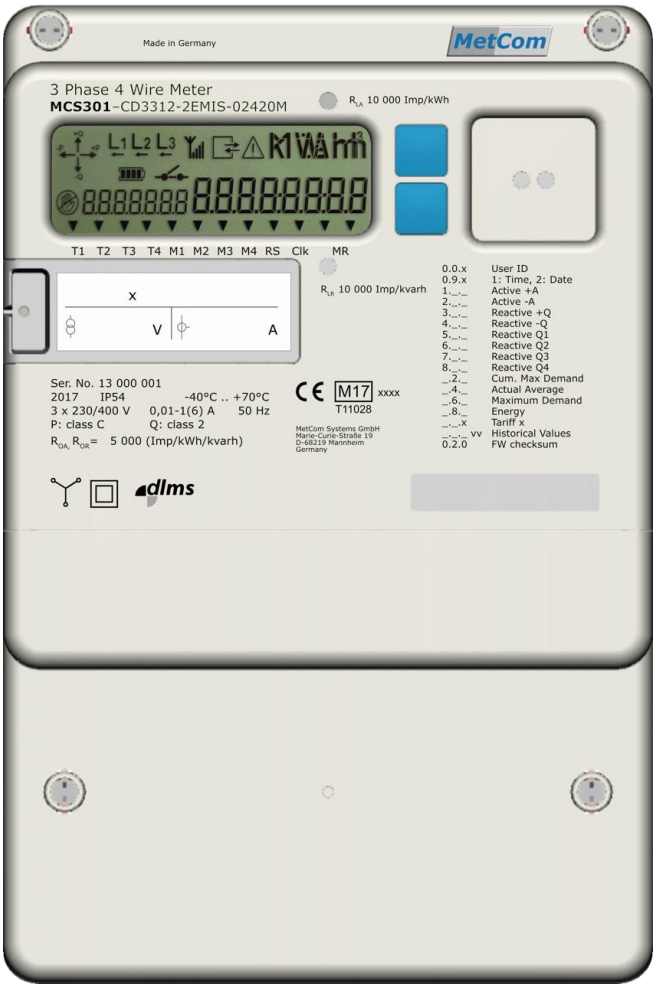
MCS301

Polyphase Smart Meter

Product Manual



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1 Overview

The MCS301 meter is available in different variants for direct and CT and CT/VT connection. The meter conforms to the relevant specifications of the DIN, MID and IEC standards. The meter is prepared for AMI application by using communication modules plugged under the terminal cover of the meter. Below variants are supported:

- 3ph meter, CT and CT/VT connected with dedicated power supply
- 3ph meter, CT/VT connected with wide range power supply
- 3ph meter, DC connected

This manual describes the feature set of the different FW versions of the MCS301, which is displayed on the LCD as well as readout through any interface using below OBIS codes:

	OBIS code	**CT & CT/VT meter**	**DC meter**
MCOR FW identification	1-0:0.2.0	01.01.14	
MCOR FW signature	1-0:0.2.8	A257F480	
MCOR FW identification	1-0:0.2.0	01.01.20	03.01.20
MCOR FW signature	1-0:0.2.8	9D6F9ECA	3798EED1
MCOR FW identification	1-0:0.2.0	01.01.21	03.01.21
MCOR FW signature	1-0:0.2.8	0EFA195B	49FD765D
MCOR FW identification	1-0:0.2.0	01.01.23	03.01.23
MCOR FW signature	1-0:0.2.8	E79AF67A	BDBE62F8
MCOR FW identification	1-0:0.2.0	01.01.24	03.01.24
MCOR FW signature	1-0:0.2.8	C820532A	4413E7C1

1.1 Referenced documents

Titel	Version	Datum
Electricity metering – data exchange for meter reading, tariff and load control – part 21	EN 62056-21	06.2002
Electricity metering – data exchange for meter reading, tariff and load control – part 53 COSEM application layer	EN 62056-53	06.2002
Electricity metering – data exchange for meter reading, tariff and load control – part 62 Interface classes	EN 62056-62	06.2002
Electricity metering – data exchange for meter reading, tariff and load control – part 61:	EN 62056-61	06.2002
Electricity metering equipment (AC) – general requirements, test and test conditions – part 11	EN 62052-11	02.2003
Electricity metering equipment (AC) – general requirements, test and test conditions – part 21:	EN 62053-21	01.2003
Electricity metering equipment (AC) – general requirements, test and test conditions – part 22:	EN 62053-22	01.2003
Electricity metering equipment (AC) – general requirements, test and test conditions – part 23:	EN 62053-23	01.2003
Electricity metering equipment (AC) – part 1: general requirements, test and test conditions, – metering equipment (class indexes A, B and C)	EN 50470-1	09.2005
Electricity metering equipment (AC) – part 3: particular requirements – static meters for active energy (class indexes A, B and C)	EN 50470-3	09.2005
Environmental Management System	ISO14001e.pdf	10.2011
DLMS Blue Book version 1000-1 Ed. 12.1, interfaces classes, OBIS definition	Ed. 12.1	
DLMS Green Book version 1000-2 Ed. 8.1, architecture and protocols	Ed 8.1	
DLMS Yellow Book version 1000-2 Ed. 8.1, conformance & testing	Ed. 3	
IDIS Standard Package 2, Edition 2.0.pdf	Ed. 2.0	03.06.2014
IDIS-S02-001 E2.0 IDIS Pack2 IP profile.pdf	V2.0	10.09.2014
IDIS-S02-001b C1 w1.1 IDIS Pack2 IP Profile corrigendum1,	Ed 2.0 corr.	12.01.2015
IDIS-S02-004 - object model Pack2 Ed2.0.xls	V2.26	26.08.2016
160226 w1.12 IDIS-S03-001 Pack3 IP profile-X.pdf	W1.14	16.09.2016
FID2 -Interoperability Specification.pdf	V1.1	01.06.2016
FID2-Object list.pdf	V1.1	01.06.2016

1.2 Definitions and Abbreviations

Abbreviation	Eexplanation
THD	Total Harmonic Distortion
HES	Head-End-System for remote meter reading
HHU	Hand Held Unit for local meter reading
FW	Firmware of the meter
SW	Software
HW	Hardware of the meter
PQ	Power Quality
CT	External current transformer
VT	External voltage transformer
Sag	Under voltage
Swell	Over voltage
LLS	Low level security, (Password)
HLS	High level security, (Key exchange)
DST	Day light saving
TOU	Time of use, tariffication
IDIS	Interoperable Devive Interface Specification

1.3 Meter standards

The MCS301 meter is tested and approved according below standards:

- **IEC standards**
  - EN62052-11 basic standard for electronic meters
  - EN62053-21 active energy meters, class 1 and 2
  - EN62053-22 active energy meters, class 0,5 and 0,2
  - EN62053-23 reactive energy meters, class 2 and 3
  - EN62056-xx DLMS communication protocol
  - EN62056-21 IEC communication protocol
  - EN62056-53 COSEM application layer
  - EN62056-62 interface classes
  - EN62056-61 OBIS identifier system

- **MID standards**
  - EN50470-1 basic standard for electronic meters
  - EN50470-3 electronic meters, class A, B, or C

1.4 Meter approvals

The following approvals are available for the MCS301 meter

NMI MID approval, See T11028.pdf
Conformity to relevant IEC standard

2 Safety and maintenance information

2.1 Responsibilities

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

The installation personnel must possess the required electrical knowledge and skills, and must be authorised by the utility to perform the installation procedure.

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

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

MetCom Solutions provides training courses related to the above mentioned items.

2.2 Safety instructions

The following safety regulations must be observed:

- The conductors to which the meter will be connected must not be under voltage during installation or change of the meter. Contact with live parts is dangerous to life. The relevant preliminary fuses should therefore be removed and kept in a safe place until the work is completed, so that other persons cannot replace them unnoticed.

- Local safety regulations must be observed. Installation of the meters must be performed exclusively by technically qualified and suitably trained personnel.

- Secondary circuits of current transformers must be short-circuited (at the test terminal block) without fail before opening. The high voltage produced by the interrupted current transformer is dangerous to life and destroys the transformer.

- Transformers in medium or high voltage Solutions must be earthed on one side or at the neutral point on the secondary side. Otherwise they can be statically charged to a voltage which exceeds the insulation strength of the meter and is also dangerous to life.

- Meters which have fallen must not be installed, even if no damage is apparent. They must be returned for testing to the service and repair department responsible (or the manufacturer). Internal damage can result in functional disorders or short-circuits.

- The meter must on no account be cleaned with running water or with high pressure devices. Water penetrating can cause short-circuits.

2.3 Maintenance

No maintenance is required during the meter's life-time. The implemented metering technique, built-in components and manufacturing procedures ensure high long-term stability of meters. Therefore, no recalibration is required during entire meters life-time.

- In case the service of the meter is needed, the requirements from the meter installation procedure must be observed and followed.

- Cleaning of the meter is allowed only with a soft dry cloth. Cleaning is forbidden in the region of terminal cover, where cables are connected to the meter. Cleaning can be performed only by the personnel responsible for meter maintenance.

  CAUTION: 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.

- The quality of seals and the state of the terminals and connecting cables must be regularly checked.

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

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

2.4 Disposal

The components used in the MCS301 are largely recyclable according to the requirements of the environmental management standard ISO14001. Specialized disposal and recycling companies are responsible for material separation, disposal and recycling. The following table identifies the components and their treatment at the end of the life cycle.

Components	Waste collection and disposal
Circuit boards	Electronic waste disposal according to local regulations
LED's, LCD	Special waste: Dispose of according to local regulations.
Metal parts	Recyclable material: Collect separately in metal containers.
Plastic parts	To be recycle separately. If necessary, Of waste incineration.
Batteries	Prior to disposal of unused or used Li-Batteries, safety precautions must be taken against short circuits. Batteries can leak or ignite. Do not dispose of used or defective lithium batteries in the household waste but observe the local waste and environmental regulations.

3 Basic functionality

The basic functionality of the meter is described below:

- **High accuracy**
  Digital measured data processing with a digital signal processor (DSP) and high sample rate for accurate, flexible measured-value processing the energy and demand in all 4 quadrants. Additionally, Power Quality data are provided
- **Configuration**
  User-friendly readout and configuration tool *Blue²Link*, enabling users to define their own different function variants.
- **Load profile for billing and power quality purpose**
  Providing an extended load profile functionality all billing data as well as the Power quality data, like voltage, current, harmonics and THD can be stored over a longer time period and can be readout by the connected HES system.
- **Anti-Tampering features**
  The meter supports a lot of Anti tampering features like
  - terminal and main cover detection
  - communication module removal detection
  - magnetic field detection
- **Communication modules for AMI application**
  The MCS301 meter is prepared for AMI application by using communication modules (GSM / GPRS / LTE, Ethernet …), which can be exchanged in the field.
- **Power supply**
  The meter's power supply is available for 2 different application
  - Transformer rated power supply for dedicated nominal voltage level, like 3x220/380V–3x240/415V or 3x58/100V-3x63/110V
  - Wide range power supply working from 3x58/100V – 3x277/480V

  i.e. if two phases fail, or one phase and the neutral, the meter will remain fully functional. If phase and neutral conductor will be connected in a wrong way the meter displays an alarm. All meter types of the MCS301 are earth fault protected; in that case the meter can handle a voltage of 1.9Un for more than 12h.
- **Readout during power outage (only with external battery support)**
  The behavior during power outage is described below.
  - After pressing the alternate button the LCD will be switched ON.
    - All data can be displayed on the LCD.
    - All data can be readout through the optical interface.
  - The LCD will be switched OFF after the following events:
    - Without pressing the push button within 10s.
    - At reaching the end of the data readout list
- **Auxiliary power supply**
  The CT meter can be supported with an auxiliary power supply from 48 – 230V AC/DC. In case the auxiliary power supply is connected, the meter is powered from this power supply, otherwise its using his own power supply

4 General concept

The meter is based on below concept:

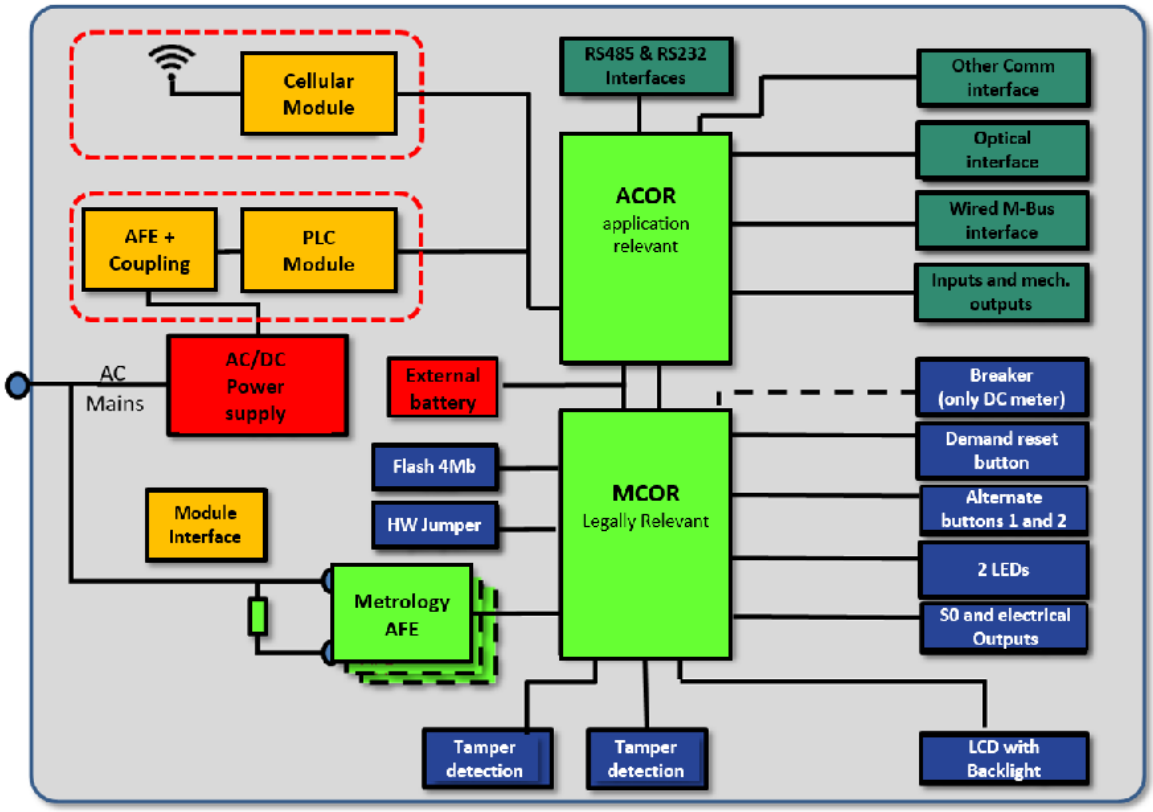


Figure 1: General concept of the meter

The meter firmware (FW) is split in two parts

- metrological relevant FW
- application relevant FW (remote or local download supported)

4.1 Application relevant FW part

The application part of the FW supports below HW and FW functionality

- Optical interface
- RS485 and/or RS232 interface
- Communication module interface or Ethernet interface
- Wired M-Bus interface
- 2 control inputs or 2 pulse inputs
- 1 mechanical relay outputs (up to 10A)
- display control of non MID relevant data
- load profile
- historical data
- log file
- PQ profile
- Customer interface acc. DSMR
- tariffication of energy and demand register
- FW download of the application relevant part

4.2 Metrological relevant FW part

The metrological part of the FW supports below HW+FW functionality

- Measurement / metrology part
- Flash memory
- HW jumper to secure specific register data
- display control of MID relevant data
- Internal supercap and battery support
- Demand reset button
- Alternate button
- tamper detection (terminal & main cover opening, magnet detection, …)
- 2 metrological LED’s
- 6x 230V, 100mA outputs

5 Meter construction

This section describes the mechanical construction of the MCS301 meter. The PCB of the meter is mounted in a rectangular case and meets or exceeds the following standards:

- DIN 43857, part 2
- EN 50155

The 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.

5.1 Front view

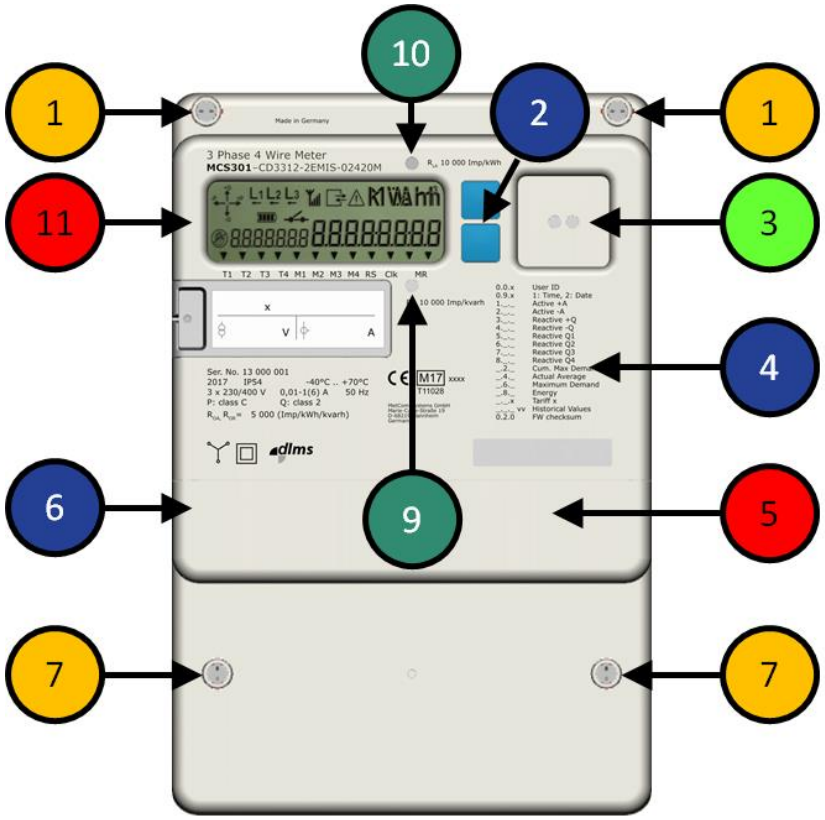


Figure 2: Front view of the meter

1 - Main seals
2 - Alternate push buttons (up/down)
3 - Optical interface
4 - Name plate
5 - Splitted terminal cover for communication module protection
6 - Splitted terminal cover for meter terminal protection
7 - Utility seals
8 - CT/VT ratio name plate, exchangeable, battery, demand reset push button access
9 - LED for optical test output – active energy testing
10 - LED for optical test output – reactive energy testing
11 - Display

5.2 Outside meter dimensions

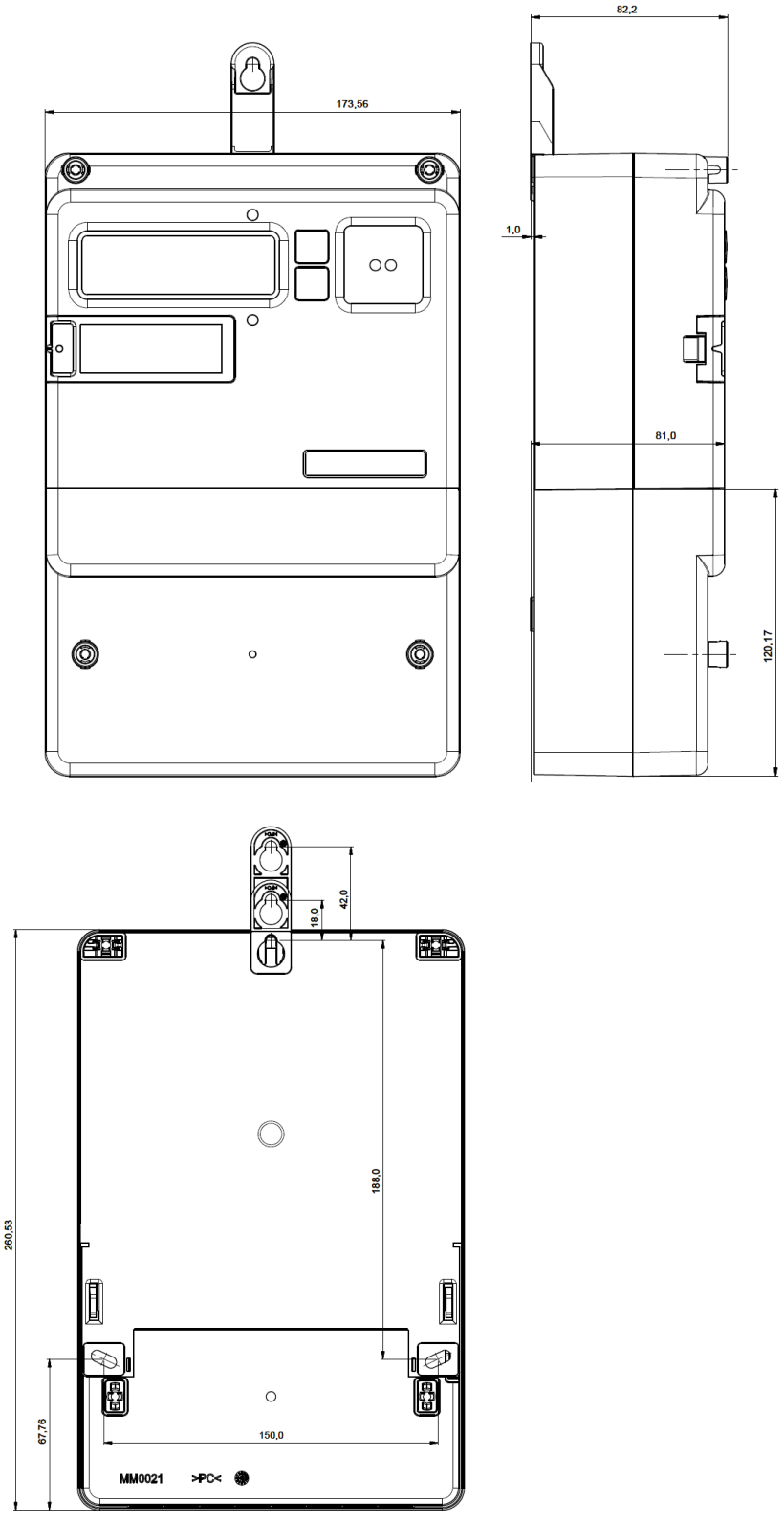


Figure 3: Outside dimension of the meter

5.3 Meter case parts

5.3.1 Terminal block

The MCS301 can be provided with different terminal blocks for DC and CT meter type

5.3.1.1 CT connected terminal block

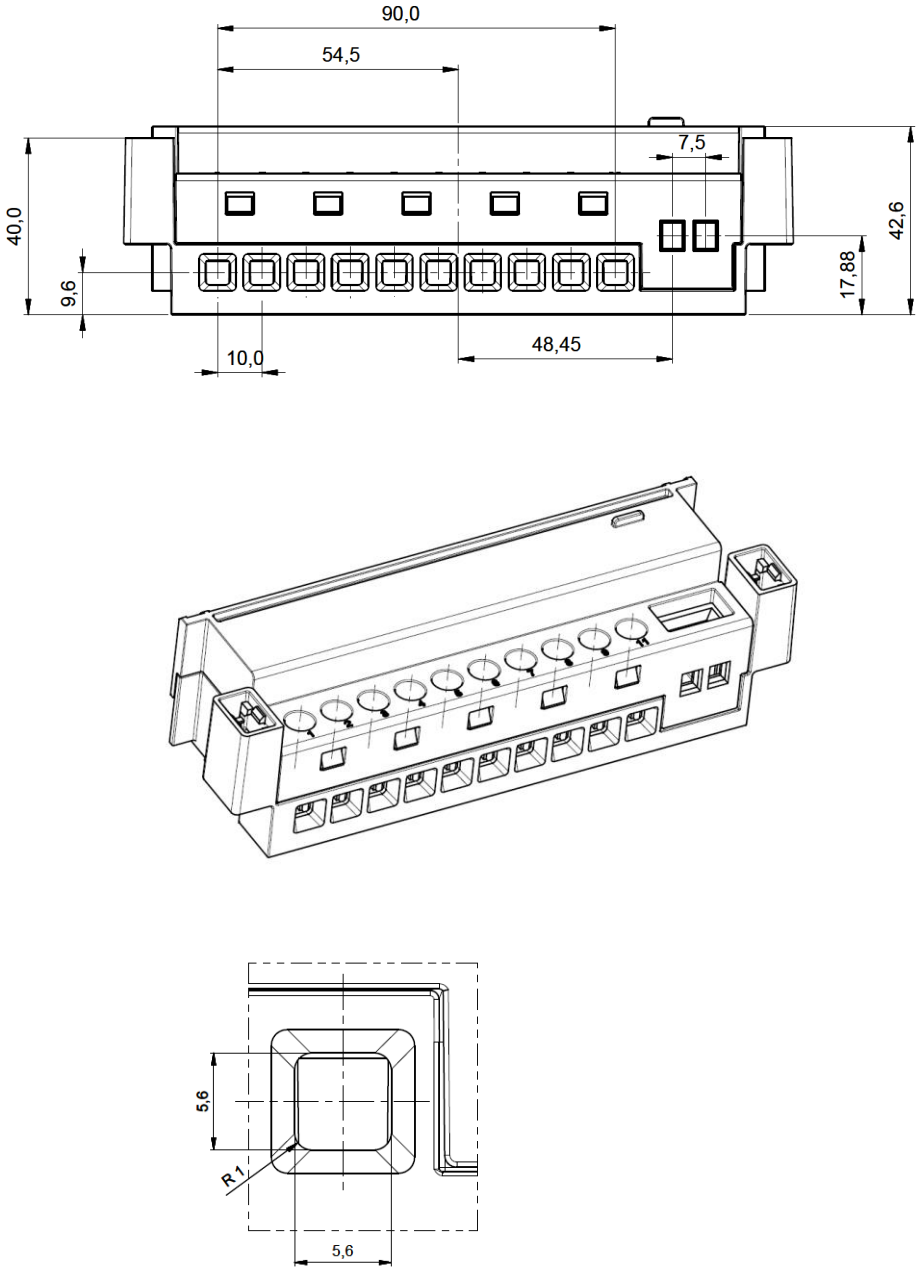


Figure 4: terminal block of the CT connected meter

5.3.1.2 Direct connected (DC) terminal block

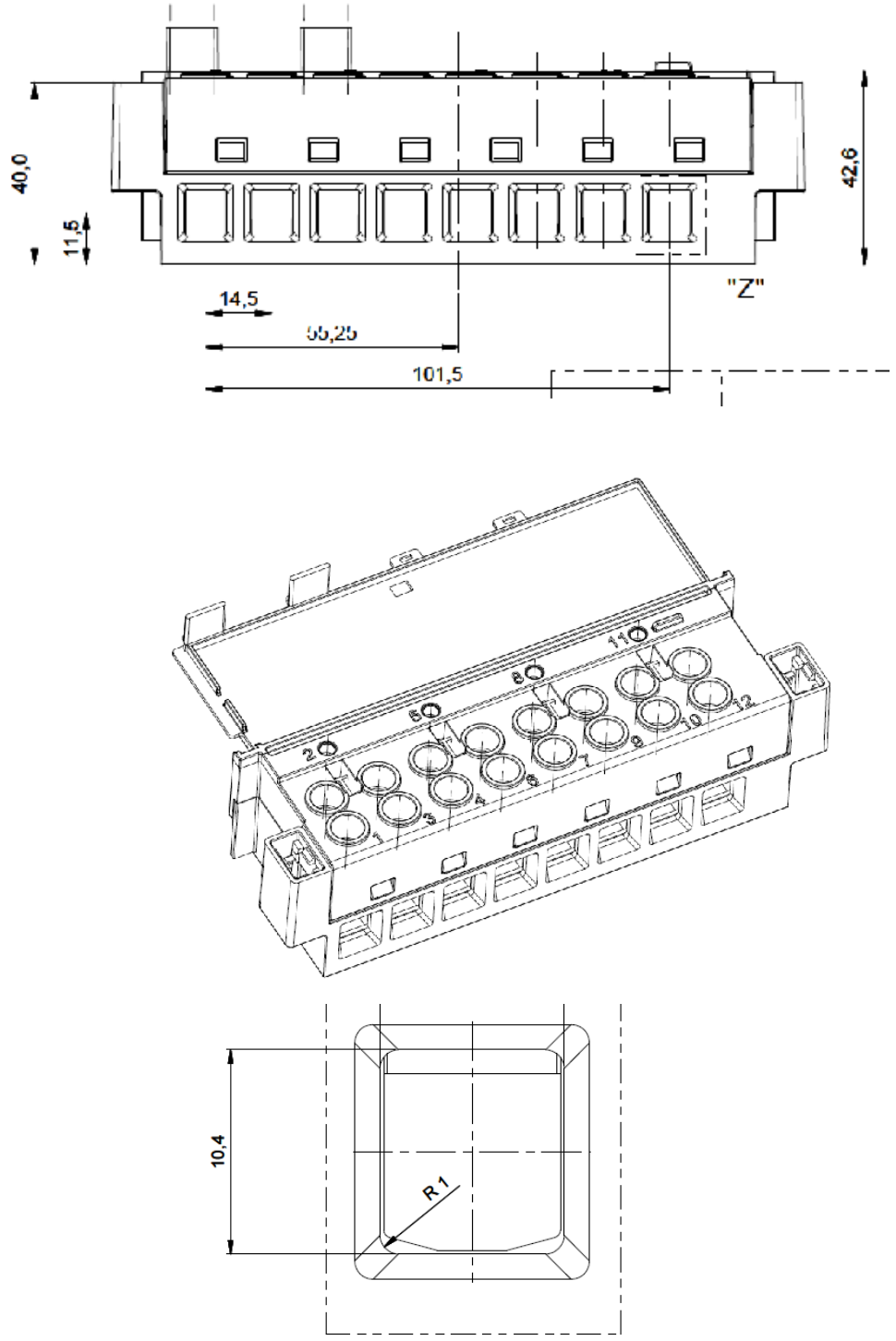


Figure 5: terminal block of the direct connected meter

5.3.2 Main cover

Meter cover is made of non-transparent high quality self-extinguishing UV stabilized polycarbonate that can be recycled. The MCS301 meter is equipped with a meter main cover opening detector.

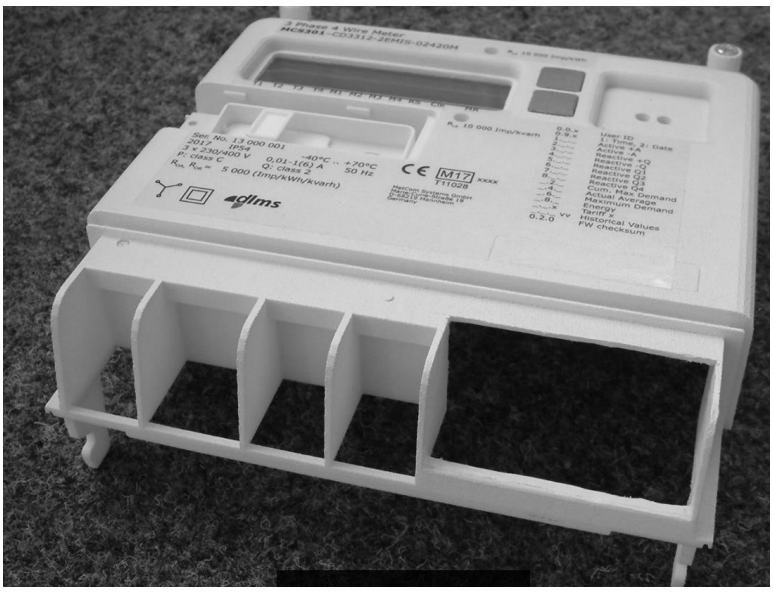


Figure 6: main cover of the meter

5.3.3 Terminal cover

The meter provides different terminal covers:

- **Standard terminal cover**
  The standard terminal cover covers the meter terminal block. It's made of
  - Non transparent, self-extinguished UV stabilized polycarbonate **or**
  - transparent, self-extinguished UV stabilized polycarbonate

Figure 7: Standard terminal cover

5.3.4 Communication module cover

The communication module is placed in a separate module housing with below features:

- Can be separately sealed
- Access to the communication module without breaking the utility seal

Figure: 8 Communication module cover with open and closed cover

Remark: The communication module is equipped with a module removal detector.

5.4 Sealing

The meter can be sealed with different type of sealing:

a) Pin seal

Figure 9: Pin seal

b) Plastic seal

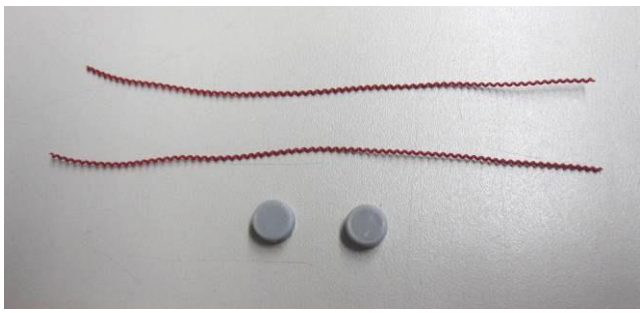


Figure 10: Plastic sealing - standard

5.5 Name plate

The MCS301 nameplate is laser printed on the meter cover:

- Property Number
- Serial Number
- Manufacturer (name and address)
- Model type
- Year of manufacture
- Conformity symbol
- Rated voltage
- Rated/Limit current
- Rated frequency
- CT/VT ratio
- Accuracy Class
- LED test pulse constants RA and RL
- Meter and consumption type
- Symbol for degree of protection
- Identifier system

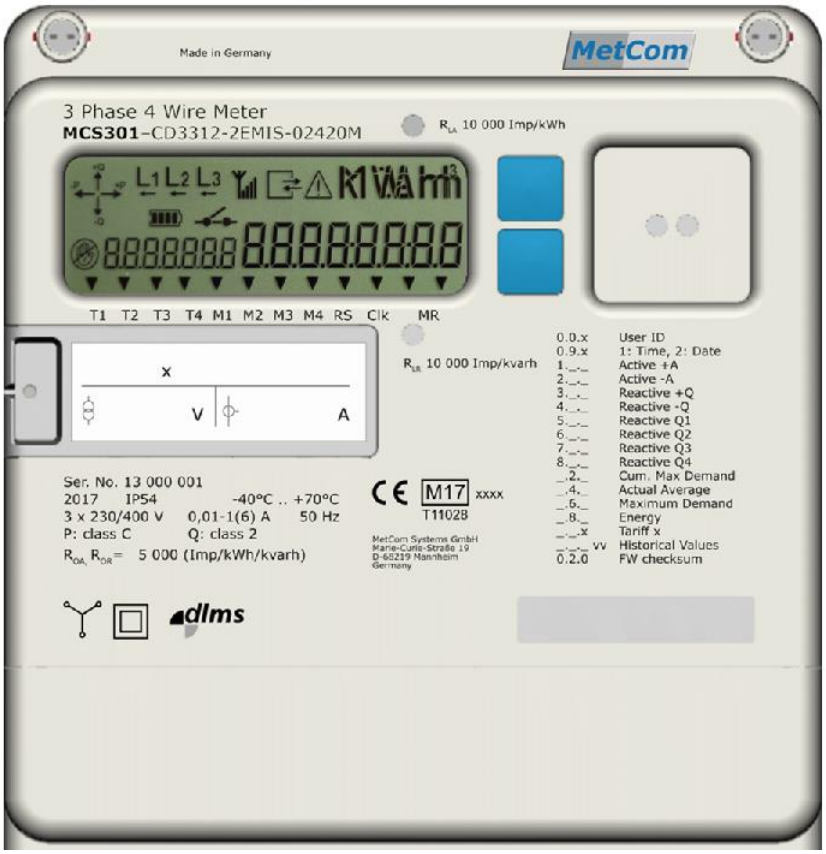


Figure 11: Nameplate of the meter

6 Display Control

6.1 Display

The LCD of the meter should have the following format:

- LCD size: 80 x 24,5 mm
- Digit size: 8 x 4,0 mm
- Digit size (OBIS code): 5,5 x 2,8 mm

The digits for the LC display of the MCS301 you will find in Fig 15:

Figure 12: display of the meter

8.8.8.8:8.8:8.8	Value range (8 digits), separated by dots and top dots
8.8.8.8.8.8.8	OBIS codes (7 digits), separated by dots
	Tampering symbol
▼ ▼ ▼ ▼ ▼ ▼ ▼ ▼ ▼ ▼ ▼ ▼	Configurable arrows (max. 12), example
▼	Activated energy tariff indication (T1 … T8)
▼	Activated demand tariff indication (M1 .. M4)
▼	Test mode indication
▼	Tariff control by internal clock
▼	Status of 2 load control relays (ON/OFF)
▼	EOI, end of interval
▼	Load profile activated
▼	Display of successful communication of M-Bus since last 24h
▼	Indication of legally relevant data (arrow no 12)

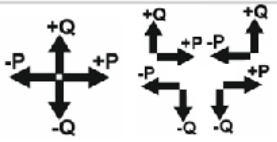
	Low battery symbol (symbol)
	Status of disconnector (3 symbols)
	Status of GPRS signal strength (4 symbols), 1-4 symbols will be displayed depending on the signal strength
	Alarm symbol or demand exceed (1 symbol)
	3ph energy flow indication (4 symbols) for active and reactive energy import and export. Representing the 4 Quadrants (Q1, Q2, Q3 and Q4) +P means energy means that the utility is delivering energy
	Phase voltage indication (3 symbols), ON means present Present status of phase voltage, wrong rotation field => all symbols are blinking
	Indication of reverse energy flow per phase (3 symbols)
	Communication indication (1 symbol), active if communication on optical or any electrical interface. 4 states: Open session, Transmit, receive, transmit and received
	Display of Units: kWh, kW, kvarh, kvar, kVAh, kVA (same in MW..) A, kA, V, kV, Hz, %, m^3

Table 1: list of display items

GPRS signal strength indication

Up to 4 signal strength symbols are used on the LCD to check a good reception:

- >= -95dBm no connection
- -86 dBm … -95 dBm => 1 bar on the LCD
- -76 dBm … -85 dBm => 2 bar on the LCD
- -66 dBm … -75 dBm => 3 bar on the LCD
- >= -65 dBm => 4 bar on the LCD

6.1.1 Back lightened display

The display can optionally be back-lightened to be readable under dark reading conditions. The back lightened display will be activated for a configurable time (5 ... 255s) by pressing the alternate or the demand reset button.
This feature will be available even if the meter is not connected to the main power.

6.2 Display formats

6.2.1 Display of Unit parameters

On the Display below format should be configurable

- nothing – for Wh
- k - for kWh
- M – for MWh

The units can be configured separately for

- energy register
- demand register
- voltage and current data

6.2.2 Display of decimals

On the Display below decimals of the displayed parameters should be supported

o energy register	total number is 8; 0 .. 4 decimals (configurable) leading “0” will be displayed
o demand register	1 .. 3 decimals (configurable)
o current	2,3 (no of digits in front of the comma / no of decimals)
o voltage	3,2 (no of digits in front of the comma / no of decimals)
o power factor	1,3 (no of digits in front of the comma / no of decimals)
o Harmonics, THD	2,2 (no of digits in front of the comma / no of decimals)
o Frequency	2,2 (no of digits in front of the comma / no of decimals)
o phase angle	3,1 (no of digits in front of the comma / no of decimals)

6.2.3 Display of MID relevant data on the LCD

Below MID relevant data are controlled by the MCOR shown on the LCD using arrow number 12 on the right side of the LCD.

o Active energy register, +A	1.8.0
o Active energy register, -A	2.8.0
o MCOR FW name	0.2.0
o MCOR FW signature	0.2.8
o Metrological relevant error code	F.F or 97.97.1

6.3 Display Modes

The following principles apply for display control:

Alternate button 1

- pressing briefly (<2s) switches to the next list value or menu option
- pressing for longer (2s < t < 5s) either activates the menu options currently being is displayed or causes preceding values to be skipped
- pressing the alternate button for longer (>5 s) returns you from any display mode back into the scroll mode (rolling display)

Alternate button 2

- pressing briefly (<2s) switches to the previous value of the selected list
- pressing the alternate button for longer (>5 s) returns you from any display mode back into the scroll mode (rolling display)
- **remark:** the alternate button 2 can only be used to scroll up and down inside a selected list

Demand Reset button (sealable)

- pressing it for any length of time, **in Scroll mode only**, always causes a reset
- pressing the demand reset button during the display test mode will activate the test mode of the meter, where all energy data will be displayed with a higher resolution

Different operating modes for the display are:

- Scroll Mode
- Display test
- Display mode menu "Alternate mode"
  - **"Std-dAtA"** Standard display mode displaying all the list's register contents
  - **"Protect Std-dAtA"** display mode containg metrological relevant data
  - **"SEr-dAtA"** Second display mode displaying all the list's register contents)
  - **“P.01”** Load profile 1 mode displaying all load profile 1 data
  - **“P.02”** Load profile 2 mode displaying all load profile 2 data
- Display mode menu "Reset mode"
  - **“tESt”** High-resolution test mode for testing purposes
  - **“CELL connect”** Activation of Push Mode to connect to HES
  - **“Slave InStALL”** Activation of M-Bus installation

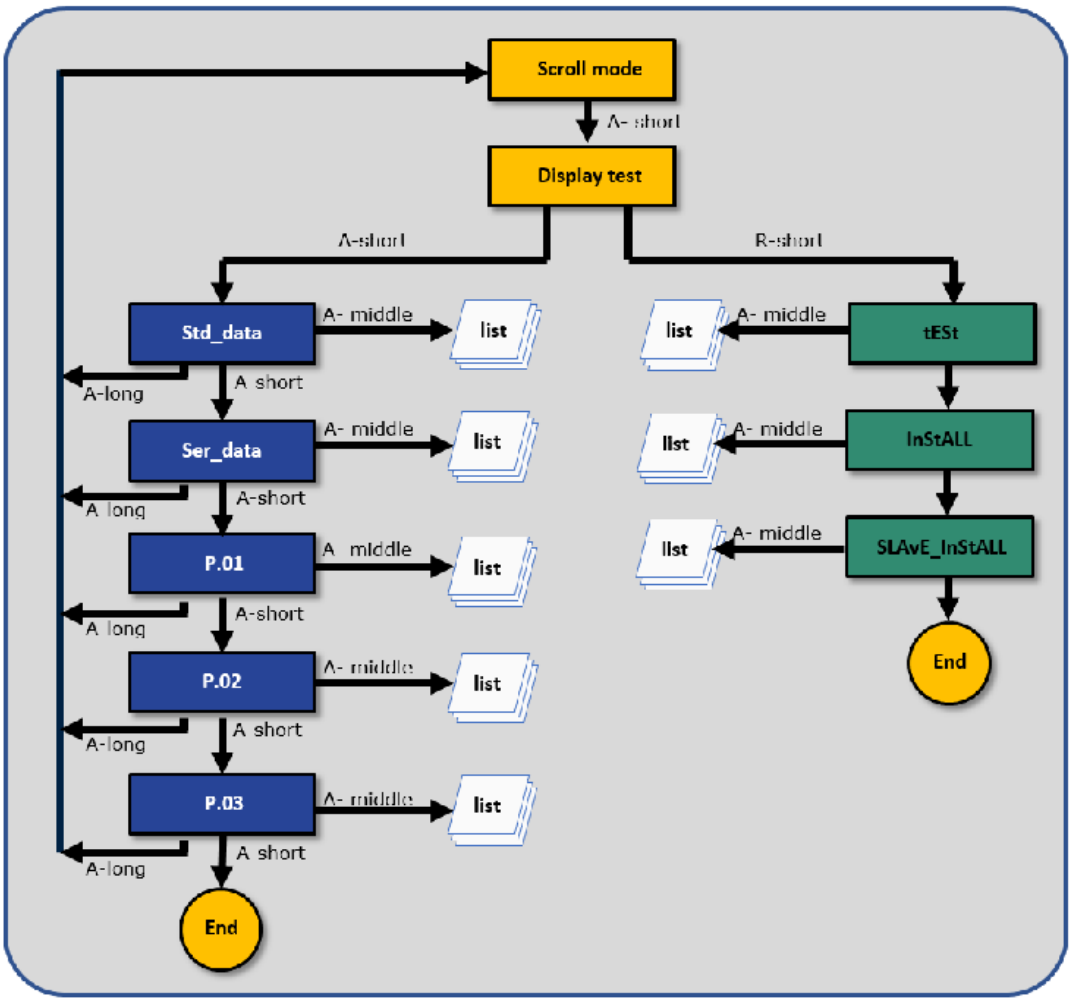


Figure 13: Display modes

6.4 Scroll mode

The operating display is the standard display function. The measured values involved are displayed in rolling mode, with the data relevant to billing being displayed for a configurable duration (e.g. 10s). While a measured value is actually being displayed, then it will not be updated in the scroll mode.
All **billing relevant** data of the scroll list can't be changed without breaking the certification seal (scroll list 1 with 100 entries). Additionally it is possible to select data in a second object list, which can be attached to the scroll list 1. The objects of the second list can be changed without breaking the certification seal.

Parameter of the scroll mode:

- scroll time (1 … 20s)
- number of display for changeable entries (scroll list 1): 70
- number of display for protected entries (scroll list 2): 10

6.5 Different Display Mode

6.5.1 Display test mode

Pressing the alternate button (<5 s) causes the meter to switch over from scroll to display test mode, in which all segments on the display are activated. The display test mode is retained from approx. 3s after the alternate button is released. During the display test mode, you can

- press the alternate button 1 to switch to the Alternate Mode ("A-button menu")
- press the demand reset key to switch to the Reset Mode ("R-button menu")

6.5.2 Alternate Mode (A-button menu)

The first value displayed in the menu list is the single-display mode entitled **"Std-dAtA".** Every time you press the alternate button briefly again, more menu options as available will be displayed, e.g. the second alternate list **“Protect Std-dAtA”** or **“SEr-dAtA”**. For purposes of menu option selection, the alternate button must be held down for at least 2s.
If the time limit after the last touch on the button has been reached (this can be parameterized in a range from 1 min to 2 h) or the alternate button has been kept depressed for not less than 5 s, the meter will automatically switch over to the scroll mode.
While a measured value is being displayed in this mode, it will be updated in the display once a second. Below menu is supported in the A-button menu

- Standard data mode (Std-dAtA)
- Metrology relevant data mode (Protect Std-dAtA)
- second data readout list (SEr-dAtA)

6.5.2.1 Standard mode (Menu Option "Std-dAtA")

The first value displayed in the list is the Identifier and the content of the function error. Every time the alternate button is pressed again, further data will be displayed. In order to call up data more quickly, existing preceding values can be skipped and the value following the preceding values can be displayed (pressing the alternate button longer than 2s.
If the time limit after the last touch on the button has been reached (configurable from 1min to 2h) or the alternate button has been kept depressed for not less than 5s, the meter will automatically switch over to the operating display. The final value in this display mode is the end-of-list identifier shown on the LCD by **"End"**.
All billing relevant data of the Std-data list can’t be changed without breaking the certification seal (Std-data list 1 with 100 entries).

- number of display for changeable entries (Std_data list 1): 70

6.5.2.2 Metrological relevant standard mode (Menu Option "Protect Std-dAtA")

The “Protect Std-dAtA” list is identical to the “Std-dAtA” list beside below items

- It contains only metrological relevant data
- The list can’t be changed anymore after the meter is produced

6.5.2.3 Service mode (Menu Option "SEr-dAtA")

Furthermore the meter supports second standard data list (“SEr-dAtA”). The handling of this list is the same as described in the menu “Std_data). The main difference between this 2 lists is, that the “SEr-dAtA” list can be set without breaking the certification seal.

- number of display entries: 10

6.5.2.4 Load profile 1 – “Standard profile” - (Menu Option "P.01")

Details about recording load profile 1 (“Standard profile”) data are described in chapter 13.2. The display menu acts as explained below.

- **Date selection for the day block**

  The first value displayed in the list is the date of the most recent available day block in the load profile. Every time the alternate button is pressed shortly again, the display will show the preceding available day in the load profile.
  If the alternate button is pressed for >2 s, then for precise analysis of the day block selected the day profile will be displayed in increments of the demand integration period, provided no events have led to the demand integration period being cancelled or shortened.
  If the time limit after the last touch on the button has been reached or the alternate button has been kept depressed for not less than 5 s, the meter will automatically switch over to the operating display.
  The final value in the call list is the end-of-list identifier, which is designated in the display's value range by the word **"End"**.

- **Load profile values of the selected day**

  Display of the day block selected begins by showing the oldest load profile values stored on this day (the value stored at 0.00 h is assigned to the preceding day), beginning with the lowest OBIS Identifier from left to right (time, Channel 1 value, .. Channel n value). Every time the alternate button is pressed briefly (<2 s) again, the next available measured value for the same demand integration period will be displayed. Once all the period's measured values have been displayed, they are followed by the data of the next available demand period.
  The last value in the call list is the end-of-list identifier, which is designated in the display's value range by the word "End" and which appears after the final load profile value of the day selected. If the alternate button is pressed for >2 s, the meter will switch back to the day block previously selected from the date list.
  If the time limit after the last touch on the button has been reached (this can be parameterized in a range from 1 min to 2 h) or the alternate button has been kept depressed for not less than 5 s, the meter will automatically switch over to the operating display.

6.5.2.5 Load profile 2 – “Daily profile” - (Menu Option "P.02")

Details about recording load profile 2 (“Daily profile”) data are described in chapter 13.3. The display menu acts as explained in chapter 6.5.2.3.

6.5.3 Reset Mode (R-button menu)

The first value displayed from the menu list is the R-button menu entitled **"tESt"**. Every time the alternate button is pressed briefly (<2s) again, any other menu options available will be displayed, e.g. the connection to the AMM system, called "**CELL_connect"** or the M-Bus installation mode, called **"Slave_InStALL "**. To select a menu option, the alternate button must be held down for longer than 2s. The final value in this display mode is the end-of-list identifier, which is designated in the display's value range by the word **"End"**.
If the time limit after the last touch on the button has been reached (this can be parameterized in a range from 1min to 2h) or the alternate button has been kept depressed for not less than 5 s, the meter will automatically switch over to the operating display.

6.5.3.1 High resolution mode for test purposes (Menu option „tESt")

In the "Test" operating mode, the display will show the same data as in the scroll mode, but the energy register are displayed with a higher resolution (up to 4 decimals). The "Test" mode is activated by pressing the alternate button during the text „tESt" is displayed on the LCD. After successful activation on the display the text "**Active tESt**" is shown for about 2s.

Test mode is quit via the following events:

- Command via comms interface (optical or electrical)
- after activation of a configurable time period (1 … 60min)
- [A]-button pressed >5s

6.5.3.2 Activation of Push Mode (Menu option „Cell connect")

After activation of the Push Mode the meter automatically pushes a predefined set of data through the communication module to the HES. On the display the message "done" appears if the push was executed successfully. More details are described in chapter 27.2.

6.5.3.3 Activation of M-Bus installation (Menu option „Slave_InSTALL")

After activation of the M-Bus installation Mode, the meter automaticallytries to connect to the next M-Bus slave meter. On the display the message "done" appears if the push was executed successfully. More details are described in chapter 26.7.

7 Measurement functionality

7.1 Measuring principle

The measuring part of the meter comprises the current transformation, a voltage divider plus a highly integrated customized circuit (ASIC). The analog measured variables obtained are digitized in the ASIC and fed to a downstream digital signal processor, which uses them to compute the active or reactive powers plus the corresponding energies. The scanning frequency has been selected so as to ensure that the electrical energy contained in the harmonics is acquired with the specified class accuracy.

7.1.1 Calculation of voltage and current

The effective voltages and currents are calculated on each phase, every second, according to the following formulas:

$$V_{eff} = \sqrt{\frac{1}{T}\int_{t_0}^{t_0+T} v_{inst}^2(t).dt} \qquad I_{eff} = \sqrt{\frac{1}{T}\int_{t_0}^{t_0+T} i_{inst}^2(t).dt}$$

With T = 1 or 0.3s

The voltage measurement is supported from 160 – 440V with an accuracy of <0.5%

7.1.2 Calculation of active/reactive and apparent demand

The active, reactive and apparent demand is calculated according below formula:

Active power	$P_1 = \int v_1.i_1$
Reactive power	$Q_1 = V_{1fond}.I_{1fond}.\sin\Phi_1$
Apparent power	$S_1 = V_{1eff} \times I_{1eff}$

7.1.3 Calculation of harmonics and THD

The measuring chip offers a hardware DFT Engine for **2nd to 32rd** order harmonic component calculation: Both voltage and current of each phase are provided with the same time period.

The register can be divided as follows:

- voltage and current for each phase
- 32 frequency components (fundamental value, and harmonic ratios)
- Total Harmonic Distortion (THD)

The harmonic analysis is implemented with a DFT engine. The DFT period is 0.5s, which gives a resolution frequency of 2Hz. The input samples are multiplied with a Hanning window before feeding to the DFT processor. The DFT processor computes the fundamental and harmonic components based on the measured line frequency and sampling rate of 8kHz.

The THD measurement is done according below formula

$$\text{voltage THD} = \frac{\sqrt{(V_{rms\_total}^{\ 2} - V_{rms\_fundamental}^{\ 2})}}{V_{rms\_fundamental}}$$

7.2 Measuring methods

Below the different possible measuring principles are shown:

7.2.1 Standard measuring method (vectorial method)

The standard measurement method is based on the Ferraris principle

$$P = P_1 + P_2 + P_3$$

Example: P1 = 40W
P2 = -25W
P3 = 50W

⇨ +P = 40 -25 + 50 = 65W
⇨ -P = 0W

7.2.2 Absolute measuring method (optional)

This theft resistant measurement records negative energy flow as positive energy flow on a phase by phase basis. This feature can be used to determine power theft or minimize the effects of improper meter wiring. The following equation shows how the total active power is calculated using theft-resistant measurement.

$$P = |P_1| + |P_2| + |P_3|$$

Example: P1 = 40W
P2 = -25W
P3 = 50W

⇨ +P = /40/ +/-25/ + /50/ = 115W
⇨ -P = 0W

7.2.3 Arithmetic measuring method (optional)

The meter is counting the energy of every phase dependent on the sign of the phase energy

Example: P1 = 40W
P2 = -25W
P3 = 50W

⇨ +P = 40 + 50 = 90W
⇨ -P = 25 = 25W

8 Measurement data

8.1 Energy measurement

Below energy register should be configurable, with below features

- up to 16 different type of energy register (configurable)
- up to 8 energy tariffs
- > 15 historical set of data (see billing profile)
- resolution on communication interface (9,x) number of decimals: x=0…4
- resolution on LCD (8,x) number of decimals: x=0…4

8.1.1 Energy measurement (3ph values)

Below energy register data are supported, including tariff register

	Energy register	total	Tariff 1	…	Tariff 8
1	active energy, +A	1-0:1.8.0.255	1-0:1.8.1.255		1-0:1.8.8.255
2	active energy, -A	1-0:2.8.0.255	1-0:2.8.1.255		1-0:2.8.8.255
3	reactive energy, +R	1-0:3.8.0.255	1-0:3.8.1.255		1-0:3.8.8.255
4	reactive energy, -R	1-0:4.8.0.255	1-0:4.8.1.255		1-0:4.8.8.255
5	reactive energy, R1	1-0:5.8.0.255	1-0:5.8.1.255		1-0:5.8.8.255
6	reactive energy, R2	1-0:6.8.0.255	1-0:6.8.1.255		1-0:6.8.8.255
7	reactive energy, R3	1-0:7.8.0.255	1-0:7.8.1.255		1-0:7.8.8.255
8	reactive energy, R4	1-0:8.8.0.255	1-0:8.8.1.255		1-0:8.8.8.255
9	apparent energy, +S	1-0:9.8.0.255	1-0:9.8.1.255		1-0:9.8.8.255
10	apparent energy, -S	1-0:10.8.0.255	1-0:10.8.1.255		1-0:10.8.8.255
11	Absolue active energy, /+A/ + /-A/	1-0:15.8.0.255	1-0:15.8.1.255		1-0:15.8.8.255
12	Net active energy, /+A/ - /-A/	1-0:16.8.0.255	1-0:16.8.1.255		1-0:16.8.8.255
13	iron losses, +I*I*h	1-0:83.8.4.255			
14	copper losses, +U*U*h	1-0:83.8.1.255			
15	iron losses, -I*I*h	1-0:83.8.5.255			
16	copper losses, -U*U*h	1-0:83.8.2.255			

Table 2: list of 3ph energy register with OBIS codes

8.1.2 Energy measurement (3ph values) – since last demand reset

Below energy register are supported, starting always from the begin of the last demand reset.

	Energy register	total
1	active energy, +A	1-0:1.29.0.255
2	active energy, -A	1-0:2.29.0.255
3	reactive energy, +R	1-0:3.29.0.255
4	reactive energy, -R	1-0:4.29.0.255
5	apparent energy, +S	1-0:9.29.0.255
6	apparent energy, -S	1-0:10.29.0.255

Table 3: list of 3ph energy register with OBIS codes since last demand reset

Remark: All register can be stored as historical data.

8.1.3 Energy measurement (1ph measurement)

Below 1ph energy register data are supported (without tariff information)

	Energy register	L1	L2	L3
1	active energy, +A	1-0:21.8.0.255	1-0:41.8.0.255	1-0:61.8.0.255
2	active energy, -A	1-0:22.8.0.255	1-0:42.8.0.255	1-0:62.8.0.255
3	reactive energy, +R	1-0:23.8.0.255	1-0:43.8.0.255	1-0:63.8.0.255
4	reactive energy, -R	1-0:24.8.0.255	1-0:44.8.0.255	1-0:64.8.0.255
5	reactive energy, R1	1-0:25.8.0.255	1-0:45.8.0.255	1-0:65.8.0.255
6	reactive energy, R2	1-0:26.8.0.255	1-0:46.8.0.255	1-0:66.8.0.255
7	reactive energy, R3	1-0:27.8.0.255	1-0:47.8.0.255	1-0:67.8.0.255
8	reactive energy, R4	1-0:28.8.0.255	1-0:48.8.0.255	1-0:68.8.0.255
9	apparent energy, +S	1-0:29.8.0.255	1-0:49.8.0.255	1-0:69.8.0.255
10	apparent energy, -S	1-0:30.8.0.255	1-0:50.8.0.255	1-0:70.8.0.255

Table 4: list of 1ph energy register with OBIS codes

8.2 Maximum Demand measurement

The demand measurement offers below characteristic:

- Demand measurement type
  - support of block demand
  - support of sliding demand according DLMS blue book, up to 15 sub-intervals

	Demand register	Max demand	Current / last average demand
1	active demand, +P	1-0:1.6.0.255	1-0:1.4.0.255
2	active demand, -P	1-0:2.6.0.255	1-0:2.4.0.255
3	active demand, /+P/ + /-P/	1-0:15.6.0.255	1-0:15.4.0.255
4	reactive demand, +Q	1-0:3.6.0.255	1-0:3.4.0.255
5	reactive demand, -Q	1-0:4.6.0.255	1-0:4.4.0.255
6	apparent demand, +S	1-0:9.6.0.255	1-0:9.4.0.255
7	apparent demand, -S	1-0:10.6.0.255	1-0:10.4.0.255

Table 5: list of demand register with OBIS code

- up to 4 demand tariffs
- up to 15 set of historical data
- resolution on communication interface (6,x) number of decimals: x= 1…3
- resolution on LCD (6,x) number of decimals: x= 1…3
- configurable period, 1..60min (independent from the load profile period)
- power up and power down <= configurable interval
  => Ongoing demand period
- power up and power down >= configurable interval
  => Stop of current demand measurement, restart of new demand period
- time synchronization deviation <= configurable interval
  => Ongoing demand period
- time synchronization deviation >= configurable interval
  => Stop of current demand measurement, restart of new demand period

8.3 Instantaneous measurement

8.3.1 Instantaneous measurement – demand data

Below demand data are supported as instantaneous demand data

		Total	L1	L2	L3
1	active demand, +P	1-0:1.7.0.255	1-0:21.7.0.255	1-0:41.7.0.255	1-0:41.7.0.255
2	active demand, -P	1-0:2.7.0.255	1-0:22.7.0.255	1-0:42.7.0.255	1-0:62.7.0.255
3	active demand, /+P/ + /-P/	1-0:15.7.0.255			
4	reactive demand, +Q	1-0:3.7.0.255	1-0:23.7.0.255	1-0:43.7.0.255	1-0:63.7.0.255
5	reactive demand, -Q	1-0:4.7.0.255	1-0:24.7.0.255	1-0:44.7.0.255	1-0:64.7.0.255
6	apparent demand, +S	1-0:9.7.0.255	1-0:29.7.0.255	1-0:49.7.0.255	1-0:69.7.0.255
7	apparent demand, -S	1-0:10.7.0.255	1-0:30.7.0.255	1-0:50.7.0.255	1-0:70.7.0.255

Table 6: list of instantaneous demand data with OBIS codes

8.3.2 Instantaneous measurement data – PQ data without harmonics

Below data are supported as instantaneous PQ data without harmonics

	Instantaneous data	total	L1	L2	L3
1	Voltage		1-0:32.7.0.255	1-0:52.7.0.255	1-0:72.7.0.255
2	Current		1-0:31.7.0.255	1-0:51.7.0.255	1-0:71.7.0.255
3	Current, sum of all phases	1-0:90.7.0.255			
4	Power factor	1-0:13.7.0.255	1-0:33.7.0.255	1-0:53.7.0.255	1-0:73.7.0.255
5	phase angle, ref U1		1-0:81.7.0.255	1-0:81.7.10.255	1-0:81.7.20.255
6	Current angle, Ux-Ix		1-0:81.7.4.255	-0:81.7.15.255	1-0:81.7.26.255
7	frequency in any phase	1-0:14.7.0.255			
8	Neutral current calculation	1-0:91.7.3.255			
9	Internal temperature	0-0:96.9.0.255			

Table 7: list of instantaneous PQ data without harmonics

8.3.3 Instantaneous measurement data – PQ data with harmonics + THD

Below data are supported as instantaneous PQ data including harmonics and THD

		L1	L2	L3
1	3.te harmonic, voltage	1-0:32.7.3	1-0:52.7.3	1-0:72.7.3
2	5.te harmonic, voltage	1-0:32.7.5	1-0:52.7.5	1-0:72.7.5
3	7.te harmonic, voltage	1-0:32.7.7	1-0:52.7.7	1-0:72.7.7
4	9.te harmonic, voltage	1-0:32.7.9	1-0:52.7.9	1-0:72.7.9
5	11.te harmonic, voltage	1-0:32.7.11	1-0:52.7.11	1-0:72.7.11
6	13.te harmonic, voltage	1-0:32.7.13	1-0:52.7.13	1-0:72.7.13
8	15.te harmonic, voltage	1-0:32.7.15	1-0:52.7.15	1-0:72.7.15
9	3.te harmonic, current	1-0:31.7.3	1-0:51.7.3	1-0:71.7.3
10	5.te harmonic, current	1-0:31.7.5	1-0:51.7.5	1-0:71.7.5
11	7.te harmonic, current	1-0:31.7.7	1-0:51.7.7	1-0:71.7.7
12	9.te harmonic, current	1-0:31.7.9	1-0:51.7.9	1-0:71.7.9
13	11.te harmonic, current	1-0:31.7.11	1-0:51.7.11	1-0:71.7.11
13	13.te harmonic, current	1-0:31.7.13	1-0:51.7.13	1-0:71.7.13
14	15.te harmonic, current	1-0:31.7.15	1-0:51.7.15	1-0:71.7.15
15	THD, voltage	1-0:32.7.124	1-0:52.7.124	1-0:72.7.124
16	THD, current	1-0:31.7.124	1-0:51.7.124	1-0:71.7.124

Table 8: list of instantaneous PQ data with harmonics and THD

8.4 Average- / min- / max- interval data

8.4.1 Last average values

Below data are calculated as **average** value with below characteristic in a defined interval

- programmable interval (1..60min)
- default interval: 10min (measuring period 3)
- average value over the samples of the interval

		total	L1	L2	L3
1	active demand, +P	1-0:1.25.0.255	1-0:21.25.0.255	1-0:41.25.0.255	1-0:61.25.0.255
2	active demand, -P	1-0:2.25.0.255	1-0:22.25.0.255	1-0:42.25.0.255	1-0:62.25.0.255
3	reactive demand, +Q	1-0:3.25.0.255	1-0:23.25.0.255	1-0:43.25.0.255	1-0:63.25.0.255
4	reactive demand, -Q	1-0:4.25.0.255	1-0:24.25.0.255	1-0:44.25.0.255	1-0:64.25.0.255
5	apparent demand, +S	1-0:9.25.0.255	1-0:29.25.0.255	1-0:49.25.0.255	1-0:69.25.0.255
6	apparent demand, -S	1-0:10.25.0.255	1-0:30.25.0.255	1-0:50.25.0.255	1-0:70.25.0.255
7	Voltage		1-0:32.25.0.255	1-0:52.25.0.255	1-0:72.25.0.255
8	current		1-0:31.25.0.255	1-0:51.25.0.255	1-0:71.25.0.255
9	power factor, total	1-0:13.25.0.255	1-0:33.25.0.255	1-0:53.25.0.255	1-0:73.25.0.255
10	frequency in any phase	1-0:14.25.0.255			
11	THD, voltage		1-0:32.25.124	1-0:52.25.124	1-0:72.25.124
12	THD, current		1-0:31.25.124	1-0:51.25.124	1-0:71.25.124
13	3.te harmonic, voltage		1-0:32.25.3	1-0:52.25.3	1-0:72.25.3
14	5.te harmonic, voltage		1-0:32.25.5	1-0:52.25.5	1-0:72.25.5
15	7.te harmonic, voltage		1-0:32.25.7	1-0:52.25.7	1-0:72.25.7
16	9.te harmonic, voltage		1-0:32.25.9	1-0:52.25.9	1-0:72.25.9
17	11.te harmonic, voltage		1-0:32.25.11	1-0:52.25.11	1-0:72.25.11
18	13.te harmonic, voltage		1-0:32.25.13	1-0:52.25.13	1-0:72.25.13
19	15.te harmonic, voltage		1-0:32.25.15	1-0:52.25.15	1-0:72.25.15
20	3.te harmonic, current		1-0:31.25.3	1-0:51.25.3	1-0:71.25.3
21	5.te harmonic, current		1-0:31.25.5	1-0:51.25.5	1-0:71.25.5
22	7.te harmonic, current		1-0:31.25.7	1-0:51.25.7	1-0:71.25.7
23	9.te harmonic, current		1-0:31.25.9	1-0:51.25.9	1-0:71.25.9
24	11.te harmonic, current		1-0:31.25.11	1-0:51.25.11	1-0:71.25.11
25	13.te harmonic, current		1-0:31.25.13	1-0:51.25.13	1-0:71.25.13
26	15.te harmonic, current		1-0:31.25.15	1-0:51.25.15	1-0:71.25.15

Table 9: list of last average data

8.4.2 Last minimum values

Below data as **minimum** value with below characteristic in a defined interval

- programmable calculated interval (1..60min)
- default interval: 10min (measuring period 3)
- minimum value over the samples of the interval

		total	L1	L2	L3
1	active demand, +P	1-0:1.23.0.255	1-0:21.23.0.255	1-0:41.23.0.255	1-0:61.23.0.255
2	active demand, -P	1-0:2.23.0.255	1-0:22.23.0.255	1-0:42.23.0.255	1-0:62.23.0.255
3	reactive demand, +Q	1-0:3.23.0.255	1-0:23.23.0.255	1-0:43.23.0.255	1-0:63.23.0.255
4	reactive demand, -Q	1-0:4.23.0.255	1-0:24.23.0.255	1-0:44.23.0.255	1-0:64.23.0.255
5	apparent demand, +S	1-0:9.23.0.255	1-0:29.23.0.255	1-0:49.23.0.255	1-0:69.23.0.255
6	apparent demand, -S	1-0:10.23.0.255	1-0:30.23.0.255	1-0:50.23.0.255	1-0:70.23.0.255
7	Voltage		1-0:32.23.0.255	1-0:52.23.0.255	1-0:72.23.0.255
8	Current		1-0:31.23.0.255	1-0:51.23.0.255	1-0:71.23.0.255
9	power factor, total	1-0:13.23.0.255	1-0:33.23.0.255	1-0:53.23.0.255	1-0:73.23.0.255
10	frequency in any phase	1-0:14.23.0.255			

Table 10: list of last minimum data

8.4.3 Last maximum values

Below data are calculated as **maximum** value with below characteristic in a defined interval

- programmable interval (1..60min)
- default interval: 10min (measuring period 3)
- maximum value over the samples of the interval

		total	L1	L2	L3
1	active demand, +P	1-0:1.26.0.255	1-0:21.26.0.255	1-0:41.26.0.255	1-0:61.26.0.255
2	active demand, -P	1-0:2.26.0.255	1-0:22.26.0.255	1-0:42.26.0.255	1-0:62.26.0.255
3	reactive demand, +Q	1-0:3.26.0.255	1-0:23.26.0.255	1-0:43.26.0.255	1-0:63.26.0.255
4	reactive demand, -Q	1-0:4.26.0.255	1-0:24.26.0.255	1-0:44.26.0.255	1-0:64.26.0.255
5	apparent demand, +S	1-0:9.26.0.255	1-0:29.26.0.255	1-0:49.26.0.255	1-0:69.26.0.255
6	apparent demand, -S	1-0:10.26.0.255	1-0:30.26.0.255	1-0:50.26.0.255	1-0:70.26.0.255
7	Voltage		1-0:32.26.0.255	1-0:52.26.0.255	1-0:72.26.0.255
8	Current		1-0:31.26.0.255	1-0:51.26.0.255	1-0:71.26.0.255
9	power factor, total	1-0:13.26.0.255	1-0:33.26.0.255	1-0:53.26.0.255	1-0:73.26.0.255
10	frequency in any phase	1-0:14.26.0.255			

Table 11: list of last maximum data

8.5 Primary / Secondary measurement

The meter support the secondary as well as the primary measurement

8.5.1 Secondary measurement

The secondary measurement is **not** considering any CT or CT/VT ratio of the transformers installed upfront the meter.
The secondary measurement is valid for

- All energy register
- All demand register
- All PQ register like U, I, P, Q, …

8.5.2 Primary measurement

The primary measurement is considering the CT or CT/VT ratio of the transformers installed upfront the meter.
The primary measurement is valid for

- All energy register
- All demand register
- All PQ register like U, I, P, Q, …

Below parameters can be configured:

- CT ratio in the range of 1 ... 2000
- VT ratio in the range of 1 … 4000

Both parameters (CT and CT/VT ratio) can be displayed on the LCD as well as readable on optical and electrical interface

9 Meter registration

9.1 Meter identification

All identification numbers of the meter are based on the DLMS/COSEM model. According to the DLMS/COSEM requirements, each physical device in the system shall be uniquely identified. Each physical device is identified by following designations in the system:

- **System title**
  The 8 Bytes System Title is assigned to each physical device (meter, data, concentrator and head-end system) during manufacturing stage and based on manufacturer FLAG code, device type and product serial number.

- **Logical Device name**
  The 16 bytes Logical Device Name is another format of the system title. The Logical Device Name will be stored in "COSEM Logical DeviceName" COSEM object (0-0:42.0.0.255) during manufacturing stage.

- **Utility Device ID**
  Utility Device ID is specified during production. Utility Device ID has be at least 14 digits. The 8 rightmost for each type of device are unique (as product serial number). The leading (the 6 leftmost) is extra information including manufacturer ID (Defined by customer), device type and year of production respectively. The Utility Device ID will be printed on device body and will be stored in "Device ID7" COSEM object (1-0:0.0.0.255) during manufacturing stage.

9.1.1 System title

Each physical device in the system (meter, data concentrator and the Head-end system) can be uniquely identified by its "System Title". The "System Title" is defined as:

- length of 8 octets;
- the leading 3 octets are showing the three-letter manufacturer ID
- the 5 rightmost octets specifies device type and its serial number;

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5		Byte 6	Byte 7	Byte 8
MC	MC	MC	DT	FT	SN	SN	SN	SN

Table 12: System title structure

MC: Manufacturer ID

3 letters (for MCS301 meter: "MCS")

DT: Device type

001	1ph meter, BS type
003	3ph meter, direct connection
004	3ph meter, CT connection
005	3ph meter, CT/VT connection
……	

FT: Function type

Shows the supported functionality of the meter

Bit 3	Bit 2	Bit 1	Bit 0

Bit 0 = 1: disconnector
Bit 1 = 1: load management relay
Bit 2 = 1: multi utility meter (M-Bus interface)
Bit 3 = 1: reserved

Example: MCS301 CT connected meters with unique ID (MCS: 4D, 44, 53), (DT: 004) with load management relay and M-bus (FT: 06 equal to 0110) and serial number 12345678 (0x0BC614E) results in following system title (Hex coded):

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
4D	44	53	04	60	BC	61	4E

Table 13: Example of System title of MCS301, CT connected version

9.1.2 Logical Device Name

Each COSEM logical device is identified by its unique COSEM logical device name, defined as an octet-string of up to 16 octets (bytes). The first 3 octets carry the manufacturer identifier “MCS”.The logical device name structure is described in following figure.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
MC	MC	MC	DT	DT	DT	FT	FT

Byte 9	Byte 10	Byte 11	Byte 12	Byte 13	Byte 14	Byte 15	Byte 16
SN	SN	SN	SN	SN	SN	SN	SN

Table 14: Logical Device name structure

MC: Manufacturer ID (3 Bytes, ASCII format of MCS)
DT: Device Type, ASCII encoded
FT: Function Type, ASCII encoded
SNM: The last 8 digits of the manufacturer specific serial number ASCII encoded.

Example: The MCS301 CT connected meters with unique ID (MCS: 4D, 44, 53), (DT: 004) with load management relay and M-bus (FT: 06 equal to 0110) and serial number 12345678 (BC, 61, 4E) results in the following logical device name MCS0040612345678. The Hex coded of this logical device name is shown in below figure:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
4D	43	53	30	30	34	30	36

Byte 9	Byte 10	Byte 11	Byte 12	Byte 13	Byte 14	Byte 15	Byte 16
31	32	33	34	35	36	37	38

Table 15: Example of Logical Device name of MCS301, CT connected version

9.1.3 Utility Device ID

The different identifications of each device are presented as device ID. Each device may have different device IDs. Each device ID is stored in a dedicated COSEM object from interface class 1. The proposed device IDs are as following table

Device ID	Type	Description	COSEM object	Remark
Device ID 1	Octet string (8)	E-meter serial number (ASCII coded): production serial number	0-0:96.1.0.255	Stored during manufacturing
Device ID 2	Octet string (0-48)	E-meter identifier (ASCII) (optional text like meter type)	0-0:96.1.1.255	Stored during manufacturing
Device ID 3	Octet string (0-48)	Function location (ASCII) (optional text like utility name)	0-0:96.1.2.255	Stored during manufacturing
Device ID 4	Octet string (0-48)	Location information (ASCII coded): GPS Information	0-0:96.1.3.255	Stored during manufacturing
Device ID 5	Octet string (0-48)	General purpose (ASCII) like Consumer Unique Utility number	0-0:96.1.4.255	Stored during manufacturing
Device ID 6	Octet string (0-48)	IDIS or other certification number (ASCII)	0-0:96.1.5.255	Stored during manufacturing
Device ID 7	Octet string (14)	Manufacturer Code + Meter/Device type + Production Year + Serial Number	1-0:0.0.0.255	Stored during manufacturing

Table 12: list of different Device ID's

9.2 Meter registration using Data notification service

Independently of fixed or dynamic IP addressing, the IP address is typically provided to the HES via a Push on Connectivity operation issued by the meter. Logical registration at HES level is typically achieved by the valid system title of the meter provided by the Data-Notification service as defined by the Push setup.

After commissioning the meter sends its IP address and its system title to the HES using the Data-Notification service. The MCS301 meter provides a trigger (e.g. SMS, reset button) to invoke the push method of the corresponding push object. The execution of the push method results in a transmission of the Data-Notification message to the set IP address destination. If the "Push setup-On Installation" object is configured for SMS communication the Data-Notification message is sent by SMS to the set telephone number destination. After HES received information or data, it should acknowledge to the meter by sending consumer Message code "E_Instal " on LCD (0-0:96.13.1.255).

10 Tariff Management

The meter supports an activity calendar object. In this tariff scheme two different types can be defined:

- Active tariff scheme
- Passive tariff scheme

Furthermore the meter supports a configurable “default tariff rate”. This rate is used by the meter when the meter detects malfunctioning on its clock. When meter’s clock is not running properly, the energy values are accumulated in this default tariff rate and no other rates will be used.

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
- registering demand values in different tariffs
- Switching on/off bi-stable relay.

Graphical tariff program illustration can be seen on figure below.

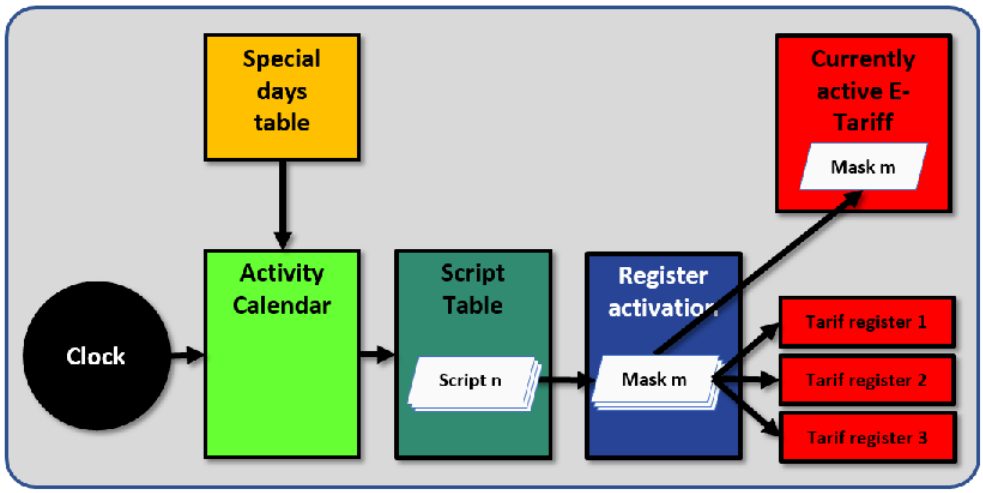


Figure 21: Tariff management

The TOU capabilities are:

- Up to 8 tariffs,
- Up to 12 seasons tariff programs,
- Up to 12 week tariff programs,
- Up to 12 day tariff programs,
- Up to 11 switching actions per day tariff program,
- Up 50 special day date definitions.

10.1 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 (energy and demand rate control).

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

- Calendar name,
- Season profile (up to 12 season)
- Week profile table (up to 12 week types)
- Day profile table (up to 12 day profiles)

10.2 Special day table

The 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 the date on which the special day is used. The “Day_id” is the reference to one day definition in day profile table of the 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.

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

10.3 Register activation

With this object registers it is determined which values should be recorded and stored. The 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

- 12 energy types (A+, A-, /+A/+/-A/, /+A/-/-A/, R+, R-, R1, ... R4, +S, -S …), 8 tariff registers each
- 7 demand types (+P, -P, /+P/+/-P/, +Q, -Q, +S, -S), 4 tariff registers each.

10.4 Real time clock

10.4.1 General characteristics of the real time clock

The real-time clock of the MCS301 has the following characteristics:

- The time basis is derived from the internal oscillator with an accuracy of <5ppm
- The energy for the running reserve is supplied by an internal battery (about 10 years backup time).
- After the running reserve has been exhausted, the device clock will start after power up with the time and date information of the last power outage. An appropriate error message will be created.
- The real-time clock supplies the time stamp for all events inside the meter, such as time stamp for maximum measurement, time stamp for voltage interruptions, etc.
- If the real-time clock stops running the meter can be set to a predefined tariff.

10.4.2 Battery backup

10.4.2.1 Internal battery

To keep the RTC of the meter running the MCS301 can is equipped with an onboard, soldered battery, which is located on the PCB under the main cover of the meter.

The features of the battery are:

- Nominal voltage /capacity 3,0V / 0,23Ah
- Life time: >10 years (normal conditions)
- Back up time for RTC: >10 years (normal conditions)

10.4.2.2 External battery

As a further option the meter can be equipped with an external, replaceable battery which is located on the right end of the terminal block. With this external battery the RTC running and readout without power feature works as listed below:

- internal supercap: keeps RTC running during power outage: about 2 days
- internal battery: keeps RTC running during power outage: >2 days (up to 10 years)
- external battery: support of readout without power, keeps RTC running in case the supercap and the internal battery is empty.

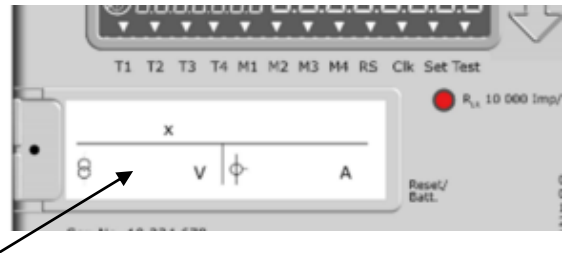


Figure 142: Location of the exchangeable battery

The battery is placed under the sealed cover, which allows the access to the demand reset push button as well as the CT/VT label.

10.5 Time & date handling

2 different time base are supported (configurable)

- Gregorian calendar
- Iranian calendar

10.6 DST time change

The meter supports below DST configurations:

- **None – DST change**

- **EU standard – DST change**
  The date, at which the clock is set forward from 02:00 to 03:00 (summer time) resp. at which it is put back from 03:00 to 02:00 (winter time) is done according to EU standards at Sunday after the 84th resp. the 298th of the year

- **User defined standard – DST change**
  The date, at which the clock is set forward from 02:00 to 03:00 (summer time) resp. at which it is put back from 03:00 to 02:00 (winter time) is done according a predefined table.
  Furthermore the time of the DST change is configurable too.

11 End of billing / Demand reset

11.1 End of billing sources

The end of billing sources (maximum demand calculation) is configurable:

- demand reset button and/or
- internal RTC
  - selectable day of the month (first day of the month)
  - time of the day (standard 00:00), configurable
- after a season change and/or
- command through optical interface and/or
- command through electrical interface
- During this predefined interval a demand reset is not accepted twice

11.2 General behavior

The general behavior of the meter after a demand reset is described below:

- Configurable interval (1 .. 60min), independent from load profile 1 period
- power outage over monthly border => automatic creation of historical data after power up
- at the end of the billing period, all maximum demand register are stored as historical data with time & date stamp; the current demand register are reset to 0
- A demand reset by pressing the reset button can be performed in the scroll mode or the alternate mode ([A]-mode).
- At every demand reset, a reset disable is activated, i.e. the a symbol in the display will flash). The demand reset disable time is configurable.

	Disable times for a new demand reset by triggering a reset through...	1	2	3	4	5
1	... button	t_1	0	0	0	0
2	... interfaces (optical, electrical)	0	t_1	0	0	0
3	... external control	0	0	t_1	t_1	t_1
4	... internal device clock	0	0	t_1	t_1	t_1

- A demand reset executed through an appropriate control input is operative only if the demand reset disable time is not active.
- The demand reset disable is cancelled by an all-pole power failure.
- The demand reset counting mechanism can run either from 0..99

11.3 End of billing profile register (historical data)

The characteristic of the end of billing data (historical data) measurement is:

- After a demand reset all historical data will be stored as a profile
- Up to 15 set of historical data can be created
- The maximum demand data are stored including time&date information
- Up to 40 different configurable values can be stored as historical data
- Below data can be selected as historical data:

	Energy register	total	Tariff 1	…	Tariff 8
1	active energy, +A	1-0:1.8.0.255	1-0:1.8.1.255		1-0:1.8.8.255
2	active energy, -A	1-0:2.8.0.255	1-0:2.8.1.255		1-0:2.8.8.255
3	reactive energy, +R	1-0:3.8.0.255	1-0:3.8.1.255		1-0:3.8.8.255
4	reactive energy, -R	1-0:4.8.0.255	1-0:4.8.1.255		1-0:4.8.8.255
5	reactive energy, R1	1-0:5.8.0.255	1-0:5.8.1.255		1-0:5.8.8.255
6	reactive energy, R2	1-0:6.8.0.255	1-0:6.8.1.255		1-0:6.8.8.255
7	reactive energy, R3	1-0:7.8.0.255	1-0:7.8.1.255		1-0:7.8.8.255
8	reactive energy, R4	1-0:8.8.0.255	1-0:8.8.1.255		1-0:8.8.8.255
9	apparent energy, +S	1-0:9.8.0.255	1-0:9.8.1.255		1-0:9.8.8.255
10	apparent energy, -S	1-0:10.8.0.255	1-0:10.8.1.255		1-0:10.8.8.255
11	active energy, /+A/ + /-A/	1-0:15.8.0.255	1-0:15.8.1.255		1-0:15.8.8.255
12	active energy, /+A/ - /-A/	1-0:16.8.0.255	1-0:16.8.1.255		1-0:16.8.8.255
13	iron losses, +U*U*h	1-0:83.8.4.255			
14	copper losses, +I*I*h	1-0:83.8.1.255			
15	iron losses, -U*U*h	1-0:83.8.5.255			
16	Copper losses, -I*I*h	1-0:83.8.2.255			

Table 13: list of end of billing data – energy register

	Demand register	total	Tariff 1	…	Tariff 4
1	active demand, +P	1-0:1.6.0.255	1-0:1.6.1.255		1-0:1.6.4.255
2	Active demand, -P	1-0:2.6.0.255	1-0:2.6.1.255		1-0:2.6.4.255
3	reactive demand, +Q	1-0:3.6.0.255	1-0:3.6.1.255		1-0:3.6.4.255
4	Reactive demand, -Q	1-0:4.6.0.255	1-0:4.6.1.255		1-0:4.6.4.255
5	apparent demand, +S	1-0:9.6.0.255	1-0:4.9.1.255		1-0:4.9.4.255
6	apparent demand, -S	1-0:10.6.0.255	1-0:4.10.1.255		1-0:4.10.4.255
7	Active demand, /+P/ + /-P/	1-0:15.6.0.255	1-0:15.6.1.255		1-0:15.6.4.255

Table 134: list of end of billing data – demand register

	M-Bus values	total
1	Instance, channel 1	0-1:24.2.1.255
2	Instance, channel 2	0-2:24.2.1.255
3	Instance, channel 3	0-3:24.2.1.255
4	Instance, channel 4	0-4:24.2.1.255

Table 15: list of end of billing data – M-Bus register

12 Data Model and protocol

12.1 Data model

Below data model and identification system are supported from the meter

- **Identification system**
  The MCS301 meter is using the OBIS identification system according EN 62056-61

- **Data model**
  Below data model are supported
  - IDIS package 2 and 3
  - More details are described in MetCom object list

12.2 Protocol

The meter support different option for communication, which are configurable by the user

12.2.1 DLMS protocol only

In this application the meter is using **only** the DLMS protocol for communication according the Green book V8.1 and blue book V12.1.
In that mode all reading and writing procedures are done by the DLMS protocol. No Mode E command is supported.

Remark: The starting baud rate on the optical interface is 9600 Baud

12.2.2 EN62056-21 and DLMS protocol

In that configuration 2 different reading possibilities exist:

- **Direct communication to the meter using the EN62056-21 protocol:**
  - Reading data using the Mode C command
  - Reading of load profile data using the R5 command
  - Reading of log file data using the R5 command
  - Reset load profile
  - Reset log file
  - Set time/date
  - Demand reset

- **DLMS communication by using the Mode E sequence of the EN62056-21 protocol.**

  The protocol stack as described in IEC 62056-42, IEC 62056-46 and IEC 62056-53 is used. The switch to the baud rate "Z" shall be at the same place as for protocol mode "C". The switch confirm message, which has the same structure as the acknowledgement/option select message, is therefore at the new baud rate, but still with parity (7E1). After the acknowledgement, the binary mode (8N1) will be established. The starting baud rate is 300 Baud.

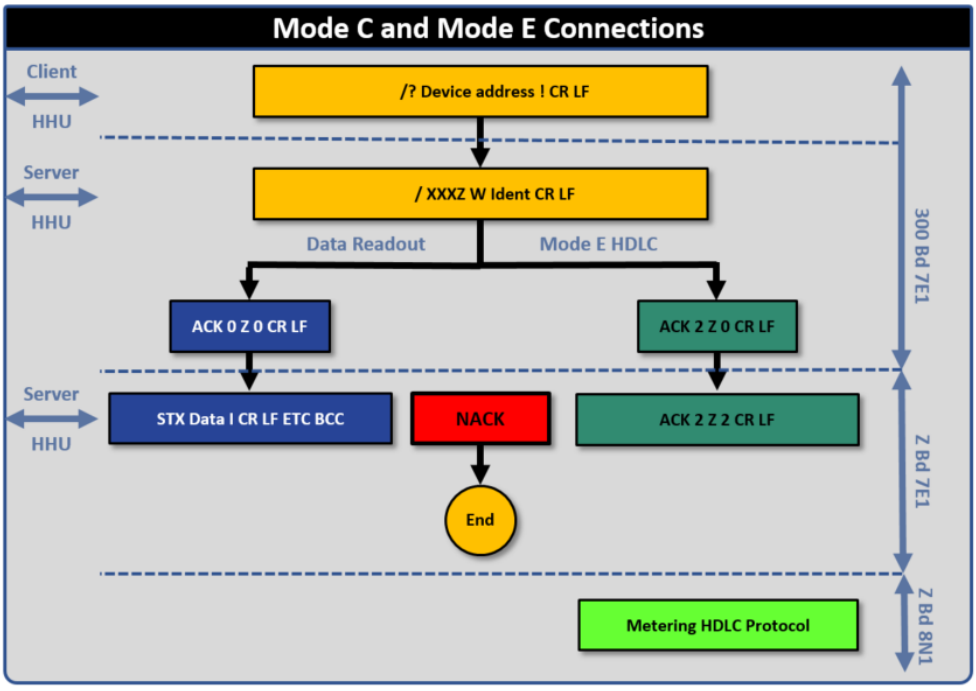


Figure 15: Entering protocol mode E (HDLC)

13 Load profile

Load profile captures and stores several parameters (defined as channels), at specified time intervals. In case of changing any of the capture objects or time interval (capture period) of the load profile, the load profile is reset. The following types of profiles are provided:

- Load Profile 1 (e.g. 1h or 15min load profile) (1-0:99.1.0.255);
- Load Profile 2 (e.g. daily load profile) (1-0:99.2.0.255);
- Average Values Profile (1-0:99.133.0.255);
- Max. Values Profile (1-0:99.134.0.255);
- Min. Values Profile (1-0:99.135.0.255);
- Harmonics Profile (1-0:99.136.0.255);
- M-Bus Load Profile Channel 1 (Water meter) (0-1:24.3.0.255);
- M-Bus Load Profile Channel 2 (Gas meter) (0-2:24.3.0.255);
- M-Bus Load Profile Channel 3 (Reserved) (0-3:24.3.0.255);
- M-Bus Load Profile Channel 4 (Irrigation meter) (0-4:24.3.0.255);

Two additional **readout profiles** with up to 42 entries for instantaneous values of energy and power quality at the reading time are supported through the reading client.

- Energy Instantaneous Values (7, 0-0:21.0.6.255);
- Power Quality Instantaneous Values (7, 0-0:21.0.5.255);

13.1 General profile Structure

All Load Profiles have the same structure. The different values (register) can be stored by each Load Profile COSEM object including capture time (as timestamp) and their status (Profile Status of relevant profile object). The status shows the situation of critical events during capturing of values.

Time Stamp	Status	Channel 1	Channel 2	….	Channel n
2016-12-15, 00:15:00	08	1234567	4561	….	981234
2016-12-15, 00:30:00	08	1234588	4563	….	981301
2016-12-15, 00:40:00	08	1234592	4566	….	981387

13.1.1 Sort method

The buffer may be defined as sorted by one of the capture objects (values e.g. the clock). For all profile generic objects, the FIFO method is used. In case of changing sorting method, the load profile will be reset.

13.1.2 Buffer reading

The reading of the buffer can be done by two different methods as follows:

- Normal Reading;
- Compressed Reading;

In **“Normal Reading”**, all buffer entries within the “From/To” range (Time-based selective access by Range) including the values at the boundaries of range, will be returned.

In “**Compressed Reading”**, the compressed method introduced in IDIS Package 2 is used and offers 3 possibilities

- (01b) – No Compression,
- (10b) – Partial Compression (entries with midnight timestamp are not compressed)
- (11b) – Total Compression

13.1.3 Profile Status

The Profile Status provides complementary information about the stored values in profiles buffer. The HES/MDM system will use this information to decide about the validity of collected values. The content of Profile Status is captured for every entry (in buffer). The size of the Profile Status is one byte. Each bit shows a critical situation in the meter as shown in following figures for different profile status.

Bit	Flag	description
7	PDN	**Power down**: This bit is set to indicate that a total power outage has been detected during the affected capture period.
6	RSV	**Reserved**: The reserved bit is always set to 0.
5	CAD	**Clock adjusted**: The bit is set when the clock has been adjusted by more than the synchronization limit
4	RSV	**Reserved**: The reserved bit is always set to 0.
3	DST	**Daylight saving**: Indicates whether or not the daylight saving time is currently active. The bit is set if the daylight saving time is active (summer) and cleared during normal time (winter).
2	DNV	**Data not valid**: Indicates that the current entry may not be used for billing purposes without further validation because a special event has occurred
1	CIV	**Clock invalid:** The power reserve of the calendar clock has been exhausted. The time is declared as invalid. At the same time the DNV bit is set.
0	ERR	**Critical error**: A serious error such as a hardware failure or a checksum error has occurred. If the ERR bit is set then also the DNV bit is set.

Table 146: Profile status Bits

13.1.4 Effect of events on load profiles

The following section describes the behavior of the profile and the setting of status bits considering different events.

- **Season Change**

  The activation or deactivation of the daylight saving time does not create any additional entries in the buffer. The timestamp together with the DST bit contains enough information to clearly identify when the season change occurred and if the buffer data was captured when daylight saving time was active or not.

- **Power Down**

  The following section describes the behavior of the profile and the setting of the status bits considering different power down events. A “Power Down” event starts with the complete loss of power in all connected phases and ends with the restoration of the power in at least one of the connected phases.

  - **Power Down within one capture period**
    The Power Down event affects only one specific capture period. The affected capture period will be marked with Power Down (PDN) bit in the profile status at the end of the capturing period.

    Example: a power down event (from 15:17 to 15:21) within the capture period of 15:15 to 15:30. The entry at 15:30, marked with the PDN flag. Since a power down doesn't affect the validity of billing data, the DNV flag is not set.

Date/time	Status Bits				Register value
	PDN	CAD	DNV	CIV	
2017-02-04, 15:00:00	0	0	0	0	110,2kW
2017-02-04, 15:15:00	1	0	0	0	123,4kW
2017-02-04, 15:30:00	1	0	0	0	146,4kW
2017-02-04, 15:45:00	0	0	0	0	153,4kW

Table 17: power failure during capture period (outage from 15:17 to 15:21)

  - **Power Down across several capture periods**
    Table 18 show a power down event (from 01:17 to 04:21) affecting all capture periods between 01:15 and 04:15. For the capturing periods which completely fall into the power down event no entry is registered in the load profile buffer.

Date/time	Status Bits				Register value
	PDN	CAD	DNV	CIV	
2017-02-04, 01:15:00	0	0	0	0	110,2kW
2017-02-04, 01:30:00	1	0	0	0	123,4kW
2017-02-04, 04:30:00	1	0	0	0	146,4kW
2017-02-04, 04:45:00	0	0	0	0	153,4kW

Table 18: power failure during capture period (outage from 01:17 to 04:21)

- **Exhaust of power reserve**

  Table 19 shows the situation when a long power down event leads to a discharged power reserve and therefore to an invalid clock. The power down event starts on 12.08.2016 at 21:16 and ends on 30.08.2016 at 08:43. The power-down is too long to keep the real time clock running with the supercap, the power reserve is exhausted. After power up (30.08. at 08:43), profile entries continue with the time set to the first capture time after the power down (12.08. at 21:30) – with the PDN=1, DNV=1 and CIV=1. Capturing continues using the invalid clock and keeping CIV=1 and DNV=1 until the clock is set.

Date/Time	**Internal Clock**
…	….
30.08. 08:45	12.08. 21:30
30.08. 09:00	12.08. 21:45
30.08. 09:15	12.08. 22:00
30.08. 09:30	13.08. 22:15
….	….

  Assuming 3 hours and 50 min after power up the clock is set to 30.8.2016, 12:35, the next regular entry will take place at 30.8.2016 at 12:45. Since the entry does not represent a full capture period the CAD flag will be set to 1.

Date/Time	**Internal Clock**
…	…
30.08. 12:35	30.08. / 12:35
30.08. 12:45	30.08. / 12:45
…	…

  The entry at 13.8.2016, 22:30 is stored as if time was advanced over the end of the next period i.e. CAD and DNV are set to 1. Additionally due to the fact power reserve is exhausted also CIV is set to 1.

Date/time	**Status Bits**				**Register value**
	PDN	**CAD**	**DNV**	**CIV**	
2016-08-12, 21:15:00	0	0	0	0	110,2kW
2016-08-12, 21:30:00	1	0	1	1	123,4kW
2016-08-12, 21:45:00	0	0	1	1	146,2kW
2016-08-12, 22:00:00	0	0	1	1	172,1kW
2016-08-12, 22:15:00	0	0	1	1	176,3kW
2016-08-12, 22:30:00	0	1	1	1	181,9kW
2016-08-30, 12:45:00	0	1	0	0	182,2kW
2016-08-30, 13:00:00	0	0	0	0	187,3kW

Table 19: Exhaust of power reserve – late clock adjustment

If the time adjustment occurs before the end of the 1st capture period after a power-up, the generated entries are additionally marked with the PDN flag.

Remark: due to the exhaust of the power reserve the internal clock stops running and looses its time. At the time of the power up the clock restarts. At the next capture time (12.08, 21:30) the CIV bit is set to 1.

In the example of Table 20 the clock is set to 30.8.2016, 08:45 just after power-up (12.08.2016, 21:15). Therefore the entry at 12.08.2008, 22:00 is closed and marked with PDN set to 1 due to the fact power down was detected in this period (at 21:15), CIV and DNV set to 1 since the clock is - due to exhaust of power reserve - not running correctly. In addition the CAD is set to 1 since shortly after the power up the time was adjusted. At the next capture time (30.08., 09:00) the incomplete registration period is marked with PDN=0, CAD=1, DNV=0, CIV=0.

Date/time	Status Bits				Register value
	PDN	CAD	DNV	CIV	
2016-08-12, 21:15:00	0	0	0	0	110,2kW
2016-08-12, 21:30:00	1	1	1	1	123,4kW
2016-08-30, 12:45:00	0	1	0	0	146,2kW
2016-08-30, 13:00:00	0	0	0	0	172,1kW
2016-08-30, 13:15:00	0	0	0	0	176,3kW

Tabelle 20: Exhaust of power reserve – immediate clock adjustment

- **Setting time**

  Clock adjustment larger than a defined synchronization limit is recorded in the event profile and the affected entries in the load profile are marked with the CAD flag.

  - **Time changes within capture period**

    Table 21 show a clock adjustment from 21:16 to 21:20. The entry at 21:30:00 will be marked with the CAD flag.

Date/time	Status Bits				Register value
	PDN	CAD	DNV	CIV	
2017-02-04, 21:15:00	0	0	0	0	110,2kW
2017-02-04, 21:30:00	0	1	0	0	123,4kW
2017-02-04, 21:45:00	0	0	0	0	153,4kW

Table 21: Time change within capture period

Any clock adjustment (forward or backwards) within the capture period is marked in this way. If the clock adjustment is smaller than the synchronization limit (depending on parameter setting) no entry is recorded.

  - **Advancing the time set over the end of the period**

    Table 22 show a clock adjustment from 21:16 to 21:36. At 21:30 an entry is generated with the CAD flag set since the period was not closed correctly. The entry at 21:45:00 is be marked with the CAD flag.

Date/time	Status Bits				Register value
	PDN	CAD	DNV	CIV	
2017-02-04, 21:15:00	0	0	0	0	110,2kW
2017-02-04, 21:30:00	0	1	0	0	123,4kW
2017-02-04, 21:45:00	0	1	0	0	153,4kW
2017-02-04, 22:0000	0	0	0	0	156,9kW

Table 22: Advancing the time over the end of the period

  - **Advancing the time over several periods**

    Table 23 show a clock adjustment from 21:16 to 22:06. All generated intermediate values are marked with the CAD flag.

Date/time	Status Bits				Register value
	PDN	CAD	DNV	CIV	
2017-02-04, 21:15:00	0	0	0	0	110,2kW
2017-02-04, 21:30:00	0	1	0	0	123,4kW
2017-02-04, 22:15:00	0	1	0	0	153,4kW
2017-02-04, 22:30:00	0	0	0	0	159,6kW
2017-02-04, 22:45:00	0	0	0	0	162,9kW

Table 23: Advancing the time over several periods

- **Setting the time back - unsorted**

  In case of an unsorted profile all profile entries remain in the buffer, which will lead to duplicated entries. Table 24 shows a profile before and after (Table 25) a time change backwards from 21:16 to 20:42.

  a) Before the change

Date/time	Status Bits				Register value
	PDN	CAD	DNV	CIV	
2017-02-04, 20:15:00	0	0	0	0	110,2kW
2017-02-04, 20:30:00	0	0	0	0	123,4kW
2017-02-04, 20:45:00	0	0	0	0	153,4kW
2017-02-04, 21:00:00	0	0	0	0	156,6kW
2017-02-04, 21:15:00	0	0	0	0	161,9kW
2017-02-04, 21:30:00	0	0	0	0	163,9kW

Table 24: Profile before setting the time back

  b) After the change backwards to 20:42

  All entries between 20:45 and 21:30 are remaining in the buffer after the time change. The next regular entry is marked with the CAD flag.

Date/time	Status Bits				Register value
	PDN	CAD	DNV	CIV	
2017-02-04, 20:30:00	0	0	0	0	123,4kW
2017-02-04, 20:45:00	0	1	0	0	153,4kW
2017-02-04, 21:00:00	0	0	0	0	156,6kW
2017-02-04, 21:15:00	0	0	0	0	161,9kW
2017-02-04, 21:30:00	0	0	0	0	163,9kW
2017-02-04, 21:45:00	0	1	0	0	171,2kW
2017-02-04, 20:45:00	0	1	0	0	173,3kW

Table 25: Profile after setting the time back

Note: there are 2 entries with the same date & time, but different register values

- **Profile reset**

  If the reset method is executed explicitly or implicitly (as a consequence of a modify-cation in the data structure of the profile, comp DLMS UA 1000-1 Ed. 12.0. the first entry after the reset will contain a valid registration period (considering the modified data structure, if the reset was the consequence of a modification).

  Table 26 shows the first entry after a reset at 15:45:35.

Date/time	Status Bits				Register value
	PDN	CAD	DNV	CIV	
2017-02-04, 16:00:00	0	0	0	0	110,2kW

Table 26: Profile reset

13.1.5 Capture Period

The captured period is controlled by the internal clock and it is synchronized with the internal time, starting always on the full hour (e.g. capture periods of 15 minutes starting at 10:00, 10:15, 10:30,10:45, 11:00, 11:15 etc.).
The capture period can be selected between 0, 60, 300, 600, 900, 1800, 3600 or 86400 seconds. If the capture period is set to 0 then the regular capturing is stopped and an external source (e.g. communication, script table, MDI reset) must be used to trigger the capturing of profile entries. The capture period of 86400s is a special case, where all values are captured once per day at midnight.

Example 1:

Profile	Description	Number of channels	Capture time example	Storing time
Load profile 1	Energy values or	5	15min	190 days
	Energy values	12	15min	92 days
Load profile 2	Daily billing data	36	24h	215 days
Avg. Profile	Power Quality	14	10min	31 days
Min. Profile	Power Quality	14	10min	31 days
Max. Profile	Power Quality	14	10min	31 days
Harmonic Profile	Power Quality	42	10min	31 days
M-Bus 1	Water meter, …	4	24h	62 days
M-Bus 2	Gas meter, …	4	24h	62 days
M-Bus 3	Reserved meter, …	4	24h	62 days
M-Bus 4	Irrigation meter, …	4	24h	62 days

Readout only Profile	Description	Number of channels	Capture time example	Storing time
Readout profile 1	Instantaneous Energy values	50	n.a.	n.a.
Readout profile 2	Instantaneous Power Quality values	50	n.a.	n.a.

Table 15: list of load profile channels

13.2 Load profile 1 – standard profile

The load profile 1 should have below characteristic:

- configurable interval, **period 1**: 1 … 60min
- default interval: 15min
- number of channels: 12
- Max. number of days per channel: 92 (15min, 12 channels)

  remark: in case the number of channels is less than 12 the size for the remaining channels increases accordingly
- storage mode per interval
  - demand values
  - index values

	Selectable energy quantity	OBIS code
1	active energy, +A	1-0:1.8.0.255
2	active energy, -A	1-0:2.8.0.255
3	reactive energy, +R	1-0:3.8.0.255
4	reactive energy, -R	1-0:4.8.0.255
5	reactive energy, R1	1-0:5.8.0.255
6	reactive energy, R2	1-0:6.8.0.255
7	reactive energy, R3	1-0:7.8.0.255
8	reactive energy, R4	1-0:8.8.0.255
9	apparent energy, +S	1-0:9.8.0.255
10	apparent energy, -S	1-0:10.8.0.255
11	iron losses, +U*U*h	1-0:83.8.4.255
12	copper losses, +I*I*h	1-0:83.8.1.255
13	iron losses, -U*U*h	1-0:83.8.5.255
14	cupper losses, -I*I*h	1-0:83.8.2.255
15	active energy, /+A/ + /-A/	1-0:15.8.0.255
16	active energy, /+A/ - /-A/	1-0:16.8.0.255

Table 28: load profile 1 data – billing data

13.3 Load profile 2 – daily profile

The load profile 2 has below characteristic:

- configurable interval, **period 2**: 1 … 60min, 24h
- default interval: 24h
- Max number of channels: 42
- Max. number of days per channel: 180 (24h, 42 channels)

  remark: in case the number of channels is less than 42 the size for the remaining channels is increased
- storage mode per interval
  - demand values
  - index values
- all energy data can be stored as **tariff register** as well

	Selectable quantity	**OBIS code**
1	Clock	1.0.0
2	active energy, +A	1-0:1.8.x.255
3	active energy, -A	1-0:2.8.x.255
4	reactive energy, +R	1-0:3.8.x.255
5	reactive energy, -R	1-0:4.8.x.255
6	reactive energy, R1	1-0:5.8.x.255
7	reactive energy, R2	1-0:6.8.x.255
8	reactive energy, R3	1-0:7.8.x.255
9	reactive energy, R4	1-0:8.8.x.255
10	apparent energy, +S	1-0:9.8.x.255
11	apparent energy, -S	1-0:10.8.x.255
12	iron losses, +U*U*h	1-0:83.8.4.255
13	copper losses, +I*I*h	1-0:83.8.1.255
14	iron losses, -U*U*h	1-0:83.8.5.255
15	copper losses, -I*I*h	1-0:83.8.2.255
16	active energy, /+A/ + /-A/	1-0:15.8.x.255
17	active energy, /+A/ - /-A/	1-0:16.8.x.255
18	Max. demand, /+A/ + /-A/	1-0:15.54.0.255
19	Time stamp of max. demand, /+A/ + /-A/	1-0:15.54.0.255
20	Max. demand, /+A/	1-0:1.54.0.255
21	Time stamp of max. demand, /+A/	1-0:1.54.0.255
22	Error register	0-0:97.97.1.255
23	Alarm register 1	0-0:97.98.0.255
24	Alarm register 2	0-0:97.98.1.255

Table 29: load profile 2 data – daily profile (x=0 … 8 max)

13.4 Load profile 3 – average profile

The load profile 3 should have below characteristic:

- configurable interval, **period 3**: 1 … 60min
- default interval: 10min
- Max. number of channels: 14
- Max. number of days per channel: 31 (10min, 14 channels)

  remark: in case the number of channels is less than 14 the size for the remaining channels is increased

Average Values Profile (1-0:99.133.0.255)

channel	Quantity	OBIS code
1	Last Average Value of Voltage L1	1-0:32.25.0.255
2	Last Average Value of Voltage L2	1-0:52.25.0.255
3	Last Average Value of Voltage L3	1-0:72.25.0.255
4	Last Average Value of current L1	1-0:31.25.0.255
5	Last Average Value of current L2	1-0:51.25.0.255
6	Last Average Value of current L3	1-0:71.25.0.255
7	Last Average Value of total power factor	1-0:13.25.0.255
8	Last Average Value of power factor L1	1-0:33.25.0.255
9	Last Average Value of power factor L2	1-0:53.25.0.255
10	Last Average Value of power factor L3	1-0:73.25.0.255
11	Last Average Value of active demand, +P	1-0:1.25.0.255
12	Last Average Value of active demand, -P	1-0:2.25.0.255
13	Last Average Value of reactive demand, +Q	1-0:3.25.0.255
14	Last Average Value of reactive demand, -Q	1-0:4.25.0.255

Table 30: load profile 3 – average data

13.5 Load profile 4 – maximum profile

The load profile 3 should have below characteristic:

- configurable interval, **period 3**: 1 … 60min
- default interval: 10min
- Max. number of channels: 14
- Max. number of days per channel: 31 (10min, 14 channels)

  remark: in case the number of channels is less than 14 the size for the remaining channels is increased

Maximum Values Profile (7,1-0:99.134.0.255)

channel	Quantity	OBIS code
1	Last maximum Value of Voltage L1	1-0:32.26.0.255
2	Last maximum Value of Voltage L2	1-0:52.2260.255
3	Last maximum Value of Voltage L3	1-0:72.26.0.255
4	Last maximum Value of current L1	1-0:31.26.0.255
5	Last maximum Value of current L2	1-0:51.26.0.255
6	Last maximum Value of current L3	1-0:71.26.0.255
7	Last maximum Value of total power factor	1-0:13.26.0.255
8	Last maximum Value of power factor L1	1-0:33.26.0.255
9	Last maximum Value of power factor L2	1-0:53.26.0.255
10	Last maximum Value of power factor L3	1-0:73.26.0.255
11	Last maximum Value of active demand, +P	1-0:1.26.0.255
12	Last maximum Value of active demand, -P	1-0:2.26.0.255
13	Last maximum Value of reactive demand, +Q	1-0:3.26.0.255
14	Last maximum Value of reactive demand, -Q	1-0:4.26.0.255

Table 31: load profile 4 – maximum data

13.6 Load profile 5 – minimum profile

The load profile 3 should have below characteristic:

- configurable interval, **period 3**: 1 … 60min
- default interval: 10min
- Max. number of channels: 14
- Max. number of days per channel: 31 (10min, 14 channels)

  remark: in case the number of channels is less than 14 the size for the remaining channels is increased

Minimum Values Profile (1-0:99.135.0.255)

channel	Quantity	OBIS code
1	Last minimum Value of Voltage L1	1-0:32.23.0.255
2	Last minimum Value of Voltage L2	1-0:52.23.0.255
3	Last minimum Value of Voltage L3	1-0:72.23.0.255
4	Last minimum Value of current L1	1-0:31.23.0.255
5	Last minimum Value of current L2	1-0:51.23.0.255
6	Last minimum Value of current L3	1-0:71.23.0.255
7	Last minimum Value of total power factor	1-0:13.23.0.255
8	Last minimum Value of power factor L1	1-0:33.23.0.255
9	Last minimum Value of power factor L2	1-0:53.23.0.255
10	Last minimum Value of power factor L3	1-0:73.23.0.255
11	Last minimum Value of active demand, +P	1-0:1.23.0.255
12	Last minimum Value of active demand, -P	1-0:2.23.0.255
13	Last minimum Value of reactive demand, +Q	1-0:3.23.0.255
14	Last minimum Value of reactive demand, -Q	1-0:4.23.0.255

Table32: load profile 5 – minimum data

13.7 Load profile 6 – harmonics and THD values

The load profile 6 should have below characteristic:

- configurable interval, **period 3**: 1 … 60min
- default interval: 10min
- Configurable number of quantities, up to 15th harmonic
- Max. number of channels: 42
- Max. number of days per channel: 31 (10min, 42 channels)

  remark: in case the number of channels is less than 42 the size for the other channels is increased

Harmonic Values Profile (1-0:99.136.0.255)

channel	Quantity	OBIS code
1	Last Average Value of 3th harmonic, Voltage, L1	1-0:32.25.3.255
2	Last Average Value of 3th harmonic, Voltage, L2	1-0:52.25.3.255
3	Last Average Value of 3th harmonic, Voltage, L3	1-0:72.25.3.255
4	Last Average Value of 5th harmonic, Voltage, L1	1-0:32.25.5.255
5	Last Average Value of 5th harmonic, Voltage, L2	1-0:52.25.5.255
6	Last Average Value of 5th harmonic, Voltage, L3	1-0:72.25.5.255
7	Last Average Value of 7th harmonic, Voltage, L1	1-0:32.25.7.255
8	Last Average Value of 7th harmonic, Voltage, L2	1-0:52.25.7.255
9	Last Average Value of 7th harmonic, Voltage, L3	1-0:72.25.7.255
10	Last Average Value of 9th harmonic, Voltage, L1	1-0:32.25.9.255
11	Last Average Value of 9th harmonic, Voltage, L2	1-0:52.25.9.255
12	Last Average Value of 9th harmonic, Voltage, L3	1-0:72.25.9.255
13	Last Average Value of 11th harmonic, Voltage, L1	1-0:32.25.11.255
14	Last Average Value of 11th harmonic, Voltage, L2	1-0:52.25.11.255
15	Last Average Value of 11th harmonic, Voltage, L3	1-0:72.25.11.255
16	Last Average Value of 13th harmonic, Voltage, L1	1-0:32.25.13.255
17	Last Average Value of 13th harmonic, Voltage, L2	1-0:52.25.13.255
18	Last Average Value of 13th harmonic, Voltage, L3	1-0:72.25.13.255
19	Last Average Value of THD, Voltage, L1	1-0:32.25.124.255
20	Last Average Value of THD, Voltage, L2	1-0:52.25.124.255
21	Last Average Value of THD, Voltage, L3	1-0:72.25.124.255

channel	Quantity	OBIS code
22	Last Average Value of 3th harmonic, current, L1	1-0:31.25.3.255
23	Last Average Value of 3th harmonic, current, L2	1-0:51.25.3.255
24	Last Average Value of 3th harmonic, current, L3	1-0:71.25.3.255
25	Last Average Value of 5th harmonic, current, L1	1-0:31.25.5.255
26	Last Average Value of 5th harmonic, current, L2	1-0:51.25.5.255
27	Last Average Value of 5th harmonic, current, L3	1-0:71.25.5.255
28	Last Average Value of 7th harmonic, current, L1	1-0:31.25.7.255
29	Last Average Value of 7th harmonic, current, L2	1-0:51.25.7.255
30	Last Average Value of 7th harmonic, current, L3	1-0:71.25.7.255
31	Last Average Value of 9th harmonic, current, L1	1-0:31.25.9.255
32	Last Average Value of 9th harmonic, current, L2	1-0:51.25.9.255
33	Last Average Value of 9th harmonic, current, L3	1-0:71.25.9.255
34	Last Average Value of 11th harmonic, current, L1	1-0:31.25.11.255
35	Last Average Value of 11th harmonic, current, L2	1-0:51.25.11.255
36	Last Average Value of 11th harmonic, current, L3	1-0:71.25.11.255
37	Last Average Value of 13th harmonic, current, L1	1-0:31.25.13.255
38	Last Average Value of 13th harmonic, current, L2	1-0:51.25.13.255
39	Last Average Value of 13th harmonic, current, L3	1-0:71.25.13.255
40	Last Average Value of THD, current, L1	1-0:31.25.124.255
41	Last Average Value of THD, current, L2	1-0:51.25.124.255
42	Last Average Value of THD, current, L3	1-0:71.25.124.255

Table 33: load profile 6 – harmonic and THD data

13.8 Snapshot profiles of instantaneous PQ and/or energy values

2 additional **readout profiles** with up to 50 entries for instantaneous values of energy and power quality are supported by the reading client through the optical port too:

13.8.1 Instantaneous Energy profile

Below data are the default values for the “Energy Instantaneous values readout”

- Clock 0-0:1.0.0.255
- Device ID1,manufacturing number 0-0:96.1.0.255
- Utility Device ID 1-0:0.0.0.255
- Active import energy, +A , (x=0, 1, 2, 3, 4) 1-0:1.8.x.255
- Active export energy, -A , (x=0, 1, 2, 3, 4) 1-0:2.8.x.255
- Reactive import energy, +R 1-0:3.8.0.255
- Reactive export energy, -R 1-0:4.8.0.255
- Reactive import energy, R1 1-0:5.8.0.255
- Reactive export energy, R2 1-0:6.8.0.255
- Reactive import energy, R3 1-0:7.8.0.255
- Reactive export energy, R4 1-0:8.8.0.255
- Apparent import energy, +S 1-0:9.8.0.255
- Apparent export energy, -S 1-0:10.8.0.255
- Active energy combined, total, /+A/ + /-A, (x=0,1,2,3,4) 1-0:15.8.x.255
- Active energy net, total, /+A/ - /-A, (x=0,1,2,3,4) 1-0:16.8.x.255
- Ampere hours, L1, L2, L3, (x=31, 51, 71) 1-0:x.8.0.255

13.8.2 Power Quality Instantaneous Values

Below data are the default values for the “Power Quality Instantaneous readout”

- Clock 0-0:1.0.0.255
- Device ID1,manufacturing number 0-0:96.1.0.255
- Utility Device ID 1-0:0.0.0.255
- Voltage L1, L2, L3 (x=32, 52, 72) 1-0:x.7.0.255
- Current L1, L2, L3 (x=31, 51, 71) 1-0:x.7.0.255
- Power factor L1, L2, L3 (x=33, 53, 73) 1-0:x.7.0.255
- Active import power L1, L2, L3 (x=21, 41, 61) 1-0:x.7.0.255
- Active export power L1, L2, L3 (x=22, 42, 62) 1-0:x.7.0.255
- Reactive import power L1, L2, L3 (x=23, 43, 63) 1-0:x.7.0.255
- Reactive export power L1, L2, L3 (x=24, 44, 64) 1-0:x.7.0.255
- Current (sum over all phases 1-0:90.7.0.255
- Active import power (/+A/ + /-A/ 1-0:15.7.0.255
- Active import power, +A 1-0:1.7.0.255
- Active export power, -A 1-0:2.7.0.255
- Reactive import powe, +R 1-0:3.7.0.255
- Reactive export power –R 1-0:4.7.0.255
- Apparent import powe, +S 1-0:9.7.0.255
- Apparent import powe, -S 1-0:10.7.0.255
- Power factor, +A/+VA 1-0:13.7.0.255
- Phase angle from I(L1) to U(L1) 1-0:81.7.4.255
- Phase angle from I(L2) to U(L2) 1-0:81.7.15.255
- Phase angle from I(L3) to U(L3) 1-0:81.7.26.255

13.9 Load profile 7-10 for up to 4 M-Bus meter

The load profile 7 should have below characteristic:

- support of M- Bus meters: 4
- configurable interval: 1 … 24h
- default interval: 24h
- number of channels: 4 channels per M-Bus meter
- number of days: 62 (for each channel)

- **Load profile of M-bus meter 1 (e.g. Water meter)**

channel	Quantity	OBIS code
1	M-Bus value	0-1:24.2.1.255
2	M-Bus value	0-1:24.2.2.255
3	M-Bus value	0-1:24.2.3.255
4	M-Bus value	0-1:24.2.4.255

- **Load profile of M-bus meter 2 (e.g. Gas meter)**

channel	Quantity	OBIS code
1	M-Bus value	0-2:24.2.1.255
2	M-Bus value	0-2:24.2.2.255
3	M-Bus value	0-2:24.2.3.255
4	M-Bus value	0-2:24.2.4.255

- **Load profile of M-bus meter 3 (e.g. Water meter)**

channel	Quantity	OBIS code
1	M-Bus value	0-3:24.2.1.255
2	M-Bus value	0-3:24.2.2.255
3	M-Bus value	0-3:24.2.3.255
4	M-Bus value	0-3:24.2.4.255

- **Load profile of M-bus meter 4 (e.g. Water irrigation)**

channel	Quantity	OBIS code
1	M-Bus value	0-4:24.2.1.255
2	M-Bus value	0-4:24.2.2.255
3	M-Bus value	0-4:24.2.3.255
4	M-Bus value	0-4:24.2.4.255

14 Event and Alarm Management

The meter is able to log events with time & date stamp and required parameters in which they occurred. The Alarms (important events) can be sent automatically to the Central System using the Push mode.

The meter is logging all activities that modify the meters's statement/configuration/setting or any attempt to do it as a dedicated event. Each logged event shall contain at least the following information:

- Timestamp of the logged event;
- Activity type of the logged event (event code);
- Parameters of the logged event (Where specified);

The events are divided into two main groups as follows:

- Normal Events (Status);
- Alarm;

The **Normal Events** are collected by the Central System as "Pull" mode, but the **Alarms** can be sent to the Central System via "Push" mechanism.

14.1 Event Management

There are different types of events supported from the meter. The events are divided into 7 main groups as follows:

- Standard Event log;
- Fraud Detection Event log;
- Disconnect Control Event log;
- Power Quality Event log;
- Communication Event log;
- Power Failure Event log;
- M-Bus Event log;

More details of the events / logs are described in chapter 15.

14.2 Alarm Management

Some of the critical events are considered as Alarms. The Alarms can be sent to the central system using the Push mode. The Data Notification Service of DLMS is used to send the Alarms to central system. The Alarm sending process is depicted in below figure.

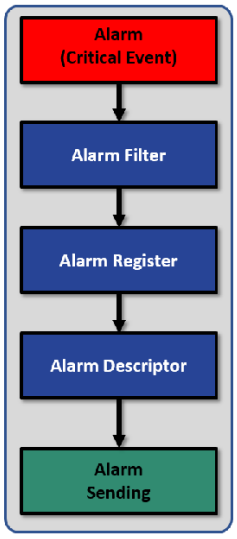


Figure 16: Alarm handling

As has been shown in Figure 23, different parts are involved in alarm handling process. These parts are as follows:

- Alarm Register;
- Alarm Filtering;
- Alarm Descriptor:
- Reporting (sending) Alarm;

The details of each part is presented in the following sections.

14.2.1 Alarm register

The Alarm register are intended to log the occurrence of alarms. This is a 4 Bytes register. Each Bit in the alarm register represents an alarm or a group of alarm. If any alarm occurs, the corresponding Flag in the alarm register is set and an alarm is then raised via communication channel. All alarm flags in the alarm register remain active until the alarm registers are cleared. The value in the Alarm Registers is a summary of all active and inactive alarms at that time.

The Bits of the Alarm Registers may be internally reset, if the “cause of the alarm” has disappeared. Alternatively, bits in Alarm Register can be externally reset by the DLMS client. In external resetting case (by DLMS client), Bits for which the “cause of alarm” still exists will be set to 1 again and an alarm will be issued.
There are 2 Alarm Registers available: “Alarm Register 1” and “Alarm Register 2”.

Bit no	Description Alarm Register 1	Triggering event	Description Alarm Register 2	Trigger event
0	Clock Invalid	06	Power Down	01
1	Battery Replace	07	Power Up	02
2	Reserved	-	Voltage Missing, Phase 1	82
3	Reserved	-	Voltage Missing, Phase 2	83
4	Reserved	-	Voltage Missing, Phase 3	84
5	Reserved	-	Voltage Normal, Phase 1	85
6	Reserved	-	Voltage Normal, Phase 2	86
7	Reserved	-	Voltage Normal, Phase 3	87
8	Program Memory Error	12	Missing Neutral	89
9	RAM Error	13	Phase Assymetrie	90
10	NV Memory Error	14	Current reversal	91
11	Measurement System Error	16	Wrong phase sequence	88
12	Watchdog Error	15	Unexpected consumption	52
13	Fraud Attempt	40, 42, 44, 46, 49, 50, 200, 201, 202	Key changed	48
14	Reserved	-	Bad Voltage Quality L1	92
15	Reserved	-	Bad Voltage Quality L2	93
16	M-Bus communication Error, ch 1	100	Bad Voltage Quality L3	94
17	M-Bus communication Error, ch 2	110	External alert	20
18	M-Bus communication Error, ch 3	120	Local communication Attempt	158
19	M-Bus communication Error, ch 4	130	New M-Bus device installed, ch 1	105
20	M-Bus Fraud Attempt, ch 1	103	New M-Bus device installed, ch 2	115
21	M-Bus Fraud Attempt, ch 2	113	New M-Bus device installed, ch 3	125
22	M-Bus Fraud Attempt, ch 3	123	New M-Bus device installed, ch 4	135
23	M-Bus Fraud Attempt, ch 4	133	Reserved	-
24	Permanent Error M.Bus ch 1	106	Reserved	-
25	Permanent Error M.Bus ch 2	116	Reserved	-
26	Permanent Error M.Bus ch 3	126	Reserved	-
27	Permanent Error M.Bus ch 4	136	M-Bus Valve Alarm, ch 1	164
28	Battery low on M-bus ch 1	102	M-Bus Valve Alarm, ch 2	174
29	Battery low on M-bus ch 2	112	M-Bus Valve Alarm, ch 3	184
30	Battery low on M-bus ch 3	122	M-Bus Valve Alarm, ch 4	194
31	Battery low on M-bus ch 4	132	Disconnect / Reconnect Failure	68

Table 16: Alarm Register 1 and 2 description

14.2.2 Alarm Filters

In some cases, there is no need to send some of the defined alarms to central system. To mask out unwanted alarms, the Alarm Filters are considered. There are 2 alarm filters as Alarm Filter 1 and 2 to mask the Alarm Registers 1 and 2 respectively. The Alarm Filters have exactly the same structure as the Alarm Registers:

- Alarm Filter 1 (0-0:97.98.10.255);
- Alarm Filter 2 (0-0:97.98.11.255);

14.2.3 Sending Alarms

The last part of Alarm Handling process is "Alarm Sending/Reporting". The Data Notification Service of DLMS is used. In case of GPRS, if an Alarm happens, first, the GPRS connection will be established (if the always-on mode is not used).

15 Event Log file

The meter generates a number of Events for additional information concerning the status of the meter or configuration.
Certain conditions can trigger the event and initiate the logging into the event log. The root cause for the individual trigger depends on the nature of the events. As long as the root cause is still active, the event will not be re-triggered. The meter supports different log files:

- 1 - Standard Event Log
- 2 - Fraud Detection Log
- 3 - Disconnector Control Log
- 4 - Power Quality Log
- 5 - Communication Log
- 6 - Power Failure Log
- 7 - Special log with storing index value of 1.8.0
- 8 - M-Bus log

In each event log, different values are stored in case of event. The values of each event log (Event parameters) and the source COSEM objects are shown in below table.

Event log	**Event Parameter**	
	Parameter name	**COSEM object**
Standard Event log (0-0:99.98.0.255)	Clock (time stamp)	0-0:1.0.0.255
	Event Code	0-0:96.11.0.255
	Event Parameter (sub events	0-0:96.11.10.255
Fraud detection Event log (0-0:99.98.1.255)	Clock (time stamp)	0-0:1.0.0.255
	Event Code	0-0:96.11.1.255
Communication Event log (0-0:99.98.5.255)	Clock (time stamp)	0-0:1.0.0.255
	Event Code	0-0:96.11.5.255
Disconnect Control Event log (0-0:99.98.2.255)	Clock (time stamp)	0-0:1.0.0.255
	Event Code	0-0:96.11.3.255
	Active Threshold value of limiter	0-0:17.0.0.255
Power Quality log (0-0:99.98.4.255)	Clock (time stamp)	0-0:1.0.0.255
	Event Code	0-0:96.11.4.255
	Magnitude of Power Quality event	0-0:96.11.11.255
	Duration/Number of PQ event	0-0:96.11.11.255
Power Failure Event log (0-0:99.97.0.255)	Clock (time stamp)	0-0:1.0.0.255
	Event Code	0-0:96.11.6.255
	Magnitude of Power Quality event	0-0:96.7.19.255
M-Bus Master Control log object 1 (0-0:99.98.1.255)	Clock (time stamp)	0-0:1.0.0.255
	Event Code	0-0:96.11.4.255
…	**…**	
M-Bus Master Control log object 4 (0-0:99.98.1.255)	Clock (time stamp)	0-0:1.0.0.255
	Event Code	0-0:96.11.4.255

Table 35: Different Event log and Event parameters

15.1 Log file 1 – Standard Event Log

Size of the Standard Event Log: 580 entries (rolling storage)

Below events are recorded with time and date stamp in the Standard Event Log

No	Name	Description
1	Power Down	Complete power down of the device.
2	Power Up	Device is powered again after a complete power down.
3	Daylight saving time enabled or disabled	Regular change from and to daylight saving time. The time stamp shows the time before 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)	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)	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	Invalid clock, i.e. if the power reserve of the clock has exhausted. It is set at power up.
7	Replace Battery	Battery must be exchanged due to the expected end of life time
8	Battery voltage low	Current battery voltage is low.
9	TOU activated	Passive TOU has been activated.
10	Error register cleared	Error register was cleared.
11	Alarm register cleared	Alarm register was cleared.
12	Program memory error	Pysical or a logical error in the program memory.
13	RAM error	Physical or a logical error in the RAM.
14	NV memory error	Physical or a logical error in the non volatile memory
15	Watchdog error	Watch dog reset or a hardware reset of the microcontroller.
16	Measurement system error	Logical or physical error in the measurement system
17	Firmware ready for activation	New FW has been successfully downloaded and verified
18	Firmware activated	New firmware has been activated
19	Passive TOU programmed	The passive structures of TOU or a new activation date/time were programed
20	External alert detected	Signal detected on the meter's input terminal
21	End of non-periodic billing interval	End of a non-periodic billing interval
22	Capturing of load profile 1 enabled	Capturing of load profile 1 has started
23	Capturing of load profile 1 disabled	Capturing of load profile 1 has ended
24	Capturing of load profile 2 enabled	Capturing of load profile 2 has started
25	Capturing of load profile 2 disabled	Capturing of load profile 2 has ended
47	One/more parameters changed	**Change of** at least parameter, with below sub-events 1 - Demand register 1,2,3,4,7 period 2 - Demand register 1,2,3,4,7 number of period 3 - Limiter Threshold Normal 4 - Limiter Threshold Emergency 5 - LP1 Capture Period 6 - LP2 Capture Period 7 - LP Average Capture Period 8 - LP Max Capture Period 9 - LP Min Capture Period 10 - LP Harmonics Capture Period 11 - Secret change 12 - Security policy changed (meter) 13 - Security policy changed (IHD) 14 – M-Bus security parameters changed 15 - Transformer ratio- current numerator changed 16 - Transformer ratio- voltage numerator changed

		17 – Transformer ratio- current denominator changed 18 – Transformer ratio- voltage denominator changed 19- Limiter action activated (Attr. 11, IC 71, changed to any action) 20- Limiter action deactivated (Attr. 11, IC 71, changed to any action) 21- Minimum Time Under Threshold 22- Minimum Time Over Threshold 23- Time Threshold for Under Voltage Detection 24- Time Threshold for Over Voltage Detection 25- Threshold for Under Voltage Detection 26- Threshold for Over Voltage Detection 27- Time Threshold for Missing Voltage 28- Threshold for Missing Voltage 29- Time threshold for long power failure
48	Global key(s) changed	One or more global keys changed, with sub-events 1– Authentication Key for meter change 2 – Encryption Unicast key for meter change 3 – Encryption Broadcast key for meter change 4 – Authentication Key for IHD change 5 – Encryption Unicast key for IHD change 6 – Master Key Change 7- Authentication Key for Local Port 8- Encryption Unicast Key for Local Port
51	FW verification failed	Transferred firmware verification failed i.e. cannot be activated.
52	Unexpected consumption	Consumption is detected at least on 1 ph when the disconnector was disconnected
88	Phase sequence reversal	Indicates wrong mains connection. Usually indicates fraud or wrong installation.
89	Missing neutral	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
97	Load Mgmt activity calendar activat.	Passive Load Management activity calendar has been activated
98	Load Mgmt passive activity calendar programmed	Passive Load Management activity calendar has been programmed
108	LPCAP_1 enabled	Capturing of Load Profile 1 is enabled
109	LPCAP_1 disabled	Capturing of Load Profile 1 is disabled
117	LPCAP_2 enabled	Capturing of Load Profile 2 is enabled
118	LPCAP_2 disabled	Capturing of Load Profile 2 is disabled
203	Manual demand reset	A manual demand reset was executed
226	Firmware activation failed	Failed FW 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 event appears in the M-Bus Event log => one of the M-Bus load profiles was cleared 1 – Monthly 2 – LP1 (hourly) 3 – LP2 (daily) 4 - Supervision Average 5 - Supervision Minimum 6 - Supervision Maximum 7 - Supervision Harmonics 8 - LP Mbus1 9 - LP Mbus2 10 – LP Mbus 3 11 – LP Mbus 4
255	Event log cleared	Event log was cleared. This is always the first entry in the effected event log.

Table 36: Definition of log file 1 - Standard Event Log

15.2 Log file 2 – Fraud detection event log

Size of the Fraud Detection Event Log: 680 entries (rolling storage)
Below events are recorded with time and date stamp in the Standard Event Log

No	Name	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 detection) 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.
91	Current Reversal	Indicates unexpected energy export (for devices which are configured for energy import measurement only)
200	Current in absense of voltage at L1 detected	Indication of Current in absense of voltage at L1 detected
201	Current in absense of voltage at L2 detected	Indication of Current in absense of voltage at L2 detected
202	Current in absense of voltage at L3 detected	Indication of Current in absense of voltage at L3 detected
255	Event log cleared	Event log was cleared. This is always the first entry in the effected event log.

Table 37: Definition of log file 2 – Fraud Detection Event Log

15.3 Log file 3 – Disconnector Control Log

Size of the Disconnector Control Log: 680 entries (rolling storage)

Below events are recorded with time and date stamp in the Disconnector Control Log

No	Name	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 (i.e. via the limiter or current supervision monitors).
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 (control state does not match output state)
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	Event log was cleared. This is always the first entry in the effected event log.

Table 38: Definition of log file 3 – Disconnector Control Log

15.4 Log file 4 – Power Quality Event Log

Size of the Power Quality Event Log: 340 entries (rolling storage)

Below events are recorded with time and date stamp in the Power Quality Event Log

No	Name	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 voltage of L1 is below the Umin threshold for longer than the time delay.
83	Missing voltage L2	Indicates that voltage of L2 is below the Umin threshold for longer than the time delay.
84	Missing voltage L3	Indicates that voltage of L3 is below the Umin threshold for longer than the time delay.
85	Voltage L1 normal	The mains voltage of L1 is in normal limits again, e.g. after overvoltage.
86	Voltage L2 normal	The mains voltage of L2 is in normal limits again, e.g. after overvoltage.
87	Voltage L3 normal	The mains voltage of L3 is in normal limits again, e.g. after overvoltage.
90	Phase Asymmetry	Indicates phase asymmetry due to large unbalance of loads connected
92	Bad Voltage Quality L1	Indicates that during one week, 95 % of the 10min mean r.m.s values of L1 are within the range of Un+/- 10 % and all 10 mín mean r.m.s. values of L1 shall be within the range of Un + 10%/- 15%. (acc. EN50160, section 4.2.2)
93	Bad Voltage Quality L2	Same indication as for the voltage L1
94	Bad Voltage Quality L3	Same indication as for the voltage L1
204	Power direction has changed	Indication of power direction change
217	Under voltage end, phase 1	Amplitude and duration of phase 1, Under voltage end
218	Under voltage end, phase 2	Amplitude and duration of phase 2, Under voltage end
219	Under voltage end, phase 3	Amplitude and duration of phase 3, Under voltage end
220	Over voltage end, phase 1	Amplitude and duration of phase 1, Over voltage end
221	Over voltage end, phase 2	Amplitude and duration of phase 2, Over voltage end
222	Over voltage end, phase 3	Amplitude and duration of phase 3, Over voltage end
223	Missing voltage end, phase 1	Amplitude and duration of missing voltage L1
224	Missing voltage end, phase 2	Amplitude and duration of missing voltage L2
225	Missing voltage end, phase 3	Amplitude and duration of missing voltage L3
255	Event log cleared	Event log was cleared. This is the first entry in the effected event log.

Table 39: Definition of log file 4 – Power Quality Event Log

At the starting of the over/under voltage events (event code 76, 77, 78, 79, 80, 81) the following parameters are stored in the Power Quality log too

- Starting time of the Over/Under voltage
- Number of the Over/Under voltage

At the *end of the over/under voltage* events (event code 217, 218, 219, 220, 221, 222) the following parameters are stored in the Power Quality log too

- End time of the Over/Under voltage
- Duration of last Over/Under voltage
- Magnitude of the last Over/Under voltage

15.5 Log file 5 – Communication Event Log

Size of the Communication Event Log: 680 entries (rolling storage)

Below events are recorded with time and date stamp in the Communication Event Log

No	Name	Description
119	IF_LO_2W enabled	2 way communication on local port enabled
127	IF_LO_2W disabled	2 way communication on local port disabled; i.e. 1-way communication enabled
140	No connection timeout	There has been no remote communication on application layer for a predefined period of time; i.e. meter could not be reached remotely.
141	Modem Initialization failure	Modem's response to initialization AT command(s) is invalid or ERROR or no response received
142	SIM Card failure	SIM card is not inserted or is not recognized.
143	SIM Card ok	SIM card has been correctly detected
144	GSM registration failure	Modem's registration on GSM network was not successful
145	GPRS registration failure	Modem's registration on GPRS network was not successful
146	PDP context established	PDP context is established
147	PDP context destroyed	PDP context is destroyed
148	PDP context failure	No Valid PDP context(s) retrieved
149	Modem SW reset	Modem restarted by SW reset
150	Modem HW reset	Modem restarted by HW reset (event is not issued after a general power resume)
151	GSM outgoing connection	Modem is successfully connected, initiated by an outgoing call.
152	GSM incoming connection	Modem is successfully connected, initiated by an incoming call
153	GSM hang-up	Modem is disconnected
154	Diagnostic failure	Modem's response to diagnostic AT command(s) is invalid
155	User initialization failure	Modem's initialization AT command(s) is invalid.
156	Signal quality low	Signal strength too low, not known, or not detectable
157	Auto Answer No of calls exceed.	Number of calls has exceeded (in mode(1) or mode(2))
158	Local communication attempt	Indicates a successful communication on any local port has been initiated.
214	Communic. module removed	Indicate a removal of the communication module
215	Communication module inserted	Indicate an insertion of the communication module
255	Event log cleared	Event log was cleared. This is always the first entry in the effected event log.

Table 40: Definition of log file 5 – Communication event log

15.6 Log file 6 – Power Failure Event Log

Size of the Power Failure Event Log: 400 entries (rolling storage)

Below events are recorded with time and date stamp in the Standard Event Log

No	Name	Description
210	Long power failure in all phases	Duration of power failure in all phases
211	Long power failure in phase 1	Duration of power failure in phase 1
212	Long power failure in phase 2	Duration of power failure in phase 2
213	Long power failure in phase 3	Duration of power failure in phase 3
255	Event log cleared	Event log was cleared. This is always the first entry in the effected event log.

Table 41: Definition of log file 6 – Power Failure Event log

15.7 Log file 7 – Special Event log

In this log file additional to the below mentioned Events the total active energy consumption **1.8.0 is stored too**.

Size of the Special Event Log: 400 entries (rolling storage)

Below events are recorded with time and date stamp in the Special Event Log

No	Name	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.
82	Missing voltage L1	Indicates that voltage L1 is below Umin threshold
83	Missing voltage L2	Indicates that voltage L2 is below Umin threshold
84	Missing voltage L3	Indicates that voltage L3 is below Umin threshold
1	Power down	Complete power down of the meter
5	Clock adjusted (new date/time)	Clock has been adjusted. The date/time that is stored in the event log is the new date/time after adjusting the clock.
15	Watchdog	Watch dog reset or a hardware reset of the microcontroller.
18	FW activated	New firmware has been activated
47	One/more parameters changed	
12	Program memory error	Program memory error
13	RAM error	Physical or a logical error in the RAM.
14	NV memeory error	Physical or a logical error in the non volatile memory
16	Measurement system error	Logical or physical error in the measurement system

Table 42: Definition of log file 7 – Special Event log

15.8 Log file 8 – M-Bus Event log

Size of the M-Bus Event Log: 550 entries (rolling storage)

Below events are recorded with time and date stamp in the M-Bus Event Log

No	Name	Description
38	M-Bus FW ready for activation	M-Bus channel x the FW has been successfully downloaded and verified; i.e. it is ready for activation
39	M-Bus FW activated	M-Bus channel x the FW has been activated
53	LPCAP_M1 enabled	Capturing of M-Bus profile 1 is enabled
54	LPCAP_M1 disabled	Capturing of M-Bus profile 1 is disabled
55	LPCAP_M2 enabled	Capturing of M-Bus profile 2 is enabled
56	LPCAP_M2 disabled	Capturing of M-Bus profile 2 is disabled
57	LPCAP_M3 enabled	Capturing of M-Bus profile 3 is enabled
58	LPCAP_M3 disabled	Capturing of M-Bus profile 3 is disabled
99	LPCAP_M4 enabled	Capturing of M-Bus profile 4 is enabled
100	Comms error M-Bus channel 1	Comms problem when reading the meter connected to channel 1 of the M-Bus

101	Comms ok M-Bus channel 1	Comms with M-Bus meter connected to channel 1 of the M-Bus is ok again.
102	Replace Battery M-Bus channel 1	Battery must be exchanged due to the expected end of life time.
103	Fraud attempt M-Bus channel 1	Fraud attempt has been registered.
104	Clock adjusted M-Bus channel 1	Clock has been adjusted.
105	New M-Bus device installed channel 1	The meter (M-Bus master) has registered a M-Bus device connected to channel 1 with a new serial number
106	Permanent Error M-Bus channel 1	Severe error reported by M-Bus device
107	LPCAP_M4 disabled	Capturing of M-Bus profile 4 is disabled
110	Comms error M-bus channel 2	Comms problem when reading the meter connected to channel 2 of the M-Bus
111	Comms ok M-bus channel 2	Comms with M-Bus meter connected to channel 2 of the M-Bus is ok again.
112	Replace Battery M-Bus channel 2	The battery must be exchanged due to the expected end of life time.
113	Fraud attempt M-Bus channel 2	Fraud attempt has been registered in the M-Bus device.
114	Clock adjusted M-Bus channel 2	Clock has been adjusted.
115	New M-Bus device installed channel 2	The meter (M-Bus master) has registered a M-Bus device connected to channel 2 with a new serial number
116	Permanent Error M-Bus channel 2	Severe error reported by M-Bus device (Bit 3 in MBUS status EN13757)
120	Comms error M-bus channel 3	Comms problem when reading the meter connected to channel 3 of the M-Bus
121	Comms ok M-bus channel 3	Comms with M-Bus meter connected to channel 3 of the M-Bus is ok again
122	Replace Battery M-Bus channel 3	The battery must be exchanged due to the expected end of life time.
123	Fraud attempt M-Bus channel 3	Fraud attempt has been registered.
124	Clock adjusted M-Bus channel 3	Clock has been adjusted.
125	New M-Bus device installed channel 3	The meter (M-Bus master) has registered a M-Bus device connected to channel 3 with a new serial number
126	Permanent Error M-Bus channel 3	Severe error reported by M-Bus device (Bit 3 in MBUS status EN13757)
128	M-Bus FW verification failed	M-Bus channel x the FW verification failed
130	Comms error M-bus channel 4	Comms problem when reading the meter connected to channel 4 of the M-Bus
131	Comms ok M-bus channel 4	ICcomms with M-Bus meter connected to channel 4 of the M-Bus is ok again
132	Replace Battery M-Bus channel 4	The battery must be exchanged due to the expected end of life time.
133	Fraud attempt M-Bus channel 4	Fraud attempt has been registered.
134	Clock adjusted M-Bus channel 4	The clock has been adjusted.
135	New M-Bus device installed channel 4	The meter (M-Bus master) has registered a M-Bus device connected to channel 4 with a new serial number
136	Permanent Error M-Bus channel 4	Severe error reported by M-Bus device (Bit 3 in MBUS status EN13757)
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 1 – Monthly 2 – LP1 (hourly) 3 – LP2 (daily) 4 - Supervision Average 5 - Supervision Minimum 6 - Supervision Maximum 7 - Supervision Harmonics 8 - LP Mbus1 9 - LP Mbus2 10 – LP Mbus 3 11 – LP Mbus 4
255	Event log cleared	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 43: Definition of log file 8 – M-Bus Event Log

16 Power Quality measuring

The meter registers and provides below power quality information about:

- Average Voltage
- Under Voltage and Over Voltage (sags and swells)
- Voltage Cut (Power outage)
- Harmonics and THD
- Unbalanced load

16.1 Average voltage measurement

The average voltage is determined in each phase. The average voltage values are stored in the following COSEM objects:

- Average voltage L1 (1-0:32.24.0.255);
- Average voltage L2 (1-0:52.24.0.255);
- Average voltage L3 (1-0:72.24.0.255);

The average voltage is determined according to the configurable aggregation time interval between 1 min to 60 min. The default value is 10 minutes. At the start of aggregation interval, the meter starts sampling phase voltage and averages them at the end of time interval.

16.1.1 Voltage Level Monitoring based on EN50160

The voltage level (measured average voltage level, ULX average with an interval of 10min can be divided into two main groups as follow (based on definition in EN 50160).

U_{LX} Normal: During each period of one week 95% of U_{LX} average shall be within the range of U_N +/-10% and all U_{LX} average shall be within the range of U_N -15% to +10% (according EN50160).

U_{LX} Bad: Any other cases

In case of "U_{LX} Bad" voltage, an event in the Power Quality event log will be generated regarding each phase. The following events are considered:

- Event Code 92: Bad Voltage Quality L1
- Event Code 93: Bad Voltage Quality L2
- Event Code 94: Bad Voltage Quality L3

16.2 Under-/ Overvoltage (sags and swells)

The meter detects the under voltage (sag) and over voltage (swell) in all phases. The threshold of under voltage is from -5% Vref to -20% Vref by 5V steps and for overvoltage is from +15% Vref to +5% Vref by 5V steps. The threshold values of under voltage and over voltage are stored in the following COSEM objects and can be set/adjust locally or remotely.

- Threshold for Under Voltage (sags) (1-0:12.31.0.255);
- Threshold for Over Voltage (swells) (1-0:12.35.0.255);

The under/over voltage will not be recorded unless they continue for equal or greater than the time set for under voltage and overvoltage threshold. This time is adjustable by the following parameters:

- Time Threshold for Over Voltage (1-0:12.44.0.255);
- Time Threshold for Under Voltage (1-0:12.43.0.255);

The time threshold for over voltage is between 1s to 60s and the default value is 15s. The time threshold for under voltage is between 1s to 180s, default: 60s.
If any under voltage and Over Voltage happens, an event will be logged.

The total number of over/under voltage, the **duration of last** over/under voltage and **magnitude of last** over/under voltage are stored in the dedicated COSEM objects.

- Number of Under Voltage in Phase L1 (1-0:32.32.0.255);
- Number of Under Voltage in Phase L2 (1-0:52.32.0.255);
- Number of Under Voltage in Phase L3 (1-0:72.32.0.255);
- Duration of Last Under Voltage in Phase L1 (1-0:32.33.0.255);
- Duration of Last Under Voltage in Phase L2 (1-0:52.33.0.255);
- Duration of Last Under Voltage in Phase L3 (1-0:72.33.0.255);
- Magnitude of Last Under Voltage in Phase L1 (1-0:32.34.0.255);
- Magnitude of Last Under Voltage in Phase L2 (1-0:52.34.0.255);
- Magnitude of Last Under Voltage in Phase L3 (1-0:72.34.0.255);
- Number of Over Voltage in Phase L1 (1-0:32.36.0.255);
- Number of Over Voltage in Phase L2 (1-0:52.36.0.255);
- Number of Over Voltage in Phase L3 (1-0:72.36.0.255);
- Duration of Last Over Voltage in Phase L1 (1-0:32.37.0.255);
- Duration of Last Over Voltage in Phase L2 (1-0:52.37.0.255);
- Duration of Last Over Voltage in Phase L3 (1-0:72.37.0.255);
- Magnitude of Last Over Voltage in Phase L1 (1-0:32.38.0.255);
- Magnitude of Last Over Voltage in Phase L2 (1-0:52.38.0.255);
- Magnitude of Last Over Voltage in Phase L3 (1-0:72.38.0.255);

Note: these COSEM objects are intended to provide over/under voltage information in local reading. For details information of over/under voltages or to read from central system, the related event log COSEM objects shall be considered.

At the starting of Over/Under voltage events, below parameters will be captured by the Power Quality Event Log COSEM object (0-0:99.98.4.255):

- Number of Over/Under Voltage;
- Starting time of Over/Under Voltage;

At the end of Over/Under voltage the following events information will be stored in the Power Quality Event Log:

- End time of Over/Under Voltage;
- Duration of Last Over/Under Voltage;
- Magnitude of Last Over/Under Voltage;

16.3 Voltage Cut (power outage)

If the voltage drops below the "Threshold for Voltage Cut" and continues for the "Time Threshold for Voltage Cut" seconds, the situation will be considered as Voltage Cut and an event will be logged.

The threshold of voltage cut is adjustable and can be set by central system. The default value is -50% Vref. The threshold value is stored in the following COSEM object and can be set/adjust remotely by central system.

- Threshold for Missing Voltage (Voltage Cut) (1-0:12.39.0.255);

As mentioned, the voltage cut will not be recorded unless it continues for equal or greater than the specific time. Time threshold for voltage cut is between 1s to 30s and the default value is 30s. This time is adjustable and can be set via below parameter:

- Time Threshold for Voltage Cut (1-0:12.45.0.255);

The voltage cut events are considered as Power Quality events and are captured by Power Quality Event Log. The events codes 82, 83 and 84 are considered as starting of voltage cut in phases L1, L2 and L3 respectively and events codes 223, 224 and 225 as end of voltage cut.

16.4 Harmonics / THD measuring

The MCS301 meter supports the harmonics and THD measurement (harmonics up to 15th and THD up to the 32th in each phase for current and voltage). Below harmonics and THD values are supported:

- Instantaneous THD for voltage and current per phase (up to the 32th)
- Instantaneous Harmonics for voltage and current per phase (up to the 15^{th})
- Average values for THD and harmonics
- Profile for harmonics and THD

16.5 Unbalanced load

Load Unbalance situation is the condition, when the current value in all phases is greater than a minimum value (as precondition to start load unbalance detection process) and at least one phase current deviates from average three phase current more than a defined threshold because of unbalance loads.

Note: The “Load Unbalance” event (code: 90) is generated only when the unbalance situation has not been detected in previous unbalance calculation period, But setting profile status bit should be done at any unbalance detection period. The asymmetry event is logged by “Power Quality” event log.

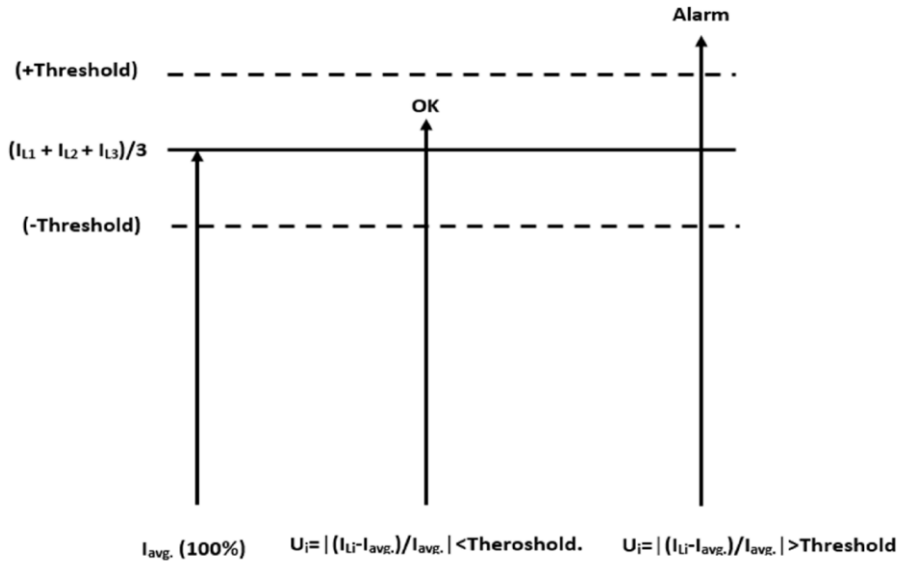


Figure 17: Load Unbalance Situation

I_{Li} (that has been shown in Figure 22) is the last average value of phase Li that has been captured by Average Values Profile COSEM object. The averaging period (to detect the unbalancing situation) is same as capture period of Average Value Profile (default value is 15 min).

Events for unbalance load are always generated at the end of aggregation period (capture period of Average Values Profile), when meter stores average phase values in Average Values Profile. At the same time also dedicated alarm is set or cleared. However if alarm bit is cleared by the central system before meter detects normal condition (which can only happen at the end of next aggregation period), alarm is immediately set back.

The minimum current in phases (to start asymmetry detection process) in (A) and threshold value for asymmetry detection in (%) can be set as parameters in COSEM object “Unbalance Load Detection”:

- Minimum Current (A);
- Unbalance Threshold (%);

These parameters can be set remotely.

17 Power Outage

17.1 General

The power failure/interruption happens when the voltage is lost in phase(s). There exists 3 types of power failure as follows:

- Short Power Failure/Interruption (Simply “Power Failure”)
- Long Power Failure/Interruption
- Power Down (power interruption in all phases)

The power interruption time <= "T" is considered as “Short Power Failure” (or simply “Power Failure”) and greater than it is called “Long Power Failure”. The "T" is configurable and its default value is 3 minutes. The power interruption in all phases is considered as “Power Down”.

Note: Time threshold for power failure is allowed to change between 1 to 60 min.

Meter detects and registers power failures per phase, for any phase and for all phases. Registration of power failures is done by, incrementing dedicated counters, setting alarms and storing events in “Standard” and “Power Failure” event logs.

There are different policies about registration of information of Short and Long power failure / interruption.

Short Power interruption, the following information shall be provided:

- Number of Interruptions

Long Power Interruption, the following information shall be provided:

- Number of Interruptions
- Interruption Duration
- Timestamp of interruption

The number and duration of interruptions are stored in dedicated COSEM object. They are presented in following sections.

17.2 Power outage Counter

There are different power failures considered, to count and store the number of short and long power failures. The counters and their related COSEM objects are as follow:

Short power outages

- Number of Short Power Failures in All Phases (0-0:96.7.0.255);
- Number of Short Power Failures in L1 (0-0:96.7.1.255);
- Number of Short Power Failures in L2 (0-0:96.7.2.255);
- Number of Short Power Failures in L3 (0-0:96.7.3.255);
- Number of Short Power Failure in **Any** Phases (0-0:96.7.21.255);

Long power outages

- Number of Long Power Failures in All Phases (0-0:96.7.5.255);
- Number of Long Power Failures in Phase L1 (0-0:96.7.6.255);
- Number of Long Power Failures in Phase L2 (0-0:96.7.7.255);
- Number of Long Power Failures in Phase L3 (0-0:96.7.8.255);
- Number of Long Power Failures in **Any** Phase (0-0:96.7.9.255);

The counter's value is incremented by "1" in cases of any related event. The counter can't be reset. It is reset automatically, if it reaches the maximum value according to its size.

17.3 Power outage duration register

The duration of last long power failure shall be registered by meter. The following registered store the duration of the last long power failure.

- Duration of Last Long Power Failure in All Phases (0-0:96.7.15.255);
- Duration of Last Long Power Failure in Phase L1 (0-0:96.7.16.255);
- Duration of Last Long Power Failure in Phase L2 (0-0:96.7.17.255);
- Duration of Last Long Power Failure in Phase L3 (0-0:96.7.18.255);
- Duration of Last Long Power Failure in Any Phase (0-0:96.7.19.255);

17.4 Power Failure Event log for long power outages

There is one event log for power failure as COSEM object "Power Failure Event Log" (1-0:99.97.0.255).

- The power failure event log contains all events related to long power outages.

It stores the time stamp, duration of long power failures in any phase (where the time stamp represents the end of power failure) and event code related to phase (that long power failure occurred). The more detailed view into the duration of the power outage events is provided via dedicated COSEM object for each phase. Each entry, recorded in Power Failure Event Log, contains the following information about power failure events:

- Time of power return after long power failure;
- Duration of long power failure (in phase L1, L2 and L3);
- Event code related to long power failure in L1, L2 and L3;

18 Configuration parameters

Below configuration parameters can be changed depending on the access.

18.1 Standard parameters

- Demand register 1,2,3,4,7 period
- Demand register 1,2,3,4,7 number of period
- Limiter Threshold Normal
- Limiter Threshold Emergency
- LP1 Capture Period
- LP2 Capture Period
- LP Average Capture Period
- LP Max Capture Period
- LP Min Capture Period
- LP Harmonics Capture Period
- Secret change
- Security policy changed (meter)
- Security policy changed (IHD)
- M-Bus security parameters changed
- Transformer ratio- current
- Transformer ratio- voltage
- Limiter action activated (Attr. 11, IC 71, changed to any action)
- Limiter action deactivated (Attr. 11, IC 71, changed to any action)
- Minimum Time Under Threshold
- Minimum Time Over Threshold
- Time Threshold for Under Voltage Detection
- Time Threshold for Over Voltage Detection
- Threshold for Under Voltage Detection
- Threshold for Over Voltage Detection
- Time Threshold for Missing Voltage
- Threshold for Missing Voltage
- Time threshold for long power failure

18.2 Global key parameters

- Authentication Key for meter change
- Encryption Unicast key for meter change
- Encryption Broadcast key for meter change
- Authentication Key for IHD change
- Encryption Unicast key for IHD change
- Master Key Change
- Authentication Key for Local Port
- Encryption Unicast Key for Local Port

19 Inputs / Outputs

Below picture shows the position of the different communication interfaces as well as the input / outputs.

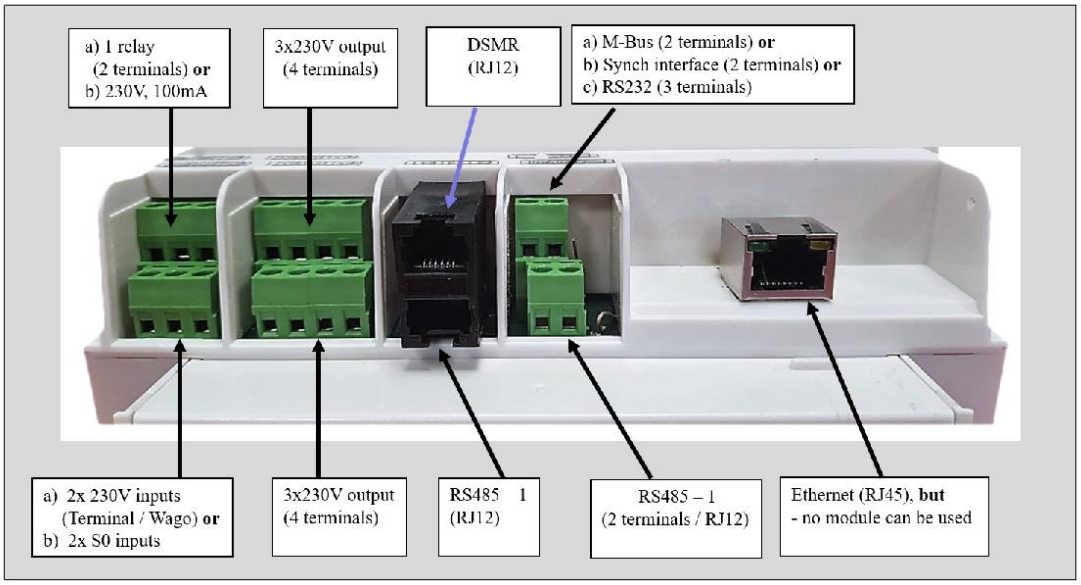


Figure 18: Auxiliary terminals of the meter (input/outputs, coms interface)

19.1 Communication interfaces

Different interfaces like optical or electrical interfaces (RS485) are available for reading or configuring the meter. Using one of these interfaces the meter can be readout by a handheld unit or PC in combination with an optical probe or by connection the meter to a modem for AMR purposes.

The data protocol is implemented according the DLMS/COSEM protocol. The data model is compliant to IDIS package 2 and 3

19.1.1 Optical interface

The characteristics of the optical interface are listed below:

- Electrical characteristics: as per EN 62056-21
- Protocol: as per DLMS/COSEM
- Baud rate: max. 9600 baud

19.1.2 Wired M-Bus interface

The characteristics of the wired M-Bus interface are listed below:

- Electrical characteristics: as per EN13757-3
- Protocol: as per EN13757-2 physical and link layer
- Baud rate: 2400 baud

19.1.3 RS485 interface

The characteristic of the RS485 interface are listed below:

- Electrical characteristic: 24 - RT+ (Data+),
  23 - RT- (Data-)
- Protocol: DLMS/COSEM, half-duplex
- Baud rate: max. 19.200 / 38.400 baud
- Terminating resistor: The first and last device need to be terminated with 100 Ohm.

By using the RS485 interface up to 31 meters can be connected to an external modem with a line length of 1000m. The used protocol corresponds to DLMS/COSEM.

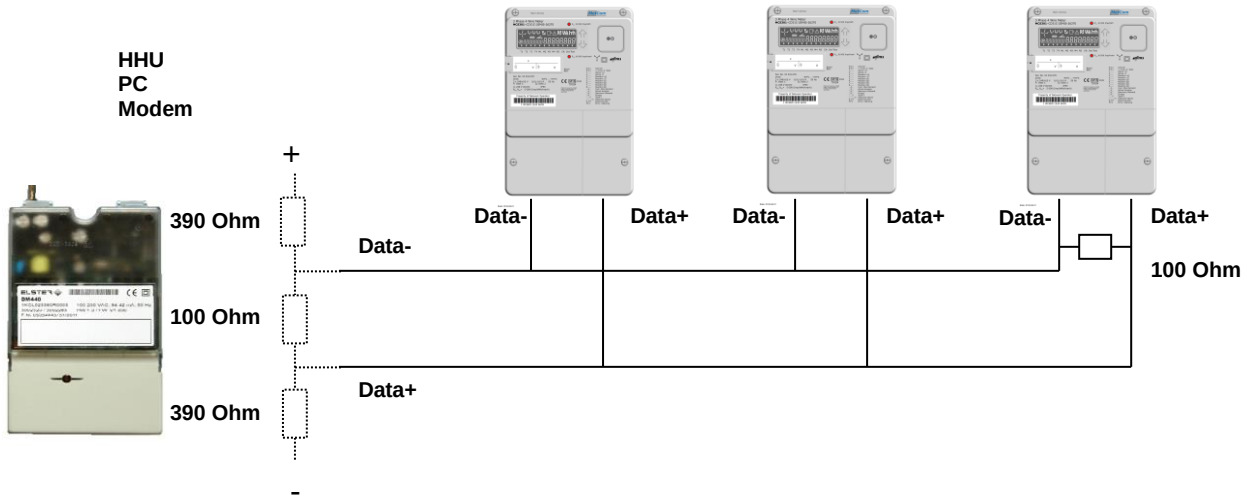


Figure 19: Connection of MCS301 to a modem using the RS485 interface

The RS485 interface connection can be selected between:

- 2 terminals **or**
- RJ12 connector

19.1.4 RS232 interface

The characteristic of the RS232 interface are listed below:

- Electrical characteristic (3 terminals):
  - Tx (Data+)
  - Rx (Data-)
  - GND
- Protocol: DLMS/COSEM, half-duplex
- Baud rate: max. 19.200 / 38.400 baud

By using the RS232 **and** RS485 interface the communication is **no more** simultaneously.

19.1.5 Ethernet interface

The MCS301 meter provides, as an option, a network interface as standard Ethernet 10/100 Mbps (RJ-45 socket), enabling the use of TCP / IP version 4 or IPv6.

The characteristic of the Ethernet interface are listed below:

- Mechanical RJ45 connector
- Electrical characteristic: IPV4, future IPV6
Fixed IP support
- Protocol: DLMS/COSEM, half-duplex

Remark: By using the Ethernet interface the M-Bus interace can't be use anymore.

19.1.6 Communication module interface

The characteristic of the interface between the meter and communication module are listed below:

- Electrical characteristics: SPI interface
- Protocol: as per DLMS/COSEM
- Baud rate: up to 1MBit

19.1.7 Simultaneous communication

Below communication interfaces are able to communicate simultaneously:

- Optical interface
- RS485 interface
- Wired M-Bus interface
- Communication module interface or Ethernet interface

19.2 Inputs

19.2.1 Control inputs

The meter provides up to 2 control inputs. The assignment of the control input to the corresponding functions is user-configurable.

- Energy tariff control, T1-T2
- Maximum demand tariff control, M1-M2
- Any Status information
- Push activation (only in combination with Com200 module)

Electrical characteristics:

- OFF at <= 40V
- ON at >= 60V

Remark: in case of using the 2 control inputs the 2 pulse inputs can't be used in parallel

19.2.2 Pulse inputs

The meter can provides up to 2 pulse inputs to collect the pulse output of external meters. The functionality of the pulse inputs described below:

- Configurable pulse constant of the inputs
- Selection of counting active or reactive pulses
- Storing energy and demand data in separate register
- Storing pulse input data in a load profile
- Possibility to summate the external pulses with the internal register of the meter
- Up to 2 summation pulse output

Remark: in case of using the 2 pulse inputs the 2 control inputs can't be used in parallel

19.3 Outputs

The MCS301 meter is able to provide up to 6 electronic 230V, 100mA outputs placed on the main PCB of the meter as well as 1 mechanical relay output with up to 10A.

19.3.1 Electronic outputs

The assignment of the 6 control outputs is user-configurable:

- Use as pulse outputs (S0 or 230V connection)
  - Active energy +A or –A
  - Reactive energy +R, -R, R1, R2, R3, R4
- Energy tariff T1-T8 indication
- Maximum demand tariff M1-M4 indication
- Controlled by Real time clock (RTC)
- Controlled by remote commands
- Alarm indication
- End of interval
- Power outage (1ph or 2-phase)
- Reverse run detection
- Error status indication

19.3.2 Mechanical relay outputs

As an additional option 1 mechanical bi-stable relays (230V, +/-20%, up to 10A) is supported. The assignment of the control output is user-configurable:

- Energy tariff T1-T8 indication
- Maximum demand tariff M1-M4 indication
- Controlled by Real time clock (RTC)
- Controlled by remote commands
- Alarm indication
- End of interval
- Power outage (1ph or 2-phase)
- Reverse run detection
- Error status indication
- Load limitation

19.3.3 Overload Control

With the MCS301 it is possible to use up to 3 outputs for load control opportunities. After exceeding a predefined threshold an output contact can be closed or opened.

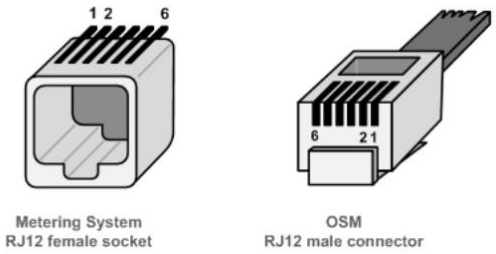
The number of overload exceeds can be counted and/or stored in a log file. The user can define different thresholds for the outputs.

20 Customer interface

The meter can optionally support a customer interface too. This interface is accessible by the customer without breaking any seal.

20.1 Physical interface (P1)

The P1 port connector type is RJ12. The meter holds a female connector; the OSM (Other Service Module) connects via standard RJ12 male plug.



The Pin assignment is listed below

Pin #	Signal name	Description	Remark
1	+5V	+5V power supply	Power supply line
2	Data Request	Data Request	Input
3	Data GND	Data ground	
4	n.c.	Not connected	
5	Data	Data line	Output. Open collector
6	Power GND	Power ground	Power supply line

20.2 Data interface according DSMR 5.0 specification

The protocol is based on EN62056-21 Mode D. The P1 port is activated (start sending data) by setting “Data Request” line high (to +5V). While receiving data, the requesting OSM must keep the “Data Request” line activated (set to +5V).
To stop receiving data OSM needs to drop “Data Request” line (set it to “high impedance” mode). Data transfer will stop immediately in such case. For backward compatibility reason, no OSM is allowed to set “Data Request” line low (set it to GND or 0V).

The interface must use a fixed transfer speed of 115.200 baud. The Metering System must send its data to the OSM device every single second and the transmission of the entire P1 telegram must be completed within 1s.
The format of transmitted data must be defined as “8N1”.

- 1 start bit,
- 8 data bits,
- no parity bit and
- 1 stop bit.

See below example telegram

```
/MCS5\@00000000001234
0-0:1.0.0(101209113020W)
0-0:96.1.1(4B384547303034303436333935353037)
1-0:1.8.1(123456.789*kWh)
1-0:1.8.2(123456.789*kWh)
1-0:2.8.1(123456.789*kWh)
1-0:2.8.2(123456.789*kWh)
1-0:1.7.0(01.193*kW)
1-0:2.7.0(00.000*kW)
1-0:32.7.0(220.1*V)
1-0:52.7.0(220.2*V)
1-0:72.7.0(220.3*V)
1-0:31.7.0(001*A)
1-0:51.7.0(002*A)
1-0:71.7.0(003*A)
1-0:21.7.0(01.111*kW)
1-0:41.7.0(02.222*kW)
1-0:61.7.0(03.333*kW)
1-0:22.7.0(04.444*kW)
1-0:42.7.0(05.555*kW)
1-0:62.7.0(06.666*kW)
0-1:24.1.0(003)
```

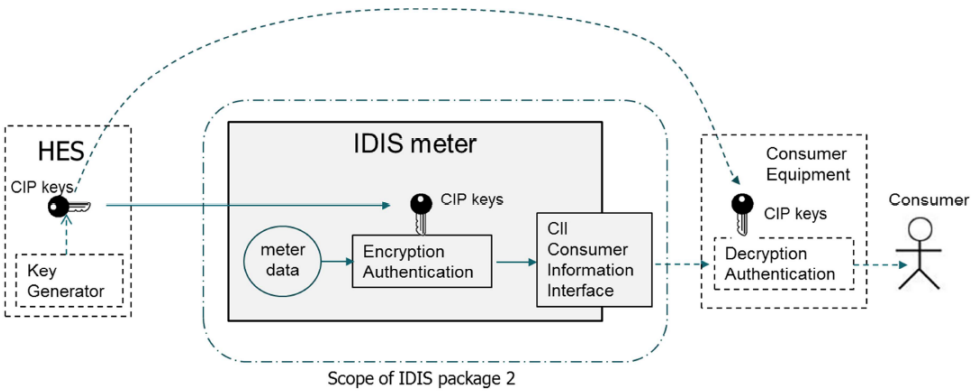
20.3 Data interface according IDIS package 2 specification

The data from the meter pushed to the CII (consumer information interface) are secured (encryption and/or authentication) by the meter.

- If it is secured, then security suite 0 is applied.
- The security material used for this Meter-CII- ConsumerEquipment communication is independent of the security material used for the remote Meter-HES communication.

The CIP security context is defined in a dedicated security setup object. The keys (CIP keys) used for the data pushed to the CII are managed by the HES. To change a CIP key:

1. the HES wraps the new CIP key with the meter's master key,
2. the HES sends the wrapped key to the meter using the method global_key_transfer of the object "Security setup-Consumer Information" (logical_name: 0-0:43.0.1.255) via the Management Client association.



21 Load control relay for external disconnect

In case the CT or CT/VT meter should control an external disconnector the internal 10A load control relay of the meter can be used in 3 different ways.

- Remote Control (via communication)
- Manual (using e.g. a push button)
- Locally (using the load limitation function)

Below 3 states are defined for the internal relay or disconnector (see DLMS blue book):

- Disconnected
- Ready for Reconnection
- Connected

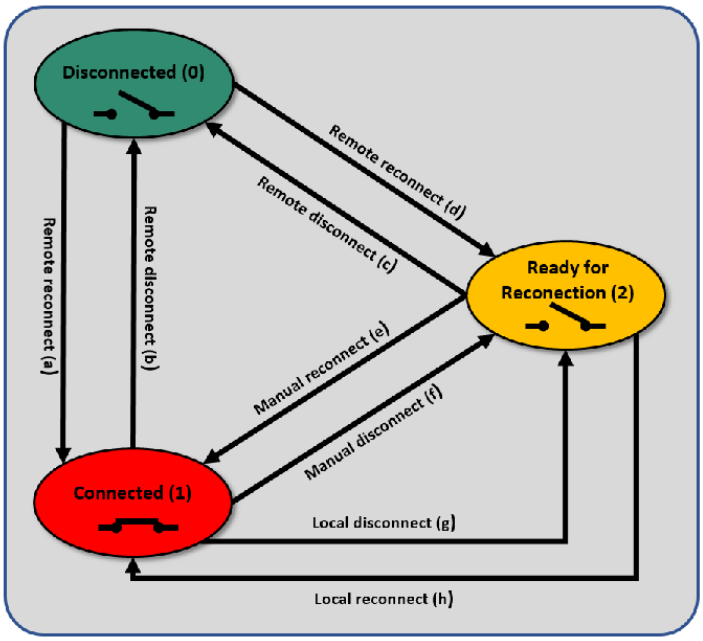


Figure 20: State diagram of the load control relay / disconnector relay

As has been shown in Figure 24, the possible transitions have been specified by letters ("a" to "h"). The different "Control Mode" can be defined based on possible/permissible transitions between states.

Remark: For manipulation reasons the status of the relay is retriggered once every 60s

The defined "Control Modes" are presented below table:

Transition	Transition name	State transition
a	remote_reconnect	Moves the “Disconnector control” object from the Disconnector (0) state directly to the Connected (1) state without manual intervention
b	remote_disconnect	Moves the “Disconnector control” object from the Connector (1) state directly to the Disconnected (0) state without manual intervention
c	remote_disconnect	Moves the “Disconnector control” object from the Ready_for_ reconnection (2) state to the Disconnected (0)
d	remote_reconnect	Moves the “Disconnector control” object from the Discoonector (0) state directly to the Ready_for_reconnection (2). From this state, it is possible to move to the Connected (1) state via the manual_reconnect transisition (e) or local_reconnect transition (h)
e	manual_resconnect	Moves the “Disconnector control” object from the Ready_for _connection (2) state to the Connected (1) state
f	manual_disconnect	Moves the “Disconnector control” object from the Connected (1) state to the Ready_for_connection (2) state. From this state, it is possible to move to the Connected (1) state via the manual_reconnect transisition (e) or local_reconnect transition (h)
g	Local_disconnect	Moves the “Disconnector control” object from the Connected (1) state to the Ready_for_Connection (2) state. From this state, it is possible to move to the Connected (1) state via the manual_reconnect transisition (e) or local_reconnect transition (h) **Note:** transisition (f) and (g) are essentially the same, but their trigger is different
h	local_reconnect	Moves the “Disconnector control” object from the Ready_for_connection (2) state to the Connected (1) state **Note:** transisition (f) and (g) are essentially the same, but their trigger is different

Table 44: Disconnect control status and transitions

21.1 Disconnect control by command

The integrated load control relay for external disconnect purpose offers the attached feature set:

- Remote disconnect (transition b or c)
  - After the relay is switched OFF the appropriate symbol for the OFF position is displayed on the LCD

- a) Remote reconnect (transition a)
  - After the relay is switched ON the appropriate symbol for the ON position is displayed on the LCD

- b) Remote reconnect (transition d)
  - The relay goes in the “Ready for connection” mode, the appropriate symbol on the LCD is in the OFF position and blinking
  - on the LCD display attached message is displayed:

    “PRESS ON”
  - Long Push button pressed
    - When the **“PRESS ON”** message appears on the LCD the customer has to press the push button >2s to switch the relay in the ON position (transition e). After the relay is switched ON the appropriate symbol for the ON position is displayed on the LCD.
  - Short Push button pressed
    - press of the push button (<2s) => the scroll mode is activated for 10s and afterwards the message “PRESS ON” is displayed again

21.2 Disconnect control by schedule

The load control relay can be controlled using the internal clock of the meter. The reconnection is secured in the same way as described above

21.3 Disconnect control by load limitation

The limiter control is intended to limit the demand at a defined value. The limiter issues a command to disconnect the internal relay when the monitored value crosses the threshold value and stay for specific time duration.
The limiter control acts as internal process and change the relay state from **“connected”** to **“ready for reconnection”** and vice versa.
Two disconnecting modes with separate threshold parameters can defined by the meter:

- Normal Operation;
- Emergency Operation;

21.3.1 Load limitation in “Normal operation”

Demand limitation in normal condition is adjustable when energy is transmitted from network to the consumer.

- Whenever the average Power exceeds the normal demand limitation ("y" kW) for more than "x" sec., the internal relay (contactor) will be opened and move to "**Ready for Reconnection**" state.
- If the relay is opened due to exceeding normal demand limitation it remains opened (stay in “**Ready for Reconnection state”**) for a time interval of "T1" min. Afterwards it closes automatically (move to "**Connected" state**). It can alo be reconnected manually or by other automatic mechanism (e.g. scheduler)
- The number of opening of the internal relay after exceeding Normal demand threshold is adjustable (parameter n1). After "n1" times of opening and closing, if the consumption remains more than the demand limitation (Normal threshold), the relay moves to “**Norm. Final State**”.
- The “**Norm. Final State**” can be “**Connected**” or “**Ready_for_reconnection**”.
    - In case of choosing “**Connected**” as “**Norm. Final State**”, the costumer's load should be reconnected and stay connected until central system sends disconnection command.
    - In case of using “**Ready_for_reconnection**” as “**Norm. Final State**”, if the customer was disconnected, the costumer's load will be disconnected and stay in this state until central system send reconnection command (after selecting appropriate relay mode) or connected manually by customer. Also the customers load will be connected after finishing timeout time (T5).

21.3.2 Load limitation in “Emergency operation”

Whenever the emergency profile is activated or deactivated, an active final state is ended and the counters for opening and reclosings are resetted. The load limitation with an activated emergency profile works exactly like the normal load limitation with some different parameters:

- Emergency Threshold
- Emergency number of allowed reclosing
- Emergency reset timeout
- Emergency connection mode of the final state

21.3.3 Final State Situation

When the limiter is in the normal or emergency final state, the connection mode can be:

- **“connected”**
  The load stays connected until the central system sends a disconnection command
- **“ready for reconnection”:**
  The load is disconnected and stays in this state until the central system sends a reconnection command or until it is reconnected manually.

21.3.4 Resetting Reclosing Process

The reclosing process shall be reset in the two following cases:

Case 1 (Before Ending Reclosing Process):
If the reclosing happened less than the number of allowed reclosings, but the next threshold value crossing does not happen during a reset timeout (middle timeout), the reclosing process is reset, counter is set to “0” and relay state moves to connected-state.

Case 2 (After Ending Reclosing Process):
If the limiter is in the final state, it reset after the final state timeout time (end timeout). The counter is reset and the relay is moved back to “connected”. This applies for both final state connection modes.

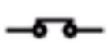
21.3.5 Monitored values

The monitored value for controlling the power can be one of following objects:

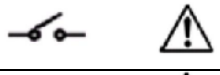
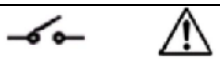
- Average Import Power (+A) (1-0:1.24.0.255);
- Average Net Power (|+A|-|-A|) (1-0:16.24.0.255);
- Average Total Power (|+A|+|-A|) (1-0:15.24.0.255);

21.3.6 Internal relay status Symbol on LCD

The internal relay can be in three states as “Connected”, “Ready for Reconnection” and “Disconnected”. Each state is shown on meter’s LCD by a dedicated symbol.

State	Symbol on LCD	Remark
Disconnected		
Ready for connection		Blinking symbols
Connected		

The limiter can acts in normal or emergency modes. The combination of relay and danger symbols is used to show the limiter situation on LCD. Below table shows the combinations:

State	Symbol on LCD	Remark
Limiter, Normal Condition		Only relay symbol is blinking
Limiter, Emergency Condition		Both Symbols are blinking

22 Communication module

For Smart Metering or C&I applications a communication module will fit under the terminal cover of the MCS301 meter, see fig 24.

Figure 21: MCS301 with communication module

The interface between meter and communication module provides the following feature set:

- The module is powered from the meter
- Uart interface between meter and communication module
- Transparent communication, using the DLMS/COSEM protocol of the meter

With this solution different communication module are supported:

- **COM200**
  GSM/GPRS module
- **COM210**
  LTE module
- **COM300**
  Ethernet based module
- **COM400**
  adapter module

More details are described in the specific user manual of the COM modules

23 Security functions

23.1 Status and Fatal Error messages

The status of the alarm and Fatal error register can be displayed on the LCD or readout through the optical or electrical interface. The Alarm Register is intend to log the occurrence of any alarms. This is a four bytes register. If any alarm occurs, the corresponding flag in alarm register is set. All alarm flags in the alarm register remain active until the alarm registers are cleared.

23.1.1 Display of alarm register 1

OBIS code of the alarm register 1: **0-0:97.98.0**

The bit assignment of the alarm register 1 is shown below

Bit	Alarm Description
0	Clock Invalid
1	Battery Replace
2	Reserved
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	Reserved
8	Program Memory Error
9	RAM Error
10	NV Memory Error
11	Measurement System Error
12	Watchdog Error
13	Fraud Attemp
14	Reserved
15	Reserved
16	M-bus Communica on Error Ch1
17	M-bus Communica on Error Ch2
18	M-bus Communica on Error Ch3
19	M-bus Communica on Error Ch4
20	M-bus Fraud A empt Ch1
21	M-bus Fraud A empt Ch2
22	M-bus Fraud A empt Ch3
23	M-bus Fraud A empt Ch4
24	Permanent Error M-bus Ch1
25	Permanent Error M-bus Ch2
26	Permanent Error M-bus Ch3
27	Permanent Error M-bus Ch4
28	Battery low on M-bus Ch1
29	Battery Low on M-bus Ch2
30	Battery Low on M-bus Ch3
31	Battery Low on M-bus Ch4

Table 45: Alarm register 1

23.1.2 Display of alarm register 2

The OBIS code of the alarm register 2 is: **0-0:97.98.1**

The bit assignment of the alarm register 2 is shown below

Bit	Alarm Description
0	Power Down
1	Power Up
2	Voltage Missing Phase L1
3	Voltage Missing Phase L2
4	Voltage Missing Phase L3
5	Voltage Normal Phase L1
6	Voltage Normal Phase L2
7	Voltage Normal Phase L3
8	Missing Neutral
9	Phase Asymmetry
10	Current Reversal
11	Wrong Phase Sequence
12	Unexpected Consumption
13	Key Exchanged
14	Bad Voltage Quality L1
15	Bad Voltage Quality L2
16	Bad Voltage Quality L3
17	External Alert
18	Local Communication Attempt
19	New Mbus Device Installed Ch1
20	New M-bus Device Installed Ch2
21	New M-bus Device Installed Ch3
22	New M-bus Device Installed Ch4
23	Reserved
24	Reserved
25	Reserved
26	Reserved
27	M-bus Valve Alarm Ch1
28	M-bus Valve Alarm Ch2
29	M-bus Valve Alarm Ch3
30	M-bus Valve Alarm Ch4
31	Disconnect/Reconnect Failure

Table 176: Alarm Register 2

23.1.3 Display of Fatal Error register

The OBIS code of the error message register is: **0-0:97.97.1**

The bit assignment of the Fatal error register is shown below

Bit	Alarm Description
0	Reserved
1	Reserved
2	Program Memory Error
3	RAM Error
4	NV Memory Error
5	Measurement System Error
6	Watchdog Error
7	Reserved

Table 47: Fatal error messages

23.2 Terminal cover removal detection

Every terminal cover removal will be detected by the meter with following actions:

- Log file entry with time & date stamp
- The appropriate Fraud attempt Bit in the alarm register 1 is set and can be displayed on the LCD or readout by any interface
- This feature is available during power outage
- The terminal cover opening alarm can be reset by command
- In case the terminal cover is placed again, the appropriate alarm register Bit is cleared automatically

23.3 Main cover removal detection

Every main cover removal will be detected by the meter with following actions:

- Log file entry with time & date stamp
- The appropriate Fraud attempt Bit in the alarm register 1 is set and can be displayed on the LCD or readout by any interface
- This feature is available during power outage
- Main cover opening alarm can be reset by command (specific access rights needed)

23.4 Magnetic field detection

Every magnet field detection will be detected by the meter (in case the event stays longer than 30s) with following actions:

- Log file entry with time & date stamp
- The appropriate Fraud attempt Bit in the alarm register 1 is set and can be displayed on the LCD or readout by any interface
- The magnet field detection alarm can be reset by command

23.5 Comms module removal detection

Every Comms module removal will be detected by the meter with following actions:

- Log file entry with time & date stamp
- The appropriate Fraud attempt Bit in the alarm register 1 is set and can be displayed on the LCD or readout by any interface
- The comms module removal alarm can be reset by command

23.6 Detection of current flow without voltage

In case no voltage is connected to the meter but still a current is flowing, this event can be detected by using 3 register, which are counting the Ah consumption of the meter (only in case no voltage is connected);

- Register for measuring Ah in phase L1 without voltage in phase L1 1-0:31.8.0.255
- Register for measuring Ah in phase L2 without voltage in phase L2 1-0:51.8.0.255
- Register for measuring Ah in phase L3 without voltage in phase L3 1-0:71.8.0.255

23.7 Meter reprogramming protection

23.7.1 Password protection (LLS)

The MCS301 meter possesses different security levels for meter reprogramming in case the LLS (Low Level Security) is activated only.

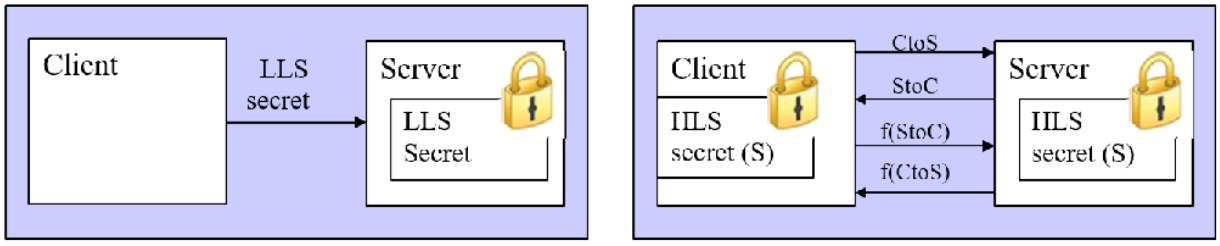
- Different access rights for all clients
- Password for all parameter changes
- Hardware protection for specific billing parameters

23.7.2 High level security (HLS)

The HLS security is implemented according the DLMS Blue Book (edition 12.1th) and the Green book (edition 8.1th) with the provision of.

23.7.2.1 Data access security

Definitions for authentication mechanism for high-level-security (HLS) of the sign-on process between clients and server.

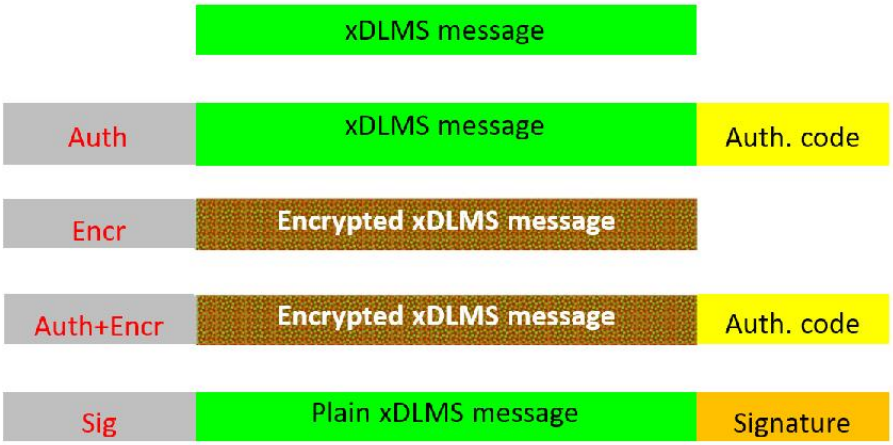


- Authentication: verifying the claimed identity of the partners before data exchange
  - identification elements: system title, client user id, Service Access Point (SAP)
- Authentication procedures
  - no security: „public" access, no identification takes place
  - LLS, Low Level Security authentication: server identifies client by password
  - HLS, High Level Security authentication: mutual identification
    - exchange challenges
    - exchange result of processing the challenge using different algorithms
- Different Associations may use different Authentication mechanisms
- All Association events may be logged in Event logs

23.7.2.2 Data transport security – message (ADPU) protection

Definitions for a security context with a security policy, security suite and the security material elements.

- Cryptographic protection to messages – xDLMS APDUs – during transport
  - authentication to ensure authenticity (legitimate source) and integrity of messages
  - encryption to ensure confidentiality
  - authenticated encryption to provide both
  - digital signature: authentication and non-repudiation
    these can be applied in any combination, separately on requests and responses



- Protection determined by
  - security policy: sets general message protection requirements
  - access rights: sets local, COSEM object attribute / method level
  - protection requirements
  - the stronger requirement applies
  - protection can be applied independently on requests and responses

23.7.3 Hardware protection

The MCS301 meter can be configured by using one of its interfaces (electrical or optical). All parameters are secured at least by a password. Billing relevant parameters can be additionally secured by a HW jumper:

- After opening the meter main cover, the user has access to the parameterization button.
- After setting the jumper (2 pins need to be connected) the meter parameterization mode is enabled. All cursors on the LCD are flashing

After removing the jumper, the meter parameterization is disabled again.

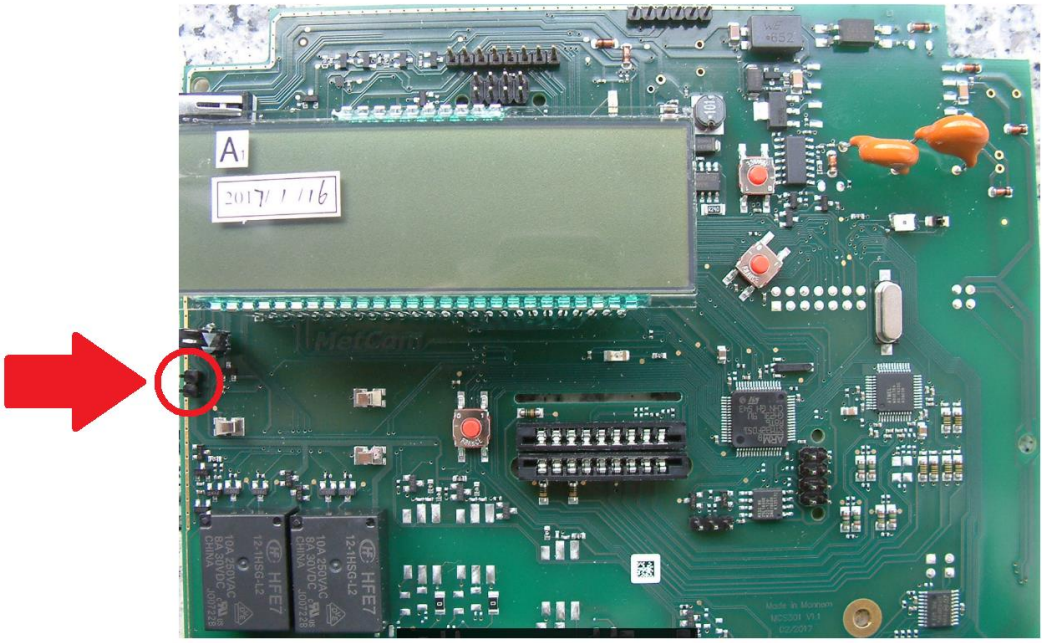


Figure 22: Parameterization jumper of the MCS301

Below parameter can be secured by an additional HW jumper (configurable):

- All calibration data (always protected)
- Configuration of energy measurement parameters for active and reactive energy
- Configuration of demand measurement parameters for active and reactive demand
- Reset of energy register
- Reset of load profile data
- Change of load profile 1 and 2 data
- Change of specific display data, which are billing relevant
- Change of pulse constants
- Change of CT/VT ratio

23.8 Summary of Anti Tampering features

Below Anti Tampering Features are supported by the meter:

- **Terminal cover opening detection**

  To manipulate the meter in most cases the terminal cover has to be opened. This event can be stored with time and date stamp.

- **Main cover opening detection**

  The opening of the certified main cover is detected in the same way like the terminal cover opening.

- **Magnetic manipulation detection**

  In case a big magnetic is used nearby the meter this event will be detected

- **Security concept**

  The tampering of the meter configuration is secured by different security levels (LLS and/or HLS).

- **Log file**

  All tampering issues, power outages, etc. can be stored with time and date stamp in the log file of the meter

- **Detection of anti-creep conditions**

  The duration of anti-creep conditions can be measured by the meter. This can be used as an indication of meter manipulation.

- **Always run positive measurement**

  The meter can be configured in that way that it always the total energy is measured, even in the case of reverse energy flow.

- **Reverse run detection**

  The reverse energy measurement can be used for detect tampering. In that case the exact “tampered energy value” is available

- **Wrong password access**

  In case several times a wrong password is used, the communication will be blocked by the meter until the next demand reset.

24 Line loss and transformer loss measurement

24.1 Line loss (copper loss) measurement

The meter supports the line loss measurement as attached:

- The cupper losses **I^2h** are stored in separate energy register.
- Use of 2 separate register depending on the energy direction (with 4 decimals)
- Support of historical data (up to 15)
- The decimals for the line loss energy register is independently configurable from the energy register
- The cupper loss constant is not stored in the meter. To get the final losses the energy value of the meter has to be multiplied by the constant “R” entered in the unit Ohm.

24.2 Transformer (iron loss) measurement

The meter supports the transformer loss measurement as attached:

- The line losses **U^2h** are stored in separate register
- Use of 2 separate register depending on the energy direction (with 4 decimals)
- Support of historical data (up to 15)
- The decimals for the transformer loss energy register is independently configurable from the energy register
- The iron loss constant is not stored in the meter. To get the final losses the energy value of the meter has to be divided by the constant “X” entered in the unit kOhm.

25 FW Upgrade

The remote FW update follows below definitions. The following objects support this functionality:

Object / Attribute Name	Class	Ver.	OBIS code
Image transfer	18	0	0-0:44.0.0.255
Image transfer activation scheduler	22	0	0-0:15.0.2.255
Predefined Scripts - Image activation	9	0	0-0:10.0.107.255
Active firmware identifier	1	0	1-0:0.2.0.255
Active firmware signature	1	0	1-0:0.2.8.255
Active firmware identifier 1	1	0	1-1:0.2.0.255
Active firmware signature 1	1	0	1-1:0.2.8.255
Active firmware identifier 2	1	0	1-2:0.2.0.255
Active firmware signature 2	1	0	1-2:0.2.8.255

Table 48: FW Upgrade objects

The active FW identifiers and the version signatures of all individual parts of the firmware are available for readout using the corresponding objects.
The B field of the OBIS codes gives a clear identification of the individual firmware parts

- The **metrological** relevant part of the FW uses B=0.
- The main **application** part (non-metrological relevant) of the FW uses B=1
- Other parts (e.g. modem firmware) must use a B field value in the range of B=2..9.

Every image for download to the E-meter requires a digital signature. The Companion Standard specifies the usage of the following algorithm

=> ECDSA P-256.

In order to ensure the correct reception of the FW (Firmware) when servers (meters) from different vendors are upgraded, the broadcast services are not used. Only unicast (as default) and multicast services can be used in firmware upgrade process.
The meter is able to store two versions of firmware. The current version that is used and the new version that is intend to be installed. The meter is not allowed to discard any of the stored firmware (current or old versions) until the final confirmation of new firmware has been done and the new version has been installed.
The Firmware Upgrade is done based on DLMS/COSEM image transfer services and the new firmware will be sent to devices by image transfer object. The FW upgrade process is done in 4 main steps as follows:

- Initial Phase;
- Firmware (Image) Transfer;
- Firmware (Image) Check;
- Firmware (Image) Activation;

25.1 Initial Phase

The initial phase is the first phase of firmware upgrade process. In this phase the information of new firmware (image) is sent to the target server. This includes the following information:

- Firmware Identifier
- Firmware Size

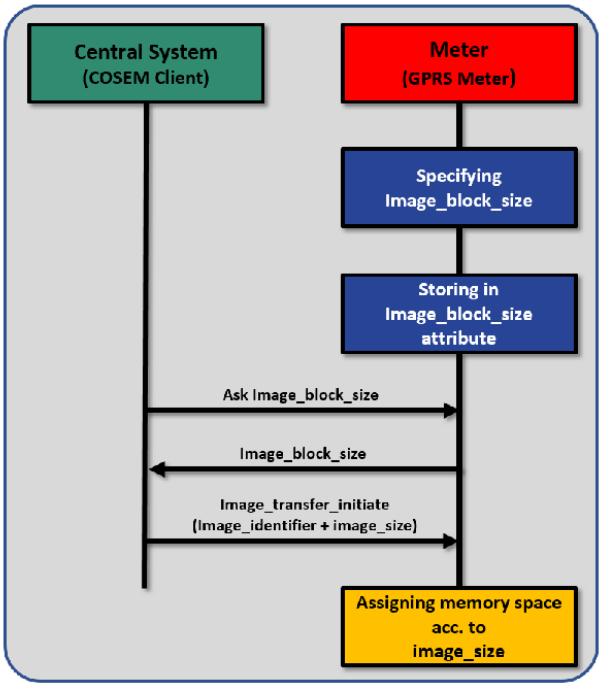


Figure 23: FW Upgrade

After successful initiating, the server assigns the required memory space for new FW and waits to receive it. The value of the "Image Transfer" COSEM object is set to "1" to show the successful initiation.

25.2 Image Transfer

After successful initiation, the value of the image_transfer_status attribute of “Image Transfer” object (0-0:44.0.0.255) will be set to "1" (in meter). It means the firmware upgrade process has been successfully initiated and servers (meters) are ready to receive image blocks from client. In this step, the image blocks are transferred to servers sequentially.

Note: if any communication problems happens during image transfer, the process will be continued (from the last block that has been sent) automatically as soon as the communication established again.

25.3 Image Check

After successful transferring of new firmware (image), the server (meter) starts checking the received file. If new firmware (image file) passes successfully all of check, the "Firmware Ready for Activation" event will be generated and the next step in firmware upgrade process (activation step) can be started. If one of these checks has not been done successfully, an event will be generated.

25.4 Firmware (Image) Activation

The firmware (image) activation is the last step of FW upgrade process. The FW activation will be done at time and date specified by central system. The FW activation includes 3 steps:

- Using (Activating) New Firmware;
- Testing New Firmware;
- Discarding Firmware (New or Old);

In the first step, the old firmware will be replaced by new FW and the meter will reboot with the new version of FW. After new FW activation, it enters the next step (Testing New FW).

25.4.1 Firmware Activation Time

The activation time of all firmware is specified by central system. The firmware activation can be done via one of two following ways:

- Immediate Activation;
- Scheduled Activation;

25.4.2 Firmware (Image) Activation Process

Three COSEM objects are involved in firmware (image) activation process, see below:

- Image Transfer Activation Scheduler (0-0:15.0.2.255);
- Image Activation Scripts (0-0:10.0.107.255);
- Image Transfer (0-0:44.0.0.255);

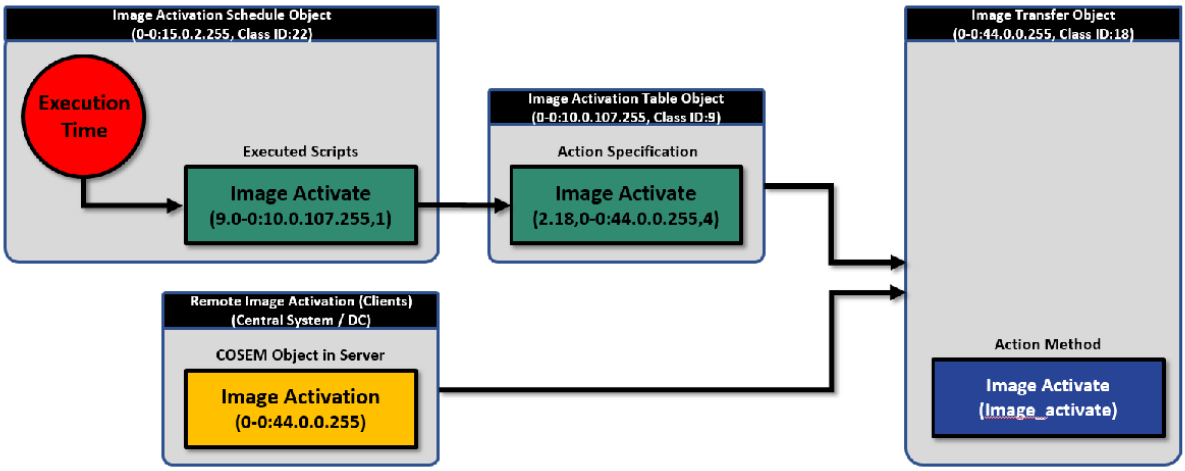


Figure 24: FW activation process

As indicated in Figure 28, the main trigger of new firmware (image) activation is the time (and date) specified in Image (Transfer) Activation Schedule object.
The on-demand activation by central system has higher priority over two other activation mode. It means, the central system can activate the new firmware even it has been scheduled.
After successful activation of new firmware, an event will generated by server. If the meter can't activate the new firmware the meter discards the new FW and reboots again with old FW.

Note: If power-off situation happens during FW activation, the meter reboots again with old FW, but the new FW is not discarded. In this case, the meter waits for activation command from central system.

25.5 Active Firmware Identification

Each firmware is specified by a unique number called Firmware (Image) Identification. This is a six bytes octet-string value. The identification of all images (firmware) used in devices stored in the following COSEM objects.

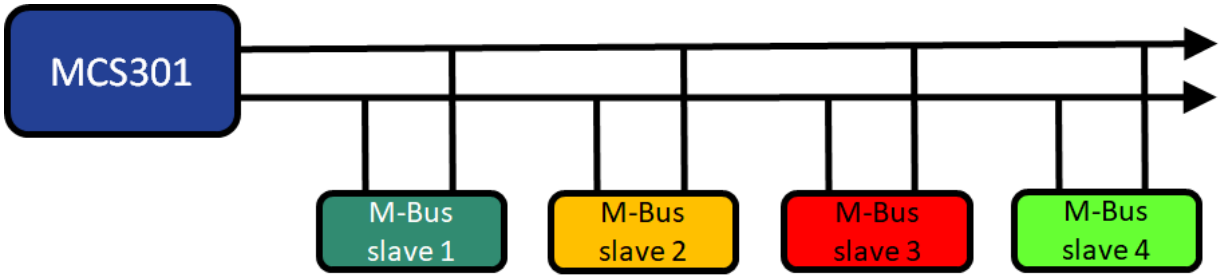
- Active FW Identifier (Metrology Relevant FW) (1-0:0.2.0.255);
- Active FW Identifier 1 (Meter Application relev. FW) (1-1:0.2.0.255);
- Active FW Identifier 2 (GPRS Comms Module FW) (1-2:0.2.0.255);

Each COSEM object keeps the list of images (firmware) identification in each group of images (firmware). Each object includes an array with at least 10 elements. It means, each object can store 10 identification. COSEM client (Central System) can know about the version of active images (firmware) in each device by reading the value of mentioned object

26 M-Bus support

26.1 General

The MCS301 meter supports wired M-Bus communication interface and functions as a communication master, while other devices connected to the E-meter function as slaves.



The MCS301 meter allows a total maximum current consumption of up to 5 unit loads where one unit load is defined as the maximum mark state current of 1.5 mA.
The data of the M-Bus devices are mapped to COSEM objects in the E-meter (According to EN 13757-3). The M-Bus devices are accessed via COSEM objects in the E-meter (not transparent access through electricity meter). The required functions and data mapping model are defined in this document. The physical interface for communication with gas/water meters is wired M-Bus, but the provisions are provided to convert it to wireless (by using convertor/transceiver) in wireless M-Bus applications.

Wired M-BUS definitions

- The format class FT1.2 of EN 60870-5-1 and the telegram structure is used according to EN 60870-5-2.
- The wired M-Bus is based on the EN 13757-2 physical and link layer.
- The baud rate is 2400 b/s, E,8,1

Uniqueness of M-bus device identification

According to EN 13757-3 the following 4 parameters are needed to guarantee uniqueness of the M-Bus device identification:

- Fabrication Number (DIF/VIF);
- Manufacturer (header of M-Bus frame);
- Version (header of M-Bus frame);
- Medium (header of M-Bus frame).

Below information for an uniquely identification of the device are provided:

M-Bus Information	object model information
Fabrication Number	Object (IC 1): “M-Bus Device ID 1 channel X” Type octet string containing the ASCII encoded fabrication number. The length of the octet string matches the length of the fabrication number.
Manufacturer	Object (IC 72): M-Bus client channel X Attribute: manufacturer_id
Version	Object (IC 72): M-Bus client channel X Attribute: version
Medium	Object (IC 72): M-Bus client channel X Attribute: device type

Conversion of M-Bus VIF into COSEM scaler_unit

In the MCS301 meter the scenario 2 is used

1. The E-meter automatically configures the COSEM scaler_unit according to the corresponding information contained in VIF.
2. The COSEM scaler_unit is manually configured in the E-meter. In this case the E-meter automatically converts the values coming from the M-bus device considering the information provided by VIF.

26.2 Device ID's for M-Bus meters

Device ID's are stored in dedicated COSEM objects from interface class 1. The device ID's that have been used in sub meters are as following table:

Device ID	Type	Description	COSEM Object	Remark
M-Bus Device ID 1, channel 1,2,3,4	Octet-string (0-48)	Fabrication Number	0-b:96.1.0.255	On installation
M-Bus Device ID 2, channel 1,2,3,4	Octet-string (0-48)	Reserved	0-b:96.1.1.255	

26.3 M-Bus profile

E-meter saves the load profile of sub-meter for up to 4 M-BUS channels.

	Features	
Load Profile M-Bus 1,2,3,4 (0-b:24.3.0.255)…..)	Min capacity:	At least 52 days for daily recording
	Default captured objects:	Clock; profile status; M-Bus intances 1 .. 4
	Capture period:	Choice (60, 300, 600, 900, 1800, 3600, 86400)
	Sorted method:	Sorted by FIFO, smallest
	Selective Access:	By range: mandatory

Profile status

The Profile Status provides complementary information about the stored values in profiles buffer. The HES/MDM system will use this information to decide about the validity of collected values. The content of Profile Status is captured for every entry (in buffer).

The size of Profile Status is one byte and each bit shows a critical situation in meter as shown in following figures for different profile status.

ID	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Description	Power Down	Reserved	Clock adjusted	Reserved	Daylight saving	Data not valid	Clock invalid	Critical Error

26.4 Connect/Disconnect for M-Bus meters

Relay Disconnection/Reconnection of sub-meters can be done either remotely or manually / locally. In case of need for a scheduled control of relay, it will be handled by COSEM objects "Discount/Reconnect Control Scheduler". This schedule can be used for both disconnection and reconnection of internal relay.

26.5 Event management for M-Bus meters

The E-meter is able to log the events related to sub-meters with time stamp, E-meter manages the events of sub meters using these objects:

- Event Objects - M-BusMaster Control logs 1,2,3,4
- M-BusMaster Control log object 1,2,3,4
- Event Object - M-Bus Event Log
- M-Bus Event Log

26.5.1 M-Bus event codes supported by the meter

The following events are supported by the E-meter and are recorded in the relevant log files

- Communication Error M_Bus channel [1..4]
- Communication OK M-Bus channel [1..4]
- Battery must replace M_Bus [1..4]
- Fraud attempt M_Bus [1..4]
- Clock adjusted M_Bus [1..4]
- New M_Bus device installed M_Bus [1..4]
- Permanent error M_Bus [1..4] (Bit 3 M_bus status EN13757)
- Manual disconnection M_Bus [1..4]
- Manual connection M_Bus [1..4]
- Remote disconnection M_Bus [1..4]
- Remote connection M_Bus [1..4]
- Valve alarm M_Bus [1..4]
- Local disconnection M_Bus [1..4]
- Local connection M_Bus [1..4]

26.5.2 Alarm register

Carries the Alarm state specified in EN 13757-3:2013 Annex D. It is updated with every readout of the M-Bus slave device.

Bit Number	Description
0	Battery replacement
1	Fraud attempt
2	Manual disconnection
3	Manual connection
4	Remote disconnection
5	Remote connection
6	Local disconnection
7	Local connection

Table 49: M-Bus Alarm register

26.5.3 Status information

Carries the Status byte element of the data header as specified in EN 13757-3:2013, 5.10, Table 68 and 69. It is updated with every readout of the M-Bus slave device.

Bit	Meaning with Bit Set	Significance with bit no Set
0,1	See below table	See below table
2	Power low	Power ok
3	Permanent error	No permanent error
4	Temporary error	No temporary error
5	Valve alarm M-Bus	No valve alarm
6	Manufacture specific	Manufacture error
7	Manufacture specific	Manufacture error

Table 50: M-Bus Status information

Power low Warning

The bit “power low” is set only to signal interruption of external power supply or the end of battery life.

Permanent error Failure

The bit “permanent error” is set only if the meter signals a fatal device error (which requires a service action). Error can be reset only by a service action.

Temporary error Warning

The bit “temporary error” is set only if the meter signals a slight error condition (which not immediately requires a service action). This error condition may later disappear.

Any application error

Shall be used to communicate a failure during the interpretation or the execution of a received command, e.g. if a not decrypt able message was received.

Abnormal conditions

Shall be used if a correct working application detects an abnormal behavior like a permanent flow of water by a water meter.

Capture data from M_bus device

“Capture definition element”, Provides the capture_definition for M-Bus slave devices.

26.6 Data encryption for M-Bus channels

Configuration bytes, carries the Configuration field as specified in EN 13757-3:2013, 5.12. It contains information about the encryption mode and the number of encrypted bytes. It is updated with every readout of the M-Bus slave device.

- Encryption according to the AES-128
- Cipher Block Chaining (CBC) method
- coding of the config field for AES encryption mode with a dynamic initial vector is 5

26.7 M-Bus installation

M-Bus installation process can be activated by 3 different actions:

- locally or remotely using a communication interface (remark: only devices with primary address can be installed in that mode)
- pressing the Reset button, while the meter is in the “Reset mode”
- after power up of the meter.

After activation of the installation procedure the E-meter scans for physically connected M-Bus devices for addresses from 1 to 4, and then also for address 0. After the M-Bus device is registered in the MCS301 meter the regular communications can begin.

26.7.1 Scan for M-Bus devices

The MCS301 meter manages a list of connected devices and their addresses. The list can hold 4 M-Bus devices. During installation, the MCS301 will scan for devices on the wired M-Bus. All responding devices will be registered in the list. Two different methods are supported to discover M-Bus devices connected to the MCS301 meter:

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

Poll for M-Bus devices with Address 0

The address 0 is reserved for unconfigured M-Bus devices. Each unconfigured M-Bus device shall accept and answer all communication to this address. The MCS301 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”.

Poll for Devices with Unregistered Address

The Poll method is based on the procedure according EN 13757-3 (chapter 11.5.1). In case at least one channel is still empty, the E-meter scans for unused M-Bus addresses in the range from 1-4 and assigns the new address to the free channel of the E-meter.

26.7.2 M-Bus installation Flag

In case at least 1 (out of the maximum of 4 M-Bus) meter is successfully connected to the MCS301 meter an arrow on the meter LCD, marked with “M”, is displayed.

27 GPRS support

This interface is based on IP network and SMS service. The DLMS protocol is used for data exchange between electricity meters and HES. The HES acts as DLMS client and the E-meter as DLMS server. The following communication services are provided:

- GPRS
- SMS (Wake-up)

Two operating modes are used in this interface as follows:

- Pull or Push

The “Pull” mode is initiated by HES. It is used for collecting data from meters or sending commands to meters and consumer’s interface. The “Pull” is using following DLMS services:

- OPEN
- RELEASE
- GET or SET
- Action

The “Push” mode is initiated by the meter to send critical information such as Alarms and so on to the HES. The DATA-NOTIFICATION service of DLMS is used in this mode. Following table shows the DLMS services in Pull and Push modes for IP-based or SMS communication.

Operating Mode	DLMS Services	
	IP Communication	**SMS Communication**
Pull	GET, SET, ACTION (Confirmed)	SET, ACTION (Unconfirmed)
Push	DATA-NOTIFICATION (Unconfirmed)	DATA-NOTIFICATION (Unconfirmed)

27.1 Identification and Addressing

In COSEM TCP-UDP/IP based network (in WAN level), all COSEM physical devices are identified in system by their network IP address. This is an address in network layer of each device. There are 3 types IP addresses in each device in network for different addressing purpose. They are as follows:

- Broadcast IP Address
- Multicast IP Address
- Device Unique IP Address

27.1.1 Broadcast IP Address

The Broadcast address is an address at which all devices connected to network are enabled to receive datagrams. A message sent to a broadcast address is typically received by all network attached hosts. This is an all-ones rest field IP address and can be defined in each defined network.

27.1.2 Multicast IP Address

The Multicast address is an address for a group of devices in network, that are available to process datagrams or frames intended to be multicast for a designated service. The several groups can be defined in system according to different requirements and a multicast IP address will be assigned to each group. The Multicast IP address of each device will be specified by Central System.

27.1.3 Device Unique IP Address

The Device Unique IP address assigned to device in network. The meter should support both of the static and dynamic IP address types.

27.2 Push Process

The push process is defined by using three main groups of COSEM objects as follows:

- Triggering Objects
- Script Table
- Push Set-up

Below figure depict the COSEM objects are involved in the Push process and their relationship:

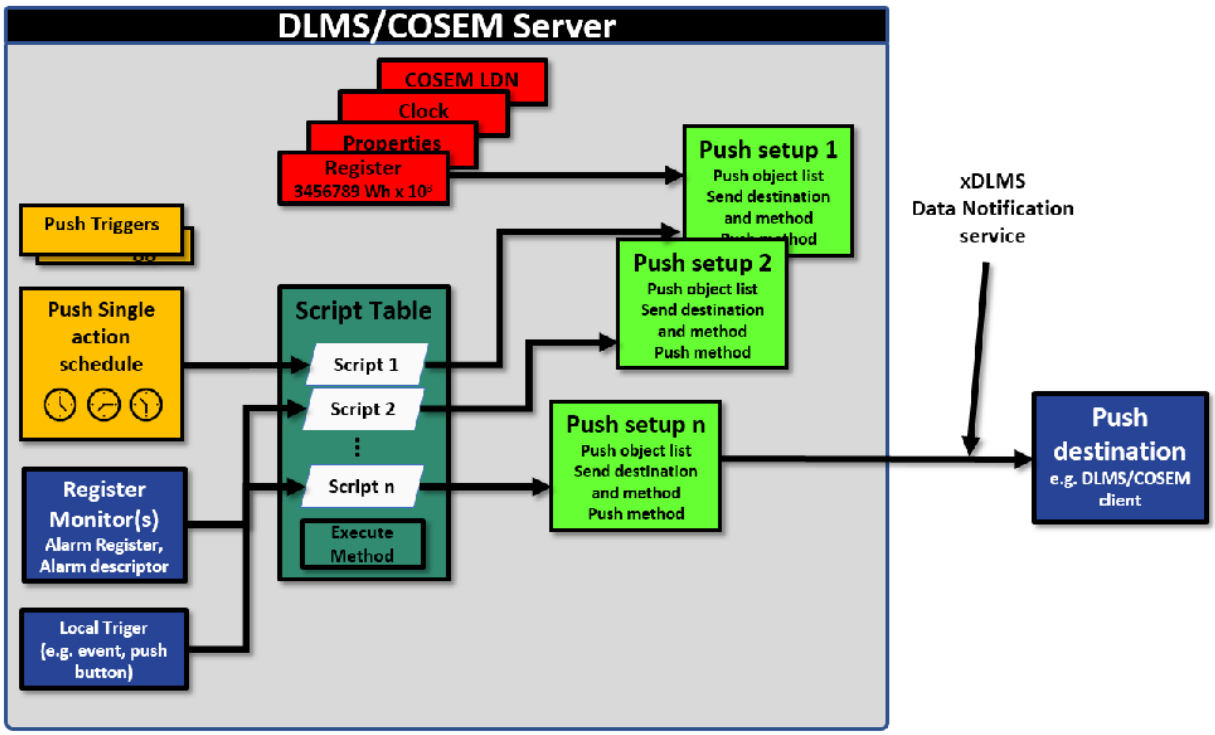


Figure 25: Pushing Process

As shown in Figure 33, the devices can be woken up by a trigger (internally or externally) to connect to network and exchange data with Central System. This is called Triggering Process. The following COSEM objects are considered to provide triggering:

- Push action scheduler – Interval_1
- Push action scheduler – Interval_2
- Push action scheduler – Interval_3
- Alarm Monitor 1
- Alarm Monitor 2
- Auto Answer (SMS)

A trigger calls a script in Push Script Table (0-0:10.0.108.255) and the called script invokes the "Push" method of relevant "Push Setup" objects. At the end, the "Push" method of "Push Setup" object sends the specified message/data to Central System.

27.2.1 Triggering Scheduler

3 different schedules can be used for triggering the making GPRS connection and pushing message to the HES. They are as follows:

- Push action scheduler – Interval_1
- Push action scheduler – Interval_2
- Push action scheduler – Interval_3

The "Push action scheduler – Interval_1" is intended to trigger making connection with CS (Central System) at the specific time or regular fashion to activate the PDP context and establish new GPRS session. This will be done to establish connection with Central System at some specific time points.

27.2.2 Triggering by Alarm

If an Alarm happens, the GPRS connection can be established and the Alarm Descriptor will be sent to CS (Central System). The COSEM objects "Alarm Monitor 1" (21, 0-0:16.1.0.255) and “Alarm Monitor 2” (21, 0-0:16.1.1.255) are used to handle triggering by Alarm.
If an Alarm happens in device, these objects call a fourth script in "Push Script Table" object (9,0-0:10.0.108.255) and the called script invokes the "Push" method of "Push Setup-Alarm" object (40, 0-4:25.9.0.255). The "Push Setup-Alarm" objects send the Alarm Descriptor Central System.

27.2.3 Triggering by GPRS Connection Detection

The Push on GPRS Connection Detection (Connectivity) is triggered each time a new network connection is established. A new network connection may be caused internally (e.g. reconnection in mode 101 -always ON mode-, starting a new connection window in mode 102 and 103) or externally by sending a wake-up signal to the meter in mode 104 –wake-up by trigger- or 103 -SMS.
The SMS (as external triggering) is handled by “Auto Answer” COSEM object (28, 0-0:2.2.0.255). The listening window is always ac ve in case of external triggering mechanism is used. The device answers (receives) only (message from) to the calling numbers that are specified in "list_of_allowed_callers" attribute of mentioned COSEM object.

27.2.4 Push protocol

Two different protocol/formats can be used to push the data to one of the selected targets

- **EN62056-21 data format**

  The data format of this push type is identical to the protocol EN62056-21, Mode C

```
Example:    <STX>96.1.0(1MCS17100000051)<CR><LF>
            0.9.1(14:45:59)<CR><LF>
            0.2.2(12345678)<CR><LF>
            1.8.1(123.34kWh)<CR><LF>
            1.8.2(37.57kWh)<CR><LF>
               ....
            2.8.2(101.23kWh)<CR><LF>
            !<CR><lf>
            <ETX><BCC><CR><LF>
```

- **DLMS/COSEM data format**

  The data format of the DLMS push type is identical to the COSEM format

```
Example:    <STX>96.1.0(1MCS17100000051)<CR><LF>
```

  …….

27.2.5 Push targets

Up to 5 different push targets can be selected using different lists of push parameters

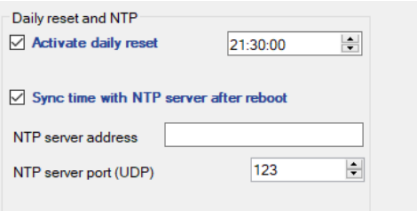
- **Push target - TCP**
  TCP server settings
  - Server
  - Port number
- **Push target - UDP**
  UDP server settings
  - Server
  - Port number
- **Push target - SMS**
  SMS server settings
  - Phone number
- **Push target - E-Mail**
  Email settings
  - Recipient
  - sender
  - subject

  SMTP server settings
  - Server
  - Port number
  - User name
  - Password
  - Mode
- **Push target – FTP**
  FTP file
  - File name

  FTP server settings
  - Server
  - Port
  - User name
  - Password
  - Timeouts
  - Mode

27.3 Time synchronization using NTP

In combination with the COM200 module the time&date of the meter can be synchronized using a NTP server. Below setting are needed:



Time and date of the meter are synchronized after every reset, which occurs after power-up or at a specific (configurable) date of the day

28 Client and Server architecture

The Meter consists of one COSEM Logical Device (LD name: 0-0:42.0.0.255, SAP: 001), which supports a

- Public Client (SAP: 016)
- Pre-established Client (SAP: 102)
- Management Client (SAP: 001)
- Reading Client (SAP: 002)

The Public client is provided for reading meter's general information (e.g. logical device name). Because of lowest access level security (no security) in this type of association, this client is permitted to reveal some limited information of meter, and is not allowed to read metering data and performing any programming or changing in meters settings.

The Pre-established client is intended to perform broadcasting and multicasting services (unconfirmed) services. This type of association includes only the message exchange (not establishing and releasing). The Pre-established can be considered as an association that has been established previously. The Pre-established association can't be released.

The Management client is allowed to perform any operation on devices in point to point connections. Both services like "Confirmed" and "Unconfirmed" service can be used.

Reading client is for parameters and energy data reading mostly in local access.

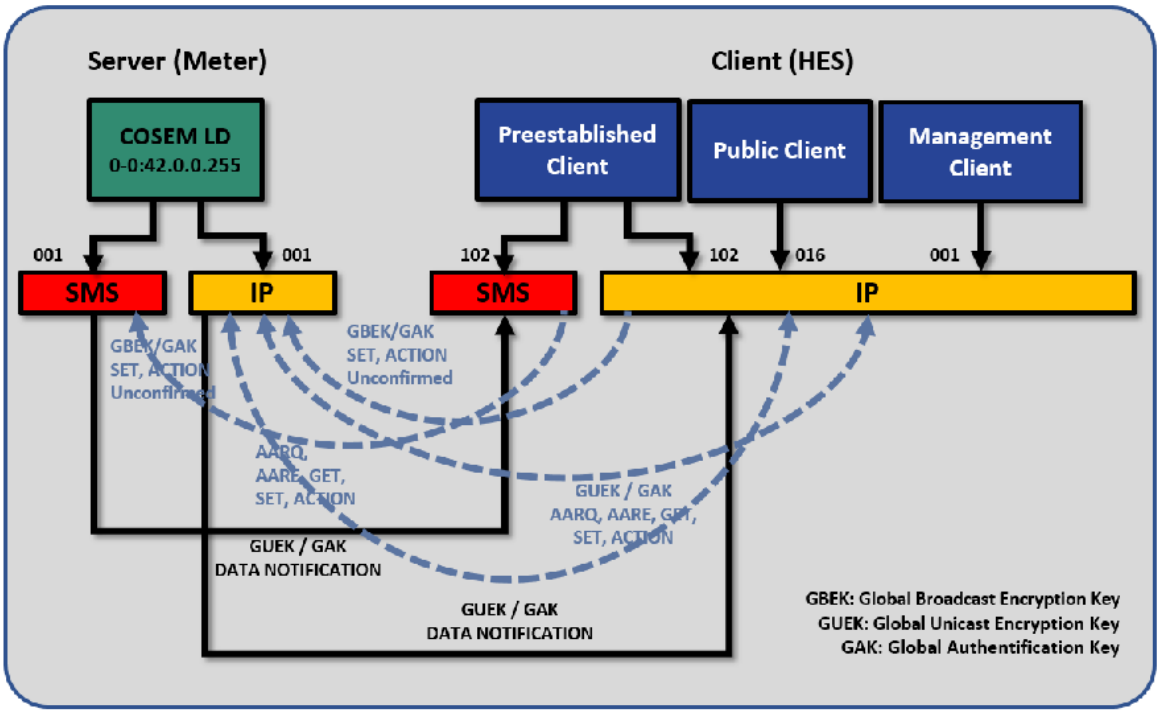


Figure 26: Client and Server model

The following restrictions apply for the SMS channel:

- Only unconfirmed services can be used.
- The SMS channel can only be used from/to the Pre-established client at HES side.
- In direction to the meter the Broadcast Key must be used (if required by the security policy).
- In direction to the HES the Global Unicast Key must be used (if required by the security policy).

The permissible activities in each client are presented in following table.

Client	Activities	Description
Public	Reading device general information	- **Accessible via remote communication and local interface,** - No security - Established using DLMS-OPEN (AARQ) service
Management	Management and any setting/action in device, plus reading values	- **Accessible via remote communication and local interface** - With Authentication HLS (LLS backup). Established using DLMS-OPEN (AARQ) service
Pre-established	Unconfirmed application layer services for Set / Action / Data Notification	- **Accessible only via remote communication/ RS485** - optical interface is not allowed - Always Established
Reading	Reading Parameters and Energy data	- **Accessible via local interface with Security** - Established using DLMS-OPEN (AARQ) service With Authentication HLS (LLS backup)

Parallel Association Policies

The following policies are provided by the meter about establishing parallel association.

- On the local communication port (IEC 62056-21) only one association can be opened at a time.
- On remote communication port (IP) several associations can be opened parallel
- At different communication ports, several associations (with the same client or with different clients) can be opened at the same time.
- If a client wants to use several communication ports at the same time an association at each communication port will be opened separately.

Note: If a client wants to use several communication ports at the same time it must open an association at each communication port separately.

29 Calibration and test

29.1 Calibration

The MCS301 meter has been adjusted in the factory, with the calibration constants matched to the software concerned. Subsequent calibration by the customer is not required.

29.2 Precondition during testing

Normally the accuracy testing of the meter is done using the 2 LED's, which are blinking according the consumed active (LED 1) and reactive energy (LED 2). During the tests below preconditions need to be considered to get solid accuracy information

- The minimum testing time period: >= 15s
- The minimum number of pulses: 2

29.3 Manufacturer specific test mode

By sending a specific command, the meter can be set into a special test mode, for reducing the test duration's involved. In this test mode, the following parameters can be selected:

- Automatic increase of the decimal for all energy values to 3, 4
- Assignment of energy quantity to LED 1
- Increase in the LED flashing frequency (Imp/kWh)

The test mode can be quit via the following events:

- Formatted command
- After configurable time (1 …255min)
- After power outage

Optionally, after the power returns, a test mode can be activated for a configurable period of time T2 from 1 to 255 minutes by displaying all energy registers with an increased number of decimal places.
After exiting the test mode, the previous resolution of the energy registers is reused.

29.4 Simple creep and anti-creep test

The shortened creep and anti-creep test can be shown on the LC display or the shared LED.

- **Display**
  Arrow in display "ON": meter starts measuring
  Arrow in display "OFF": no energy is being measured. This applies for all 4 possible energy types (+P, -P, +Q, -Q) showing the energy direction
- **LED**
  The "Anti Creep" function and "energy-proportional pulse output" are indicated for each energy type by a shared LED. "Anti Creep" is signaled by a steady-light at the LED. Energy-proportional pulses occur as optical "momentary pulses".

30 Reading and Configuration Tool

The MCS301 meter can be read out, set and parameterized via the optical and/or electrical (RS485) interface, in accordance with the DLMS/COSEM protocol.
For this purpose, you need the *Blue²Link* readout and setting tool, which can be used to alter and read out the meter's register and all setting parameters.

Blue²Link supports the following functionality:

Readout parameters

- All register data
- All PQ data (instantaneous, 10min interval, …)
- Power outage data
- All log file Log file data
- All Load profile data
- All connected M-Bus data
- Communication module status
- Meter status
- Complete meter configuration

Change of meter parameters

- Identification and passwords
- TOU parameters
- Baud rates
- Parameter of display list
- Pulse constants, CT/VT ratio
- Input / output configuration
- All Load profile parameters
- All log file parameters
- M-Bus parameter
- Communication module parameter (GPRS)
- Push mode parameters

Actions

- Set time and date
- Reset all counters
- Reset log file parameters
- Reset load profile of billing data
- Reset register data
- FW download of the meter application
- FW download of the GPRS module

All parameters can be readout or changed remotely by using transparent GSM/GPRS or Ethernet modules too.

31 Installation and start-up

31.1 Installation and general function control

The meter is mechanically secured in place by first suspending it in the upper eye, and screwing it into position through the two bottom mounting points to the left and right of the terminal block, which are 150 mm apart in conformity with the dimensions laid down in DIN 43857. The suspension eye enables the meter to be installed in either an open or concealed configuration as desired. Using these 3 mounting points, the meter is installed on a meter panel.
As soon as the meter has been connected to the power supply, a corresponding indicator in the display will show that the phase voltages L1 to L3 are present.
If the meter has started up, this will be indicated directly by an arrow in the display, and by the energy pulse LED, which will flash in accordance with the preset pulse constant.

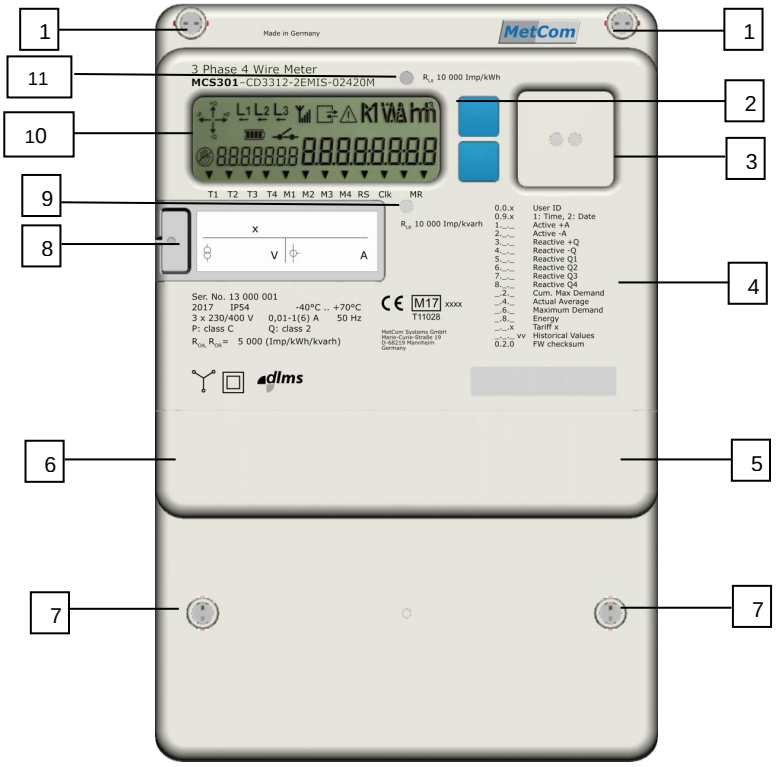


Figure 27: Front view of the MCS301

1 – Main seals
2 – 2 alternate push buttons (up/down)
3 – Optical interface
4 – Name plate
5 – Part of splitted terminal cover (for communication module protection)
6 – Part of splitted terminal cover (for meter terminal protection)
7 – Utility seals
8 – CT/VT ratio name plate, ext. battery, demand reset push button access
9 – LED for optical test output – active energy
10 – Meter LCD
11 – LED for optical test output – active energy

31.2 Installation check using the meter display

After the meter has been properly connected, its function can be tested as follows:

Scroll mode	As long as the alternate button is not pressed, the scroll mode will appear. Depending on the version involved, this may consist of one value or of several values, shown in a rolling display mode.
Display check	When the alternate button 1 is pressed, the first thing to appear is the display check. All segments of the display must be present. Pressing the alternate button will switch the display to its next value.
Error message	If the display check is followed by an error message
Fast run-through	If the alternate button is repeatedly pressed at intervals of 2s < t <5s , all the main values provided will appear.
Phase failure	Display elements L1, L2, L3 are used to indicate which phases of the meter are energized.
Rotating-field detection	If the meter's rotating field has been inversely connected, the phase failure detection symbols will flash.
creep check	If the meter starts measuring, the energy pulse diode will blink according the measured energy. The relevant arrows (+P, -P, +Q, **-**Q) on the display are switched ON after 2-3s.
Anti-creep check	If the meter is in idling mode, the energy pulse diode will be continuously lit up. The relevant arrows (+P, -P, +Q, -Q) on the display are also switched off.
Reverse run	If the meter is measuring in 1 or 2 phases in the reverse direction, the appropriate arrow under the L1, L2, L3 symbol is displayed.

Attention!

Phase and neutral mix up

If during the installation process of a 3x230/400V meter phase and neutral will be changed the meter will responds on the LCD as follow:

- blinking of L1, L2, L3 segments
- activation of the error indicator
- log file event will be created

In that case the power of the meter should be switched off immediately and the installation should be checked again. Otherwise the meter can be damaged after 12h.

31.3 Installation comment

31.3.1 Fuse protection

Attention!

In the application of meters in the low voltage level the voltage path is direct connected to the phases. Thereby the only security against a short circuit is the primary fuses of some 120A.
In that case the whole current is running inside the meter or the connection between phase - phase or phase – neutral, which can cause a lightening or a damage against persons or buildings.
The recommendation for CT connected meters in the low voltage level is the usage of fuses in the voltage path with a maximum of 10A.

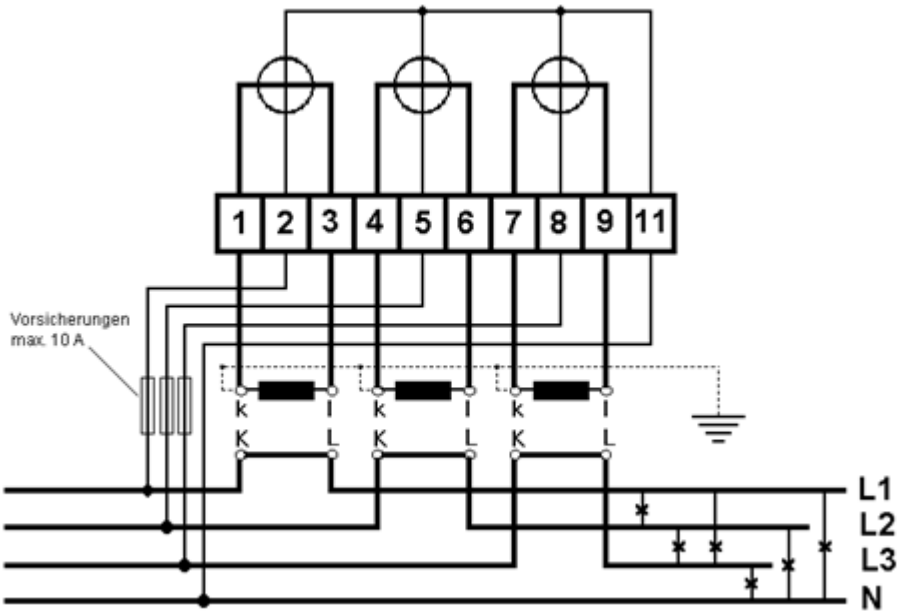
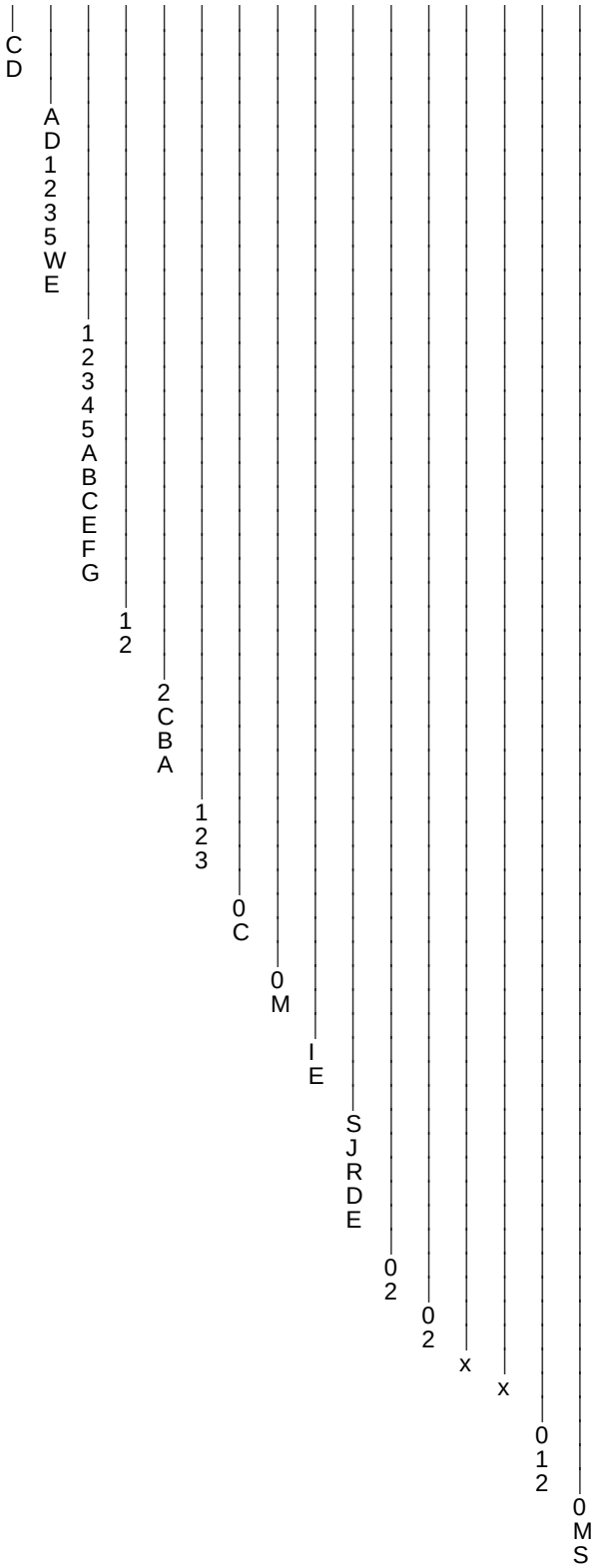


Figure 28: Connection of a CT meter in the low voltage level

32 Type key

MCS301 - _ _ _ _ _ - _ _ _ _ - _ _ _ _ _ _



Connection Type:
- C Transformer rated meter
- D Direct connected meter

Nominal Voltage and Network Type
- A 3 x 100V or 3 x 110 V (3-wire, 2 Systems)
- D 3 x 220V or 3 x 230 V (3-wire, 2 Systems)
- 1 3 x 58/100V or 3 x 63/110 V (4-wire, 3 Systems)
- 2 3 x 127/220V (4-wire, 3 Systems)
- 3 3 x 230/400V (4-wire, 3 Systems)
- 5 3 x 220/380V or 230/400V (4-wire, 3 System)
- W 3 x 58/100V...3x 240/415 V (4-wire, 3 Systems)
- E 3 x 58/100V...3x 277/480 V (4-wire, 3 Systems)

Nominal Current:
- 1 1 (2) A
- 2 5 (6) A
- 3 5//1 A or 1 (6) A
- 4 1 (10) A
- 5 5 (10) A
- A 5 (60) A
- B 5 (80) A
- C 5 (100) A
- E 10 (60) A
- F 10 (80) A
- G 10 (100) A

Frequency:
- 1 50 Hz
- 2 60 Hz

Accuracy Class:
- 2 +A energy, cl. 0.2S (EN 62053-22)
- C +A energy, cl. 0.5S, C (EN 62053-22, EN50470- 3)
- B +A energy, class 1, B (EN 62053-21, EN50470-3)
- A +A energy, class 2, A (EN 62053-21, EN50470-3)

Measured Quantities:
- 1 Active energy only
- 2 Active energy and reactive energy
- 3 Active, reactive, apparent energy

Customer interface:
- 0 No customer interface
- C Customer interface (RJ12)

Modularity:
- 0 No module support
- M Slot for external communication modules

Battery:
- I Internal battery for buffering real time clock
- E Internal and external battery (RWP)

Communication Interface:
- S RS485 (terminals)
- J RS485 (RJ12)
- R RS485 + RS232 (terminals) *1)
- D RS485 (terminals) + Ethernet (RJ45) *2)
- E Ethernet (RJ45) only *2)

Input / Outputs
- 0 No input
- 2 2x control inputs, 230V *3)
- 0 No S0 pulse inputs.
- 2 2x S0 pulse inputs. *3)
- x Electr. Outputs, 230V, 100 mA, (x= 0 ... 6)
- x Bistable relays, up to 10A, (x= 0 / 1)

Additionals:
- 0 No auxiliary power supply
- 1 Auxiliary power supply (48-230V AC/DC)
- 2 Auxiliary power supply (24V DC)
- 0 No wired M-Bus
- M Wired M-Bus Master (EN 13757-2)
- S Synch interface

Remark:
*1) in case of using RS485+RS232 => the M-Bus and Synch interface is not available
*2) in case of using onboard Ethernet interface => no comms module support possible
*3) only control inputs **or** S0 inputs can be selected

33 Technical data of the MCS301

Nominal voltage	4-wire, 3 Solutions 3-wire, 2 Solutions	3 x 58/100 V … 3x63/110V; or 3 x 230/400 V; +/-20% or 3x58/100 … 3x240/415V, -20/+15%
Nominal / maximum current	Indirect Connection Direct Connection Short circuit current Start-up current	1(2) A; 1(6) A; 1.5(6) A; 5(6) A; 5(10) A; 5 (15) A 5(60) A; 5(80) A; 5(100) A; Half cycle at rated frequency, 30 x Imax <0.1% (indirect) / 0.4% (direct) of reference current
Frequency		50 or 60 Hz ±5%
Accuracy class	Indirect Connection Direct Connection Reactive energy	Class C or B (EN 50470-3); or Class 0.2S (IEC 62053-22) Class B or A (EN 50470-3); Class 1 or 2 (IEC 62053-21) Class 2 or 3 (IEC 62053-23)
Temperature / Environmental influences	Operation/storage temp. Humidity Temperature coefficient Ingress protection Protection class	- 40°C ... +70°C / - 40°C ... +85°C 95% rel. humidity, non-condensing Average value (typical): < ±0.01% / °K IP54 Class II to IEC 62052-11 ⧈
Electromagnetic Compatibility	Surge withstand 1.2/50 µs Insulation strength other Environmental conditions	6 kV, Rsource = 40 Ω, optional 12kV 4 kVrms, 50 Hz, 1 min. Conducted disturbances from 2 kHz to 150kHz acc. 61000-4-19 MID E2
Real time clock	Accuracy Supercap Internal / external battery	Crystal < 5 ppm = < 3 min./year (at T= +25°C) 2 days 10 years (without main power) / external battery (optional)
Internal tariff source	Acc. EN 62052	Up to 8 tariffs, 4 seasons, weekday dependent tariff scheme
Display	Characteristics number of digits digit size Read-out without power Back lighten display	Type: LCD liquid crystal display Value field: up to 8; index field: up to 7 Value field: 4 x 8 mm; index field: 3 x 6 mm With external battery (option)
Power supply	Type self-consumption	Transformer based power supply < 1 W; < 2,3 VA
Inputs and Outputs (option)	Control- or alarm-input S0 pulse inputs Output (electronic) Bistable mech. relay	Up to 2; Control voltage Us 50 – 276 V Up to 2; acc. IEC 62053-31; Class A (max. 27 V DC) Up to 6: 12 to 230 VAC/DC (+15%); 100 mA Up to 1: 230 V AC (+/- 15%); 10A
Pulse LED (test)	Type / Number Impulse frequency / length meter constant	LED red / 2 – function kWh / kvarh; kWh / kVAh Programmable; max. 64Hz / 7.8 ms programmable
Communication Interfaces	Optical interface Electrical interface Communication module	Infrared, serial, half-duplex; max. 9.600 bps; DLMS RS485, half-duplex 2 wires; max. 38.400 bps; DLMS RS232, half-duplex 2 wires; max. 38.400 bps; DLMS Ethernet interface (IPV4/V6) Exchangeable comms module
Housing	Dimensions Material Environmental conditions	DIN 43857 part 2; DIN 43859 Polycarbonate (Lexan), partly glass-fiber reinforced, flame-retardant, self-extinguishing plastic, recyclable MID M1
Connections	Indirect Connection Direct Connection Auxiliary connections	Screw type terminals with cages; Diameter 5.0 mm Pozidrive Combi No. 2; tightening torque max. 1.4 Nm Screw type terminals with cages; Diameter 9.5 mm Pozidrive Combi No. 2; tightening torque max. 2.5 Nm Screw type terminals 2.5 mm recommended conductor cross section: 1.5 to 2.5 mm² Head screw size 2 (slit); tightening torque max. 1.0 Nm
Weight	Direct / Indirect Connection	1.3 / 1.2kg
Terminal cover	Standard Splitted cover	40 mm free space, height 100mm (also in transparent version) 40 mm free space, height 100mm, sealable main terminals and access to sealable communication unit

34 Connection diagram

34.1 Complete connection diagram

In below figures the complete connection diagram (main + auxiliary connection) is shown. The diagram is fixed under the terminal cover of every meter.

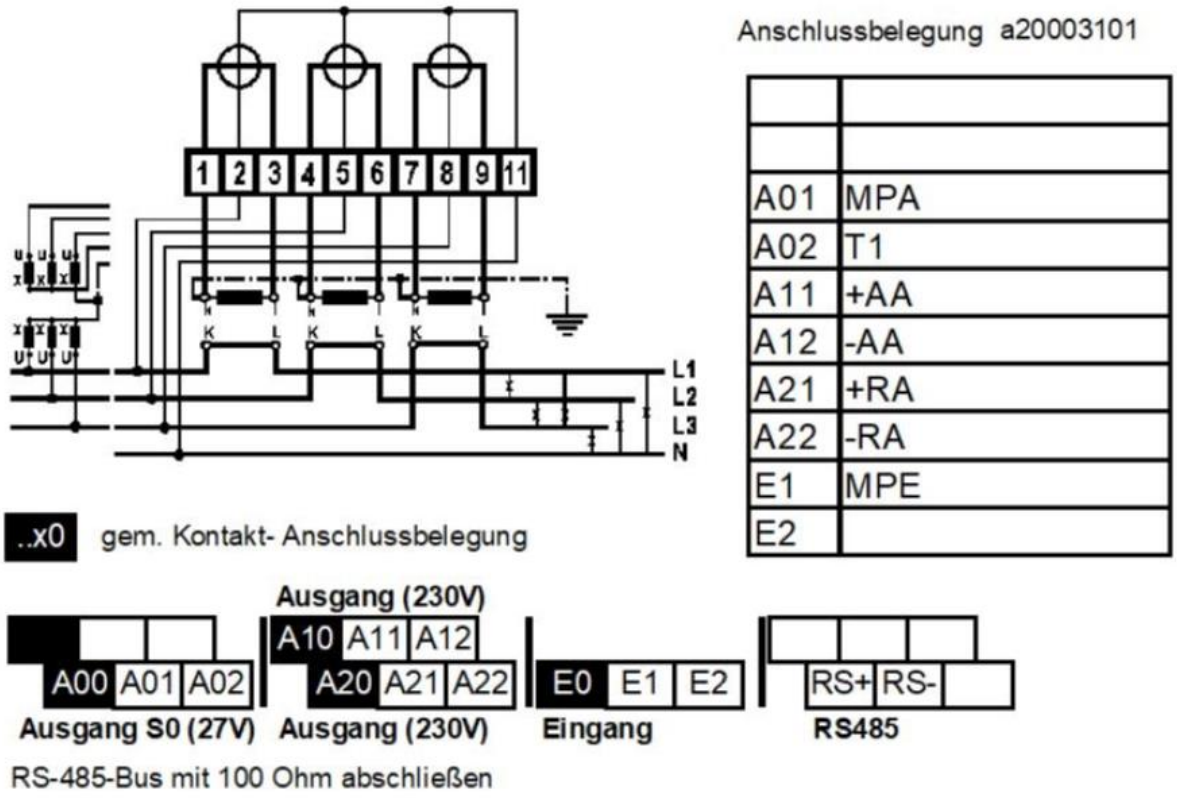


Figure 32: complete connection diagram

34.2 Mains connection diagram

The main connection diagram is shown in the following figures

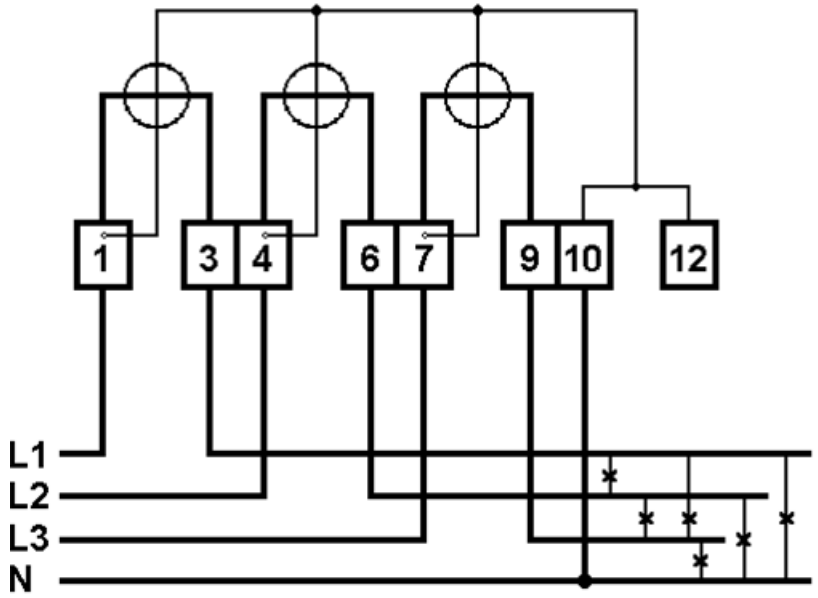


Figure 33: 4-wire meter (3 Solutions), direct connection

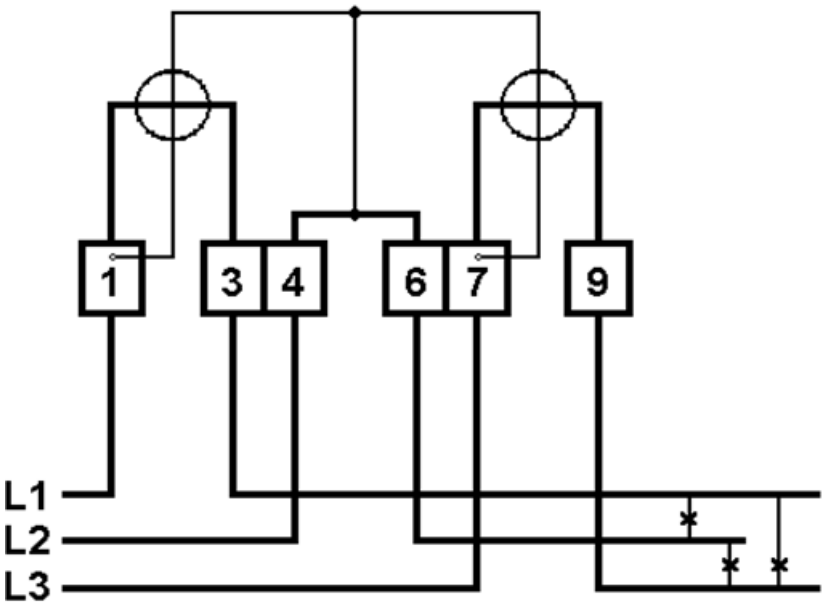


Figure 294: 3-wire meter (2 Solutions), direct connection

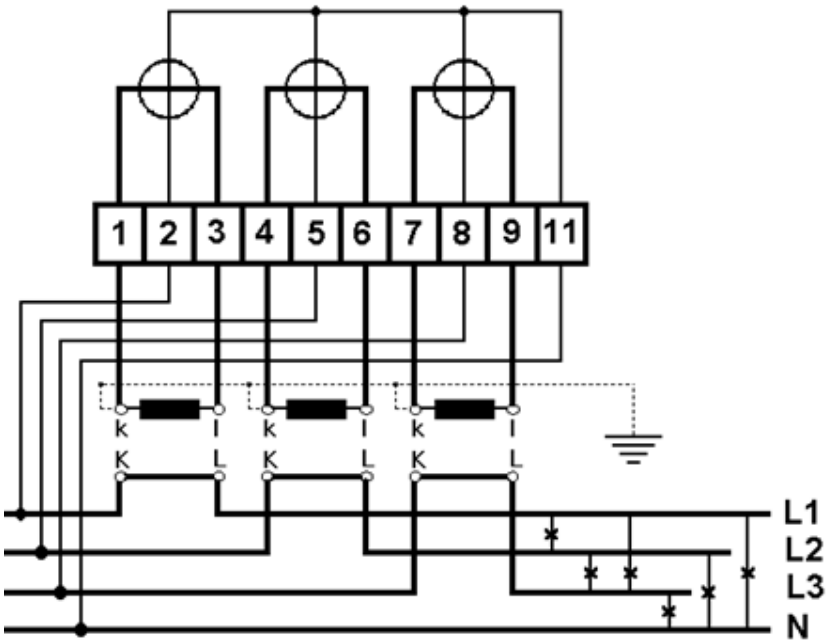


Figure 305: 4-wire meter (3 Solutions) for CT standard connection

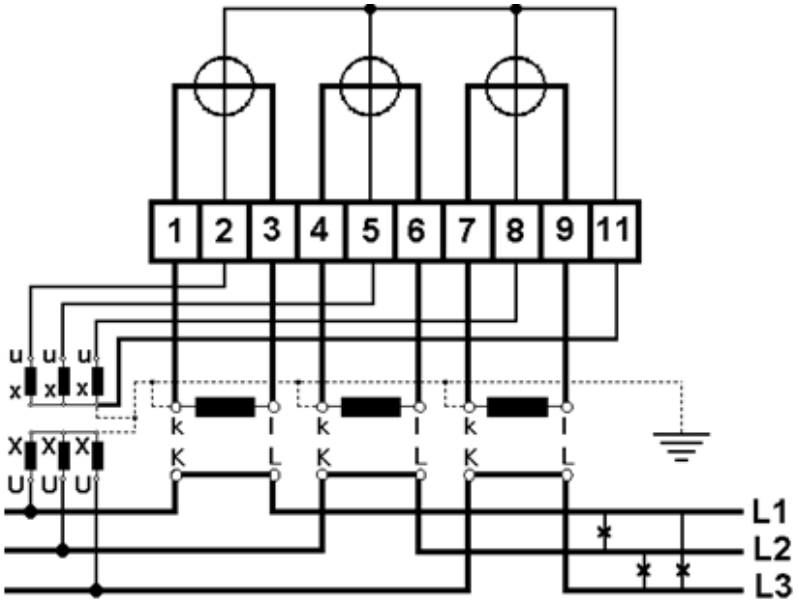


Figure 36: 4-wire meter (3 Solutions) for CT- and VT- standard connection

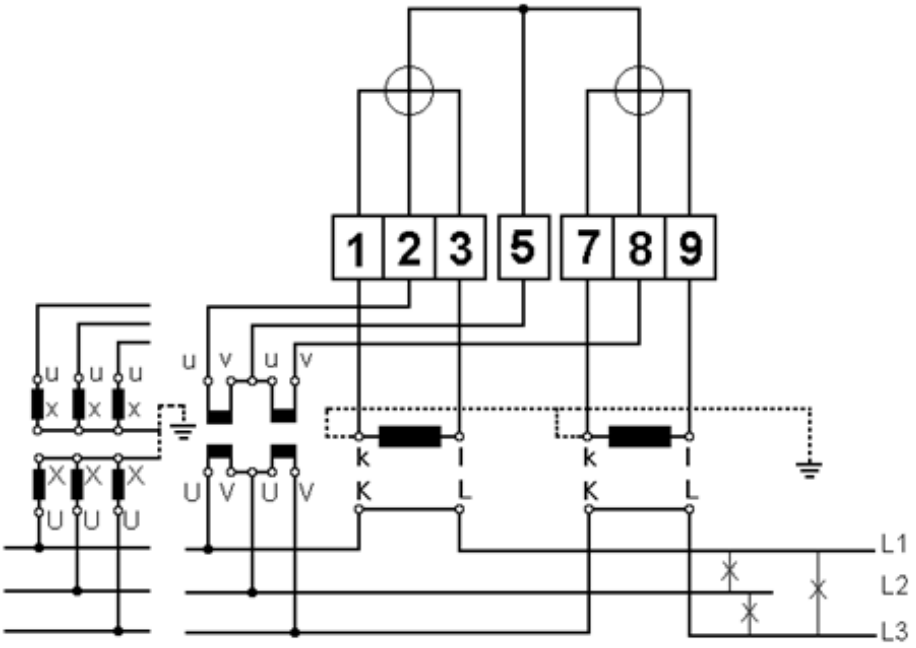


Figure 31: 3-wire meter (2 Solutions) for CT- and VT- standard connection (on request)

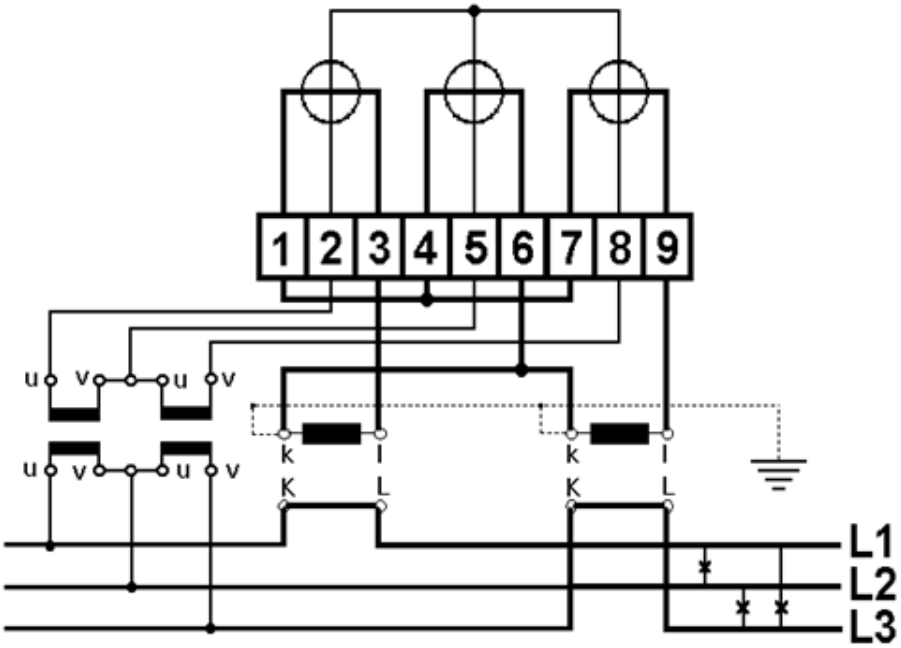


Figure 328: 4-wire meter (3 Solutions) without connection of the neutral

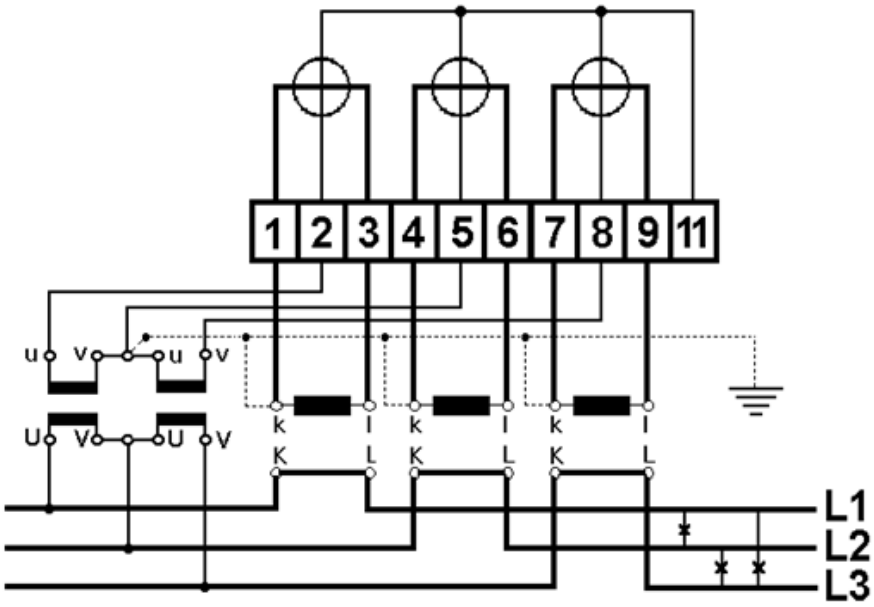


Figure 33: 4-wire meter (3 Solutions) without connection of the neutral