 3.5.5.3. Corresponds to the maximum allowed gain bound to be used by the server system in the receiving mode. The default unit is dB.

In IEC 61334-5-1, no units are specified.

The possible values of the gain may depend on the hardware. Therefore, after writing a value to this attribute, the value should be read back to know the actual value.

Max Transmitting Gain
This attribute holds the value of the max-transmitting-gain. Corresponds to the maximum attenuation bound to be used by the server system in the transmitting mode. The default unit is dB.

In IEC 61334-4-512, no units are specified.

The possible values of the gain may depend on the hardware. Therefore, after writing a value to this attribute, the value should be read back to know the actual value.

Search Initiator Threshold
This attribute is used in the intelligent search initiator process. If the value of the signal is above the value of this attribute, a fast synchronization process is possible. The unit is in dBuV.

Frequencies
Contains frequencies required for S-FSK modulation. The default unit is Hz.

- mark frequency,
- space frequency.

Pairs: (11) – 63300 and 74000

MAC Address
Holds the MIB variable MAC-address (variable 3) specified in IEC 61334-4-512 sub-clause 5.3 and IEC 61334-5-1 sub-clause 4.3.7.6.

MAC addresses are expressed on 12 bits.

Contains the value of the physical attachment (MAC address) associated to the local system. In the unregistered state, the MAC address is “NEW-address”. This attribute is locally written by the CIASE when the system is registered (with a Register service). The value is used in each outgoing or incoming frame.

The default value is “NEW-address”. This attribute is set to NEW:

- by the MAC sub-layer, once the time-out-not-addressed delay is exceeded,
- and if a client system “unregisters” the server system. See the “S-FSK Active initiator” IC.

When this attribute is set to NEW:

- the server loses its synchronization (function of the MAC-sub layer),
- the MAC group address attribute is reset (array of 0 elements),
- server automatically releases all AAs which can be released.

The second item is not present in IEC 61334-4-512

The predefined MAC addresses in S-FSK profile and values are shown below.

- NO-BODY – 000
- Local MAC – 001… FIMA – 1
- Initiator – FIMA … LIMA
- MAC Group address – LIMA + 1 … FFB
- All-configured – FFC
- NEW - FFE
- All Physical - FFF

MAC addresses are expressed on 12bits. These addresses are specified in IEC 61334-5-1 sub-clauses 4.2.3.2, 4.3.7.5.1, 4.3.7.5.2 and 4.3.7.5.3.

- FIMA – First initiator MAC address; C00
- LIMA – Last Initiator MAC address; DFF

MAC Group Address

Holds the MIB variable MAC-group-address (variable 4) specified in IEC 61334-4-512 sub-clause 5.3 and IEC 61334-5-1 sub-clause 4.3.7.6. This attribute contains a set of MAC group addresses used for broadcast purposes. Array MAC-address

The ALL-configured-address, ALL-physical-address and NO-BODY addresses are not included in this list. These ones are internal predefined values. This attribute shall be written by the initiator using DLMS services to declare specific MAC group addresses on a server system.

This attribute is locally read by the MAC sub layer when checking the destination address field of a MAC frame not recognized as an individual address or as one of the three predefined values (ALL-configured-address, ALL-physical-address and NO-BODY).

Repeater
Holds the MIB variable repeater (variable 5) specified in IEC 61334-4-512 sub-clause 5.3 and IEC 61334-5-1 sub-clause 4.3.7.6. This attribute holds the information whether the server system effectively repeats all frames or not.

- never repeater – (0),
- always repeater – (1),
- dynamic repeater – (2).

If the repeater variable is equal to 0, the server system should never repeat the frames. If it is set to 1, the server system is a repeater: it has to repeat all frames received without error and with a current credit greater than zero. If it is set to 2, then the repeater status can be dynamically changed by the server itself.

The value 2 value is not specified in IEC 61334-4-512. This attribute is internally read by the MAC sub-layer each time a frame is received. The default value is 1.

Repeater Status
This attribute holds the current repeater status of the device.

- FALSE = no repeater,
- TRUE = repeater.

Min Delta Credit
Holds the MIB variable min-delta-credit (variable 9) specified in IEC 61334-4-512 sub-clause 5.3 and IEC 61334-5-1 4.3.7.6.

Only the three least significant bits are used.

The Delta Credit (DC) is the subtraction of the Initial Credit (IC) and Current Credit (CC) fields of a correct received MAC frame. The delta-credit minimum value of a correct received MAC frame, directed to a server system, is stored in this attribute. The default value is set to the maximal initial credit. A client system can reinitialize this variable by setting its value to the maximal initial credit.

Initiator MAC Address
Holds the MIB variable initiator-MAC-address specified in IEC 61334-5-1 4.3.7.6. Its value is either the MAC address of the active-initiator or the NO-BODY address, depending on the value of the synchronization locked attribute. See also IEC 61334-5-1 3.5.3, 4.1.6.3 and 4.1.7.2.

If the value NO-BODY is written, then the server MAC address (see the MAC address attribute) has to be set to NEW.

Synchronization Locked
Holds the MIB variable synchronization-locked (variable 10) specified in IEC 61334-4-512 sub-clause 5.3. Controls the synchronization locked / unlocked state. See in IEC 61334-5-1 for more details. If the value of this attribute is equal to TRUE, the system is in the synchronization-locked state. In this state, the initiator-MAC-address is always equal to the MAC address field of the active-initiator MIB object. See attribute 2 of the S-FSK Active initiator IC.

If the value of this attribute is equal to FALSE, the system is in the synchronization-unlocked state. In this state, the initiator MAC address attribute is always set to the NO-BODY value: a value change in the MAC address field of the active-initiator MIB object does not affect the content of the initiator MAC address attribute which remains at the NO-BODY value. The default value of this variable shall be specified in the implementation specifications.

In the synchronization-unlocked state, the server synchronizes on any valid frame. In the synchronization locked state, the server only synchronizes on frames issued or directed to the client system the MAC address of which is equal to the value of the initiator MAC address attribute.

DLC Speed
With this attribute DLC speed 300, 600, 1200 or 2400 baud can be set.

5.5.4.6. S-FSK active initiator

An instance of the “S-FSK Active initiator” class stores the data of the active initiator (client). The active initiator is the client system, which has last registered the server system with a CIASE Register request. See IEC 61334-5-511 7.2.

Active Initiator
Holds the MIB variable active-initiator (variable 15) specified in IEC 61334-4-512 sub-clause 5.6. This attribute contains the identifiers of the active initiator which has last registered the system with a Register request. See IEC 61334-4-511 7.2. The Initiator system is identified with its System Title, MAC address and L-SAP selector. Unless otherwise specified in a system specification:

- When the IEC 61334-4-32 LLC layer is used,
- When the HDLC based data link layer is used (IEC 62056-46, Green Book Clause 8),
- When the ISO/IEC 8802-2 LLC layer is used.

The system title of the initiator should have the same structure as the COSEM logical device name specified in DLMS UA 1000-1 sub-clause 4.1.8.2.

If the System-Title field of this object is set to 0s, it means that the system is not registered.

The MAC - address element is used to update the initiator-MAC-address MAC management variable when the system is configured in the synchronization-locked state. See the specification of the initiator-MAC-address and the synchronization locked attributes of the S-FSK Phy&MAC setup IC.

As long as the server is not registered by an active initiator, the L-SAP selector field is set to 0 and the system title field is equal to an octet string of 0s.

The value of this attribute can be updated by the invocation of the reset NEW not synchronized method or by the CIASE Register service.

Method Description
Reset NEW not synchronized Holds the MIB variable reset NEW not synchronized (variable 17) specified in IEC 61334-4-512 sub-clause 5.8.

This method allows a client system to unregister the server system. The submitted value corresponds to a client MAC address. The writing is refused if the value does not correspond to a valid client MAC address or the predefined NO-BODY address. When this method is invoked, the following actions are performed:

- The server system returns to the unregistered state (UNC: MAC-address equals NEW address). This transition automatically causes the synchronization lost (function of the MAC sub layer),
- The server system changes the value of the active initiator attribute: the MAC address is set to the submitted value, the LSAP selector is set to the value 0 and the System-Title is set to an octet-string of 0s,
- All AAs that can be released are released.

5.5.4.7. S-FSK MAC synchronisation timeouts

An instance of the “S-FSK synchronization timeouts” class stores the timeouts related to the synchronization process.

Search Initiator Timeout
This timeout supports the intelligent search initiator function. It defines the value of the time, expressed in seconds, during which the server system is searching for the initiator with the strongest signal. During this timeout, all initiators, which may be heard by the servers, are expected to talk. After the expiry of this timeout, the server will accept a Register request from the initiator having provided the strongest signal and it will be locked to that initiator. If the value of the timeout is equal to 0, this means that the feature is not used. The timeout starts when the server receives the first frame with a valid initiator MAC address.

A Fast synchronization may be performed if the level of signal and the gain are good enough (Gain <= Search-Initiator-Gain) and one of the MAC addresses (Source or Destination) is an Initiator MAC address. This means the module is next to a DC or next to a module that is already locked on that DC. The module locks in this case on that initiator.

Synchronization Confirmation Timeout

It is the time after which the server loses the frame synchronization when not receiving a valid MAC frame.

Holds the MIB variable synchronization-confirmation-timeout (variable 6*)* specified in IEC 61334-4-512 sub-clause 5.3 and IEC 61334-5-1 4.3.7.6. It defines the value of the time, expressed in seconds, after which a server system which just gets frame synchronized (detection of a data path equal to AAAA54C7 hex) will automatically lose its frame synchronization if the MAC sub layer does not identify a valid MAC frame. The timeout starts after the reception of the first four bytes of a physical frame. The value of this variable can be modified by a client system. This time-out ensures a fast de-synchronization of a system, which has synchronized on a wrong physical frame. See IEC 61334-5-1 3.5.3 for more details.

The default value of this variable should be specified in the implementation specifications. A value equal to 0 is equivalent to cancel the use of the related synchronization confirmation timeout counter.

Timeout Not Addressed
It is the maximum time after which the server status becomes NEW and could be discovered again.

It holds the MIB variable timeout-not-addressed (variable 7) specified in IEC 61334-4-512 sub-clause 5.3 and IEC 61334-5-1 4.3.7.6.

It defines the time, in minutes, after which a server system that has not been individually addressed:

- returns to the unregistered state (UNC: MAC-address equals NEW-address): this transition automatically involves the loss of the synchronization (function of the MAC sub layer) and releasing all AAs that can be released,
- delete its active initiator: the MAC address of the active-initiator is set to NO-BODY, the LSAP selector is set to the value 00 and the System Title is set to 0s.

Because broadcast addresses are not individual system addresses, the timer associated with the time-out-not-addressed delay ensures that a forgotten system will sooner or later return to the unregistered state. It will be then discovered again. A forgotten system is a system, which has not been individually addressed for more than the "*time-out-not-addressed*" amount of time.

The default value of this variable should be specified in the implementation specifications. A value equal to 0 is equivalent to cancel the use of the related time out not addressed counter.

Timeout Frame Not OK
It is the maximum time after which the server loses the frame synchronization if not receiving a properly formed MAC frame.

This attribute Holds the MIB variable time-out-frame-not-OK (variable 8), specified in IEC 61334-4-512 sub-clause 5.3 and IEC 61334-5-1 4.3.7.6.

Defines the time, in seconds, after which a server system that has not received a properly formed MAC frame (incorrect NS field, inconsistent number of received sub frames, false Cyclic Redundancy Code checking) loses its frame synchronization.

The default value of this variable shall be specified in the implementation specifications. A value equal to 0 is equivalent to cancel the use of the related time out frame not OK counter.

5.5.4.8. S-FSK MAC counters

An instance of the "S-FSK counters" class stores counters related to the frame exchange, transmission and repetition phases.

Synchronization Register
This attribute holds the MIB variable synchronization-register (variable 23), specified in IEC 61334-4-512 sub-clause 5.8. Synchronization couples structure:

- MAC address,
- Synchronizations Counter.

This variable counts the number of synchronization processes performed by the system. Processes that lead to a synchronization loss due to the detection of a wrong initiator are registered. The other processes that lead to a synchronization loss (time-out, Management Writing) **are not** registered. This variable provides a balance sheet of the different systems on which the server system is »potentially« able to synchronize.

A synchronization process is initialized when the Management Application Entity (connection manager) receives a MA Sync.indication (Synchronization State = SYNCHRO FOUND) primitive from the MAC Sub layer Entity. This process is registered in the synchronization-register variable only if the MA Sync.indication (Synchronization State = SYNCHRO FOUND) primitive is followed by one of the three primitives:

- MA Data.indication (DA, SA, M-SDU) primitive,
- MA Sync.indication (Synchronization State = SYNCHRO CONF, SA, DA),
- MA Sync.indication (Sync. State = SYNCHRO LOSS, Synchro Loss Cause = wrong initiator, SA, DA).

The third primitive is only generated if the server system is configured in a synchronization-locked state.

Processes which lead to the generation of MA Sync.indication (Synchronization State = SYNCHRO LOSS) primitives indicating synchronization loss due to:

- the physical layer,
- the time-out-not-addressed counter,
- setting the MAC address attribute of the S-FSK Phy&MAC setup object to NEW; see Appendix B.1; or invoking the reset NEW not synchronized attribute of the S-FSK Active initiator object.

For details on the MA Sync.indication service primitive see IEC 61334-5-1 sub-clause 4.1.7.1.

If the synchronization process ends with one of the three primitives listed above, the synchronization-register variable is updated by taking into account the SA and DA fields of the primitive. The updating of the synchronization-register variable is carried out as follows: First, the Management Entity checks the SA and DA fields.

- If one of these fields corresponds to a client MAC address (CMA) the Entity:
  - checks if the client MAC address (CMA) appears in one of the couples contained in the synchronization-register variable;
  - If it appears, the related synchronizations-counter subfield is incremented;
  - If it does not appear, a new (MAC-address, synchronizations-counter) couple is added. This couple is initialized to the (CMA, 1) value.
- If none of the SA and DA fields correspond to a client MAC address, it is supposed that the system found its synchronization reference on a Discover Report type frame. In that case, the MAC-address which should be registered in the synchronization register variable is the predefined NEW value (0FFE). The updating of the synchronization-register variable is carried out in the same way as it is done for a normal client MAC address (CMA).

When a synchronizations-counter field reaches the maximum value, it automatically returns to 0 on the next increment. The maximum number of synchronization couples {MAC-address, synchronizations counter} contained in this variable should be specified in the implementation specifications. When this maximum is reached, the updating of the variable follows a First-In-First-Out (FIFO) mechanism: only the newest source MAC addresses are memorized. The default value of this variable is an empty array.

Desynchronization Listing
This attribute holds the MIB variable desynchronization-listing (variable 24), specified in IEC 61334-4-512 sub-clause 5.8. Desynchronization listing structure:

- nb physical layer desynchronization: desync. of server unit if sync. conformation timer expires,
- nb time out not addressed desynchronization: desynchronization of server unit if timeout not addressed timer expires,
- nb timeout frame not OK desynchronization: desynchronization of server unit if timeout frame not OK timer expires,
- nb write request desynchronization: local desynchronization in server requested,
- nb wrong initiator desynchronization: desynchronization of server unit caused by synchronization on client unit with wrong MAC address.

This variable counts the number of desynchronizations that occurred depending on their cause. On reception of synchronization loss notification, the Management Entity updates this attribute by incrementing the counter related to the cause of the desynchronization. When one of the counters reaches the maximum value, it automatically returns to 0 on the next increment. The default value of this variable contains elements which are all equal to 0.

Broadcast Frames Counter
Holds the MIB variable broadcast-frames-counter (variable 19) specified in IEC 61334-4-512 sub-clause 5.8. Broadcast couples structure:

- Source MAC Address,
- Frames Counter.

It counts the broadcast frames received by the server system and issued from a client system (source-MAC-address = any valid client-MAC-address, destination-MAC address = ALL-physical). The number of frames is classified according to the origin of the transmitter. The counter is incremented even if the LLC-destination-address is not valid on the server system. When the frames-counter field reaches its maximum value, it automatically returns to 0 on the next increment. The maximum number of broadcast couples {source-MAC-address, frames-counter} contained in this variable should be specified in the implementation specifications. When this maximum is reached, the updating of the variable follows a First-In-First-Out (FIFO) mechanism: only the newest source MAC addresses are memorized.

Repetitions Counter
Holds the MIB variable repetitions-counter (variable 20) specified in IEC 61334-4-512 sub-clause 5.8. Counts the number of repetition phases. The repetition phases following a transmission are not counted. If the MAC sub-layer is configured in the no-repeater mode, this variable is not updated. The repetitions-counter measures the activity of the system as a repeater.

A received frame repeated five times (from CC=4 to CC=0) is counted only once in the repetitions counter since it corresponds to one repetition phase. The counter is incremented at the beginning of each repetition phase. When the repetitions-counter reaches the maximum value, it automatically returns to 0 on the next increment. The default value is 0.

Transmissions Counter
Holds the MIB variable transmissions-counter (variable 21) specified in IEC 61334-4-512 sub-clause 5.8

Counts the number of transmission phases. A transmission phase is characterized by the transmission and the repetition of a frame. A repetition phase, which follows the reception of a frame, is not counted. The transmission counter is incremented at the beginning of each transmission phase. A client system can write this variable to update the counter. When the transmissions-counter reaches the maximum value, it automatically returns to 0 on the next increment. The default value is 0.

CRC OK Frames Counter
Holds the MIB variable CRC-OK-frames-counter (variable 22) specified in IEC 61334-4-512 sub-clause 5.8**.** Counts the number of frames received with a correct Frame Check Sequence Field. When the CRC-OK-frames counter field reaches the maximum value, it automatically returns to 0 on the next increment. The default value is 0.

CRC NOK Frames Counter
Counts the number of frames received with an incorrect Frame Check Sequence Field. When the CRC-NOK-frames counter field reaches the maximum value, it automatically returns to 0 on the next increment. The default value is 0.

5.5.4.9. S-FSK LLC setup

An instance of the “S-FSK IEC 61334-4-32 LLC setup” class holds parameters necessary to set up and manage the LLC layer as specified in IEC 61334-4-32.

Max Frame Length
This attribute holds the length of the LLC frame in bytes. See IEC 61334-4-32 sub-clause 5.1.4. In the case of the S-FSK profile, as specified in 61334-5-1 sub-clause 4.2.2, the maximum value is 242, but lower values may be chosen due to performance considerations (see table below).

Max frame length value	Note
0 - 25	Entry rejected
26 - 95	Entry confirmed but internally set as 242 due to successful communication establishment
96 - 242	Entry confirmed
243 ->	Entry rejected

Table 41: Max frame length

Reply Status List
This attribute holds the MIB variable reply-status-list (variable 11) specified in 61334-4-512 sub-clause 5.4. The attribute lists the L-SAPs that have a not empty RDR (Reply Data on Request) buffer, which has not already been read. The length of a waiting L-SDU is specified in number of sub frames (different from zero). The variable is locally generated by the LLC sub layer. Reply status structure:

- L-SAP Selector unsigned,
- Length of Waiting L-SDU unsigned.

Length of Waiting L-SDU in the case of the S-FSK profile is the number of sub-frames; valid values are 1 to 7.

5.5.4.10. S-FSK reporting system list

An instance of the “S-FSK Reporting system list” class holds the list of reporting systems.

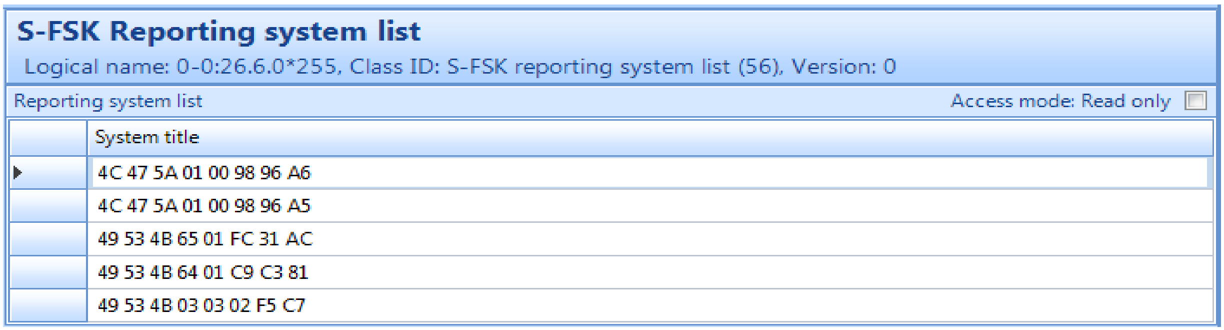


Figure 88: S-FSK reporting system list COSEM object

Reporting System List
This attribute holds the MIB variable reporting-system-list (variable 16) specified in 61334-4-512 sub-clause 5.7. Contains the system-titles of the server systems which have made a Discover Report request and which have not already been registered. The list has a finite size and it is sorted upon the arrival. The number of elements in the array is limited to one. The first element is the newest one. Once full, the oldest ones are replaced by the new ones. The reporting system list is updated:

- When a Discover Report CI PDU is received by the server system (whatever its state: non configured or configured): the CIASE adds the reporting system-title at the beginning of the list, and verifies that it does not exist anywhere else in the list, if so it destroys the old one. A system-title can only be present once in the list.
- When a Register CI PDU is received by the server system (whatever its state: non configured or configured): the CIASE checks the reporting-system list. If a system-title is present in the reporting-system-list and in the Register CI-PDU, the CIASE deletes the

system-title in the reporting-system-list: this system is no more considered as a reporting system.

5.5.4.11. DLC configuration channel 0

DLC configuration channel 0:

- OFF - 0x00,
- ON - 0x20.

5.5.4.12. Signal strength

First line in the DLC status structure below means status of PLC interface in the server unit as follows:

LSB	DLC_STATUS_SEQACTIV
	DLC_STATUS_INSTALLING
	DLC_STATUS_SETREPEATER
	DLC_STATUS_MACADDRCHANGED
	DLC_STATUS_PKTTRANSFER
	DLC_STATUS_CONFIGURED
	DLC_STATUS_REPEATER
	DLC_STATUS_INSTALLED
	DLC_STATUS_SYNCHRONIZED
	DLC_STATUS_ALARM
	DLC_STATUS_REPEATER_CALL
	DLC_STATUS_SYNC_FOUND
	DLC_STATUS_LOCKED
	DLC_STATUS_PHASE_NEUTRAL_INVERSE
	DLC_STATUS_DEP_UPDATE
MSB	DLC_STATUS_UNUSED_15

Following lines of DLC parameters in down order mean (All signal and noise values are presented in dBuV):

- last measured signal strength S0,
- last measured noise strength N0,
- last measured signal strength S1,
- last measured noise strength N1,
- minimum signal strength S0,
- minimum noise strength N0,
- minimum signal strength S1,
- minimum noise strength N1,
- maximum signal strength S0,
- maximum signal strength N0,
- maximum signal strength S1,
- maximum signal strength N1.

Last line in the structure presents last measured reception gain in dB from 0 to 42 in steps of 6dB.

PLC signal strength

Logical name: 0-0:128.0.12*255, Class ID: Data (1), Version: 0

Value : Structure — Access mode: Read only ☐

DLC status

	Description	ON/OFF
B0	Seq active	☐
B1	Installing	☐
B2	Set repeater	☐
B3	MAC address changed	☐
B4	Packet transfer	☐
B5	Configured	☑
B6	Repeater	☐
B7	Installed	☐
B8	Syncronized	☐
B9	Alarm	☑
B10	Repeater call	☐
B11	Sync found	☐
B12	Locked	☐
B13	Phase neutral inverse	☐
B14	DEP update	☐
B15	Unused 15	☐

Figure 89: Signal strength COSEM object

DLC parameters

	Description	Value
	Current signal 0 / dBuV	0
	Current noise 0 / dBuV	0
	Current signal 1 / dBuV	0
	Current noise 1 / dBuV	0
	Minimum signal 0 / dBuV	0
	Minimum noise 0 / dBuV	0
	Minimum signal 1 / dBuV	0
	Minimum noise 1 / dBuV	0
	Maximum signal 0 / dBuV	0
	Maximum noise 0 / dBuV	0
	Maximum signal 1 / dBuV	0
	Maximum noise 1 / dBuV	0
	Reception gain	0

Figure 90: Signal strength COSEM object

5.6. Fraud detection

5.6.1 Meter cover open and terminal cover open

These detectors (switches) trigger an event that lets the user know if and when terminal block cover or meter cover were opened.

Figure 91: Terminal cover opening switch

5.6.2 Magnetic field detection

This detector (reed relay) triggers a magnetic field detected event (fraud detection log event 42) and no more magnetic field detection event (fraud detection log event 43) that is recorded in fraud detection log-book if and when there was an external magnetic field (30-35mT) near the meter. This is used for security reasons as some public might try to influence the meters accuracy.

See list of fraud events in Table 50.

5.7. Meter programming

Programming of the meter as well as application part of FW upgrade can be done locally or remotely in compliance with the predefined security levels. The objects in the meter are secured with four authentication levels or most severe with param key. FW rewrite is applied in compliance with standards (Welmec).


For effective use of functionalities, meter must be properly configured.

5.8. Configuration program change

This two objects record number of configuration (parameter) changes (0-0:96.2.0) in the meter along with the timestamp of the last change (0-0:96.2.1):

- Number of configuration program changes,
- Date of last configuration program change.

6. Description of main meter functionalities

6.1. Measurements

Beside energy and power measurement and registration and instantaneous values measurement and registration (power, voltage, current, power factor, frequency) the following meter functions are available:

- Power Quality Measurements according EN 50160,
- Power Quality Measurements data available as instantaneous or average data,
- Voltage sags and swells,
- Undervoltages, overvoltages,
- Detection of minimum, maximum - daily voltage,
- Detection of instantaneous power factor; per phase, three-phase registers,
- Detection of last average power factor,
- Registration of three phase and phase power-downs and duration (long and short).

See also Chapter 3.6.

6.2. Sequences

These objects are used to configure data for quick readout, either from display or PC. Each register can accept maximum of 32 visible entries. They are usually used for most needed meter information such as energy and demand values or date and time. Only objects attribute 2 (Capture objects) is needed for correct setup entry.

The meters have three different sequences:

- P1 port readout sequence (d=0),
- General display readout sequence (d=1),
- Alternate display readout sequence (d=2).

For effective use of functionalities, meter must be properly configured.

6.2.1 P1 port readout list

With P1 port readout list object (0.0:21.0.0.255) data readout information can be set.

For effective use of functionalities, meter must be properly configured.

6.2.2 General display readout

With General display readout object (0.0:21.0.1.255) the information visible on meter's display in auto scroll mode can be set. This information automatically scrolls on display every few seconds (default period is 10 seconds) without any need to press any key.

Presentation of strings on display is performed with horizontal scroll, if the size of string is larger than the size of alphanumeric field for value on display (8 characters). Horizontal scroll shift period is one second. When the horizontal scroll is performed in Auto scroll mode, the auto scroll period (10s) is extended until end of the string is reached.

The objects, that are not intended to show on the display, will not be displayed, if they are included in General display readout list (0-0:21.0.1) or in Alternate display readout list (0-0:21.0.2). The message code Error 11 (Ident format failed) will be displayed instead.

For effective use of functionalities, meter must be properly configured.

6.2.3 Alternate display readout

With Alternate display readout object (0.0:21.0.2.255) the information visible on meter's display in manual-scroll mode can be set. Each press on **Scroll** key in manual-scroll mode scrolls to the next item from the Alternate display readout list. In transition from auto-scroll mode to manual-scroll mode the LCD test is performed (all segments on). After some time of inactivity in manual-scroll mode (default escape time is 2 minutes) the meter returns into auto-scroll mode.

For effective use of functionalities, meter must be properly configured.

6.3. Load profile recorder

Two general purpose load profiles are available in Mx381 meter. Each of two can capture any of the basic type object value present in the meter. Basic object type means any object attribute that has non-structured content.

The meter has two load profiles (LP with period 1 and LP with period 2) which are instances of the COSEM class the "Profile generic", which defines a generalized concept to store dynamic process values of capture objects. A profile has a buffer to store captured data, therefore each profile has a limit of stored data. More capture objects we select less total captured data will be possible to store. After a call of "reset" method, the buffer does not contain any entries, and this value is zero. Two read only attributes show status of this:

- Profile Entries attribute specifies how many entries could be retained in the buffer,
- Entries in Use attribute counts the number of entries stored in the buffer.

In each profile up to 32 objects can be registered. Number of objects directly defines the length of one record. Minimum and maximum profile capacity depends on the capture period selected and number of capture objects set and meter type used (ME381 or MT381).

For effective use of functionalities, meter must be properly configured.

Data in a load-profile recorder are accompanied with a timestamp and with the meter status in the last saving period as well as with a check sum. The timestamp indicates the end of a registration period.

Both profiles are compressed type – only one (first) timestamp is shown.

Profiles are implemented as FIFO buffers. Each record has associated a unique record number. Within one load profile more records can have same timestamp (in case time is shifted back) but all have different record numbers. When reading load profiles records are being put out according to their record number in increasing order.

Operation is IDIS P2 specification compliant.

6.3.1 Profile

6.3.1.1. Load profile with period 1 and 2

Capture Objects
Up to 32 objects can be captured (recorded) with capture period.

Capture Period
Capture period is variable which defines the time distance between two captured data's (seconds). The capture period of the profile can be specified by "capture period" attribute. It can be set to 5, 10, 15, 30, 60 minutes or one day. The period is synchronized with the hour; it always begins at completed hour. Value 0 of "capture period" means no registration. The profile buffer can be cleared by invocation of the "Profile generic" method "reset". These recording periods (in seconds) are recommended to choose from:

- 0 – No registration,
- 300 – 5 minute recording period,
- 600 – 10 minute recording period,
- 900 – 15 minute recording period,
- 1800– 30 minute recording period,
- 3600 – 1 hour recording period,
- 86400 – 1 day recording period.

Methods
Load profile has two methods implemented:

- Reset (erases captured values),
- Capture (performs capturing when executed) - not supported for load profile.

Load profile with period 2 has same functionality as profile with period 1, only difference is in less reserved space for records in the meter.

6.3.2 Profile status

There are two status registers:

- Profile status for load profile with period 1,
- Profile status for load profile with period 2.

The AMR Profile status code has a size of 1 byte and is shown in decimal form. The following table describes the state and the function of all bits.

If one of the events defined below has occurred during capture period, corresponding event code is added to the profile status register. By adding event codes to the profile status register all events occurred during capture period are stored to the profile buffer at the end of capture period. After storing a value of profile status register together with meter stands in the profile buffer meter resets profile status register to zero value. These status notifications shown in load profile readout are:

Status		Bit	Hex	Dec	Description
None			0x00	0	No event
Device disturbance	ERR	0	0x01	1	A serious error such as a hardware failure or a checksum error has occurred.
Clock battery discharged	CIV	1	0x02	2	The power reserve of the clock has been exhausted. The time is declared as invalid.
Measurement value disturbed	DNV	2	0x04	4	Indicates that the current entry may not be used for billing e.g. due to time shift or if no values have been recorded during the capture period.
Season changed	DST	3	0x08	8	Indicates that daylight savings is enabled
Reset cumulation		4	0x10	16	Reserved: The reserved bit is always set to 0
Device clock changed	CAD	5	0x20	32	The bit is set when clock has been adjusted more than the synchronization limit.
Power up	PUP	6	0x40	64	Reserved: The reserved bit is always set to 0
Power down	PDN	7	0x80	128	This bit is set to indicate that an all-phase power failure occurred

Table 42: List of profile statuses

6.4. Billing profile recorder

Billing functionality in the meter is used to provide process and storage for managing billing data. Data stored in the process of billing and time points when billing process is executed can be defined as parameters according to implemented object model.
All billing data are stored in form of buffer within object of class profile generic. Two billing profile objects are implemented in the meter. Each billing profile can have its own set of capture objects defined. Those two profiles do not use their capture period so this attribute should be set to 0. Capturing object values into buffer of the two billing profiles is triggered by execution of dedicated script from “End of billing script table”. This script table contains two predefined scripts, one for execution of “Billing profile 1” capture method and one for execution of “Billing profile 2” capture method.

The following actions are carried out by the meter when script 1 of “End of billing script table” is executed:

- Execute capture method for “Billing profile 1”,
- Reset maximum demand registers,
- Reset minimum power factor (value is set to 1),
- Increment “Total billing reset counter”,
- Create event in log-book to log execution of billing reset.

The following actions are carried out by the meter when script 2 of “End of billing script table” is executed:

- Execute capture method for “Billing profile 2”.

Each of two scripts from “End of billing script table” can be executed in two ways:

- By invoking execute method of “End of billing script table” via communication channel,
- Internally by “Single Action Schedule” object which refers to specific script.

Two single action schedule objects are dedicated to billing process. Each of those two can refer to any of the two scripts of “End of billing period” script table. Each single action schedule can have up to four time definitions that trigger execution of its associated script. Time definitions can be set as periodic (e.g. every day, every month …) or exact specified date-time.

The billing reset is executed immediately when triggered (via single action schedule or via communication channel), there is no waiting for completion of measurement period. When synchronization with measurement period is required, user should assure this by setting appropriate times in single action schedules.

If clock is set forward or backward over n periodic billing execution times, then only one entry will be generated in billing profile, marked with first time of periodic definition appearing after old time. The event in log-book will be generated with the new set time.

If clock is set forward over n exactly specified billing execution date-times, then only one will be generated in billing profile, marked with the nearest time appearing after old time.

If billing reset (end of billing period) is set to occur while the meter is powered-down (power-down before billing reset), the billing reset will occur immediately when meter is powered-up again. The event in log-book will be generated with the timestamp when meter is powered-up.

The data of the past billing periods stored in profile buffer cannot be displayed on LCD, they can be read out via communication channels, i.e. via optical port or dedicated modem.

6.4.1 End of billing period

Script is executed once a month typically at midnight at the end/start of every month, however other times can be set. Execution can be disabled if the execution time is left empty or set with “FFFFFFFF", "FFFFFFFFFF”. Activation time should be rounded up to a minute (seconds set to 00 as defined in COSEM Blue Book 10th Edition).

There are two Single action schedule objects, 0-0:15.0.0 (end of billing period 1 – d=0) and 0-0:15.1.0 (end of billing period 2- d=2), which trigger billing actions and represent start point for Billing Read E-meter events.

6.4.2 End of billing period script table

Each of billing sources invokes script from “end of billing” script table. That script starts the billing process. The main function of billing script table is to provide interface for execution of actions related to each specific billing type when script is executed.

6.4.3 Billing period counter

Billing period counter counts all billings that were performed in the past.

6.4.4 Data of billing period – Billing profile

Billing profile is the storage for billing data, captured by execution of billing actions. Billing profile buffer is organized as an array of entries. Each entry is a snapshot of capture object values at the moment of capture time. By default the first data in billing profile entries is time mark (0-0:1.0.0). Capture time is triggered from single action scheduler.

Each billing profile has the capacity of:

- 35 entries with default number of capture objects (5) (clock + 4 objects of size 4 bytes),
- 88 with minimum number of captured objects (2) (clock + 1 object of size 4 bytes),
- 5 entries with maximum number of capture objects (32) (clock + 31 objects of size 4 bytes).

There are two objects of billing profiles:

- Data of billing period 1 (d=1),
- Data of billing period 2 (d=2).

6.5. Event logs

Basic principle is shown in a diagram below:

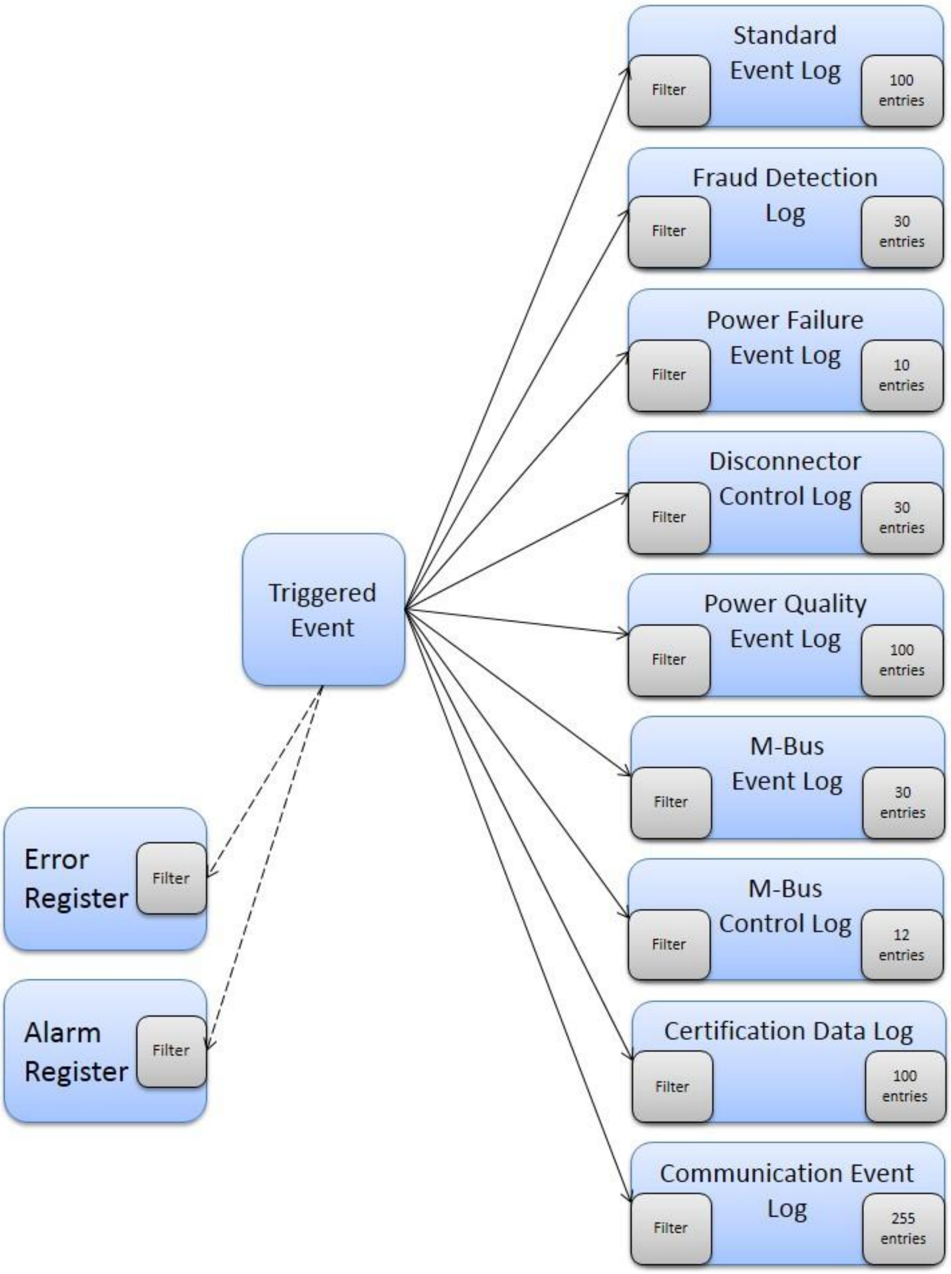


Figure 92: Event handling

Events are generated by the meter itself or by its environment. All these events are logged in several event logs. Every event has a unique code to identify the action which has triggered it. Every event is assigned to one event log (event filter) and it is only stored there. The e-meter features ten different event logs as described below. All logs except the power failure log have the same basic structure (timestamp and event code). The structure per event log is fixed, i.e. it is not possible to store different parameters per event.

Mx381 meters support different event codes. The Event system object (1-0:96.245.0.255) enables the meter to provide three different types of event code presentation. Depending on projects these can be set to:

- VDEW / IE - (0),
- IDIS - (1),
- EDF - (2).

Change takes effect after power-down/up or reset.

For effective use of functionalities, meter must be properly configured.

6.5.1 Event code objects

Events are generated by the meter itself of by its environment. Each type of an event is presented with a unique code (event code) to identify the action which has triggered it. Event codes are stored in corresponding Event code objects. Each event object holds only the most recent event. The event code object has the value of 0 until the first event is detected/generated by the meter or every time a power-up is performed.

6.5.2 Event log objects

Instances of event code objects are captured in corresponding event logs. Event log objects are instances of COSEM class “profile generic” and are used to store events. They are organized as FIFO buffers where records are sorted by time. Once the buffer is full, the oldest entry in the buffer is the first to be replaced. The capacity (maximum number of records in a buffer) of the event log objects varies from object to object. Records in the buffer are captured asynchronously, as the events occur.

The majority of the supported event log objects (with the exception of Power failure event log) follow the same basic structure containing the timestamp (time of the occurrence of the event) and the event code object.

The meter features the following event log objects:

Event log object	logical name	capacity	captured objects
Standard event log	0-0:99.98.0.255	100	0-0:1.0.0.255 0-0:96.11.0.255
Fraud detection log	0-0:99.98.1.255	30	0-0:1.0.0.255 0-0:96.11.1.255
Disconnector control log	0-0:99.98.2.255	30	0-0:1.0.0.255 0-0:96.11.2.255
M-Bus event log	0-0:99.98.3.255	30	0-0:1.0.0.255 0-0:96.11.3.255
Power quality event log	0-0:99.98.4.255	100	0-0:1.0.0.255 0-0:96.11.4.255
M-Bus control log [1]	0-x:24.5.0.255	12	0-0:1.0.0.255 0-x:96.11.4.255

[1] x represent M-Bus channel from 1 to 4

Power failure event log	1-0:99.97.0.255	10	0-0:1.0.0.255 0-0:96.7.19.255
Certification data log	1-0:99.99.0.255	100	0-0:1.0.0.255 0-0:96.128.0.255 0-0:96.128.1.255 0-0:96.128.2.255

Table 43: Event log objects

6.5.3 Standard event log

Standard event log contains all events not recorded in a special event log, e.g. changes of the clock, changes of the configuration, clearing of profiles, all kind of self check errors, activation of new parameters, activation of new time of use, etc. Standard event log structure consists of timestamp and event code.

6.5.3.1. Standard event log codes

Standard event log code object holds the code from the last event triggered. These codes along with timestamps are then used in event log.

Standard IDIS event codes are listed in Table below.

IDIS event code	Event name	Event description
1	Power Down	Indicates a complete power down of the device. Please note that this is related to the device and not necessarily to the network.
2	Power Up	Indicates that the device is powered again after a complete power down.
3	DST enabled or disabled	Indicates the regular change from and to daylight saving time. The timestamp shows the time after the change. This event is not set in case of manual clock changes and in case of power failures.
4	Clock adjusted (old date/time)	Indicates that the clock has been adjusted. The date/time that is stored in the event log is the old date/time before adjusting the clock.
5	Clock adjusted (new date/time)	Indicates that the clock has been adjusted. The date/time that is stored in the event log is the new date/time after adjusting the clock.
6	Clock invalid	Indicates that clock may be invalid, i.e. if the power reserve of the clock has exhausted. It is set at power up.
7	Replace Battery	Indicates that the battery must be exchanged due to the expected end of life time.
8	Battery voltage low	Indicates that the current battery voltage is low.
9	TOU activated	Indicates that the passive TOU has been activated.
10	Error register cleared	Indicates that the error register was cleared.
11	Alarm register cleared	Indicates that the alarm register was cleared.
12	Program memory error	Indicates a physical or a logical error in the program memory.
13	RAM error	Indicates a physical or a logical error in the RAM
14	NV memory error	Indicates a physical or a logical error in the non volatile memory
15	Watchdog error	Indicates a watch dog reset or a hardware reset of the microcontroller.
16	Measurement system error	Indicates a logical or physical error in the measurement system
17	Firmware ready for activation	Indicates that the new firmware has been successfully downloaded and verified, i.e. it is ready for activation
18	Firmware activated	Indicates that a new firmware has been activated

19	Passive TOU programmed	The passive structures of TOU or a new activation date/time were programmed
47	One or more parameters changed	
48	Global key(s) changed	One or more global keys changed
51	FW verification failed	Indicates the transferred firmware verification failed i.e. cannot be activated.
88	Phase sequence reversal	Indicates wrong mains connection. Usually indicates fraud or wrong installation. For poly phase connection only!
89	Missing neutral	Indicates that the neutral connection from the supplier to the meter is interrupted (but the neutral connection to the load prevails). The phase voltages measured by the meter may differ from their nominal values
230	Fatal error	Indicates any fatal error length
231	Billing reset	Indicates billing reset
232	Power down phase L1	Indicates power loss / power disconnected on phase L1
233	Power down phase L2	Indicates power loss / power disconnected on phase L2
234	Power down phase L3	Indicates power loss / power disconnected on phase L3
235	Power restored phase L1	Indicates power restored / power connected to phase L1
236	Power restored phase L2	Indicates power restored / power connected to phase L2
237	Power restored phase L3	Indicates power restored / power connected to phase L3
238	No connection timeout	Indicates No connection timeout when there is no communication for 30h
239	Prepay Token Enter Success	Indicates Successful Prepay Token Enter
240	Prepay Token Enter Fail	Indicates Failed Prepay Token Enter
241	Prepay Credit Expired	Indicates Prepay Credit Expiration
242	Prepay Emergency Credit Expired	Indicates Emergency Credit Expiration
243	Prepay Emergency Credit Activated	Indicates Emergency Credit Activation
254	Load profile cleared	Any of the profiles cleared. NOTE: If it appears in Standard Event Log then any of the E-load profiles was cleared. If the event appears in the M-Bus Event log then one of the M-Bus load profiles was cleared
255	Event log cleared	Indicates that the event log was cleared. This is always the first entry in an event log. It is only stored in the affected event log.

Table 44: List of events in the Standard event log

6.5.4 Fraud detection event log

Fraud detection event log contains all events related to the detection of fraud attempts, e.g. removal of terminal cover, removal of meter cover, strong DC field detection, access with wrong password, etc. There is a 15 minute (900s) hold-off period (time interval) between two events (only events detected after 15 of latest one are recorded).

For events that are saved in fraud detection log we have assigned a time interval. This interval is started at fraud event and disables another logging of same fraud event for its duration. That prevents completely filling fraud detection log with quickly repeated fraud events.

Example: When strong DC field is detected, event is saved in fraud log and time interval is started. DC field is then removed, event is saved in fraud log and another time interval is started. For next 15 minutes no such event is recorded if we apply and remove DC field. We can apply strong DC field that will not be marked with event, wait until the time interval for DC removed runs out and then remove DC field. Event will be logged in fraud log and time interval will be started again.

9:00 strong DC field detected - event 42 saved in fraud log
900s time interval for DC ON started
9:01 strong DC field removed - event 43 saved in fraud log
900s time interval for DC OFF started
…
9:14 strong DC field detected - logging of event 42 is blocked!
Time interval for DC ON ends, time interval for DC OFF ends
9:17 strong DC field removed - event 43 saved in fraud log
900s time interval for DC OFF started
…

Fraud detection event log structure consists of timestamp and event code.

6.5.4.1. Fraud detection event log codes

Fraud Detection event log code object holds the code from the last event triggered. These codes along with timestamps are then used in event log.

List of events in the Fraud detection event log is shown in the Table below.

IDIS event code	Event name	Event description
40	Terminal cover removed	Indicates that the terminal cover has been removed
41	Terminal cover closed	Indicates that the terminal cover has been closed
42	Strong DC field detected	Indicates that a strong magnetic DC field has been detected.
43	No strong DC field anymore	Indicates that the strong magnetic DC field has disappeared.
44	Meter cover removed	Indicates that the meter cover has been removed.
45	Meter cover closed	Indicates that the meter cover has been closed.
46	Association authentication failure (n time failed authentication)	Indicates that a user tried to gain LLS access with wrong password (intrusion detect) or HLS access challenge processing failed n-times
49	Decryption or authentication failure (n time failure)	Decryption with currently valid key (global or dedicated) failed to generate a valid APDU or authentication tag
50	Replay attack	Receive frame counter value less or equal to the last successfully received frame counter in the received APDU. Event signalizes as well the situation when the DC has lost the frame counter synchronization.

255	Event log cleared	Indicates that the event log was cleared. This is always the first entry in an event log. It is only stored in the affected event log.

Table 45: List of events in the Fraud detection event log

6.5.5 Power quality event log

Power quality event log contains all events related to power quality, see Power Quality section. Power quality event log structure consists of timestamp and event code.

6.5.5.1. Power quality event log codes

Power Quality event log code object holds the code from the last event triggered. These codes along with timestamps are then used in event log.

List of events in the Power quality event log is shown in the Table below:

IDIS event code	Event name	Event description
76	Undervoltage L1	Indicates undervoltage on at least L1 phase was detected.
77	Undervoltage L2	Indicates undervoltage on at least L2 phase was detected.
78	Undervoltage L3	Indicates undervoltage on at least L3 phase was detected.
79	Overvoltage L1	Indicates overvoltage on at least L1 phase was detected.
80	Overvoltage L2	Indicates overvoltage on at least L2 phase was detected.
81	Overvoltage L3	Indicates overvoltage on at least L3 phase was detected.
82	Missing voltage L1	Indicates that the voltage on at least L1 phase has fallen below the U_{min} threshold for longer than the time delay.
83	Missing voltage L2	Indicates that the voltage on at least L1 phase has fallen below the U_{min} threshold for longer than the time delay.
84	Missing voltage L3	Indicates that the voltage on at least L1 phase has fallen below the U_{min} threshold for longer than the time delay.
85	Voltage L1 normal	Indicates that the mains voltage is in normal limits again, e.g. after overvoltage.
86	Voltage L2 normal	Indicates that the mains voltage is in normal limits again, e.g. after overvoltage.
87	Voltage L3 normal	Indicates that the mains voltage is in normal limits again, e.g. after overvoltage.
255	Event log cleared	Indicates that the event log was cleared. This is always the first entry in an event log. It is only stored in the affected event log.

Table 46: List of events in the Power quality event log

6.5.6 Power failure event log

Power failure event log contains all events related to long power outages, i.e. start and end of a long power outage.

It is a simplified version of the full power quality event log storing just the timestamp and the duration of last long power failure in any phase. The timestamp represents the end of power failure. The object Duration of last long power failure in any phase (0-0:96.7.19.255) stores only the duration of the most recent power outage.

Time thresholds for long power failure is defined with Time threshold for long power failure object (0-0:96.7.20.255), see Power Failure section.

6.5.7 Certification data log

Certification data log (1-0:99.99.0.255) is another special log, used to log modifications of critical parameters which influence measurement values. The basic structure of the data log contains the timestamp and three additional objects:

- Last modified secure parameter identifier (0-0:96.128.0.255),
- Last modified secure parameter old value (0-0.96.128.1.255),
- Last modified secure parameter new value (0-0.96.128.2.255).

“Last modified secure parameter identifier” object contains the logical name of the most recently modified critical measurement parameter object. “Last modified secure parameter old value” object and the “Last modified secure parameter new value” object contain the last modified object’s previous and newly set values.

Capture to this log is done when one of the critical measurement parameters changes. In this case, all the needed information (logical name, old value and new value) are stored in dedicated objects first and then captured into certification data log.

The following critical parameters are being monitored:

- Active energy metrological LED (1-0:0.3.0.255),
- Reactive energy metrological LED (1-0:0.3.1.255),
- Apparent energy metrological LED (1-0:0.3.2.255),
- Transformer ratio – current (numerator) (1-0:0.4.2.255),
- Transformer ratio – current (denominator) (1-0:0.4.5.255),
- Measurement period 1, for average value 1 (1-0:0.8.0.255).

The capacity of the Certification data log is set to 100 entries. When log is full, the critical measurement objects can no longer be changed. All change requests are rejected. The log can only be erased when meter is in unlocked state. This can only be achieved by removing meter cover.

6.5.8 Disconnector control log

IDIS event code	Event name	Event description
59	Disconnector ready for manual reconnection	Indicates that the disconnector has been set into the Ready for reconnection state and can be manually reconnected
60	Manual disconnection	Indicates that the disconnector has been manually disconnected.
61	Manual connection	Indicates that the disconnector has been manually connected.
62	Remote disconnection	Indicates that the disconnector has been remotely disconnected.
63	Remote connection	Indicates that the disconnector has been remotely connected.
64	Local disconnection	Indicates that the disconnector has been locally disconnected
65	Limiter threshold exceeded	Indicates that the limiter threshold has been exceeded.
66	Limiter threshold ok	Indicates that the monitored value of the limiter dropped below the threshold.
67	Limiter threshold changed	Indicates that the limiter threshold has been changed
68	Disconnect/Reconnect failure	Indicates that the a failure of disconnection or reconnection has happened
69	Local reconnection	Indicates that the disconnector has been locally re-connected (i.e. via the limiter or current supervision monitors).

70	Supervision monitor 1 threshold exceeded	Indicates that the supervision monitor threshold has been exceeded.
71	Supervision monitor 1 threshold ok	Indicates that the monitored value dropped below the threshold.
72	Supervision monitor 2 threshold exceeded	Indicates that the supervision monitor threshold has been exceeded.
73	Supervision monitor 2 threshold ok	Indicates that the monitored value dropped below the threshold.
74	Supervision monitor 3 threshold exceeded	Indicates that the supervision monitor threshold has been exceeded.
75	Supervision monitor 3 threshold ok	Indicates that the monitored value dropped below the threshold.
255	Event log cleared	Indicates that the event log was cleared. This is always the first entry in an event log. It is only stored in the affected event log.

Table 47: List of events in the Disconnector control log

6.5.9 M-Bus event log

IDIS event code	Event name	Event description
100	Comm. error M-Bus Ch. 1	Indicates com. problem when reading the meter connected to Ch.1 of the M-Bus
101	Comm. ok M-Bus Ch.1	Indicates that the communication with the M-Bus meter connected to Ch.1 of the M-Bus is ok again.
102	Replace Battery M-Bus Ch. 1	Indicates that the battery must be exchanged due to the expected end of life time.
103	Fraud attempt M-Bus Ch.1	Indicates that a fraud attempt has been registered.
104	Clock adjusted M-Bus Ch. 1	Indicates that the clock has been adjusted.
110	Communication Error M-Bus Ch. 2	Indicates com. problem when reading the meter connected to Ch.2 of the M-Bus
111	Comm. ok M-Bus Ch. 2	Indicates that the communication with the M-Bus meter connected to channel 2 of the M-Bus is ok again.
112	Replace Battery M-Bus Ch. 2	Indicates that the battery must be exchanged due to the expected end of life time.
113	Fraud attempt M-Bus Ch. 2	Indicates that a fraud attempt has been registered.
114	Clock adjusted M-Bus Ch. 2	Indicates that the clock has been adjusted.
120	Comm. Error M-Bus Ch. 3	Indicates com. problem when reading the meter connected to Ch.3 of the M-Bus
121	Comm. ok M-Bus Ch. 3	Indicates that the communication with the M-Bus meter connected to Ch.3 of the M-Bus is ok again.
122	Replace Battery M-Bus Ch. 3	Indicates that the battery must be exchanged due to the expected end of life time.
123	Fraud attempt M-Bus Ch. 3	Indicates that a fraud attempt has been registered.
124	Clock adjusted M-Bus Ch. 3	Indicates that the clock has been adjusted.
130	Comm. Error M-Bus Ch. 4	Indicates com. problem when reading the meter connected to Ch.4 of the M-Bus
131	Comm. ok M-Bus Ch. 4	Indicates that the communication with the M-Bus meter connected to ch.4 of the M-Bus is ok again.
132	Replace Battery M-Bus Ch. 4	Indicates that the battery must be exchanged due to the expected end of life time.
133	Fraud attempt M-Bus Ch. 4	Indicates that a fraud attempt has been registered.
134	Clock adjusted M-Bus Ch. 4	Indicates that the clock has been adjusted.
254	Load profile cleared	Any of the profiles cleared. NOTE: If it appears in Standard Event Log then any of the E-load profiles was cleared. If the event appears in the M-Bus Event log then one of the M-Bus load profiles was cleared
255	Event log cleared	Indicates that the event log was cleared. This is always the first entry in an event log. It is only stored in the affected event log.

Table 48: List of events in the M-Bus event log

6.5.10 M-Bus control logs

IDIS event code	Event name	Event description
160	Manual disconnection M-Bus Ch.1	Indicates that the disconnector has been manually disconnected
161	Manual connection M-Bus Ch.1	Indicates that the disconnector has been manually connected
162	Remote disconnection M-Bus Ch.1	Indicates that the disconnector has been remotely disconnected
163	Remote connection M-Bus Ch.1	Indicates that the disconnector has been remotely connected
164	Valve alarm M-Bus Ch. 1	Indicates that a valve alarm has been registered
170	Manual disconnection M-Bus Ch.2	Indicates that the disconnector has been manually disconnected
171	Manual connection M-Bus Ch.2	Indicates that the disconnector has been manually connected
172	Remote disconnection M-Bus Ch.2	Indicates that the disconnector has been remotely disconnected
173	Remote connection M-Bus Ch.2	Indicates that the disconnector has been remotely connected
174	Valve alarm M-Bus Ch. 2	Indicates that a valve alarm has been registered
180	Manual disconnection M-Bus Ch.3	Indicates that the disconnector has been manually disconnected
181	Manual connection M-Bus Ch.3	Indicates that the disconnector has been manually connected
182	Remote disconnection M-Bus Ch.3	Indicates that the disconnector has been remotely disconnected
183	Remote connection M-Bus Ch.3	Indicates that the disconnector has been remotely connected
184	Valve alarm M-Bus Ch.3	Indicates that a valve alarm has been registered
190	Manual disconnection M-Bus Ch.4	Indicates that the disconnector has been manually disconnected
191	Manual connection M-Bus Ch.4	Indicates that the disconnector has been manually connected
192	Remote disconnection M-Bus Ch.4	Indicates that the disconnector has been remotely disconnected
193	Remote connection M-Bus Ch.4	Indicates that the disconnector has been remotely connected
194	Valve alarm M-Bus Ch.4	Indicates that a valve alarm has been registered
255	Event log cleared	Indicates that the event log was cleared. This is always the first entry in an event log. It is only stored in the affected event log.

Table 49: List of events in the M-Bus control log

6.6. Alarms

When some special events occur in meter, internal alarm is generated in meter which can be sent to the central system. The alarm parameters are predefined. The priority levels of alarms are adjustable. Alarms are then registered and handled by the utility HES.

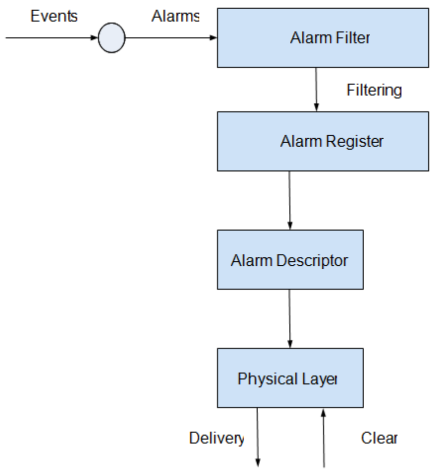


Figure 93: Alarm reporting process

Each bit in the alarm register represents a different alarm. If any bit is set, corresponding alarm was recorded. Value of the alarm register is a 32-bit value of all active and inactive alarms. Depending on the capabilities of the HES and the utility policy it is possible to mask unwanted alarms through the alarm filter.

6.6.1 Alarm system

Mx381 meters support three different alarm system codes (active after PD/PU procedure):

- VDEW / IE - (0),
- IDIS - (1),
- EDF - (2).

6.6.2 Alarm codes

Bit	Alarm	Description
0	Clock invalid	Current clock is compared with internal clock structure and if there is any deviation the bit is set.
1	Replace battery	Clock battery or backup capacitor is discharged.
2	A2*	
3	A3*	
4	A4*	
5	A5*	
6	*Reserved for future use*	
7	*Reserved for future use*	
8	Program memory error	Set whenever a program memory error bit in error register is set.
9	RAM error	Set whenever a RAM error bit in error register is set.
10	NV memory error	Set whenever a NV memory error bit in error register is set.
11	Measurement system error	Set whenever a measurement system error bit in error register is set.
12	Watchdog error	Set whenever a watchdog error bit in error register is set.
13	Fraud attempt	Set when fraud attempt is detected.
14	*Reserved for future use*	
15	*Reserved for future use*	
16	Comm. error M-Bus Ch1	M-Bus device connected to the channel 1 does not respond.
17	Comm. error M-Bus Ch2	M-Bus device connected to the channel 2 does not respond.
18	Comm. error M-Bus Ch3	M-Bus device connected to the channel 3 does not respond.
19	Comm. error M-Bus Ch4	M-Bus device connected to the channel 4 does not respond.
20	Fraud attempt M-Bus Ch1	Alarm is set when M-Bus device connected to the Ch. 1 reports a fraud attempt.
21	Fraud attempt M-Bus Ch2	Alarm is set when M-Bus device connected to the Ch. 2 reports a fraud attempt.
22	Fraud attempt M-Bus Ch3	Alarm is set when M-Bus device connected to the Ch. 3 reports a fraud attempt.
23	Fraud attempt M-Bus Ch4	Alarm is set when M-Bus device connected to the Ch. 4 reports a fraud attempt.
24	*Reserved for future use*	
25	*Reserved for future use*	
26	*Reserved for future use*	
27	*Reserved for future use*	
28	*Reserved for future use*	
29	*Reserved for future use*	
30	*Reserved for future use*	

31	*Reserved for future use*	

(*) Only valid for the PLC meters. Alarms A2 to A5 are mapped into bit3 to bit6. See “CIASE - Alarm Descriptor Service”.

Table 50: Alarm 1 codes (IDIS P1/P2)

Bit	Alarm	Description
0	Total Power Failure	Set when power-down on meter occurs.
1	Power Resume	Set when meter power returns.
2	Voltage Phase Failure L1	Set when voltage on at least L1 phase has fallen below the Umin threshold for longer than time delay.
3	Voltage Phase Failure L2	Set when voltage on at least L2 phase has fallen below the Umin threshold for longer than time delay.
4	Voltage Phase Failure L3	Set when voltage on at least L3 phase has fallen below the Umin threshold for longer than time delay.
5	Voltage Phase Resume L1	Set when the mains voltage on L1 is in normal limits again.
6	Voltage Phase Resume L2	Set when the mains voltage on L2 is in normal limits again.
7	Voltage Phase Resume L3	Set when the mains voltage on L3 is in normal limits again.
8	Missing Neutral	Set when the neutral connection from the supplier to the meter is interrupted.
9	Phase Asymmetry	Set when large unbalance loads is present
10	Current Reversal	Set when unexpected energy export is present (for energy import configured devices only).
11	Wrong Phase Sequence	Set when wrong mains connection or fraud (polyphase meters only).
12	Unexpected Consumption	Set when consumption is detected on at least one phase when disconnector has been disconnected.
13	Key Exchanged	Set when one or more global keys changed.
14	Bad Voltage Quality L1	Set when L1 voltage is not within ranges for defined period of time (see EN50160:2010, section 4.2.2).
15	Bad Voltage Quality L2	Set when L2 voltage is not within ranges for defined period of time (see EN50160:2010, section 4.2.2).
16	Bad Voltage Quality L3	Set when L3 voltage is not within ranges for defined period of time (see EN50160:2010, section 4.2.2).
17	External Alert	Set when signal is detected on meter’s INPUT terminal.
18	Local Communication Attempt	Set when communication on any local port is detected (i.e. unauthorized access)
19	New M-Bus Device Installed Ch1	Set when new M-Bus device is registered on the Ch1 with new serial number.
20	New M-Bus Device Installed Ch2	Set when new M-Bus device is registered on the Ch2 with new serial number.
21	New M-Bus Device Installed Ch3	Set when new M-Bus device is registered on the Ch3 with new serial number.
22	New M-Bus Device Installed Ch4	Set when new M-Bus device is registered on the Ch4 with new serial number.
23	*Reserved for future use*	
24	*Reserved for future use*	
25	*Reserved for future use*	
26	*Reserved for future use*	
27	M-Bus Valve Alarm Ch1	Set when ALARM STATUS bit is received from device on Ch1.
28	M-Bus Valve Alarm Ch2	Set when ALARM STATUS bit is received from device on Ch2.
29	M-Bus Valve Alarm Ch3	Set when ALARM STATUS bit is received from device on Ch3.
30	M-Bus Valve Alarm Ch4	Set when ALARM STATUS bit is received from device on Ch4.
31	Disconnect/Reconnect Failure	Set when disconnector failed to connect/disconnect.

Table 51: Alarm 2 codes (IDIS P2)

6.6.2.1. CIASE - Alarm Descriptor Service

All fraud attempts are grouped, i.e. for alarming it is not necessary to see the exact type of fraud which caused the alarm. This can be found out by checking the error register or the appropriate event log.

The S-FSK profile provides the transport of an alarm from the meter to the data collector (DC) by means of the Discovery Service. The Alarm Descriptor is a parameter of the Discover service (comp. DLMS UA 1000-2 Ed. 7.0, sect 10.4.5.2) carrying the alarming information.

The Alarm Descriptor is of type *Integer* which is interpreted as a set of 8 bits. A set bit (bit=1) means that the corresponding alarm has been the detected. The meaning of the bit position is as follows:

Bit	Alarm
0	PLC equipment in state “new”
1	Clock invalid
2	Battery replace
3	A2
4	A3
5	A4
6	A5
7	Extended Alarm status

Table 52: Assignment of alarm descriptor bits

6.6.3 Alarm register

If any of the special events occurs, which triggers alarm, the corresponding flag in the alarm register is set. All alarm flags in the alarm register remain active until the alarm register is cleared internally (by device) or remotely (by client). Each bit in alarm register represents a different alarm. If any bit is set (logical 1), alarm was recorded. Value in the register is a 32-bit value of all active and inactive alarms at that time.

6.6.4 Alarm filter

Alarms can be masked through the Alarm Filter object. To mask out unwanted alarm, corresponding bit (logical 0) in the alarm filter register must be cleared (unchecked). By default no alarm is enabled. Structure of the Alarm filter is the same as structure of the Alarm register.

6.6.5 Alarm status

Alarm status register shows which alarm has been triggered. There is a separate register for the ON and OFF statuses. Each bit represents the corresponding alarm. Recorded bit remains active until it is cleared by the client. This registers cannot be cleared by the device. Structure of the Alarm status is the same as the Alarm register.

6.7. Errors

The meter uses its automatic supervision mechanism to detect and log different types of events related to meter operation. These events can be a part of meter's internal functionality or can occur due to changes in the meter's environment. When an event which indicates a malfunction in meter operation is triggered, the appropriate flag in the error register is set.

Once a flag in the Error register object (0-0:97.97.0.255) is set, it remains active even after the corresponding error condition has disappeared. The Error register object has to be cleared manually (using supported communication interfaces). If, after the flag in the error register has been cleared, the corresponding error condition still remains, the flag in the error register is re-set by the meter.

During operation, the meter performs tests of individual functions. In case of an error it is represented with corresponding error bit in the Error Object register and FF flag on the LCD display is set. The Error Object value register is 32 bits long and is organized in 4 groups of errors:

- Memory errors,
- Communication errors,
- Clock errors,
- Control errors.

6.7.1 Error register

Mx381 meters contain two sets of error registers. First set is used to report errors with IDIS specifications, while the second set is used for backward capability with other Iskraemeco AMI meters.

The table below gives an overview of all errors (IDIS errors codes) and their assignments.

Bit	Error	Description
0	Clock invalid	Clock is invalid.
1	Replace battery (discharged)	Clock battery or backup capacitor is discharged.
2-7	Unused	/
8	Program memory error	Indicates error in the meters program space (internal flash memory) when the behavior of meter is unpredictable and the meter should be replaced. The results stored in the meter should be inspected and validated.
9	RAM error	Error detected in RAM (data) memory. The meter can operate irregularly.
10	NV memory error	Error detected in non-volatile memory. The meter can operate irregularly.
11	Measurement system error	Error detected in measurement system. The measurement could be inaccurate.
12	Watchdog error	Meter has been restarted by watch-dog circuitry.
13-15	Unused	/
16	Communication error M-Bus channel 1	Communication with M-Bus device on channel 1 failed.
17	Communication error M-Bus	Communication with M-Bus device on channel 2 failed.

	channel 2	
18	Communication error M-Bus channel 3	Communication with M-Bus device on channel 3 failed.
19	Communication error M-Bus channel 4	Communication with M-Bus device on channel 4 failed.
20-31	Unused	/

Table 53: IDIS error codes register

The table below gives an overview of all errors (IE errors codes) and their assignments.

Bit	Error	Description
0-7	Unused	
8	ROM checksum error	
9	Back-up data checksum	
10	Parameters checksum	
11	Profile checksum	
12	Event log checksum	
13	RAM checksum	
14-15	Unused	
16	RAM error	Error detected in RAM (data) memory. The meter can operate irregularly.
17	FRAM memory error	Error detected in non-volatile memory. The meter can operate irregularly
18	Measurement error	
19	RTC error	
20-21	Unused	
22	Communication error	
23	Display error	
24	Battery discharged	Clock battery or backup capacitor is discharged.
25	Invalid time	Clock is invalid.
26-31	Unused	

Table 54: IE error codes register

6.7.2 Error filter

Depending on the capabilities of the system and the policy of the utility, not all possible errors are desired. Therefore the error filter object can be programmed to mask out unwanted errors. The structure of the Error 1 filter object (0-0:196.97.0.255) is the same as the structure of the Error register object (0-0:97.97.0.255). To mask out unwanted errors the corresponding bit in the error filter should be set to logical 1.

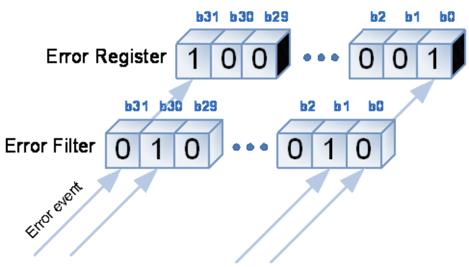


Figure 94: Error filtering

6.7.3 Error display filter

With this objects errors can be filtered out on display FF flag. In order to filter out the right error the corresponding bit in the error display filter should be set to logical 1.

6.7.4 Error types

Errors recorded in the Error register object (0-0:97.97.0.255) fall into one of five categories:

- Clock errors,
- Memory errors,
- Measurement system error,
- Communication errors,
- Control errors.

6.7.4.1. Clock errors

Invalid clock error
Current clock is compared with internal clock structure and if there is any deviation error will be set. When the meter clock is set the meter will reset invalid time bit in error register. The energy registers are not affected by “Invalid time error”.

Check battery state error
The state of battery or real time backup capacitor is monitored continuously and if voltage level falls under specified threshold an error is reported by setting Replace Battery Error flag.

6.7.4.2. Memory errors

Program memory error
Program memory is checked by integrity of program code stored. Program code is signed by MD5 algorithm during the build time. The signature is stored together with program code in program memory. In the run time meter calculates signature over program code and compares it with previously stored one. If signatures are different, Program Memory Error flag is set.

Due to substantial size of program memory, program memory checking runs as background task to not affect normal execution of other program code. By continuous running any unpredicted changes in program code can be detected and reported.

Data memory error
Complete data memory (RAM) is checked during initialization process of the meter, which is started after power-up or firmware upgrade. During initialization procedure a meter performs test of RAM through whole address range. The test is executed for every memory location and it is nondestructive. The original content of memory location under test is loaded to the CPU register, and then inverted content is stored to the same memory location and compared with inverted content stored in CPU register. Upon successful comparison of the inverted content, the original content of memory location

is restored and compared with its copy sorted in CPU register at the beginning of the test. If test fails, meter sets RAM Error flag.

Otherwise during the normal operation meter checks integrity data structures where critical data are stored. Each time when such data structure is intentionally changed, new signature is calculated and stored. Later on when data are accessed again by the program, the integrity can be checked by comparing newly calculated signature with one calculated during last intentionally change. If signatures do not match, meter sets RAM Error flag. In such way continuous monitoring of RAM is achieved.

Non-Volatile memory error
The non-volatile memory is used to retain the stored information even when a meter is not powered. It is used as long-term persistent storage for periodical history data, billing data, event logs, register back-up copies, parameters and any other data meter needs for normal start.

Data integrity checking is performed periodically or randomly during data access. Checking of data which are results of meter processes and they are changing more often is done during data access. The meter configuration parameters are checked periodically with period of one hour. If any of the checks fails Non-volatile Memory in errors register is set.

6.7.4.3. Measurement system error

Check accuracy measurement error
Checking of undisturbed operation and accuracy of the meter, to certain extend, performs a meter by itself. If any error is detected, meter reports it by setting Measurement System Error flag.

6.7.4.4. Communication errors

M-Bus Communication error
Connection of meter with hosted M-Bus meter is checked during communication with M-Bus slave device. If there is no respond from a slave device or there is a respond but structure of the data frame on data link layer is incorrect, meter will set corresponding error bit.

6.7.4.5. Control errors

ROM Checksum error
Indicates error in the meters program space (micro-controller internal FLASH memory) when the behavior of meter is unpredictable and meter should be replaced. The results stored in the meter should be inspected and validate.

Backup Error
Indicates CRC error in FRAM for energy back-up data and every time when new copy is created meter calculates CRC for it. Before use of such copy meter checks CRC and if CRC is not valid generates “Backup Error”.

Parameter Error
Indicates checksum error in parameter storage (meters non-volatile memory). The error does not affect energy cumulative registers but can affect tariff registers if an error is detected inside tariff program. The error bit can be reset by writing new set of parameters.

Data Error
Indicates CRC error for energy data stored in RAM and this error appears in combination with “Backup Error”. Since occurrence of that error results in the meter are not valid, the meter should be replaced.

6.8. Activity calendar and TOU registration

See Chapter 5.4.

6.9. Disconnector – Load switch

Plug-in (Only for direct connected MT381 meters) disconnector is used for remote disconnection and reconnection of electric network to individual customers. Control can be performed locally (from the meter) or from a remote control centre using the meter AMR communication. ME381 meters have build-in disconnector. Transformer connected MT381 meters can have configured relay as a “disconnector functionality”, which can drive external transformer disconnector.

Figure 95: Disconnector for MT381-D1

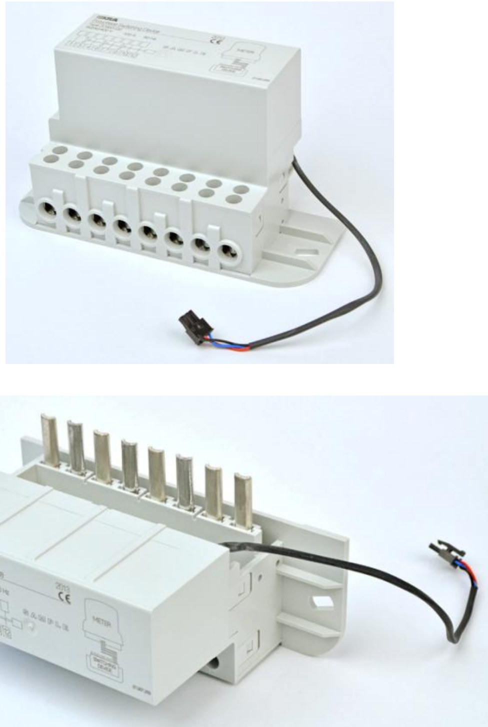


Figure 96: Disconnector for MT381-D2

Figure 97: MT381 meter with disconnector

Disconnect and reconnect can be requested:

- Remotely, via a communication channel: remote disconnect, remote reconnect,
- Manually, using e.g. a **Scroll** key: manual disconnect, manual reconnect,
- Locally, by a function of the meter (e.g. limiter, register monitor): local disconnect, local reconnect.

The state diagram and the possible state transitions are shown in the figure below:

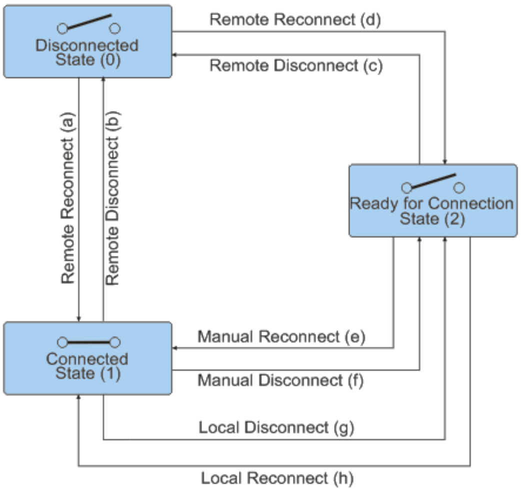


Figure 98: Disconnect state control diagram

Table below shows and describes all available disconnector transitions.

Transition	Transition name	Description
a	Remote reconnect	Moves the Disconnect control object from the Disconnected (0) state directly to the Connected (1) state without manual intervention
b	Remote disconnect	Moves the Disconnect control object from the Connected (1) state to the Disconnected (0) state
c	Remote disconnect	Moves the Disconnect control object from the Ready for reconnection (2) state to the Disconnected (0) state
d	Remote reconnect	Moves the Disconnect control object from the Disconnected (0) state to the Ready for reconnection (2) state. From this state, it is possible to move to the Connected (2) state via the manual reconnect transition (e)
e	Manual reconnect	Moves the Disconnect control object from the Ready for connection (2) state to the Connected (1) state
f	Manual disconnect	Moves the Disconnect control object from the Connected (1) state to the Ready for connection (2) state. From this state, it is possible to move back to the Connected (2) state via the manual reconnect transition (e)
g	Local disconnect	Moves the Disconnect control object from the Connected (1) state to the Ready for connection (2) state. From this state, it is possible to move back to the Connected (2) state via the manual reconnect transition (e). Transitions f) and g) are essentially the same, but their trigger is different
h	Local reconnect	Moves the Disconnect control object from the Ready for connection (2) state to the Connected (1) state. Transitions e) and h) are essentially the same, but their trigger is different.

Table 55: Disconnect transitions

Disconnector can not be in use as main network switch or fuse.

6.9.1 Disconnector type

With this object disconnector type can be selected. Available options are:

- 0 – None (disabled actions on disconnector),
- 1 – Disconnector (also called circuit breaker) OM31 or poly-phase ZO3xx unit or one phase build-in disconnect unit,
- 4 – Relay driven (external disconnect unit driven with relay).

For effective use of functionalities, meter must be properly configured.

6.9.2 Disconnect control

This object controls the connection and disconnection of the premises of the consumer.

Output State
Disconnect Output State shows the actual physical state of the disconnect unit.

- FALSE – Open – Customer is disconnected from the network - (0),
- TRUE – Closed – Customer is connected to the network - (1).

Control State
Control State defines internal logical state of the disconnect unit. Possible control states are:

- Disconnected – Customer is disconnected from the network - (0),
- Connected – Customer is connected to the network - (1),
- Ready for reconnection – Customer is disconnected from the network - (2).

When disconnector is in Ready For Reconnection control state, it is possible to perform manual connect on the meter by holding the **Scroll** key until ConnEct is shown on display.

Control Mode
Defines available transitions in Disconnect control class.

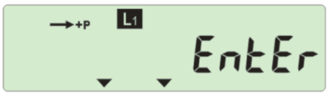
Mode	Description	
0	None. The disconnect control object is always in 'connected' state	
1	Disconnection:	Remote (b, c) Manual (f) – Press and hold **Scroll** key till Disconnect appears and release the key Local (g)
	Reconnection:	Remote (d) Manual (e) – Press and hold the **Scroll** key till EntEr appears and release the key
2	Disconnection:	Remote (b, c) Manual (f) – Press and hold **Scroll** key till Disconnect appears and release the key Local (g)
	Reconnection:	Remote (a) Manual (e) – Press and hold the **Scroll** key till EntEr appears and release the key
3	Disconnection:	Remote (b, c)

		Local (g)
	Reconnection:	Remote (d) Manual (e)
4	Disconnection:	Remote (b, c) Local (g)
	Reconnection:	Remote (a) Manual (e) – Press and hold the **Scroll** key till EntEr appears and release
5	Disconnection:	Remote (b, c) Manual (f) – Press and hold **Scroll** key till Disconnect appears and release the key Local (g)
	Reconnection:	Remote (d) Manual (e) – Press and hold the **Scroll** key till EntEr appears and release the key Local (h)
6	Disconnection:	Remote (b, c) Local (g)
	Reconnection:	Remote (d) Manual (e) – Press and hold the **Scroll** key till EntEr appears and release the key Local (h)

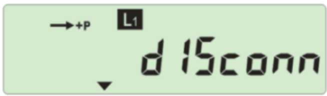
Table 56: Disconnector modes

For effective use of functionalities, meter must be properly configured.

Depending on the mode selected, manual reconnection and disconnection is possible by pressing the **Scroll** key.
Manual reconnection (all control modes): Display shows ConnEct. Press the **Scroll** key for 5 seconds (until EntEr appears on the display) and then release the key.



Manual disconnection (control modes: 1, 2, 5): Press the **Scroll** key for 10 seconds (until dISconn appears on the display) and then release it.



The switchover can be also made remotely by executing remote disconnect or remote reconnect method. Transition change is described in Disconnect control IC state diagram (BB10ed, p.84).

For manual reconnection of the meter, which is placed in the meter cabinet, the non-potential external key on the door of the cabinet can be used.

Method Description

- Remote disconnect forces the disconnector into ‘disconnected’ state if remote disconnection is enabled (control mode > 0).
- Remote reconnect forces the disconnector into the ‘ready for reconnection’ state if a direct remote reconnection is disabled (control mode = 1, 3, 5, 6) or into ‘connected’ state’ if a direct remote reconnection is enabled (control mode = 2, 4).

6.9.3 Disconnect control log

Contains all events related to the disconnector, e.g. connect, disconnect, changing of the disconnector threshold. Disconnect control log structure contains timestamp and event code. Disconnector control event log code object holds the code from the last event triggered. These codes along with timestamps are then used in event log. (See chapter 6.13.9)

6.10. Limitation

Beside collecting and processing energy consumption data, AMI system offers load balancing and control. To achieve this current and demand limitation is implemented in the meter. During short time period when power consumption excides contractual value for a specified time interval, customer is disconnected from the grid until normal conditions are achieved or when penalty time is over.

To handle consumption monitoring and disconnection of customer premises, following principles are used:

- Phase current measurement,
- Disconnection separation between disconnector and main fuse,
- Threshold level settings in accordance with customer contract and local regulator rules.

A disconnector is only disconnection element, all measurements, supervision of measured quantities is handled by AMI meter.

The meter supports two different limitation types: Limiter and Supervision monitor. Supervision monitor supports both:

- IDIS definition implementation (average phase current monitoring),
- GIZ definition implementation (instantaneous phase current monitoring with penalty timers).

For effective use of functionalities, meter must be properly configured.

6.10.1 Limiter

Limiter functions are used to monitor electrical network for exceeding maximum energy (power) in predefined period of time. Limiter object handles normal current and instantaneous power monitoring as well as the emergency settings. Meter supports two limiter objects.

The customer can (after correcting the exceeding level) reconnect network manually (by pressing the **Scroll** key on the meter) or with remote connection (depending on the disconnector mode used).

For effective use of functionalities, meter must be properly configured.

The threshold value can be normal or emergency threshold. The emergency threshold is activated via the emergency profile defined by emergency profile id, activation start time, and duration. The emergency profile id element is matched to an emergency profile group ID: this mechanism enables the activation of the emergency threshold only for a specific emergency group.

The limitation or disconnection functionality can be activated in the meter itself or by remote action. The meter disconnects the network (via disconnector) if a maximum current or power limit has exceeded during a predefined period of time. The current or power levels with the allowed exceeding periods are set in the meter.

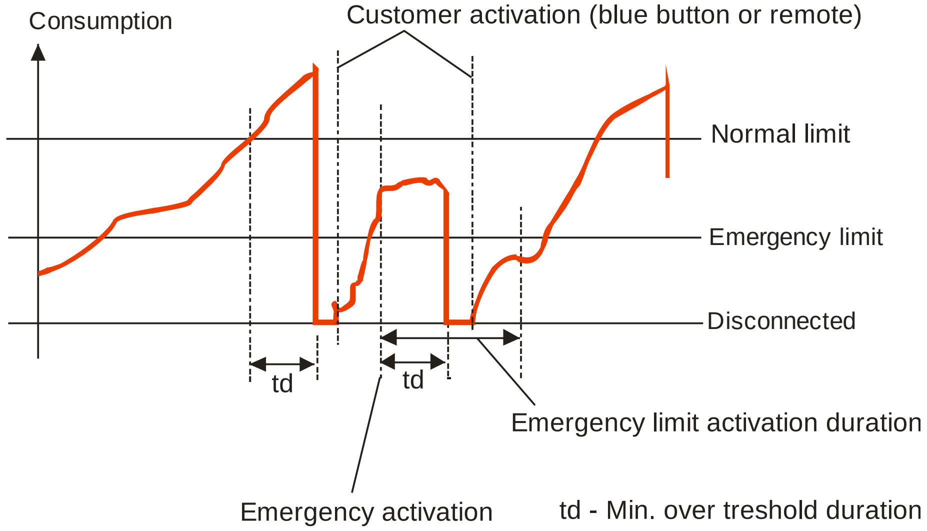


Figure 99: Limiter diagram

Instances of the Limiter interface class allows set of actions which are executed when the value of a monitored object attribute “Data”, “Register”, “Extended Register”, “Demand Register”, etc. crosses the threshold value for at least a minimal duration time.

IDIS defines only one limiter object instance. Iskraemeco meters have two limiter instances (0-0:17.0.0 and 0-0:17.0.1).

Monitored Value
Monitored value defines an attribute of an object to be monitored. Only attributes with simple data types are allowed. Instantaneous current (example for three-phase meters is object 1-0:90.7.0 (Algebraic sum L1, L2 & L3 current), or sliding demand average import/net power (1-0:1.24.0, 1-0:15.24.0).

Threshold Active
Provides the active threshold value to which the attribute monitored is compared.

Threshold Normal
Provides the threshold value to which the attribute monitored is compared when in normal operation.

Threshold Emergency
Provides the threshold value to which the attribute monitored is compared when an emergency profile is active.
Minimum over Threshold Duration
Defines minimal over threshold duration in seconds required to execute the over threshold action.

Minimum under Threshold Duration
Defines minimal under threshold duration in seconds required to execute the under threshold action.

Emergency Profile
An emergency profile is defined by three elements:

- emergency profile ID,
- emergency activation time,
- emergency duration.

An emergency profile is activated if the emergency profile ID element matches one of the elements on the emergency profile group ID list, and time matches the emergency activation time and emergency duration element:

- Emergency activation time defines the date and time when the emergency profile is activated.
- Emergency duration defines the duration in seconds, for which the emergency profile is activated.

When an emergency profile is active, the emergency profile active attribute is set to TRUE.

Emergency Profile Group ID List
It defines a list of group IDs of the emergency profile. The emergency profile can be activated only if emergency profile ID element of the emergency profile type matches one of the elements on the emergency profile group ID list.

Emergency Profile Active
It indicates that the emergency profile is active.

- False - (0),
- True - (1).

Actions
It defines the script to be executed when the monitored value crosses the threshold for minimal duration time.

- Action over threshold defines the action when the value of the attribute monitored crosses the threshold in upwards direction and remains over threshold for minimal over threshold duration time;
  (0-0:10.0.106, 1; 0-0:10.0.106, 2)
- Action under threshold defines the action when the value of the attribute monitored crosses the threshold in the downwards direction and remains under threshold for minimal under threshold duration time.
  (0-0:10.0.106, 0; 0-0:10.0.106, 1)

6.10.2 Supervision monitor - IDIS

Abbreviations, used in this chapter:
RM – register monitor,
TEE – threshold exceeding event,
TOE – threshold OK event,
OTD – over threshold duration.

Mx381 meter features phase current limitation with three RM objects. Every RM monitors the corresponding phase demand register. Actions that need to be taken are defined via the Disconnector script table object, where action on Disconnect control object is defined.

When monitored value passes threshold upwards or downwards, action up or action down is taken. For Mx381 meters, there is only one threshold allowed to be set, because of the limitation functionality.

IDIS specifies objects 1-0:31.4.0, 1-0:51.4.0 and 1-0:71.4.0 for a monitored value. This is not directly measured phase current RMS, but the averaged value over the number of periods, which is defined with demand class object instance for every phase. Phase RMS current is averaged with period (1 second) and number of periods (90) values. Value has a 1A resolution rounded down.

6.10.2.1. Register monitor – Monitored value

Current Average Value
This attribute provides the current average value of the current.

Last Average Value
Provides the last average value of the current (over the last number of periods*period) divided by number of periods*period.

Status
This attribute provides “Demand register” specific status information.

Capture Time
Provides the date and time when the last average value has been calculated. Octet-string, formatted as set in 4.1.6.1 for date time.

Start Time Current
Provides the date and time when the measurement of the current average value has been started. Octet-string, formatted as set in 4.1.6.1 for date time.

Period
Period is the interval between two successive updates of the last average value. Measuring period is in seconds.

For effective use of functionalities, meter must be properly configured.

Number of Periods
The number of periods used to calculate the last average value.

6.10.2.2. Register monitor instance

Thresholds
This attribute provides threshold values with which the attribute of the referenced register is compared. The threshold is the same type as the monitored attribute of the referenced object.

For effective use of functionalities, meter must be properly configured.

Monitored Value
Defines an object of specific class and it's attribute to be monitored. IDIS specifications require one of the next available objects with IC 5, attr. 2: 1-0:31.4.0, 1-0:51.4.0 and 1-0:71.4.0.

For effective use of functionalities, meter must be properly configured.

Actions
This attribute defines scripts to be executed when the monitored attribute of the referenced object crosses the corresponding threshold. The attribute “actions” has exactly the same number of elements as the attribute “thresholds”. The action items order corresponds to the thresholds (see above values order) where:

- action up defines the action when the attribute value of the monitored register crosses the threshold in the upwards direction
  (0-0:10.0.106, 1; 0-0:10.0.106, 2),
- action down defines the action when the attribute value of the monitored register crosses the threshold in the downwards direction
  (0-0:10.0.106, 1; 0-0:10.0.106, 0).

6.10.3 Supervision monitor - GIZ

The meter features phase current limitation with three RM objects. Every RM monitors the corresponding phase current instantaneous value. The actions that need to be taken are defined via the Disconnector script table object, where action on Disconnect control object is defined.

The functionality of the register monitor is affected with two manufacturer specific objects “Over threshold duration” and “Manual Reconnection penalty time”.

6.10.3.1. Register monitor

Thresholds
Provides the threshold values to which the attribute of the referenced register is compared. The threshold is of the same type as the monitored attribute of the referenced object.

For effective use of functionalities, meter must be properly configured.

Monitored Value
Defines an object of specific class and it's attribute to be monitored. GIZ specifications require next objects: 1-0:31.7.0, 1-0:51.7.0 and 1-0:71.7.0.

For effective use of functionalities, meter must be properly configured.

Actions
This attribute defines the scripts to be executed when the monitored attribute of the referenced object crosses the corresponding threshold. The attribute “actions” has exactly the same number of elements as the attribute “thresholds”. The ordering of the action items corresponds to the ordering of the thresholds (see above) where:

- action up defines the action when the attribute value of the monitored register crosses the threshold in the upwards direction
(0-0:10.0.106, 1; 0-0:10.0.106, 2),
- action down defines the action when the attribute value of the monitored register crosses the threshold in the downwards direction
(0-0:10.0.106, 1; 0-0:10.0.106, 0).

6.10.3.2. Over threshold duration

Defines the maximum duration in seconds, how long can monitored value stay over the threshold level, before disconnect occurs.

For effective use of functionalities, meter must be properly configured.

6.10.3.3. Manual reconnection penalty time

Defines the minimum duration in seconds, how long we have to wait after the disconnect action, before we can reconnect again.

Example: monitoring phase current with constant threshold parameter

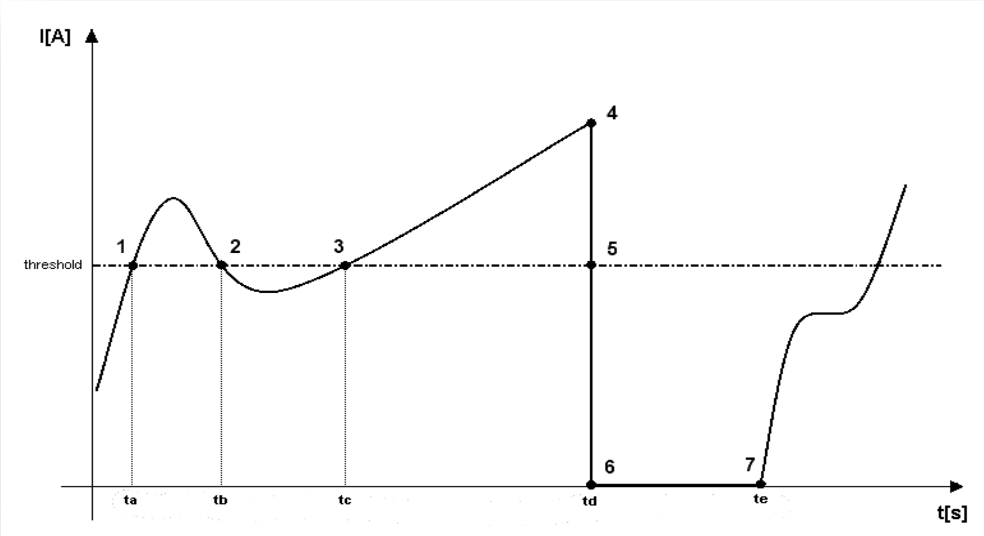


Figure 100: Monitoring phase current with constant threshold parameter

- [1] – RM detects action up. TEE for monitored register is generated in a Control log.
- [2] – RM detects action down. Duration is less than OTD time tb - ta < 90 sec. “Threshold OK” event for monitored register is generated in a Control log.
- [3] – RM detects action up. TEE for monitored register is generated in a Control log.
- [4] – RM detects time over threshold td - tc = 90 sec. Local disconnect transition (g) occurs and the disconnector disconnects. Disconnect event is generated in a Control log.
- [5] – RM detects action down. Because the reason for this is [4], no “Threshold OK” event is generated in a Control log.
- [6] – Console status “connect” is displayed. Penalty timer starts.
- [7] – After RPT is over te - td > 60 sec, it is possible to reconnect the disconnector again.

6.11. Identification numbers

6.11.1 COSEM Logical Device Name

The COSEM logical device can be identified by its unique COSEM logical device name. This name can be retrieved from an instance of IC “SAP assignment”, or from a COSEM object named “COSEM logical device name”. The name is of type octet-string of up to 16 octets in size. The following figure presents the division of the “COSEM logical device name” as enforced by the IDIS association.

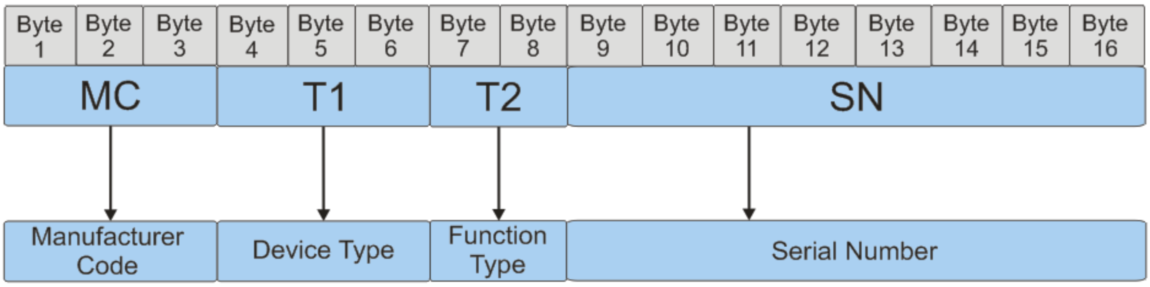


Figure 101: COSEM Logical Device Name Structure

The first three octets (MC) are ASCII encoded and uniquely identify the manufacturer of the device. The next three octets (T1) present ASCII encoded IDIS device type.

The IDIS device types have the following meanings:

Device Type	Meaning
000 … 098	reserved for non-IDIS meters; system title is considered as manufacturer specific
099	reserved system title for the DC
100	IDIS package1 PLC single phase meter
101	IDIS package1 PLC poly phase meter
102	IDIS package2 IP single phase meter
103	IDIS package2 IP poly phase meter
104 … 255	Reserved for future use

Table 57: The IDIS Device Type Meaning

The next two octets (T2) present ASCII encoded IDIS function type.

The IDIS function types have the following meanings:

Function Type	Bit Meaning
Bit0 = 1	Disconnector extension
Bit1 = 1	Load Management extension
Bit2 = 1	Multi Utility extension
Bit3 = 1	Reserved for future use by IDIS

Table 58: The IDIS Function Type Meaning

Last eight octets (SN) present ASCII encoded E-meter serial number as specified in COSEM object “Device ID” [0-0:96.1.0].

For effective use of functionalities, meter must be properly configured.

Example of the COSEM logical device name for Iskraemeco’s ME381 meter with disconnector, multi-utility and load management functionality with the Device ID 00000001:

MC			T1			T2		SN							
Octet01	Octet02	Octet03	Octet04	Octet05	Octet06	Octet07	Octet08	Octet09	Octet10	Octet11	Octet12	Octet13	Octet14	Octet15	Octet16
I	**S**	**K**	**1**	**0**	**2**	**0**	**7**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**

Table 59: COSEM logical device name example 1

6.11.2 System title

System title is tightly coupled with the COSEM logical device name. The relation between both entities is as follows:

System title is eight (8) octets in size while the COSEM logical device name is sixteen (16) octets in size. Thus the transformation is:

- MC is three (3) octets long,
- T1 is one (1) octet long and HEX encoded,
- T2 is half octet long (four MSB bits) and HEX encoded,
- SN is three and a half octets long and HEX encoded.

Example of the COSEM logical device name for Iskraemeco’s ME381 meter with disconnector, multi-utility and load management functionality with the Device ID 00000001:

<table>
<tr><th>Octet01</th><th>Octet02</th><th>Octet03</th><th>Octet04</th><th colspan="2">Octet05</th><th>Octet6</th><th>Octet07</th><th>Octet08</th></tr>
<tr><td colspan="3">MC</td><td>T1</td><td>T2</td><td>SN</td><td>Sn</td><td>SN</td><td>SN</td></tr>
<tr><td colspan="3">ISK</td><td>66</td><td colspan="2">70</td><td>0</td><td>0</td><td>1</td></tr>
</table>

Table 60: COSEM logical device name example 2

6.11.3 Device number

Device number is unique meter number in certain group of meters. The number is ASCII encoded. The length of the ID must be eight (8) octets.

The number is copied into IEC local port setup object (0-0:20.0.0) and is used when accessing the meter through IEC 61056-21 (former 1107) protocol.

For effective use of functionalities, meter must be properly configured.

6.11.4 Device ID

Meter has nine different device ID’s:

- Device ID 1 – E-Meter serial number (e=0),
- Device ID 2 – E-Meter equipment ID (e=1),
- Device ID 3 – function location (e=2),
- Device ID 4 – location information (e=3),
- Device ID 5 – general purpose (e=4),
- Device ID 6 – (e=5),
- Device ID 7 – (e=6),
- Device ID 8 – (e=7),
- Device ID 9 – meter ID (e=8).

6.11.4.1. Device ID 1

Device ID1 is e-meter factory serial number (also reflected in a COSEM logical device name). The number is ASCII encoded. The length of the ID must be eight (8) octets.

For effective use of functionalities, meter must be properly configured.

6.11.4.2. Device ID 2

Device ID2 is customer ID. The number is ASCII encoded. The length of the ID must not exceed forty eight (48) octets.

6.11.4.3. Device ID 3

Device ID3 represents function location. The number is ASCII encoded. The length of the ID must not exceed forty eight (48) octets.

6.11.4.4. Device ID 4

Device ID4 includes location information. The number is ASCII encoded. The length of the ID must not exceed forty eight (48) octets.

6.11.4.5. Device ID 5

Device ID5 has no special meaning defined. It is general purpose ID for any identification purposes. The number is ASCII encoded. The length of the ID must not exceed forty eight (48) octets.

6.11.4.6. Device ID 6

Device ID 6 is IDIS certification number. The number is ASCII encoded. The length of the ID must not exceed forty eight (48) octets.

6.11.4.7. Device ID 7 .. Device ID 9

The length of the ID must not exceed forty eight (48) octets.

6.11.5 Medium specific ID

M-Bus device id's are described under M-Bus Section: M-Bus identification numbers.

6.11.6 Meter software identification

This chapter describes metering application FW identification for electric energy meter types Mx381.

6.11.6.1. Software architecture

The main parts of the basic modular division of software for the Mx381 meters are:

- platform,
- core interface,
- module.

“Platform” and “core interface” constitute a concluded entity called CORE, while application module represents MODULE. Each of two entities has its own parameters that can be configured at build time (adjustable in time of code translation) or at configuration time in factory. Nevertheless only MODULE has specific parameters that are variable during operation.

E-meters versioning control
Due to legal constraints meter’s firmware is divided into two modules. The first is application core and the second is application module. Both entities have their own identification string and signature.

E-meter identification strings
Meter’s identification strings are divided into two subsets of sixteen (16) characters. First subset represents application core while second represents application module identification. The identification for both entities is organized as follows.

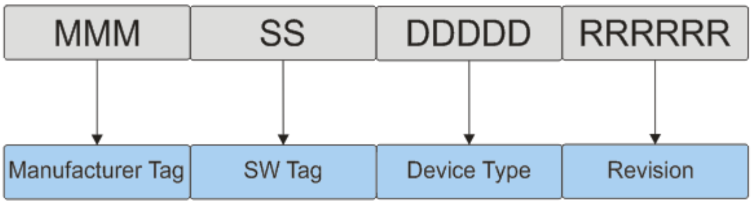


Figure 102: Identification Structure

- Manufacturer tag – ISK stands for Iskraemeco (3 characters),
- SW tag – (2 characters),
- Device type – (5 characters),
- Revision – Revision of application core or application module (6 characters).

The revision number field is organized as follows:

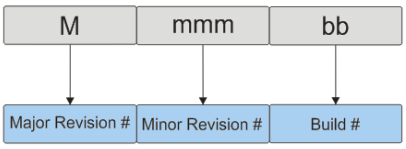


Figure 103: Revision Number Structure

Mark	Size (in characters)	Meaning
M	1	Major revision number
mmm	3	Minor revision number
bb	2	Build number

Table 61: Meaning of Revision Number Characters

6.11.6.2. E-meter signatures

Meter's signatures are divided into two subsets of sixteen (16) octets. First subset represents application core while second represents application module signature. The signature is calculated via hash function implemented with MD5 algorithm (Message-Digest algorithm 5) over both modules respectively thus integrity of both modules is achieved.

Active FW core signature
"Firmware core signature" is used to assure integrity of the core firmware. It is calculated via hash function implemented with MD5 algorithm. The presented digest is sixteen (16) octets in size and HEX encoded.

Active FW module signature
"Firmware module signature" is used to assure integrity of the module firmware. It is calculated via hash function implemented with MD5 algorithm. The presented digest is sixteen (16) octets in size and HEX encoded.

6.12. Monitoring functions

6.12.1 Power quality

Power quality module enables measurements and analyzes of mains power system voltages. The basic measurements of a voltage sag and swell are the U_{rms} measurements on each phase. A voltage sag or swell threshold is a percentage of U_{rms} nominal.

The basic measurement time interval for mains supply voltage is 200 ms, which is a 10-cycle time interval for 50Hz power systems. Basic time intervals are aggregated over recording time interval (aggregation time interval), which is 10 minutes by the default.

6.12.1.1. Voltage level

At the start of aggregation interval meter starts to sample phase U_{rms} voltages with basic time interval and averages them. On the end of aggregation period calculated average phase voltage is compared to defined thresholds. If the voltage depth value obtained at the end of aggregation time interval falls below the one of threshold voltages presented in the table below corresponding counter is incremented. The depth is the difference between the reference voltage (nominal phase voltage) and the average U_{rms} value measured on particular phase during the aggregation interval.

Threshold Levels	Threshold Voltages Depths	Threshold Level Counters
Level 1	U > +10%	Counter 1 overvoltage

Level 2	+5% < U < +10%	Counter 2 overvoltage
Level 3	0% < U < +5%	Counter 3 overvoltage
Level 4	-5% < U < 0%	Counter 4 undervoltage
Level 5	-10% < U < -5%	Counter 5 undervoltage
Level 6	-15% < U > -10%	Counter 6 undervoltage
Level 7	U < -15%	Counter 7 undervoltage

Table 62: Dip & swell detection model

During the processing of the measurement at the end of aggregation interval in case of simultaneous sags or swells corresponding phase threshold level counters and the common threshold levels counters named ANY are incremented. In case when the voltage depths measured on more phases are in the same threshold level corresponding ANY counter is incremented only by 1.

On each phase voltage is calculated every 10 minutes. Calculated is average voltage with sampling made every 200ms in 10 minute aggregation period. As a result of this calculation, appropriate level counter is incremented.

Nominal voltage (U) used in calculations is 230V. If calculated average voltage at the end of 10 min period is under, over or in the range of certain percentage (see above table), than the appropriate counter is incremented.

Example: The following Figure illustrates sampling and recording of an event: voltage sag. Figure shows voltage dip from 9th sample to 22nd sample. Average voltage of all samples is shown with straight line. Average voltage value is also used to record appropriate event: average voltage on picture is about 214 Volts, 7% sag of 230 Volts.

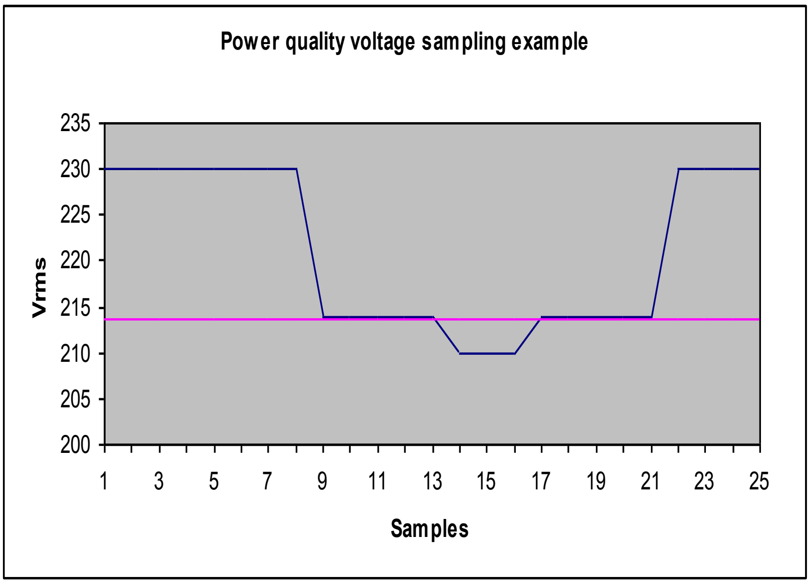


Figure 104a: Voltage sampling

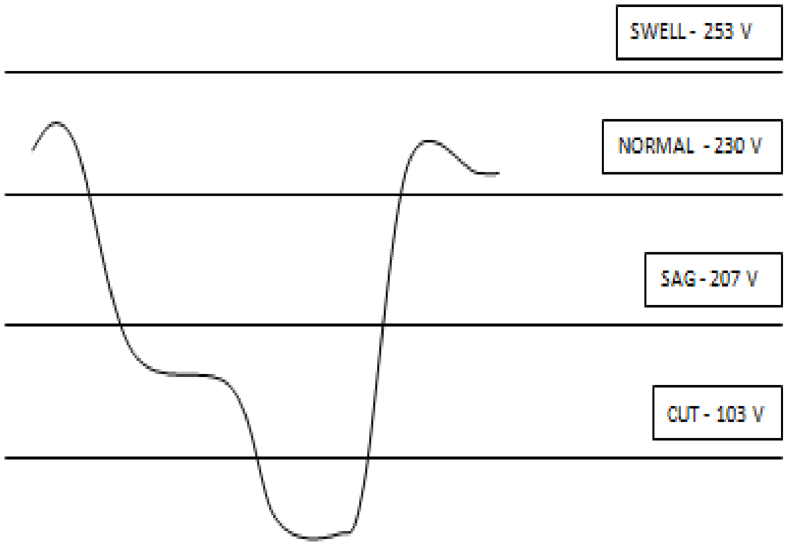


Figure 104b: Voltage sampling

6.12.1.2. Voltage sag

Voltage sags are recorded when voltage drops below “Threshold for Voltage Sag“ for the time set in “Time Threshold for Voltage Sag“. Also recorded in designated objects are each sag in counter objects, magnitude of voltage sags and duration of voltage sag.

All events are also recorded in “Power Quality Log“ as “undervoltage“ event. See Chapter 6.5.5.1.

As soon as voltage drops below value set in “Threshold for voltage sag” object for a period longer than set in “Time threshold for voltage sag” object the counter (per phase, 1-0:c.32.0, where c=32, 52 or 72) will be incremented.

6.12.1.3. Voltage swell

Voltage swells are recorded when voltage rises above “Threshold for Voltage Swell“ for the time set in “Time Threshold for Voltage Swell“. Also recorded in designated objects are: each swell in counter objects, magnitude of voltage swells and duration of voltage swell.

All events are also recorded in “Power Quality Log“ as “overvoltage“ event. See Chapter 6.5.5.1.

As soon as voltage rises above value set in “Threshold for voltage swell” object for a period longer than set in “Time threshold for voltage swell” object the counter (per phase, 1-0:c.36.0, where c=36, 56 or 76) will be incremented.

6.12.1.4. Voltage cut

Voltage that drops below the “Threshold for voltage cut” for the time set in “Time threshold for voltage cut” is recorded as a “missing voltage” event.

6.12.1.5. Voltage daily peak and minimum

Meters measure and records daily peaks and minimums of the phase voltages and peak and minimum of the average voltage of all three phases. Measured voltage values are aggregate and average during settable aggregation period. At the end of aggregation period, measured value is compared to value stored in the current register, and if it is greater or lower than existing overwrite old value with respect to that is it peak or minimum register. At the end of the day values are copied from current registers to the previous registers and current registers are reset.

Daily Peak (Minimum) Current (Previous) Voltage
Daily peak and minimum counters are: 0-0:128.8.e

- ALL phases avg U daily peak current (e=0),
- ALL phases avg U daily peak previous (e=1),
- ALL phases avg U daily minimum current (e=2),
- ALL phases avg U daily minimum previous (e=3),
- L1 voltage daily peak current (e=10),
- L1 voltage daily peak previous (e=11),
- L1 voltage daily minimum current (e=12),
- L1 voltage daily minimum previous (e=13),
- L2 voltage daily peak current (e=20),
- L2 voltage daily peak previous (e=21),
- L2 voltage daily minimum current (e=22),
- L2 voltage daily minimum previous (e=23),
- L3 voltage daily peak current (e=30),
- L3 voltage daily peak previous (e=31),
- L3 voltage daily minimum current (e=32),
- L3 voltage daily minimum previous (e=33).

Voltage Peak and Minimum Aggregation Period
With this object aggregation period can be set. Voltage sampling is made every 200ms and after the time set in this object the average voltage value to be used in daily peak/minimum objects is calculated.

6.12.1.6. Voltage asymmetry

Meter measures voltages and compares them to the average voltage of all three phases. If a difference is greater than predefined threshold, then alarm bit in ALARM ON register is set. When symmetry is established back alarm bit in ALARM OFF register is set.

The level of asymmetry which triggers alarm can be defined by two thresholds, upper and lower threshold.

Period synchronization is fixed at 10 minutes. Each phase is sampled every 200ms and at the end of 10 minute period average value for each phase is calculated. All three phases are added together and split with 3 so the result is average of all three phases. This is nominal value and each phase value is then compared with this value. If deviation percentage is greater or smaller than specified, the appropriate alarm is set. The default percentage levels are:

- Asymmetrical voltages upper threshold (0-0:128.7.50): 1030 = 103 %,
- Asymmetrical voltages lower threshold (0-0:128.7.51): 970 = 97 %.

97 – 103 % is the area in which the asymmetrical voltage alarm bit is not set, but if the average phase voltage is outside +/-3% range within 10 minute period this alarm in Alarm ON status (bit 9) is set which is set for the whole 10 minute period. When average phase voltage drops back in 3% range, asymmetrical voltage alarm bit 9 in Alarm OFF status is set. These alarms are recorded in Alarm ON status and Alarm OFF status.

Both alarms can be deleted. Alarm ON can't be deleted if present voltage is outside 3% range. Alarm OFF therefore can be deleted as soon as it is set.

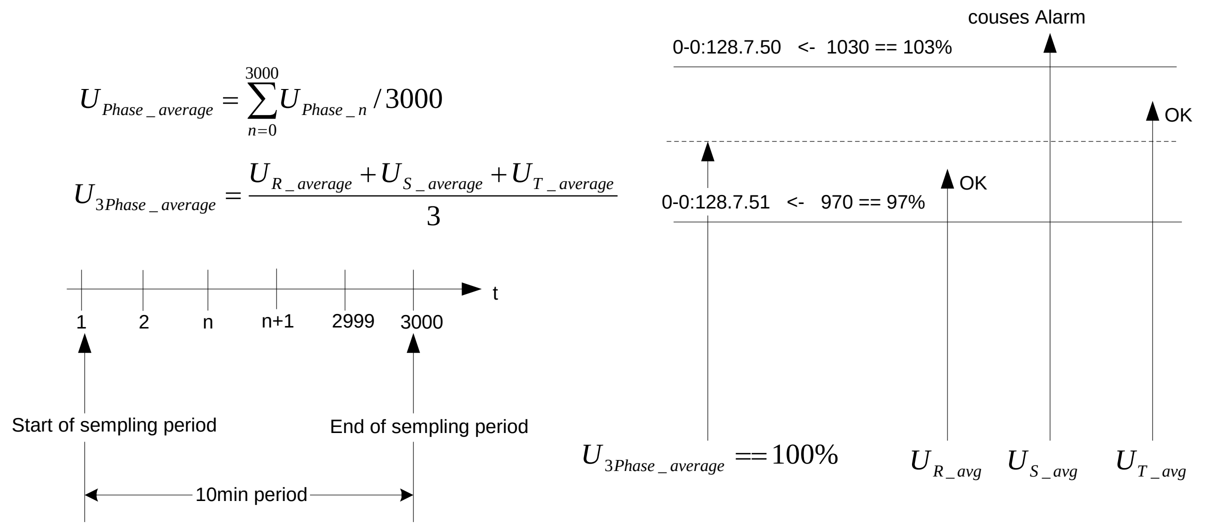


Figure 105: Voltage Asymmetry Calculation

6.12.1.7. Asymmetric current

In case of an asymmetrical load the sum of the currents in the system is equal to zero but currents are different in amplitude and RMS values. Detection of such condition refers to possible neutral break. If previously described criteria are fulfilled meter alarm bit 8 is set in ALARM ON register (IE alarm system).

6.12.1.8. Unexpected consumption

Unexpected consumption function is tied with the alarm bit 12 in Alarm status register. If all conditions are fulfilled (disconnector (circuit breaker CB) is disconnected and power consumption is still detected by the meter), the alarm bit 12 is set.

Possible reason for the unexpected power consumption is shown on the Figure below:

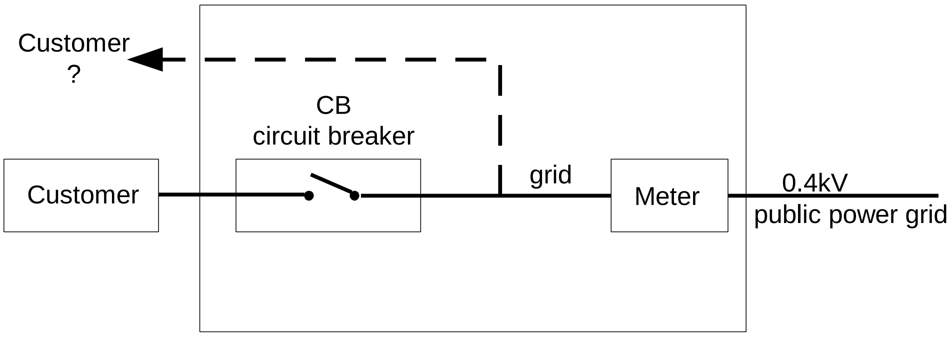


Figure 106: Unexpected consumption

6.12.1.9. Neutral missing detection

If neutral is missing the virtual neutral (N') is represent with T phase decreased toward zero, R and S phase increased toward interfacial voltage (Figure below). If in MT381 physical DLC modem is on the R phase then behavior of R and T phase is reversed.

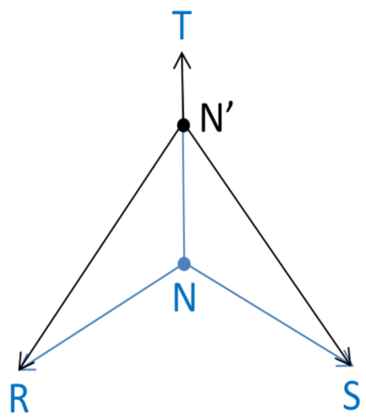


Figure 107: Intended neutral N-N'

Event "Neutral missing (89)" and system alarm "Neutral current 0" depend on the asymmetrical voltage and the deviation of the average voltage from 230V. Neutral missing event occurs if the following occurs:

- asymmetric voltage occurred (voltage on single phase differs more than 3%),
- average voltage on one phase (T) is decreased more than 30% from 230V (lower than 161V) and average voltage on any other phases (R or S) is increased more than 28% from 230V (upper than 294,4V).

6.12.1.10. Power failure

The following objects are registered in the meter:

- Number of power failures in all three phases and per phase,

- Number of long power failures in all three phases, in any phase and per phase,
- Time of power failure in all three phases, in any phase and per phase,
- Duration of last long power failures in all three phases, in any phase and per phase.

Duration of last long power failures objects show the duration of power failure if it is longer than time threshold set in Time threshold for long power failure.

When power fail time reaches time threshold (in seconds) for Long Power Fail set in Time threshold for long power failure register than Long Power Fail is registered, else Power Fail is registered.

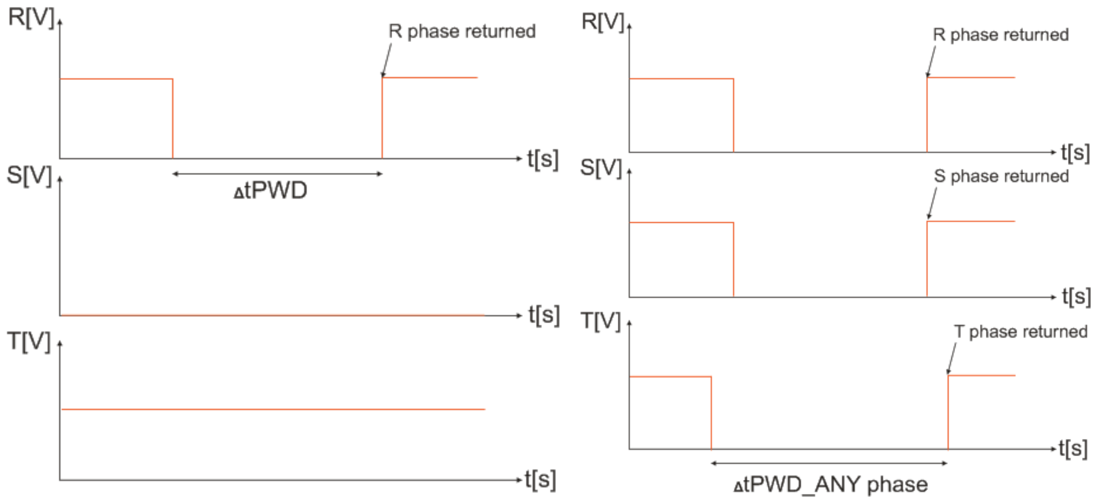


Figure 108: Power fail example

6.12.2 Reclosing counter

The re-closing counter represents number of the power outages shorter than re-closing time (3 minutes).

6.12.3 Watchdog counter

Watchdog counter represents number of watchdog events.

6.12.4 Cover opening counter

Cover opening counter represents number of meter and terminal cover openings.

6.12.5 Breaker opening counter

Breaker opening counter represents number of breaker (disconnector) disconnections.

6.13. Security

The coarse partitioning of the E-Meter security is devised into:

- Physical Security,
- Logical Security.

The physical security is a traditional way of protecting e-meter from different tampering variants and unauthorized access. With increase of smart meter numbers and the rise of AMI infrastructures, the logical security was introduced in e-meters.

6.13.1 Physical security

Physical security is comprised of:

- Seal protection,
- Parameters switch.

6.13.1.1. Seal protection

There are two different set of seal protection. First set protects terminal cover while the second protects meter cover. If seals are tampered with and either of the terminals is removed then the corresponding events are recorded in the fraud event log. In case of terminal cover open, the dedicated counter (Cover opening counter) is incremented as well. Following figure presents the Logging capabilities of two tampering processes.

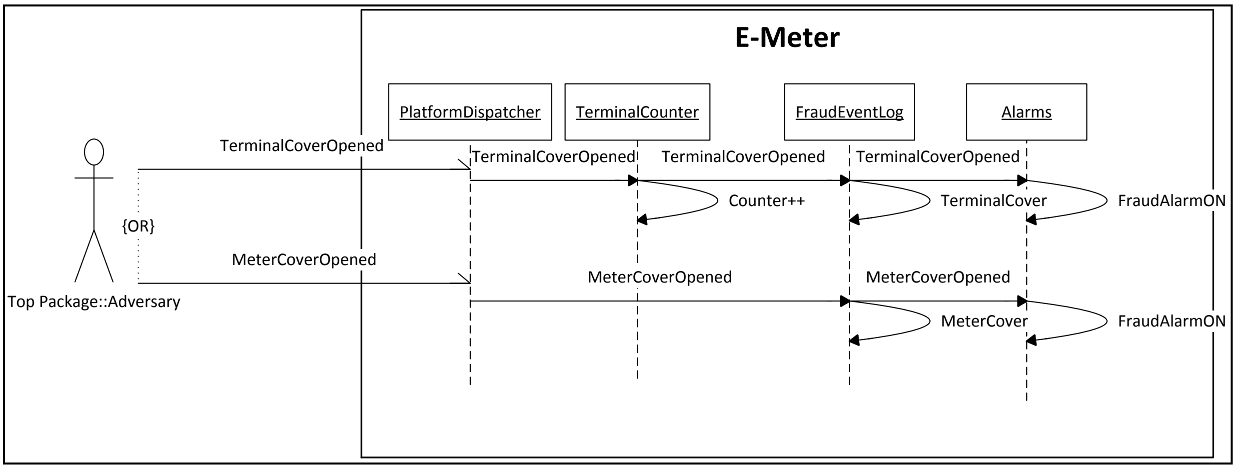


Figure 109: Meter and Terminal cover tamper logging

6.13.1.2. Parameter lock switch

Its primary function is to strengthen the meter access functionality. When put in locked position, objects dedicated to factory parameterization are not accessible anymore. Furthermore certain attributes of the dedicated objects are also inaccessible even though the proper key or security method was used. The same mechanism applies for executing specific methods. Therefore Meter reset (Master reset) can only be done when the parameter switch is in unlocked position.

6.13.1.3. Additional COSEM objects used

According to parameter switch position, bit 8 in the register is changed. If the parameter switch is in locked position the bit will be set to 1 and if the switch is in disconnected position bit 8 will be set to 0. When the switch is not locked the protection is disabled and when the switch is in locked position the protection is enabled.

6.13.2 Logical security

Logical security in e-meter is devided into two separate entities:

a) DLMS/COSEM Security,
b) Additional Communication Security.

6.13.2.1. Overview of the cryptographic methods

The cryptographic components provide the security services of confidentiality, data integrity, authentication, authorization and non-repudiation (a service that provides proof of the integrity and origin of data). Two basic components on which cryptography relies upon are: an algorithm (or cryptographic methodology) and a key. The algorithm is a mathematical function, and the key is a parameter used in the transformation.

Basic types of approved cryptographic algorithms are:

- cryptographic hash functions,
- symmetric key algorithms,
- asymmetric key algorithms.

Hash functions
Hash functions produce short representation of a longer message. A good hash function is a one-way function. It is easy to compute the hash value from the particular input while backing up the process is extremely difficult.

Hash functions take an input of arbitrary length and always output a fixed length value. Therefore the alternative name for hash functions is message digest.

Message M1 is run through a hash function and a fixed message digest H1 is produced and transferred along with the original message.

Symmetric key algorithms
Symmetric key algorithms (often called secret key algorithms) use a single key to both apply the protection and to remove or check the protection. For example, the key used to encrypt data is also used to decrypt the encrypted data. This key must be kept secret if the data is to retain its cryptographic protection. Symmetric algorithms are used to provide:

- confidentiality via encryption,
- an assurance of authenticity or integrity via authentication,
- mechanism to instantiate key establishment.

There are several approved algorithms for encryption and decryption of data chunks. Every algorithm converts data to be protected (called plaintext) via security context (keys and other security context) into ciphered text. The reverse procedure is also possible as shown in the figure below.

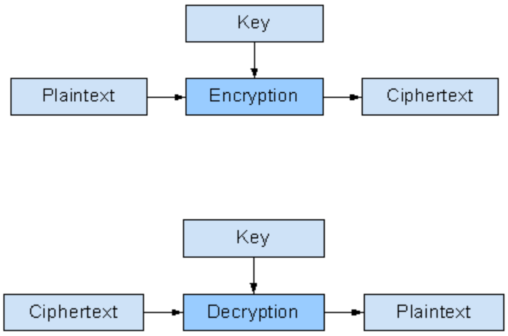


Figure 110: Encryption and decryption procedure

Currently for a forementioned procedures Advanced Encryption Standard (AES) is used. AES encrypts and decrypts data in 128-bit blocks, using 128, 192 or 256 bit keys. All three key sizes are adequate.

Message authentication code works similar as ordinary hash function with one enhancement. Additionally the secret material (secret key) is used in message digesting.

6.13.2.2. DLMS/COSEM security

Confidentiality and integrity are among the key requirements when open systems connect to public media. With the increase of computational power, the requirements for strong cryptographic methods also increase. DLMS/COSEM provides two main information security features for accessing and transporting data**:**

- **data access security** controls access to the data held by a DLMS/COSEM server,
- **data transport security** allows the sending party to apply cryptographic protection to the xDLMS APDUs to ensure confidentiality and integrity. This requires ciphered APDUs.

The information is given partly at the beginning of the application association establishment with two services:

- **applicationcontext**,
- **authenticationcontext** (the level of data access security),

and partly by COSEM objects which define access to specific attributes.

Data access security

Data access security is managed by the Association LN object. Each COSEM server i.e. a logical device may support Application Associations with various clients, each having a different role, and with this, different access rights. Each Association object provides a list of objects visible in that particular Application Association and also the access rights to objects' attributes and methods.

To be able to access data, the client must be properly authenticated. Upon Application Association establishment, an authentication context is negotiated between the client and the server. This specifies the required authentication of the peers, and, where needed, the security algorithm to verify the authentication. Three data access security levels are provided:

- Lowest level security (no security),
- Low Level Security (LLS),

- High Level Security (HLS).

For effective use of functionalities, meter must be properly configured.

E-meter supports three different clients with three different behaviors regarding authentication minimal requirements, as shown in following table:

Client name	Client L-SAP	Minimal Security Requirements
Public	16	Lowest level security (no security)
Management	1	HLS (LLS as a backup)
Pre-established	102	No HLS nor LLS

Table 63: Set of supported clients

Authentication procedures

For every security level different authentication procedures are required. Authentication context and specifically the COSEM Authentication Mechanism Name are presented in following table:

Authentication Mechanism Name	ID
COSEM lowest level security mechanism name	0
COSEM low level security mechanism name	1
COSEM high level security mechanism name using MD5	3
COSEM high level security mechanism name using SHA-1	4
COSEM high level security mechanism name using GMAC	5

Table 64: Supported authentication mechanism names

The **Lowest level security** authentication context does not require any peer authentication. It allows direct access to the data in the server, within the access rights available in the given Application Association.
Authentication mechanism name is therefore not present in Application Association Request.

The purpose of **Low Level Security (LLS)** is to allow the authentication of clients by verifying the password supplied. The server is not authenticated. The client has to supply the correct password during the process of Application Associaition establishment. If the password is Accepted, the Application Association is established and the client can access data within the access rights available in the given Application Association. Otherwise, the Application Assoication is not established.

The purpose of **High Level Security (HLS)** is to allow mutual authentication of the client and the server participating in an association.

This is a 4-pass process, involving the exchange of challenges during Application Association establishment, which is followed by exchanging the results of processing these challenges, using cryptographic methods. If the authentication takes place, the client can proceed to access data within the access rights available in the given Application Association, and it accepts data coming from the server. Otherwise, the Application Association is not established. When the number of unauthorized accesses (Authentication Failure Count) is bigger than predefined limit (Authentication Failure Count Limit), the meter logs a respective event and rejects every subsequent application request for a predefined amount of time (60 s). With this mechanism the risk of brute force attacks is mitigated. The last unauthorized access is timestamped (Authentication Failure Stamp).

Additional COSEM objects used

According to secure meter communication it is possible to access the e-meter only with Application Association which is currently active in the e-meter. If user wants to access the e-meter with different Application Association, new authentication mechanism name has to be written in the currently active Application Association's "Authentication mechanism name" attribute ("Authentication mechanism id") of the "Current association" object (0-0:40.0.0.255). The e-meter can now be accessed with the new Application Association.

Setting mechanism ID to 0 means that access is allowed with every mechanism ID set in the Application Association Request (password, SHA-1, MD5 or GMAC).

Data transport security

Data transport security relies on applying cryptographic protection to xDLMS APDUs. This is achieved via several security mechanisms. The first mechanism is incorporated in application association request with two application service elements:

- The COSEM application context,
- User information filled with Initiate Request primitive.

ASEs involved in security

The table below shows Different application context names and the relation between those names and allowed types of xDLMS APDUs. Ciphered APDUs are allowed only in Application context name with ciphering.

Application Context Name	ID	Unciphered APDUs	Ciphered APDUs
Logical Name Referencing no ciphering	1	Yes	No
Short Name Referencing no ciphering	2	Yes	No
Logical Name Referencing with ciphering	3	Yes	Yes
Short Name Referencing with ciphering	4	Yes	Yes

Table 65: Application context names

Security context

The second mechanism is called the security context. The security context defines security attributes relevant for the data transport security process of ciphering/deciphering. The elements are:

- Security policy (determining what kind of protection to be used),
- Security suite (specifying the security algorithm),
- Security material relevant for the given security suite:
  - Encryption keys,
  - Authentication keys,
  - Initialization vectors (comprised of System title and current frame counter).

First two bullets are described in and held by the Security Setup COSEM object.

Security policy

The following security policies are specified and allowed:

- Security is not imposed (0),
- All messages to be authenticated (1),
- All messages to be encrypted (2),
- All messages to be authenticated and encrypted (3).

Authenticated xDLMS APDUs may be used – within a ciphered application context – even when the security policy in effect does not require that all messages must be authenticated.
Messages protected by higher security then what the security policy requires are always allowed (provided that the application context negotiated allows them).

Security suite
A security suite determines the cryptographic algorithm used for message security. A security suite is identified with a Security Suite ID. Security suite (0) utilizes the Galois/Counter Mode (GCM) with AES-128. In this security suite, global keys are protected during transportation using the AES-128 key wrap algorithm.

Security Suite Id	Authentication algorithm	Encryption algorithm	Key transport method
0	AES-GCM-128	AES-GCM-128	Key wrapping using AES-128 key wrap

Table 66: Security suite

6.13.2.3. Additional communication security

There are several Iskraemeco's add-ons to DLMS/COSEM security. Firstly "DLMS channel options" object for every channel on which COSEM server is present is introduced in order to cater different market requirements.

DLMS channel options
With this object different settings can be introduced and technology shortcomings can be solved.
Option values are:

- 0 – All options are disabled,
- 1 – Ignore HDLC service class (need to be set for those e-meters that have external modem communicating with uC via HDLC),
- 2 – Security replay attack prevention (frame counter checking),
- 4 – Association Establishment with AARQ/AARE and Association Release follows diction in Green Book.

DLMS association restrictions
With this object different associations can be prohibited on the same server. One can disable public, management, pre-established or combination of those Application Associations by writing proper value in this COSEM object.

Certification log
Certification log monitors specific objects and logs their old and new values. When the communication log is full, the new attempts to change monitored objects are denied. More can be read at the certification data log description.

6.13.2.4. Secure storage

Secure storage is a reserved space in FRAM which is cryptographically protected. In secure storage e-meter stores all the necessary global encryption, authentication and master keys.

The cryptographic protection relies on AES-XTS Block Cipher Mode. The main characteristics of this mode are:

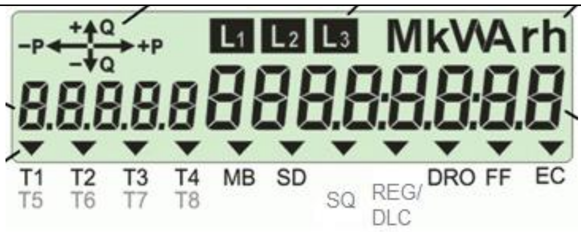
- Provide security for storage data at rest (not in transit),
- Tweakable block cipher encryption mode (“non-malleable”),
- Usage of two keys (in process of encryption/decryption) derived from cryptographic salt and hidden passwords.

7. Technical characteristics

7.1. ME381 meter

Reference voltage	
Indirect connection	230 V
Direct connection	230 V
Reference frequency	50 Hz ±2 %
Currents (A)	
Direct connection	
Reference current	5 A
Maximal current	85 A
Thermal current	120% Imax
Short circuit current Start up current	half cycle at rated frequency, 30 x I max <0.4 % of reference current
Accuracy class	
Direct connection	
Active energy	A or B (EN 50470 - 3) Class 2 or 1 (IEC 62053-21
Reactive energy	Class 3 or 2 (IEC 62053-23)
Apparent energy	Calibrated up to 3%
Outputs	
Type - OPTO-MOS relay (Auxiliary control switch)	
Contact	Make or break contact
Permitted load	100 mA
Voltage	250V AC
Pulse length	From 30 ms to 200 ms (adjustable in steps by 1 ms)
Transmission distance	Up to 1000m
Type – Relay (Load control switch)	
Voltage	250 V AC
Switching voltage	250V AC
Maximum switching current	6A
Switching power	1500VA
Inputs	
Alarm input	
Voltage level	100 – 240 V AC
Potential-free key	
Voltage level	No voltage
Self consumption	
Self consumption of current circuit	0.06 VA
Self consumption	2.0 W / 7.3 VA

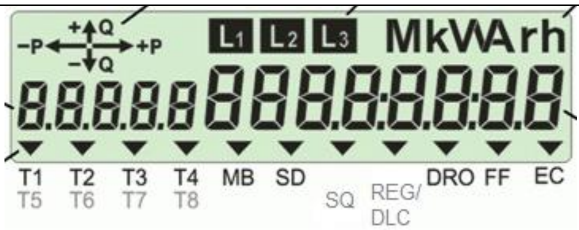
of voltage circuits	
	2.2 W / 7.4 VA (DLC communication established)
Communication	
Port 0 Port 1	Infra red optical interface (IEC 62056-21 or IEC62056-46) In-house device wired interface (IEC62056-21)
Port 2	M-Bus wired interface for multiutiliy (EN 13757)
Port 3	PLC communication interface
LED output	
Type	LED – red
Number	2, function kWh/kvarh, kWh/kVA – programmable
Impulse frequency	≤ 2.5 kHz
Impulse length	30 ms
Constant	Programmable
Real time clock	
Accuracy	Crystal: < 5 ppm = ≤ ±3 min./year (at Top= +25°C)
Back-up power supply	Super-Cap: > 7 days, charging time 250 hours Two Super-Cap: > 20 days, charging time 250 hours (optional)
EMC	
Electrostatic discharge	Contact 8kV, air 15 kV (IEC 61000-4-2)
VF magnetic field (80MHz – 2 GHz)	20 V/m active and 40 V/m passive (IEC 61000-4-3)
Transient test	
- Current and voltage circuit not under load	6 kV (IEC 61000-4-4)
- Auxiliary circuits > 40 V	2 kV
Surge test	
- Current and voltage circuits	4 kV (IEC 61000-4-5)
- Auxiliary circuits > 40 V	1 kV
Insulation strength	4 kV_{rms}, 50 Hz, 1 min
Impulse voltage	
- Current and voltage circuits	12 kV voltage circuit, 6kV other 1.2/50 µs (EN 50407-1)
- Auxiliary circuits	6 kV, 1.2/50 µs (EN 50407-1)
Radio interference suppression	Class B (EN 50022)
Immunity to conducted disturbances	20 V (EN 61000-4-6)
Glow wire test	IEC 695-2-1
Spring hammer test	IEC 60068-2-75
Temperature ranges (IEC 62052-11)	
Operation	-40°C ... +70°C
LCD operation	-25°C ... +70°C
Storing	-40°C ... +85°C

Temperature coefficient (IEC 62052-11)	
Range	-40°C ... +70°C less than ± 0.015% / K
Ingress protection IEC 60529	IP 54
Protection class IEC 62052-11	Double isolation
Liquid Crystal Display	 Number of digits for OBIS code: 5 Index digit size: 3 x 6 mm Number of digits for value: 8 Index digit size: 4 x 8 mm
Climatic conditions	
Type of meter	Indoor meter
Humidity	> 95%
Altitude	2000m
Mechanical conditions	Meter passed all mechanical tests like schock and vibration tests
Terminals (diameter)	
Direct connected meter with 85A terminal block	
Diameter	8.5 mm
Tightening torque	Max. 2,5 Nm
Mechanical environment	M1
Electromagnetic environment	E2
Climatic class	3K7
Dimensions	200 x 132 x 82 mm3 (ME382, long terminal cover) 157 x 132 x 82 mm3 (ME382, short terminal cover)
Mass	
ME382-D1	Approx. 0.82 kg
ME382-D3	Approx. 0.87 kg

7.2. MT381 meter

Reference voltage	
Indirect connection	3 x 230/400 V
Direct connection	3 x 230/400 V
Reference frequency	50 Hz ±2 %
Currents (A)	
Indirect connection	
Rated current	5 A
Maximal current	6 A
Thermal current	120% Imax
Short circuit current	0,5 sec 20 x I max
Start up current	<0.2% of rated current
Direct connection	
Reference current	5 A, 10 A
Maximal current	85 A, 120 A
Thermal current	120% Imax
Short circuit current Start up current	half cycle at rated frequency, 30 x I max <0.4 % of reference current
Accuracy class	
Indirect connection	
Active energy	B (EN 50470 - 3) Class 1 (IEC 62053-21)
Reactive energy	Class 2 (IEC 62053-23)
Apparent energy	Calibrated up to 3%
Direct connection	
Active energy	A or B (EN 50470 - 3) Class 2 or 1 (IEC 62053-21
Reactive energy	Class 3 or 2 (IEC 62053-23)
Apparent energy	Calibrated up to 3%
Outputs	
Type - OPTO-MOS relay (Auxiliary control switch)	
Contact	Make or break contact
Permitted load	100 mA
Voltage	250V AC
Pulse length	From 30 ms to 200 ms (adjustable in steps by 1 ms)
Transmission distance	Up to 1000m
Type – Relay (Load control switch)	
Voltage	250 V AC
Switching voltage	250V AC
Maximum switching current	6A
Switching power	1500VA

Inputs	
Alarm input	
Voltage level	100 – 240 V AC
Potential-free key	
Voltage level	No voltage
Self consumption	
Self consumption of current circuit	Indirect connection 0.12 VA / phase Direct connection 0.005 VA / phase
Self consumption of voltage circuits	0.9 W / 2.3 VA (L2 and L3) 0.9 W / 5.6 VA (L1 – DLC modem connected)
	DLC communication established: 1.2 W / 2.9 VA (L2 and L3) 1.2 W / 6.00 VA (L1)
Communication	
Port 0 Port 1	Infra red optical interface (IEC 62056-21 or IEC62056-46) In-house device wired interface (IEC62056-21)
Port 2	M-Bus wired interface for multiutiliy (EN 13757)
Port 3	PLC communication interface
LED output	
Type	LED – red
Number	2, function kWh/kvarh, kWh/kVA – programmable
Impulse frequency	≤ 2.5 kHz
Impulse length	30 ms
Constant	Programmable
Real time clock	
Accuracy	Crystal: < 5 ppm = ≤ ±3 min./year (at Top= +25°C)
Back-up power supply	Super-Cap: > 7 days, charging time 250 hours Two Super-Cap: > 20 days, charging time 250 hours (optional)
EMC	
Electrostatic discharge	Contact 8kV, air 15 kV (IEC 61000-4-2)
VF magnetic field (80MHz – 2 GHz)	20 V/m active and 40 V/m passive (IEC 61000-4-3)
Transient test	
- Current and voltage circuit not under load	5 kV (IEC 61000-4-4)
- Auxiliary circuits > 40 V	2 kV
Surge test	
- Current and voltage circuits	4 kV (IEC 61000-4-5)
- Auxiliary circuits > 40 V	1 kV
Insulation strength	4 kV_{rms}, 50 Hz, 1 min
Impulse voltage	
- Current and voltage circuits	12 kV voltage circuit, 6kV other 1.2/50 μs (EN 50407-1)
- Auxiliary circuits	6 kV, 1.2/50 μs (EN 50407-1)
Radio interference	Class B (EN 50022)

suppression	
Immunity to conducted disturbances	20 V (EN 61000-4-6)
Immunity to damped oscillatory waves (Indirect connection)	2.5 kV (common mode) (EN 61000-4-18 slow damped) 1 kV (differential mode)
Glow wire test	IEC 695-2-1
Spring hammer test	IEC 60068-2-75
Temperature ranges (IEC 62052-11)	
Operation	-40°C ... +70°C
LCD operation	-25°C ... +70°C
Storing	-40°C ... +85°C
Temperature coefficient (IEC 62052-11)	
Range	-40°C ... +70°C less than ± 0.015% / K
Ingress protection IEC 60529	IP 54
Protection class IEC 62052-11	Double insolation
Liquid Crystal Display	 Number of digits for OBIS code: 5 Index digit size: 3 x 6 mm Number of digits for value: 8 Index digit size: 4 x 8 mm
Climatic conditions	
Type of meter	Indoor meter
Humidity	> 95%
Altitude	2000m
Mechanical conditions	Meter passed all mechanical tests like schock and vibration tests
Terminals (diameter)	
Indirect connected meter	
Diameter	5 mm
Tightening torque	Max. 1 Nm
Direct connected meter with 85A	

terminal block	
Diameter	8.5 mm
Tightening torque	Max. 2,5 Nm
Direct connected meter with 120A terminal block	
Diameter	9.5 mm
Tightening torque	Max. 2,5 Nm
Mechanical environment	M1
Electromagnetic environment	E2
Climatic class	3K7
Dimensions	250 x 178 x 86 mm3 (long terminal cover) 193 x 178 x 86 mm3 (short terminal cover) 310 x 178 x 108 mm3 (meter with disconnector)
Mass	
MT382-D2	Approx. 1.37 kg
MT382-D2 with disconnector	Approx. 2,13 kg
MT382-T1	Approx. 1,30 kg

Annex 1: MT381 object list

Object	OBIS code
Clock	0-0:1.0.0.255
Script Global Meter Reset	0-0:10.0.0.255
Script Table Endofbilling	0-0:10.0.1.255
Script Table Tariffication	0-0:10.0.100.255
Script Table Activate Testmode	0-0:10.0.101.255
Script Table Activate Normalmode	0-0:10.0.102.255
Script Table Load Management	0-0:10.0.103.255
Script Table Disconnect Control	0-0:10.0.106.255
Script Table Image Transfer	0-0:10.0.107.255
Script Table Activate Display Testmode	0-0:10.1.101.255
Prepayment Activate Payment	0-0:10.1.251.255
Script Table Upgrade	0-0:10.1.253.255
Script Table Activate Dlc Testmode	0-0:10.2.101.255
Script Mbusclient Install	0-0:10.50.128.255
Script Mbusclient Remove	0-0:10.50.129.255
Special Days Table	0-0:11.0.0.255
Activity Calendar	0-0:13.0.0.255
Register Activation	0-0:14.0.1.255
Register Activation2	0-0:14.0.2.255
Single Action Schedule End Of Billing	0-0:15.0.0.255
Single Action Schedule Disconnect Control	0-0:15.0.1.255
Single Action Schedule Image Transfer	0-0:15.0.2.255
Single Action Schedule Read	0-0:15.1.0.255
Limiter	0-0:17.0.0.255
Limiter2	0-0:17.0.1.255
Iec Local Port Setup Ch0	0-0:20.0.0.255
Profile General Local Port Readout	0-0:21.0.0.255
Profile General Display Readout	0-0:21.0.1.255
Profile Alternate Display Readout	0-0:21.0.2.255
Iec Hdlc Setup Ch0	0-0:22.0.0.255
Mbus Master Port Setup Ch0	0-0:24.6.0.255
Sfsk Phy Mac	0-0:26.0.0.255
Sfsk Active Initiator	0-0:26.1.0.255
Sfsk Mac Synchronization	0-0:26.2.0.255
Sfsk Mac Counters	0-0:26.3.0.255
Sfsk Llc432 Setup	0-0:26.5.0.255
Sfsk Reporting System	0-0:26.6.0.255
Association Ln	0-0:40.0.0.255
Sap Assignment	0-0:41.0.0.255
Device Logical Name	0-0:42.0.0.255
Security Setup	0-0:43.0.0.255
Frame Counter Rx 0	0-0:43.1.0.255
Frame Counter Rx 1	0-0:43.1.1.255
Image Transfer	0-0:44.0.0.255

Deviceid1	0-0:96.1.0.255
Deviceid2	0-0:96.1.1.255
Deviceid3	0-0:96.1.2.255
Deviceid4	0-0:96.1.3.255
Deviceid5	0-0:96.1.4.255
Deviceid6	0-0:96.1.5.255
Deviceid7	0-0:96.1.6.255
Deviceid8	0-0:96.1.7.255
Deviceid9	0-0:96.1.8.255
Config Program Change Counter	0-0:96.2.0.255
Config Program Change Stamp	0-0:96.2.1.255
Security Switches Status	0-0:96.2.4.255
Input Control Signals	0-0:96.3.1.255
Output Control Signals	0-0:96.3.2.255
Disconnect Control	0-0:96.3.10.255
Device Status	0-0:96.5.0.255
Battery Time Use Counter	0-0:96.6.0.255
Battery Estimated Remaining Time	0-0:96.6.6.255
Phase Total Failure Counter	0-0:96.7.0.255
Phase L1 Failure Counter	0-0:96.7.1.255
Phase L2 Failure Counter	0-0:96.7.2.255
Phase L3 Failure Counter	0-0:96.7.3.255
Phase All Failure Long Counter	0-0:96.7.5.255
Phase L1 Failure Long Counter	0-0:96.7.6.255
Phase L2 Failure Long Counter	0-0:96.7.7.255
Phase L3 Failure Long Counter	0-0:96.7.8.255
Phase Any Failure Long Counter	0-0:96.7.9.255
Phase All Failure Time	0-0:96.7.10.255
Phase L1 Failure Time	0-0:96.7.11.255
Phase L2 Failure Time	0-0:96.7.12.255
Phase L3 Failure Time	0-0:96.7.13.255
Phase Any Failure Time	0-0:96.7.14.255
Phase All Failure Duration	0-0:96.7.15.255
Phase L1 Failure Duration	0-0:96.7.16.255
Phase L2 Failure Duration	0-0:96.7.17.255
Phase L3 Failure Duration	0-0:96.7.18.255
Phase Any Failure Duration	0-0:96.7.19.255
Long Power Failure Time Threshold	0-0:96.7.20.255
Phase Any Failure Counter	0-0:96.7.21.255
Profile Status0	0-0:96.10.1.255
Profile Status1	0-0:96.10.2.255
Profile Status2	0-0:96.10.3.255
Profile Status3	0-0:96.10.4.255
Serialprocess Status Ch0	0-0:96.10.128.255
Event Status1	0-0:96.11.0.255
Event Status2	0-0:96.11.1.255
Event Status3	0-0:96.11.2.255
Event Status4	0-0:96.11.3.255
Event Status5	0-0:96.11.4.255

Consumer Message Text	0-0:96.13.0.255
Consumer Message Code	0-0:96.13.1.255
Current Active Tariff	0-0:96.14.0.255
Cover Opening Counter	0-0:96.15.0.255
Breaker Opening Counter	0-0:96.15.1.255
Image Transfer Counter	0-0:96.63.10.255
Rom Checksum	0-0:96.96.0.255
Modified Secure Param Id	0-0:96.128.0.255
Modified Secure Param Old Value	0-0:96.128.1.255
Modified Secure Param New Value	0-0:96.128.2.255
Error1	0-0:97.97.0.255
Error2	0-0:97.97.1.255
Alarm Status	0-0:97.98.0.255
Alarm Status2	0-0:97.98.1.255
Alarm Filter	0-0:97.98.10.255
Alarm Filter2	0-0:97.98.11.255
Profile Billing1	0-0:98.1.0.255
Profile Billing2	0-0:98.2.0.255
Profile Eventlog	0-0:99.98.0.255
Profile Eventlog1	0-0:99.98.1.255
Profile Eventlog2	0-0:99.98.2.255
Profile Eventlog3	0-0:99.98.3.255
Profile Eventlog4	0-0:99.98.4.255
Dlc Zc Adjust Ch0	0-0:128.0.9.255
Dlc Attr	0-0:128.0.12.255
Dlc Configuration Ch0	0-0:128.0.13.255
Rtc Mode	0-0:128.1.0.255
Rtc Calibration Value	0-0:128.1.1.255
Rtc Backup Type	0-0:128.1.2.255
Rtc Backup Duration	0-0:128.1.3.255
Meas Calibrate Status	0-0:128.5.0.255
Meas Calibration Constants0	0-0:128.5.1.255
Wdt Counter	0-0:128.6.0.255
Phase All Failure Short Counter	0-0:128.6.1.255
Pq L1 Voltage Level 1	0-0:128.7.11.255
Pq L1 Voltage Level 2	0-0:128.7.12.255
Pq L1 Voltage Level 3	0-0:128.7.13.255
Pq L1 Voltage Level 4	0-0:128.7.14.255
Pq L1 Voltage Level 5	0-0:128.7.15.255
Pq L1 Voltage Level 6	0-0:128.7.16.255
Pq L1 Voltage Level 7	0-0:128.7.17.255
Pq L2 Voltage Level 1	0-0:128.7.21.255
Pq L2 Voltage Level 2	0-0:128.7.22.255
Pq L2 Voltage Level 3	0-0:128.7.23.255
Pq L2 Voltage Level 4	0-0:128.7.24.255
Pq L2 Voltage Level 5	0-0:128.7.25.255
Pq L2 Voltage Level 6	0-0:128.7.26.255
Pq L2 Voltage Level 7	0-0:128.7.27.255
Pq L3 Voltage Level 1	0-0:128.7.31.255

Pq L3 Voltage Level 2	0-0:128.7.32.255
Pq L3 Voltage Level 3	0-0:128.7.33.255
Pq L3 Voltage Level 4	0-0:128.7.34.255
Pq L3 Voltage Level 5	0-0:128.7.35.255
Pq L3 Voltage Level 6	0-0:128.7.36.255
Pq L3 Voltage Level 7	0-0:128.7.37.255
Pq Any Voltage Level 1	0-0:128.7.41.255
Pq Any Voltage Level 2	0-0:128.7.42.255
Pq Any Voltage Level 3	0-0:128.7.43.255
Pq Any Voltage Level 4	0-0:128.7.44.255
Pq Any Voltage Level 5	0-0:128.7.45.255
Pq Any Voltage Level 6	0-0:128.7.46.255
Pq Any Voltage Level 7	0-0:128.7.47.255
Pq Asym Voltage Treshold Upper	0-0:128.7.50.255
Pq Asym Voltage Treshold Lower	0-0:128.7.51.255
Pq All Voltage Avg Peak Current	0-0:128.8.0.255
Pq All Voltage Avg Peak Previous	0-0:128.8.1.255
Pq All Voltage Avg Min Current	0-0:128.8.2.255
Pq All Voltage Avg Min Previous	0-0:128.8.3.255
Pq L1 Voltage Peak Current	0-0:128.8.10.255
Pq L1 Voltage Peak Previous	0-0:128.8.11.255
Pq L1 Voltage Min Current	0-0:128.8.12.255
Pq L1 Voltage Min Previous	0-0:128.8.13.255
Pq L2 Voltage Peak Current	0-0:128.8.20.255
Pq L2 Voltage Peak Previous	0-0:128.8.21.255
Pq L2 Voltage Min Current	0-0:128.8.22.255
Pq L2 Voltage Min Previous	0-0:128.8.23.255
Pq L3 Voltage Peak Current	0-0:128.8.30.255
Pq L3 Voltage Peak Previous	0-0:128.8.31.255
Pq L3 Voltage Min Current	0-0:128.8.32.255
Pq L3 Voltage Min Previous	0-0:128.8.33.255
Pq Voltage Min Max Period	0-0:128.8.50.255
Tariff Source	0-0:128.10.0.255
Tariff Mp Synchronisation	0-0:128.10.1.255
Load Control Mode	0-0:128.30.0.255
Load Control Power On Delay	0-0:128.30.2.255
Load Control Switch On Delay	0-0:128.30.3.255
Service Control Mode	0-0:128.30.10.255
Service Control Power On Delay	0-0:128.30.12.255
Service Control Switch On Delay	0-0:128.30.13.255
Service Control Functionality	0-0:128.30.14.255
Disconnect Control Type	0-0:128.30.20.255
Disconnect Control Manual Connect Period	0-0:128.30.24.255
Mem Partition0	0-0:128.40.0.255
Mem Partition1	0-0:128.40.1.255
Mem Partition2	0-0:128.40.2.255
Mem Partition3	0-0:128.40.3.255
Mem Partition4	0-0:128.40.4.255
Flashdev Spy Param	0-0:128.41.0.255

Flashdev Spy Values	0-0:128.41.1.255
Mbus Client Config	0-0:128.50.1.255
Prepayment Payment Mode	0-0:128.60.0.255
Prepayment Available Credit	0-0:128.60.1.255
Prepayment Emergency Credit	0-0:128.60.2.255
Prepayment Payment Status	0-0:128.60.3.255
Prepayment Total Purchase Register	0-0:128.60.4.255
Prepayment Emergency Credit Initial Limit	0-0:128.60.10.255
Prepayment Emergency Credit Limit	0-0:128.60.11.255
Prepayment Emergency Credit Threshold	0-0:128.60.12.255
Prepayment Active Auxiliary Charge	0-0:128.60.20.255
Prepayment Active Rate1	0-0:128.60.21.255
Prepayment Active Rate2	0-0:128.60.22.255
Prepayment Active Rate3	0-0:128.60.23.255
Prepayment Active Rate4	0-0:128.60.24.255
Prepayment Active Rate5	0-0:128.60.25.255
Prepayment Active Rate6	0-0:128.60.26.255
Prepayment Active Rate7	0-0:128.60.27.255
Prepayment Active Rate8	0-0:128.60.28.255
Prepayment Credit Transfer	0-0:128.60.30.255
Prepayment Eneregy Register Reference	0-0:128.60.31.255
Prepayment Accounting Register Reference	0-0:128.60.32.255
Prepayment Passive Auxiliary Charge	0-0:128.60.40.255
Prepayment Passive Rate1	0-0:128.60.41.255
Prepayment Passive Rate2	0-0:128.60.42.255
Prepayment Passive Rate3	0-0:128.60.43.255
Prepayment Passive Rate4	0-0:128.60.44.255
Prepayment Passive Rate5	0-0:128.60.45.255
Prepayment Passive Rate6	0-0:128.60.46.255
Prepayment Passive Rate7	0-0:128.60.47.255
Prepayment Passive Rate8	0-0:128.60.48.255
Registermonitor Current Exceeding Period	0-0:128.62.10.255
Dlms Options Ch0	0-0:128.70.0.255
Dlms Association Restrictions Ch0	0-0:128.70.1.255
Authentication Key1	0-0:128.100.1.255
Authentication Key2	0-0:128.100.2.255
Authentication Key3	0-0:128.100.3.255
Authentication Key4	0-0:128.100.4.255
Encryption Key1	0-0:128.100.10.255
Encryption Key2	0-0:128.100.20.255
Encryption Key3	0-0:128.100.21.255
Encryption Key4	0-0:128.100.22.255
Performance Data	0-0:128.102.0.255
Performance Events	0-0:128.102.1.255
Appcoredevice Mode	0-0:128.103.0.255
Appcoredevice Stamp	0-0:128.103.1.255
Appcoredevice Flags	0-0:128.103.2.255
Meas Configuration	0-0:196.0.0.255
Trafo Meas Type	0-0:196.0.1.255

Startup Hysteresis	0-0:196.0.23.255
Console Energy Format Width Precision	0-0:196.1.0.255
Console Demand Format Width Precision	0-0:196.1.1.255
Console Display Configuration	0-0:196.1.3.255
Cfgio Configuration	0-0:196.3.0.255
Configure Io 5	0-0:196.3.6.255
Prepayment Rate Scaler	0-0:196.60.0.255
Error1 Filter	0-0:196.97.0.255
Error2 Filter	0-0:196.97.1.255
Error1 Display Filter	0-0:196.97.10.255
Error2 Display Filter	0-0:196.97.11.255
Authentication Failure Stamp	0-0:196.98.0.255
Authentication Failure Count	0-0:196.98.1.255
Authentication Failure Count Limit	0-0:196.98.2.255
Authentication Mechanism Restrictions	0-0:196.98.3.255
Decryption Failure Stamp	0-0:196.98.4.255
Decryption Failure Count	0-0:196.98.5.255
Script Table Disconnect Control Ch1	0-1:10.0.106.255
Single Action Schedule Mbus	0-1:15.0.1.255
Iec Hdlc Setup Ch1	0-1:22.0.0.255
Mbus Master Setup Ch1	0-1:24.1.0.255
Mbus Ch1 Result 0	0-1:24.2.1.255
Mbus Ch1 Result 1	0-1:24.2.2.255
Mbus Ch1 Result 2	0-1:24.2.3.255
Mbus Ch1 Result 3	0-1:24.2.4.255
Profile Mbusresults1	0-1:24.3.0.255
Disconnect Control Ch1	0-1:24.4.0.255
Profile Mbuscontroleventlog1	0-1:24.5.0.255
Deviceid1 Ch1	0-1:96.1.0.255
Deviceid2 Ch1	0-1:96.1.1.255
Disconnect Control Relay Ch1	0-1:96.3.10.255
Profile Mbusstatus1	0-1:96.10.3.255
Serialprocess Status Ch1	0-1:96.10.128.255
Event Status Mbuscontroleventlog1	0-1:96.11.4.255
Dlms Options Ch1	0-1:128.70.0.255
Dlms Association Restrictions Ch1	0-1:128.70.1.255
Mbus Master Setup Ch2	0-2:24.1.0.255
Mbus Ch2 Result 0	0-2:24.2.1.255
Mbus Ch2 Result 1	0-2:24.2.2.255
Mbus Ch2 Result 2	0-2:24.2.3.255
Mbus Ch2 Result 3	0-2:24.2.4.255
Profile Mbusresults2	0-2:24.3.0.255
Disconnect Control Ch2	0-2:24.4.0.255
Profile Mbuscontroleventlog2	0-2:24.5.0.255
Deviceid1 Ch2	0-2:96.1.0.255
Deviceid2 Ch2	0-2:96.1.1.255
Disconnect Control Relay Ch2	0-2:96.3.10.255
Profile Mbusstatus2	0-2:96.10.3.255
Serialprocess Status Ch2	0-2:96.10.128.255

Event Status Mbuscontroleventlog2	0-2:96.11.4.255
Mbus Master Setup Ch3	0-3:24.1.0.255
Mbus Ch3 Result 0	0-3:24.2.1.255
Mbus Ch3 Result 1	0-3:24.2.2.255
Mbus Ch3 Result 2	0-3:24.2.3.255
Mbus Ch3 Result 3	0-3:24.2.4.255
Profile Mbusresults3	0-3:24.3.0.255
Disconnect Control Ch3	0-3:24.4.0.255
Profile Mbuscontroleventlog3	0-3:24.5.0.255
Deviceid1 Ch3	0-3:96.1.0.255
Deviceid2 Ch3	0-3:96.1.1.255
Profile Mbusstatus3	0-3:96.10.3.255
Serialprocess Status Ch3	0-3:96.10.128.255
Event Status Mbuscontroleventlog3	0-3:96.11.4.255
Mbus Master Setup Ch4	0-4:24.1.0.255
Mbus Ch4 Result 0	0-4:24.2.1.255
Mbus Ch4 Result 1	0-4:24.2.2.255
Mbus Ch4 Result 2	0-4:24.2.3.255
Mbus Ch4 Result 3	0-4:24.2.4.255
Profile Mbusresults4	0-4:24.3.0.255
Disconnect Control Ch4	0-4:24.4.0.255
Profile Mbuscontroleventlog4	0-4:24.5.0.255
Deviceid1 Ch4	0-4:96.1.0.255
Deviceid2 Ch4	0-4:96.1.1.255
Profile Mbusstatus4	0-4:96.10.3.255
Event Status Mbuscontroleventlog4	0-4:96.11.4.255
Device Address1	1-0:0.0.0.255
Billing Period Counter	1-0:0.1.0.255
Image Core Identification	1-0:0.2.0.255
Image Core Signature	1-0:0.2.8.255
Metroled A Constant	1-0:0.3.0.255
Metroled Q Constant	1-0:0.3.1.255
Metroled S Constant	1-0:0.3.2.255
Outputpulse A Constant	1-0:0.3.3.255
Outputpulse Q Constant	1-0:0.3.4.255
Outputpulse S Constant	1-0:0.3.5.255
Traforatio Current Numerator	1-0:0.4.2.255
Traforatio Voltage Numerator	1-0:0.4.3.255
Traforatio Current Denominator	1-0:0.4.5.255
Traforatio Voltage Denominator	1-0:0.4.6.255
Voltage Nominal	1-0:0.6.0.255
Period	1-0:0.8.0.255
Measurement Period3	1-0:0.8.2.255
Local Time	1-0:0.9.1.255
Local Date	1-0:0.9.2.255
Time Set Limit	1-0:0.9.11.255
Active Demand Current Plus	1-0:1.4.0.255
Active Demand Last Plus	1-0:1.5.0.255
Maximum Demand Plus	1-0:1.6.0.255

Maximum Demand Plus T1	1-0:1.6.1.255
Maximum Demand Plus T2	1-0:1.6.2.255
Maximum Demand Plus T3	1-0:1.6.3.255
Maximum Demand Plus T4	1-0:1.6.4.255
Maximum Demand Plus T5	1-0:1.6.5.255
Maximum Demand Plus T6	1-0:1.6.6.255
Maximum Demand Plus T7	1-0:1.6.7.255
Maximum Demand Plus T8	1-0:1.6.8.255
Activepower Plus Instantaneous	1-0:1.7.0.255
Active Energy Plus	1-0:1.8.0.255
Active Energy Plus T1	1-0:1.8.1.255
Active Energy Plus T2	1-0:1.8.2.255
Active Energy Plus T3	1-0:1.8.3.255
Active Energy Plus T4	1-0:1.8.4.255
Active Energy Plus T5	1-0:1.8.5.255
Active Energy Plus T6	1-0:1.8.6.255
Active Energy Plus T7	1-0:1.8.7.255
Active Energy Plus T8	1-0:1.8.8.255
Active Demand Avg3 Plus	1-0:1.24.0.255
Active Demand Current Minus	1-0:2.4.0.255
Active Demand Last Minus	1-0:2.5.0.255
Maximum Demand Minus	1-0:2.6.0.255
Maximum Demand Minus T1	1-0:2.6.1.255
Maximum Demand Minus T2	1-0:2.6.2.255
Maximum Demand Minus T3	1-0:2.6.3.255
Maximum Demand Minus T4	1-0:2.6.4.255
Maximum Demand Minus T5	1-0:2.6.5.255
Maximum Demand Minus T6	1-0:2.6.6.255
Maximum Demand Minus T7	1-0:2.6.7.255
Maximum Demand Minus T8	1-0:2.6.8.255
Activepower Minus Instantaneous	1-0:2.7.0.255
Active Energy Minus	1-0:2.8.0.255
Active Energy Minus T1	1-0:2.8.1.255
Active Energy Minus T2	1-0:2.8.2.255
Active Energy Minus T3	1-0:2.8.3.255
Active Energy Minus T4	1-0:2.8.4.255
Active Energy Minus T5	1-0:2.8.5.255
Active Energy Minus T6	1-0:2.8.6.255
Active Energy Minus T7	1-0:2.8.7.255
Active Energy Minus T8	1-0:2.8.8.255
Reactive Demand Current Plus	1-0:3.4.0.255
Reactive Demand Last Plus	1-0:3.5.0.255
Reactive Maximum Demand Plus	1-0:3.6.0.255
Reactive Maximum Demand Plus T1	1-0:3.6.1.255
Reactive Maximum Demand Plus T2	1-0:3.6.2.255
Reactive Maximum Demand Plus T3	1-0:3.6.3.255
Reactive Maximum Demand Plus T4	1-0:3.6.4.255
Reactive Maximum Demand Plus T5	1-0:3.6.5.255
Reactive Maximum Demand Plus T6	1-0:3.6.6.255

Reactive Maximum Demand Plus T7	1-0:3.6.7.255
Reactive Maximum Demand Plus T8	1-0:3.6.8.255
Reactive Power Plus Instantaneous	1-0:3.7.0.255
Reactive Energy Plus	1-0:3.8.0.255
Reactive Energy Plus T1	1-0:3.8.1.255
Reactive Energy Plus T2	1-0:3.8.2.255
Reactive Energy Plus T3	1-0:3.8.3.255
Reactive Energy Plus T4	1-0:3.8.4.255
Reactive Energy Plus T5	1-0:3.8.5.255
Reactive Energy Plus T6	1-0:3.8.6.255
Reactive Energy Plus T7	1-0:3.8.7.255
Reactive Energy Plus T8	1-0:3.8.8.255
Reactive Demand Current Minus	1-0:4.4.0.255
Reactive Demand Last Minus	1-0:4.5.0.255
Reactive Maximum Demand Minus	1-0:4.6.0.255
Reactive Maximum Demand Minus T1	1-0:4.6.1.255
Reactive Maximum Demand Minus T2	1-0:4.6.2.255
Reactive Maximum Demand Minus T3	1-0:4.6.3.255
Reactive Maximum Demand Minus T4	1-0:4.6.4.255
Reactive Maximum Demand Minus T5	1-0:4.6.5.255
Reactive Maximum Demand Minus T6	1-0:4.6.6.255
Reactive Maximum Demand Minus T7	1-0:4.6.7.255
Reactive Maximum Demand Minus T8	1-0:4.6.8.255
Reactive Power Minus Instantaneous	1-0:4.7.0.255
Reactive Energy Minus	1-0:4.8.0.255
Reactive Energy Minus T1	1-0:4.8.1.255
Reactive Energy Minus T2	1-0:4.8.2.255
Reactive Energy Minus T3	1-0:4.8.3.255
Reactive Energy Minus T4	1-0:4.8.4.255
Reactive Energy Minus T5	1-0:4.8.5.255
Reactive Energy Minus T6	1-0:4.8.6.255
Reactive Energy Minus T7	1-0:4.8.7.255
Reactive Energy Minus T8	1-0:4.8.8.255
Reactive Energy Q1	1-0:5.8.0.255
Reactive Energy Q1 T1	1-0:5.8.1.255
Reactive Energy Q1 T2	1-0:5.8.2.255
Reactive Energy Q1 T3	1-0:5.8.3.255
Reactive Energy Q1 T4	1-0:5.8.4.255
Reactive Energy Q1 T5	1-0:5.8.5.255
Reactive Energy Q1 T6	1-0:5.8.6.255
Reactive Energy Q1 T7	1-0:5.8.7.255
Reactive Energy Q1 T8	1-0:5.8.8.255
Reactive Energy Q2	1-0:6.8.0.255
Reactive Energy Q2 T1	1-0:6.8.1.255
Reactive Energy Q2 T2	1-0:6.8.2.255
Reactive Energy Q2 T3	1-0:6.8.3.255
Reactive Energy Q2 T4	1-0:6.8.4.255
Reactive Energy Q2 T5	1-0:6.8.5.255
Reactive Energy Q2 T6	1-0:6.8.6.255

Reactive Energy Q2 T7	1-0:6.8.7.255
Reactive Energy Q2 T8	1-0:6.8.8.255
Reactive Energy Q3	1-0:7.8.0.255
Reactive Energy Q3 T1	1-0:7.8.1.255
Reactive Energy Q3 T2	1-0:7.8.2.255
Reactive Energy Q3 T3	1-0:7.8.3.255
Reactive Energy Q3 T4	1-0:7.8.4.255
Reactive Energy Q3 T5	1-0:7.8.5.255
Reactive Energy Q3 T6	1-0:7.8.6.255
Reactive Energy Q3 T7	1-0:7.8.7.255
Reactive Energy Q3 T8	1-0:7.8.8.255
Reactive Energy Q4	1-0:8.8.0.255
Reactive Energy Q4 T1	1-0:8.8.1.255
Reactive Energy Q4 T2	1-0:8.8.2.255
Reactive Energy Q4 T3	1-0:8.8.3.255
Reactive Energy Q4 T4	1-0:8.8.4.255
Reactive Energy Q4 T5	1-0:8.8.5.255
Reactive Energy Q4 T6	1-0:8.8.6.255
Reactive Energy Q4 T7	1-0:8.8.7.255
Reactive Energy Q4 T8	1-0:8.8.8.255
Apparent Demand Current Plus	1-0:9.4.0.255
Apparent Demand Last Plus	1-0:9.5.0.255
Apparent Maximum Demand Plus	1-0:9.6.0.255
Apparent Maximum Demand Plus T1	1-0:9.6.1.255
Apparent Maximum Demand Plus T2	1-0:9.6.2.255
Apparent Maximum Demand Plus T3	1-0:9.6.3.255
Apparent Maximum Demand Plus T4	1-0:9.6.4.255
Apparent Maximum Demand Plus T5	1-0:9.6.5.255
Apparent Maximum Demand Plus T6	1-0:9.6.6.255
Apparent Maximum Demand Plus T7	1-0:9.6.7.255
Apparent Maximum Demand Plus T8	1-0:9.6.8.255
Apparent Power Plus Instantaneous	1-0:9.7.0.255
Apparent Energy Plus	1-0:9.8.0.255
Apparent Energy Plus T1	1-0:9.8.1.255
Apparent Energy Plus T2	1-0:9.8.2.255
Apparent Energy Plus T3	1-0:9.8.3.255
Apparent Energy Plus T4	1-0:9.8.4.255
Apparent Energy Plus T5	1-0:9.8.5.255
Apparent Energy Plus T6	1-0:9.8.6.255
Apparent Energy Plus T7	1-0:9.8.7.255
Apparent Energy Plus T8	1-0:9.8.8.255
Apparent Demand Current Minus	1-0:10.4.0.255
Apparent Demand Last Minus	1-0:10.5.0.255
Apparent Maximum Demand Minus	1-0:10.6.0.255
Apparent Maximum Demand Minus T1	1-0:10.6.1.255
Apparent Maximum Demand Minus T2	1-0:10.6.2.255
Apparent Maximum Demand Minus T3	1-0:10.6.3.255
Apparent Maximum Demand Minus T4	1-0:10.6.4.255
Apparent Maximum Demand Minus T5	1-0:10.6.5.255

Apparent Maximum Demand Minus T6	1-0:10.6.6.255
Apparent Maximum Demand Minus T7	1-0:10.6.7.255
Apparent Maximum Demand Minus T8	1-0:10.6.8.255
Apparent Power Minus Instantaneous	1-0:10.7.0.255
Apparent Energy Minus	1-0:10.8.0.255
Apparent Energy Minus T1	1-0:10.8.1.255
Apparent Energy Minus T2	1-0:10.8.2.255
Apparent Energy Minus T3	1-0:10.8.3.255
Apparent Energy Minus T4	1-0:10.8.4.255
Apparent Energy Minus T5	1-0:10.8.5.255
Apparent Energy Minus T6	1-0:10.8.6.255
Apparent Energy Minus T7	1-0:10.8.7.255
Apparent Energy Minus T8	1-0:10.8.8.255
Voltage Underlimit Threshold	1-0:12.31.0.255
Voltage Underlimit Time Integral	1-0:12.31.129.255
Voltage Underlimit Counter	1-0:12.32.0.255
Voltage Underlimit Duration	1-0:12.33.0.255
Voltage Underlimit Magnitude	1-0:12.34.0.255
Voltage Overlimit Threshold	1-0:12.35.0.255
Voltage Overlimit Time Integral	1-0:12.35.129.255
Voltage Overlimit Counter	1-0:12.36.0.255
Voltage Overlimit Duration	1-0:12.37.0.255
Voltage Overlimit Magnitude	1-0:12.38.0.255
Voltage Cut Underlimit Magnitude	1-0:12.39.0.255
Voltage Underlimit Time Threshold	1-0:12.43.0.255
Voltage Overlimit Time Threshold	1-0:12.44.0.255
Voltage Cut Time Threshold	1-0:12.45.0.255
Power Factor Positive Minimum Sum	1-0:13.3.0.255
Power Factor Positive Last Average Sum	1-0:13.5.0.255
Power Factor Positive Sum	1-0:13.7.0.255
Net Frequency Instantaneous	1-0:14.7.0.255
Active Demand Current Absolute	1-0:15.4.0.255
Active Demand Last Absolute	1-0:15.5.0.255
Active Maximum Demand Absolute	1-0:15.6.0.255
Active Maximum Demand Absolute T1	1-0:15.6.1.255
Active Maximum Demand Absolute T2	1-0:15.6.2.255
Active Maximum Demand Absolute T3	1-0:15.6.3.255
Active Maximum Demand Absolute T4	1-0:15.6.4.255
Active Maximum Demand Absolute T5	1-0:15.6.5.255
Active Maximum Demand Absolute T6	1-0:15.6.6.255
Active Maximum Demand Absolute T7	1-0:15.6.7.255
Active Maximum Demand Absolute T8	1-0:15.6.8.255
Activepower Absolute Instantaneous	1-0:15.7.0.255
Energy Absolute	1-0:15.8.0.255
Energy Absolute T1	1-0:15.8.1.255
Energy Absolute T2	1-0:15.8.2.255
Energy Absolute T3	1-0:15.8.3.255
Energy Absolute T4	1-0:15.8.4.255
Energy Absolute T5	1-0:15.8.5.255

Energy Absolute T6	1-0:15.8.6.255
Energy Absolute T7	1-0:15.8.7.255
Energy Absolute T8	1-0:15.8.8.255
Active Demand Avg3 Absolute	1-0:15.24.0.255
Energy Active Net	1-0:16.8.0.255
Active Demand Avg3 Net	1-0:16.24.0.255
Fuse Supervision Monitor L1	1-0:31.4.0.255
Fuse Supervision Monitor L1	1-0:31.4.0.255
Current Instantaneous L1	1-0:31.7.0.255
Voltage Instantaneous L1	1-0:32.7.0.255
Pq Voltage Average L1	1-0:32.24.0.255
Voltage Underlimit Counter L1	1-0:32.32.0.255
Voltage Underlimit Duration L1	1-0:32.33.0.255
Voltage Underlimit Magnitude L1	1-0:32.34.0.255
Voltage Overlimit Counter L1	1-0:32.36.0.255
Voltage Overlimit Duration L1	1-0:32.37.0.255
Voltage Overlimit Magnitude L1	1-0:32.38.0.255
Power Factor Positive L1	1-0:33.7.0.255
Fuse Supervision Monitor L2	1-0:51.4.0.255
Fuse Supervision Monitor L2	1-0:51.4.0.255
Current Instantaneous L2	1-0:51.7.0.255
Voltage Instantaneous L2	1-0:52.7.0.255
Pq Voltage Average L2	1-0:52.24.0.255
Voltage Underlimit Counter L2	1-0:52.32.0.255
Voltage Underlimit Duration L2	1-0:52.33.0.255
Voltage Underlimit Magnitude L2	1-0:52.34.0.255
Voltage Overlimit Counter L2	1-0:52.36.0.255
Voltage Overlimit Duration L2	1-0:52.37.0.255
Voltage Overlimit Magnitude L2	1-0:52.38.0.255
Power Factor Positive L2	1-0:53.7.0.255
Fuse Supervision Monitor L3	1-0:71.4.0.255
Fuse Supervision Monitor L3	1-0:71.4.0.255
Current Instantaneous L3	1-0:71.7.0.255
Voltage Instantaneous L3	1-0:72.7.0.255
Pq Voltage Average L3	1-0:72.24.0.255
Voltage Underlimit Counter L3	1-0:72.32.0.255
Voltage Underlimit Duration L3	1-0:72.33.0.255
Voltage Underlimit Magnitude L3	1-0:72.34.0.255
Voltage Overlimit Counter L3	1-0:72.36.0.255
Voltage Overlimit Duration L3	1-0:72.37.0.255
Voltage Overlimit Magnitude L3	1-0:72.38.0.255
Power Factor Positive L3	1-0:73.7.0.255
Current Instantaneous Sum	1-0:90.7.0.255
System Status Register	1-0:96.5.1.255
Event Status1	1-0:96.241.0.255
Alarm On Status	1-0:96.242.0.255
Alarm On Status2	1-0:96.242.10.255
Alarm Off Status	1-0:96.243.0.255
Alarm Off Status2	1-0:96.243.10.255

Event System	1-0:96.245.0.255
Alarm System	1-0:96.246.0.255
Profile Period1	1-0:99.1.0.255
Profile Period2	1-0:99.2.0.255
Profile Powerfaillog	1-0:99.97.0.255
Profile Technical Log	1-0:99.99.0.255
Image Module Identification	1-1:0.2.0.255
Image Module Signature	1-1:0.2.8.255

Owing to periodically improvements of our products the supplied products
can differ in some details from data stated in this user manual.

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