ST402

Technical description

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METER&CONTROL
ST402
L1L2L3
kWh
1.8.1.
00000137
T1 T2 T3 T4 M1 M2 M3 M4 COM FF RTC SET
3-PHASE METER
0,25-5(100) A 3x230/400 V 50 Hz
Cl.B
-40°C...+70°C
1000 imp/kWh
IP54
T10628
M17 1376
dlms
MADE IN SERIA
2020
ST402-00000000
1.8.x Active energy +
2.8.x Active energy -
1.6.x Max. demand +
x = 0,1,2...
0.9.1 Time
0.9.2 Date

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About this document

This document provides information on ST402x meter types, including their purpose, construction, usage, installation, and maintenance. It is intended for technically qualified personnel at energy supply companies who are responsible for system planning and operation.
The document covers:

- The purpose of ST402x meters.
- The construction of ST402x meters.

- How measured quantities are derived.
- The functionalities of ST402x meters.

Reference documents

- ST402x - Datasheet
- ST402x - Manual for mounting, handling, transport, and storage
- PaMet – User manual

Version History

Version	Date	Changes
1.0.0.0.		The first version of the document.
1.3.5.0		
1.3.6.0		
2.0.0.0.	3. 9. 2024.	Redesign of technical description

Table 1 - Version History

Terms, definitions, and abbreviations

Abbreviations	Definition
AC	Alternating Current
AES	Advanced Encryption Standard
AFE	Analog Front End
APN	Access Point Name
ASCII	American Standard Code for Information Interchange
BS	British Standard
COM	Communication
COSEM	Companion Specification for Energy Metering
COMET	Meter&Control HES software for remote reading, parametrization, and load management
CT	Current Transformer
DC	Direct Current
DIN	Deutsches Institut für Normung
DLMS	Device Language Message Specification
DLMS UA	DLMS User Association
DNS	Domain Name Server

Abbreviations	Definition
DSMR	Dutch Smart Meter
DSO	Distribution System Operator
DST	Daylight Saving Time
EB	Electricity meter
ECDH	Elliptic Curve Diffie-HellmanGCM
ECDSA	Elliptic Curve Digital Signature Algorithm
EMC	Electromagnetic Compatibility
EN	European Norm
EPS	Elektroprivreda Srbije (Electric Power Industry of Serbia)
FF	Fatal Failure
FIFO	First In, First Out
FW	Firmware
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
HAN	Home Area Network
HDLC	High-Level Data Link Control
HES	Head-End System
HLS	High-Level Security
HW	Hardware
ICCID	Integrated Circuit Card Identification
IDIS	Interoperable Device Interface Specification
IEC	International Electrotechnical Commission
IMEI	International Mobile Equipment Identity
IMSI	International Mobile Subscriber Identity
IP	Internet Protocol
IR	Infrared
LAST GASP	Synonym for the “Push on Power down” functionality
LED	Light Emitting Diode
LCD	Liquid Crystal Display
LLS	Low-Level Security
LTE	Long Term Evolution
LP	Load Profile
LR	Legally relevant
LNR	Legally Nonrelevant
MID	Measuring Instruments Directive
NB-IoT	Narrowband Internet of Things
NTP	Network Time Protocol
OBIS	Object Identification System

Abbreviations	Definition
P1	Communication port
PAMET	Meter&Control software for parametrization of meters
PC	Personal Computer
PCB	Printed Circuit Board
PIN	Personal Identification Number
PLC	Power Line Communication
PPP	Point-to-Point Protocol
RTC	Real-Time Clock
RS485	The standard for serial communication
SAP	Service Access Point
SHA	Secure Hash Algorithm
SIM	Subscriber Identity Module
SW	Software
THD	Total Harmonic Distortion
TOU	Time Of Use
UDP	User Datagram Protocol
UDP	UDP User Datagram Protocol
wM-Bus	Wireless M-Bus
WPDU	Wrapper Protocol Data Unit

Table 2 - Terms, definitions, and abbreviations

1. General description

The ST402 series of smart meters meets the latest requirements for multifunctional smart meters and smart Advanced Metering Infrastructure (AMI) networks for remote reading and control.
These meters are designed to align with the most recent functional and technological advancements in smart metering and market demands.

Key features of the ST402 meters include:

- **Designed for 4-wire three-phase applications:** Can be connected directly to the mains or through a transformer.
- **Measures active, reactive, and apparent energy:** Suitable for residential and commercial customers.
- **Integrated features:** Includes a switching device and a cellular communication device.
- **Compliance with international standards:** Adheres to IEC, EN, VDEW, DLMS, IDIS, and M-Bus standards.
- **Bidirectional energy measurement:** Measures active and reactive energies in both directions and registers them in 8 tariffs.
- **Accurate measurement:** Offers accuracy classes 1 and 2 according to IEC and A and B according to EN for direct-connected meters. For transformer-connected meters, accuracy is 0.5S per IEC and class C according to EN. Reactive energy accuracy classes are 2 or 3 per IEC.
- **Real-time clock:** Equipped with a battery or super capacitor-backed real-time clock.
- **LCD:** Displays measured values with a programmable scroll sequence.
- **Multiple communication interfaces:** Includes M-Bus, Wireless M-Bus, IR port, RS485, and a communication modem.

1.1 Short technical overview

The ST402 meter is a cutting-edge smart electricity meter that meets the most recent industry standards for multifunctional meters and advanced metering infrastructure (AMI) networks. The ST402D model, a newer version, offers enhanced features and technology aligned with the evolving needs of the electricity market. Designed for 4-wire, 3-phase networks, the ST402D supports both direct and semi-indirect connections to the mains.

Key characteristics of the meter:

- **High precision and long-term stability:** Ensure accurate and reliable measurements over time.
- **Integrated communication and control:** Features an integrated cellular communication module, RS485 port, and disconnector for seamless connectivity and control.
- **Flexible tariff management:** Supports both internal and external tariff management (tariffs 1-8) to accommodate various pricing structures.
- **Wide measurement range:** Capable of measuring currents from 25 mA to 100 A for direct connection meters and 10 mA to 6 A for meters with transformer connections.
- **No-power reading:** Allows for data retrieval even when the meter is not powered (using LCD and optical port).

- **Security features:** Detects strong magnetic fields and unauthorized removal of the terminal block cover or measuring part cover.
- **Load management:** Adjustable input power threshold enables automatic disconnection of consumers exceeding the specified limit.
- **Minimal maintenance:** No recalibration is required during the meter's lifetime. However, object 96.2.5 records the time and date of the last calibration.
- **EMC compliance:** Adheres to IEC and EN standards for electromagnetic compatibility.

Energy and Power Measurement:

- **Active energy measurement:** Measures received, delivered, and absolute active energy according to IEC 62053-21/22 standards (class 1, 2, or 0.5S for transformer meters) or EN 50470-3 standard (class index A, B, or C for transformer meters).
- **Reactive energy measurement:** Measures reactive energy in four quadrants according to IEC 62053-23 standard, class 2 or 3 (optional).
- **Register compliance:** Active energy registers comply with EN 62056-61 (1.8.x for received active energy, 2.8.x for delivered active energy, 15.8.x for absolute active energy).
- **Voltage and current measurement:** Measures and displays the root mean square (RMS) values of voltages and currents.
- **Connection:** Suitable for three-phase four-wire connections to 3x230/400 V or 3x110/208 V mains.
- **Wide measurement range:** Offers a wide range for measuring current, from 0.025 A to 5(100) A for direct connection meters and 0.010 A to 5(6) A for transformer meters.
- **Demand measurement:** Measures current active demand and maximum average demand in both directions.
- **Power quality monitoring:** Provides power quality supervision and diagnostics of the mains.
- **Software customization:** Allows for software adjustment of meter functionalities to meet specific customer needs (parameterization).

Other Characteristics:

- **Wide operating temperature range:** Functions reliably in temperatures from -40°C to +70°C. A tropicalized version is available for regions with high humidity and temperatures.
- **High level of protection:** Offers IP54 protection against water and dust infiltration, with optional IP56 protection for more demanding environments (according to IEC60529).
- **Precise real-time clock:** The clock is controlled by a 32768Hz oscillator with a reserve battery power supply. It maintains a precision of ±3 minutes per year at ambient temperature with a cumulative error.
- **Automatic daylight saving time (DST) adjustments:** The installed calendar automatically adjusts the clock for DST changes.
- **Long-lasting battery:** A lithium battery provides reserve power for the clock for over 15 years.
- **Battery monitoring:** The meter monitors the lithium battery voltage and indicates when it is discharged.

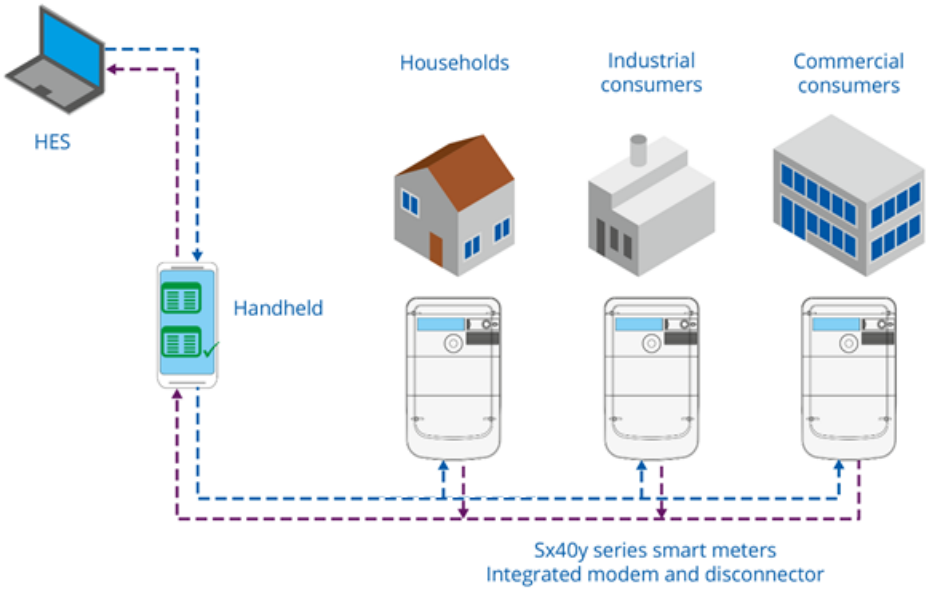

Figure 1 - Sx40y series smart meters

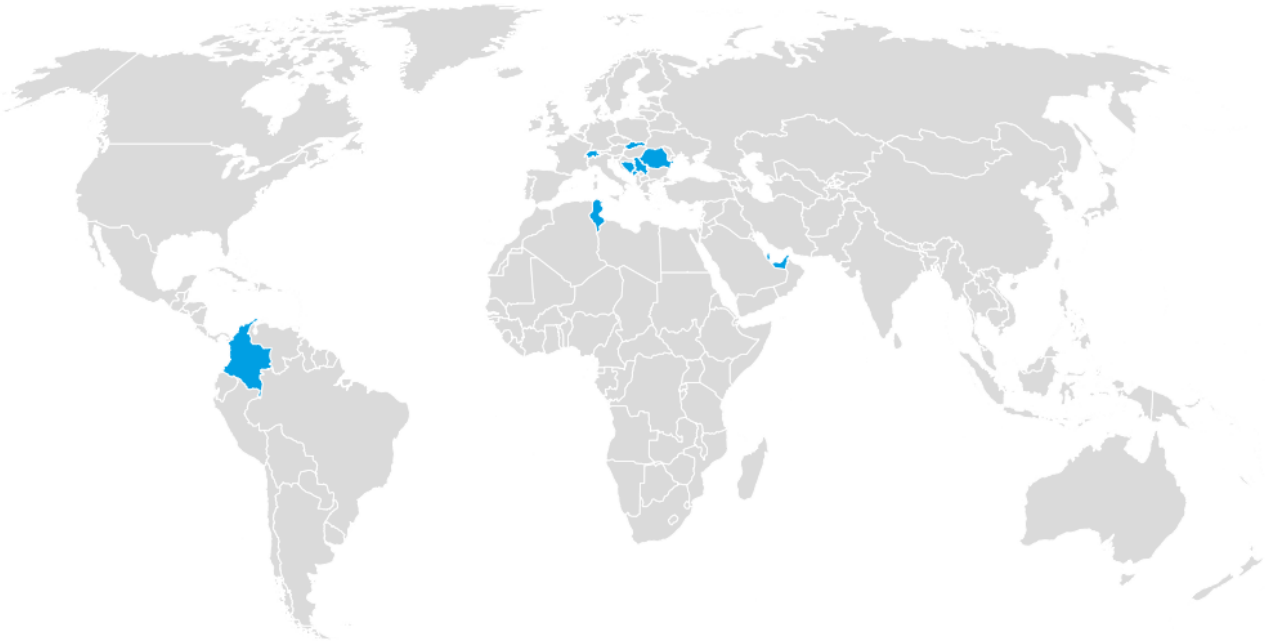

Figure 2 - ST402 worldwide coverage

2. Meter faceplate

Figure 3 - Meter faceplate

ST402x meter faceplate representing important exterior elements of the meter:

1. Meter cover.
2. Meter cover screws (meter sealing points).
3. Left button sealing door.
4. Display button.
5. LCD display.
6. Space for measuring transformer data (only for transformer meters).
7. LED imp/kwh.
8. LED imp/kvarh (optional).
9. Optical port.
10. Terminal block cover.
11. Terminal block cover screws (sealing points for the meter terminal block).

2.1. Meter Case

The meter case is constructed using high-quality, certified materials. Plastic components are made of polycarbonate or polycarbonate with 10% glass fibers, while the terminal block is made of polycarbonate with glass fibers. The case complies with mechanical requirements specified in IEC 62052-21, IEC 62052-11, and EN 50470-1.

The case is made of UV-resistant, polycarbonate material that is self-extinguishing. It consists of a housing, meter chassis, meter cover, and terminal block cover. PZ-2 screws with anticorrosive protection are used for the terminal cover, meter cover, and all meter terminals.
The measuring part and terminal block are housed within the case. The meter cover is sealed to prevent unauthorized removal without damaging the seal. The meter offers IP54 protection against water and dust infiltration (according to IEC 60529). Key meter data is indicated on the faceplate, complying with IEC 62052-11 and EN 50470-1 standards.
An adjustable hanger at the back of the case allows for three different mounting heights. A micro-switch detects if the meter cover or terminal block cover is removed.
Current terminals are made of brass (or steel) and secured with high-quality M6 screws. Steel screws have an Ocel 8 hardness. For reliable cable fixing, a PZ2 screwdriver is recommended.
All current conduction parts are made of electrolytic copper with large cross-sections to ensure even heat distribution and prevent “hot points.”

2.2. Overall and Fixing Dimensions of the Case

The meter’s dimensions, shape, and high-quality packaging ensure easy and optimal transportation. The adjustable hanger and fixing holes allow for reliable and simple mounting. The meter case dimensions comply with DIN 43857. The dimensions of the meter (in millimeters) are shown in the following figures. A variant with an extended terminal cover is also available.

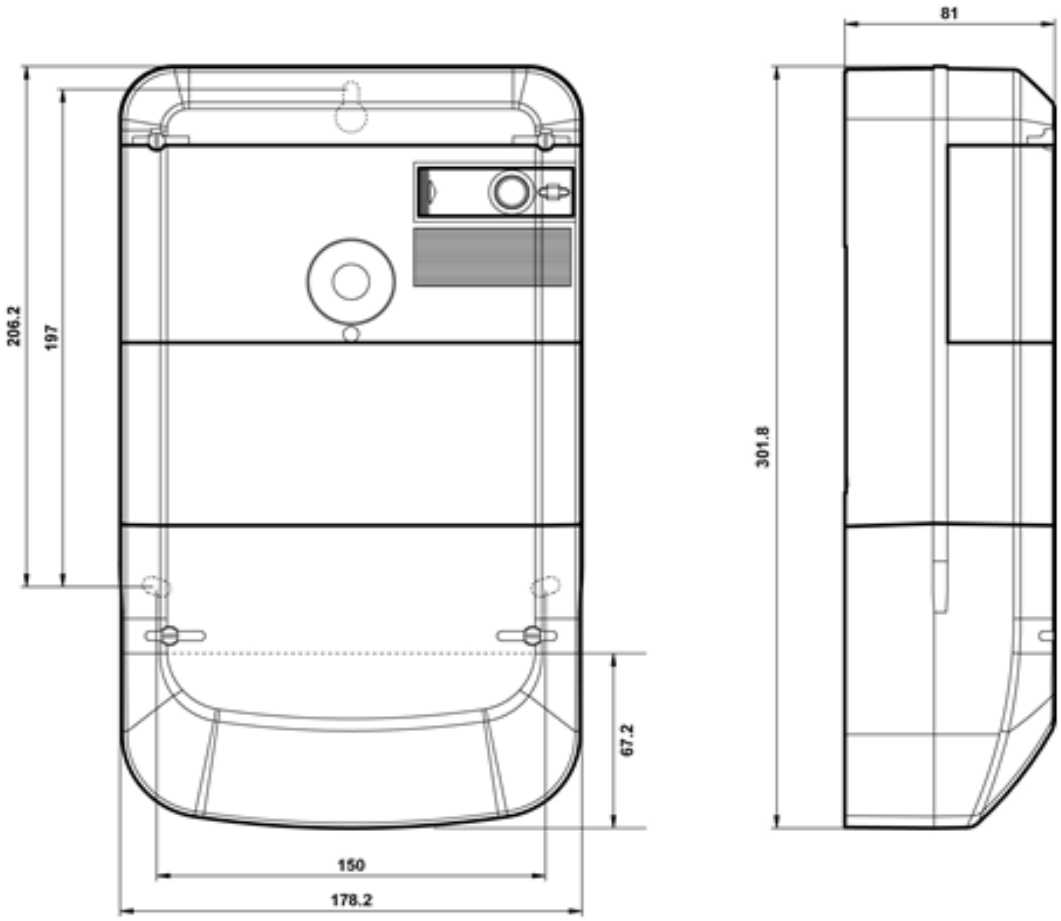

Figure 4 - Exterior dimensions of the 3-phase meter

2.3. Nameplate layout

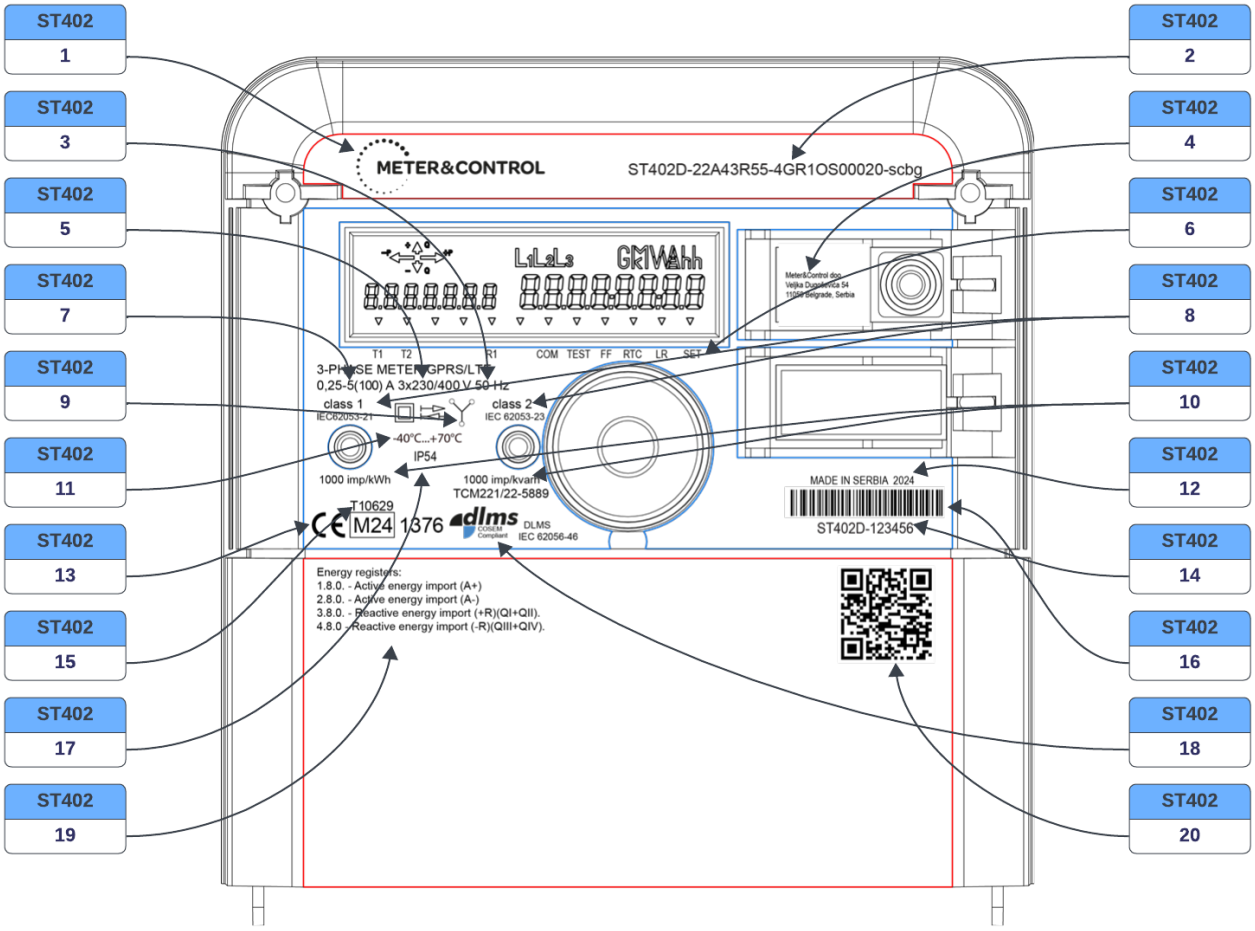

Figure 5 - Nameplate example

The figures above show the meter's nameplate with its marking. It is following IEC 62052-11 and EN 50470-1:

1. Company logo – manufacturer name.
2. Meter type with ordering designation.
3. Rated frequency.
4. Manufacturer address
5. Reference voltage.
6. Display indicators.
7. Basic and maximum current.
8. Accuracy class active and reactive energy.
9. Number of phases.
10. LED pulse constant.
11. Operating temperature range.
12. Country and year of production.
13. Meter's approval mark.
14. Serial number
15. Meter's certificate marks.

16. Barcode (meter type and serial number). The content of the bar code is adjustable. It may contain the year of production or other relevant data agreed upon with the customer
17. Insulation level label.
18. DLMS logo
19. OBIS codes description (codes on LCD).
20. A QR code is also available.

Note:
These markings' exact layout and placement may vary slightly depending on the specific market where the ST402 model is operated.

The wiring diagram is placed under the terminal cover.

Note:
The data are indelible when the meter is used normally.

2.4. Meter Sealing

The meter is sealed using sealing screws: two for the meter cover and two for the terminal cover. The left button door can also be sealed.
The figure below shows 3-meter sealing points:

1. Sealing screws for meter cover
2. Sealing of the left button door
3. Sealing of the terminal cover

Figure 6 - Sealing points of the 3-phase meter

2.5. Terminal block ST402

The terminal is designed according to IEC 62052-11 and EN 50470-1 standards. Its modular design allows for easy replacement during service.
The terminal ensures reliable contact quality regardless of whether aluminum (Al) or copper (Cu) conductors are used, and whether they are stranded or solid types. The terminals are made of corrosion-resistant material.

2.5.1. Terminal block for direct connection meter

The terminal is designed according to IEC 62052-11 and EN 50470-1 standards. Its modular design allows for easy replacement during service.
The terminal block is made of polycarbonate with 10% glass fiber, complying with ISO 75-2 (135°C, 1.8 MPa, method A).
The main current terminal blocks for direct connection meters are made of brass (or steel) shells with two M6 screws. Both solid and stranded wire with a cross-section from 4 mm² to 35 mm² can be used for connection.
The maximum applicable current is 100 A, while the maximum current for the basic configuration is 80 A.
For conductors with smaller cross-sections (less than 4 mm²), a special indentation in the copper bus bar prevents wire shift during tightening (Figure below).
The terminal ensures reliable contact quality regardless of whether aluminum (Al) or copper (Cu) conductors are used, and whether they are stranded or solid types. The current terminals provide for efficient meter wiring at the measuring point. The wiring diagram is located under the terminal cover.

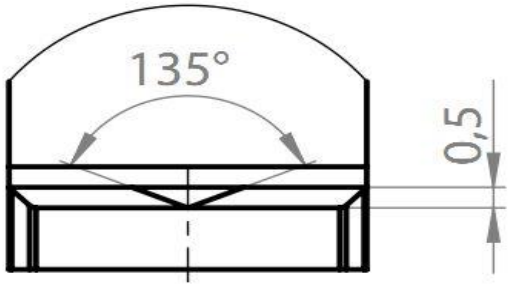

Figure 7 - Indentation (stamping) for conductors with smaller cross-sections

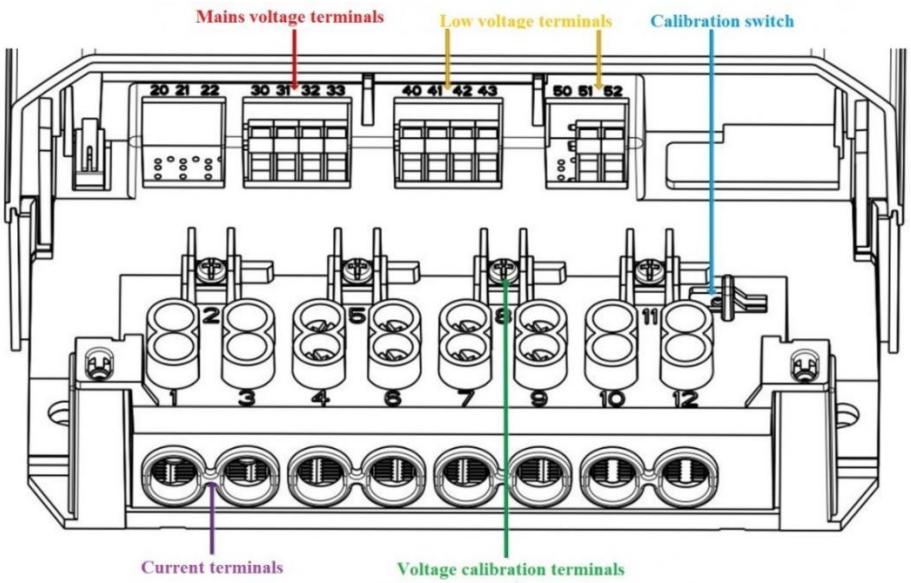

Figure 8 - Meter terminal block for direct connection to the network

Note:
The calibration switch used for separating voltage and current circuits can be sealed or optionally inaccessible

.

The figure below shows the layout of the terminal block with screws in the maximum open position.

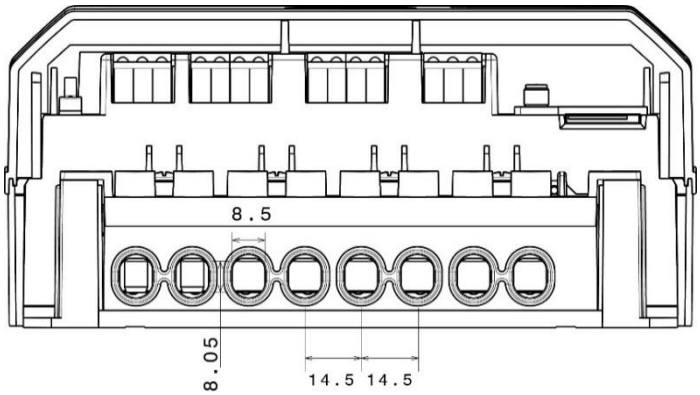

Figure 9 - Layout of the direct connection meter terminal block opening

2.5.2. Terminal block for transformer connection meter

The main terminal blocks for transformer meters are made of brass shells with two M4 screws. Both solid and stranded wire with a cross-section from 2.5 mm² to 16 mm² can be used for connection.

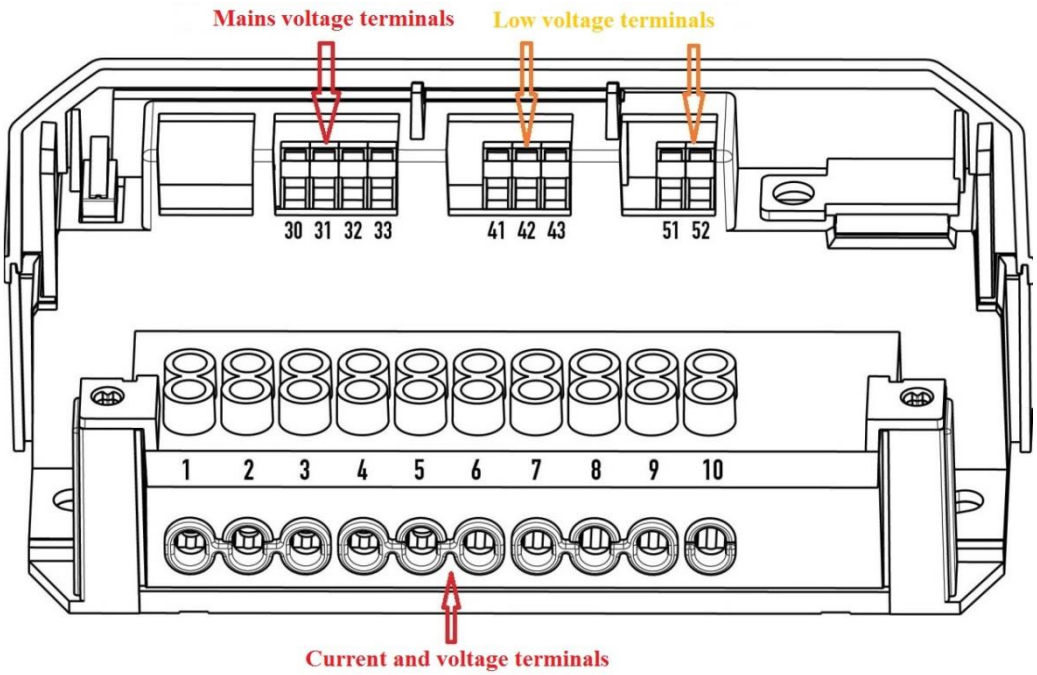

Figure 10 - Terminal block for transformer connection meter

Current and voltage terminals are arranged in a single row. Connect the current circuits to terminals 1-3, 4-6, and 7-9, corresponding to the different phases. Connect voltages to terminals 2, 5, and 8, and the neutral to terminal 10.
The figure below shows the layout of the terminal block with screws in the maximum open position.

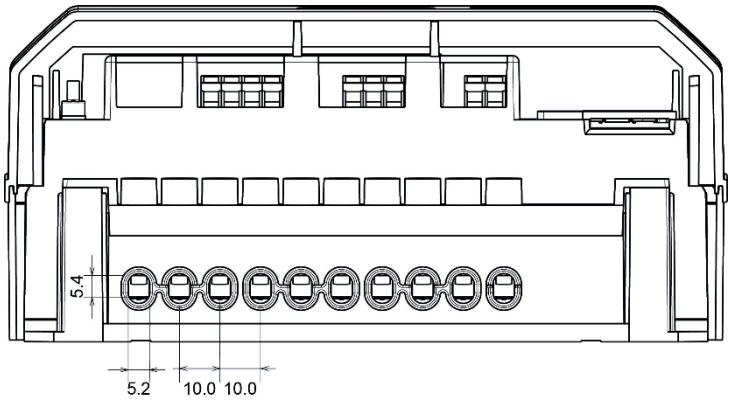

Figure 11 - Layout of the transformer connection meter terminal block opening

2.5.3. Auxiliary terminals (direct and CT-connected meters)

Auxiliary terminals are divided into two groups: mains voltage terminals and low voltage terminals (with galvanic insulation). The same auxiliary terminals are used for both direct connection meters and transformer meters. All auxiliary terminals are based on the “PLUGIN” principle.

Mains Voltage Terminals:
Depending on the assembly, mains voltage terminals can include:

- Tariff inputs.
- Relay output.
- Optomos output.

Low Voltage Terminals:
Depending on the assembly, low-voltage terminals can include:

- Impulse output.
- Alarm input.
- RS485.
- M-Bus output.

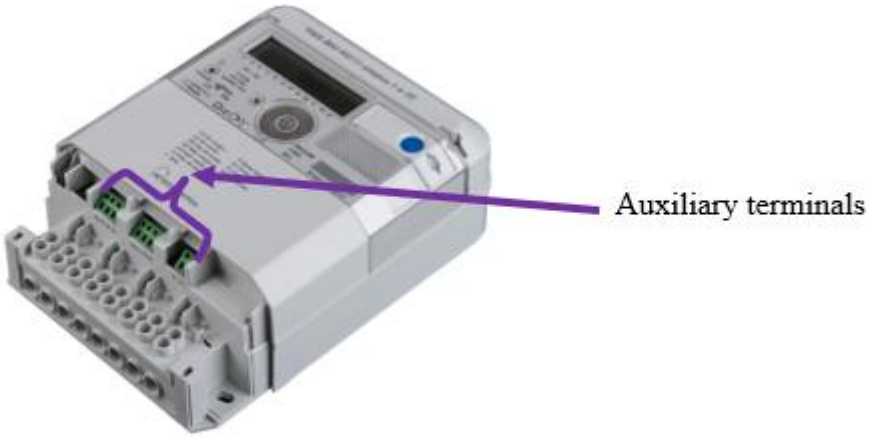

Figure 12 - Example of auxiliary meter terminals

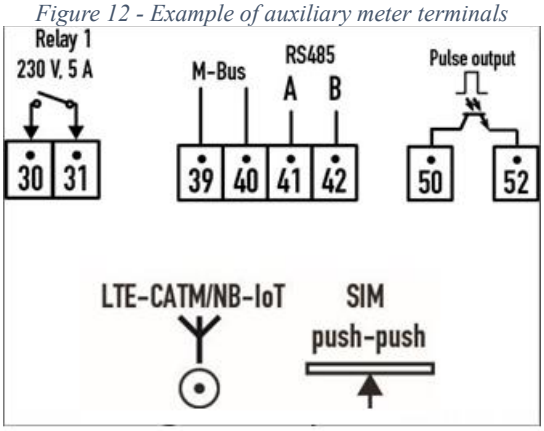

Figure 13 - Stickers with examples of auxiliary meter terminals

2.5.3.1. High-Voltage Terminals

High-voltage terminals are designed for connection to 230 V AC or 120 V AC power sources. They are classified as terminals with a voltage exceeding 40 V.
The meter offers three types of high-voltage terminals:

- Tariff inputs
- Relay outputs
- Optomos output

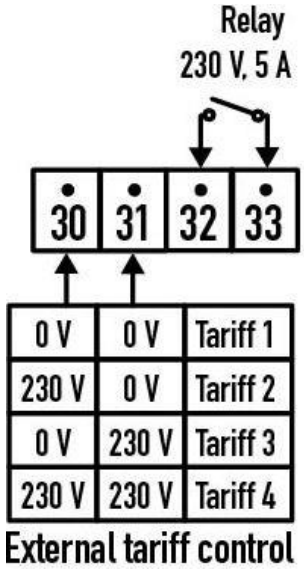

Figure 14 - Tariff inputs and relay output

2.5.3.2. Low-Voltage Terminals

Low-voltage terminals are intended for connection to other devices. They have a nominal voltage below 40 V and are galvanically isolated.
Low-voltage terminals include:

- Wired M-Bus.
- RS485 ports.
- Electrical impulse outputs.
- S0 inputs.

The meter features an M-Bus micro-master communication interface for collecting data from other measuring devices, such as gas meters, water meters, and other devices that support the M-Bus interface. Terminals 39 and 40 are used for connecting M-Bus devices.

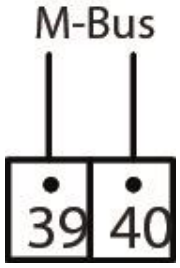

Figure 15 - M-Bus interface

2.5.3.3. Auxiliary Terminal Functions (Inputs/Outputs)

The meter offers various terminal configurations, including:

- 3 electrical pulse outputs.
- Additional 2 electrical pulse outputs or 2 S0 inputs or 1 additional electrical pulse output and 1 S0 input.
- 2 RS485 ports or 1 RS485 port and 1 wired M-Bus port.
- 2 relay outputs (230 V AC/120 V AC, 5 A).
- Tariff input (230 V AC/120 V AC).
- OPTOMOS output (230 V or 120 V/0.1 A).

The maximum number of each type of input/output can be reduced and is agreed upon with the client before contract signing.

Input/output Usage:

- **230 VAC inputs:** Used for external tariff control, such as activating special tariffs.
- **S0 inputs:** Used as control inputs for alarms, external switches for reconnecting the switching device, cabinet door state, transformer station breaker state alarms, etc.
- **Relay output:** Can be used as a tariff indicator or for independent current circuit management.
- **OPTOMOS output:** Can be used as a tariff indicator, for independent current circuit management, or measurement period indication.
- **RS485 port:** Used for bidirectional communication over HDLC with other electricity meters using RS485 bus or for bidirectional communication with In-Home Displays (IHD). More details on RS485 ports are provided in chapter 4.1.3.
- **Wired M-Bus port:** Used for communication with other types of meters (water, gas, heat) for multi-utility functions.
- **Wireless M-Bus module (optional):** Integrated on the meter PCB for communication with In-Home Displays (IHD) or other types of measuring devices (gas, heat, water).

2.5.3.3.1. Electrical Pulse Outputs

The meter offers up to five passive electrical pulse outputs for meter testing, which are galvanically isolated. The electrical characteristics of these outputs comply with IEC 62053-31, Class B.
Electrical impulse outputs are located at connectors 50, 51, 52, 60, 61, 62, and 63.
The meter can have up to 5 electrical pulse outputs (depending on the assembly variant), which can be individually configured. This configuration is set during the manufacturing process.
Each electrical pulse output can be configured to indicate the following energies:

- |A+|+|A-|
- |(A+)+(A-)|
- A+
- A-
- |R+|+|R-|
- R+
- R-
- R1
- R2
- R3
- R4

Every electrical pulse output has configurable pulse polarity, pulse rate (from 500 pulses/kWh (pulses/kvarh) up to 16000 pulses/kWh (pulses/kvarh)), and pulse width (in ms).

2.5.3.3.2. Impulse S0 Input

The impulse S0 input can be used as a control input, such as for alarms or externally switching the disconnector module.

2.5.3.3.3. Bistable Relays

The bistable relay output, rated for 5 A current, can be used for direct control of individual consumer circuits. The output can be remotely controlled or configured to indicate the active tariff.

2.5.3.3.4. Tariff Inputs

The meter is equipped with two tariff inputs that operate with 230 VAC. These inputs are used for external tariff control. Optionally, the tariff input can be used to activate special tariffs during specific network conditions.

3. Functional description of the meter

3.1. Meter Configuration and Functional Description

The meter comprises the following key units:

- **Power supply:** Ensures reliable and consistent operation of the meter.
- **Microcontroller with measuring unit:** Manages the measurement part firmware, responsible for accurate data acquisition and processing.
- **Separate microcontroller for the applicative part of the firmware:** Handles the application-specific functions of the meter, such as communication, data storage, and user interface.
- **FRAM memory:** Provides non-volatile memory for storing critical data and configuration settings, even in the event of power outages.
- **Flash memory:** Offers additional storage capacity for firmware updates, calibration data, and other relevant information.
- **Display:** Displays measurement results, status information, and user prompts.
- **Buttons:** Enables user interaction and navigation through the meter's menus and settings.
- **Analog part (AFE - voltage and current sensors):** Accurately measures voltage and current values for precise energy calculations.
- **Cellular communication module or RS485 port:** Facilitates communication with remote systems for data transfer and management.
- **Disconnector module (latching relays):** Only available for direct connection meter types, allowing for remote disconnection of the consumer.
- **Detector of unauthorized access:** Protects the meter from tampering and ensures data integrity.
- **Inputs and outputs:** Provide connectivity for external devices, alarms, and control signals.

The meters feature ample spare capacity in FRAM and FLASH memory, along with sufficient uController power to support future firmware upgrades. The retention time for stored data is a remarkable 100 years.

3.2. Analog Part (AFE - Voltage and Current Sensors)

The Analog Front-End (AFE) comprises voltage dividers, current transformers, and appropriate shunts. A/D converters within the microcontroller convert phase voltages and currents into digital values.

Beyond precise measurement of active energy and demand across a wide range of measurement and temperature conditions, the measurement systems enable measurement of phase voltages, currents, and phase angles between voltages and between voltage and current of each phase.

Analog signals representing scaled voltage values (VA, VB, or VC) and current values (IA, IB, or IC) in each phase are connected to the analog input pins of the measuring chip. These analog signals are then routed to the multiplexer input, which cyclically selects input voltages and forwards them to the analog-digital converter (ADC) output.

In addition to the scaled current and voltage values, the ADC also receives voltage from the RTC battery and temperature sensor.

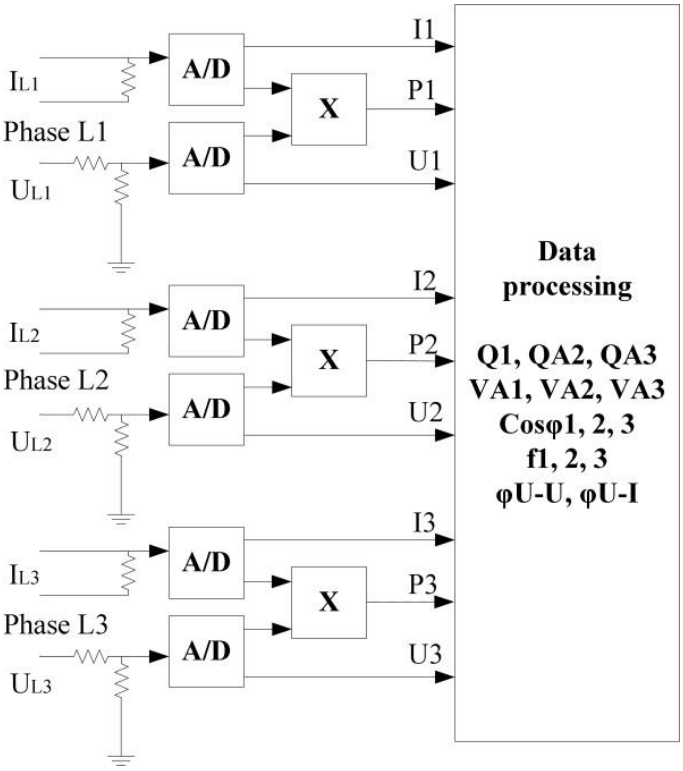

Figure 16 - Analog part – AFE for 3-phase meters

3.3. Microcontroller

The meters employ a dual microcontroller architecture, with one microcontroller dedicated to measurement functions and the other to applicative functions. This separation aligns with the WELMEC 7.2 directive, ensuring code isolation and simplifying firmware updates.
This architecture enables safe and efficient updates to the applicative part of the firmware without affecting metrology functions and eliminating the need for re-verification of the meter in case of firmware updates.

3.4. Power supply

The power supply is designed to operate within a wide voltage range of 58V to 230V, with a tolerance of ±15% to -20%. It generates two primary output voltages: +7VDC and +11VDC.
The +7VDC output is used to power the entire measurement, microcontroller, and disconnector system. This voltage is further regulated down to +3.6V and +3.3V using linear regulators. Additionally, a DC-DC converter boosts the +7VDC to +36VDC for powering the bistable switch.
The +11VDC output is galvanically isolated for safety and is used to supply power to communication ports. Similar to the +7VDC output, a DC-DC converter boosts the +11VDC to +36VDC for powering the M-Bus master.

4. Data exchange

4.1. Meter Communication

The meter offers various communication options for both local and remote data exchange. To enhance security, parameterization is divided into four levels, each protected by a unique password.

Local Data Exchange:

- **Visual:** LCD display and LED indicators provide real-time information.
- **Optical:** Infrared (IR) port for short-range data transfer.
- **Wired M-Bus:** Optional wired interface for connecting to other measuring devices.
- **Wireless M-Bus:** Optional wireless interface for connecting to other measuring devices.
- **RS485:** Optional serial interface for flexible communication.

Remote Data Exchange:

- **PLC Modem:** For connection to a programmable logic controller (PLC), suitable for meter type Sx401.
- **Cellular Modems:** Supports various cellular technologies (GPRS, 3G, LTE, NB IoT, CAT M1) for remote data transmission, suitable for meter type Sx402.

The wired M-Bus interface, when enabled, provides isolation between the meter and connected devices. The meter can handle simultaneous communication from all ports without affecting its measurement accuracy or exceeding self-power consumption.

Note:
Communication adheres to the DLMS/COSEM protocol and standards, ensuring interoperability with other devices. The meter is certified DLMS/COSEM, guaranteeing compliance with industry regulations

4.1.1. Visual communication

4.1.1.1. LCD display

The meter features a multifunctional display that adheres to VDEW specifications. The display provides clear and informative readings, including:

- **Numerical Data:** Eight digits in the lower right corner display various measurement results, with the corresponding unit shown in the upper right.
- **OBIS Codes:** The OBIS code of the displayed measurement value is shown in the lower left corner.
- **Flags:** Twelve indicators at the bottom of the display provide visual cues for different conditions or statuses.
- **Phase Indicator:** A phase indicator is located in the middle of the upper part of the display.
- **Quadrant Indicators:** The upper left corner displays indicators for the quadrant of instantaneous apparent, active, and reactive demand (and energy).

The display operates within a temperature range of -25°C to +70°C, ensuring reliable performance in various environments.

Two display sequences are available: auto and manual. The manual sequence can be activated using the meter's buttons, allowing users to select specific values for monitoring. After a programmed interval, the display automatically returns to the auto sequence.

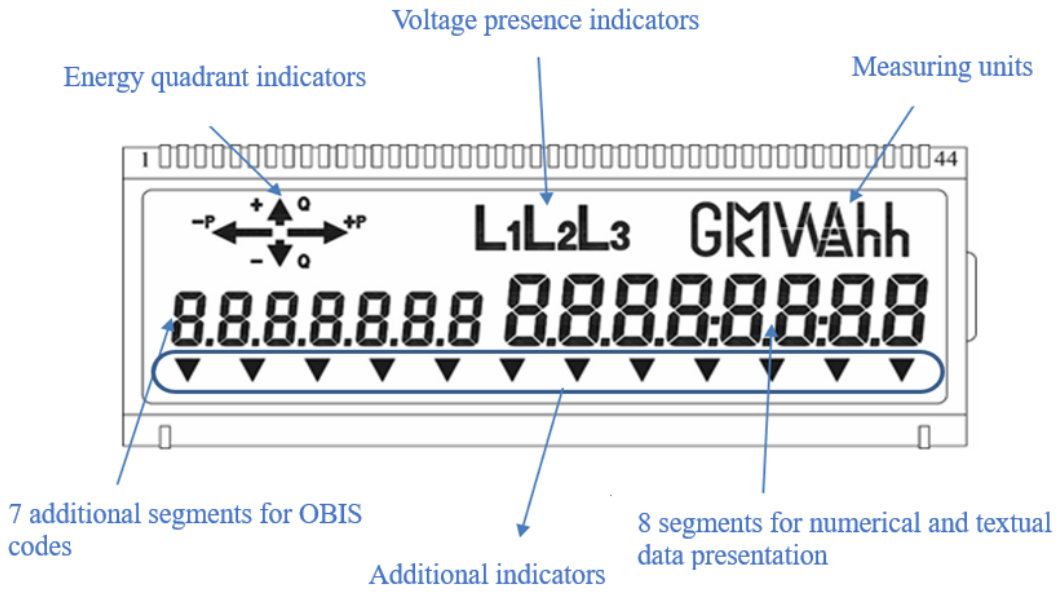

Figure 17 - All segments of the LCD

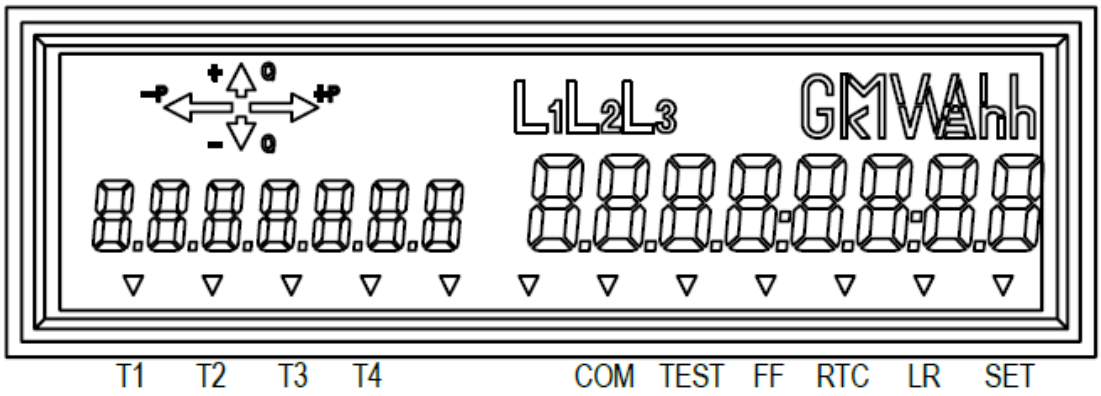

Figure 18 - Additional indicators on the LCD

The following indicators provide specific information about the meter's operation and status:

- **T1-T4:** These indicators correspond to the current tariff being recorded for consumption.
- **M1-M4:** These indicators represent the tariff in which the maximum 15-minute power is currently being recorded.
- **R1 and R2:** When these indicators are on, it signifies that relays 1 and 2 are activated.
- **COM:** This indicator has three states:
  - **Off:** The meter is not connected to a cellular network and is not communicating via the optical port.

- **On:** The meter is connected to a cellular network or is communicating locally with an optical probe.
- **Blinking:** Cellular communication is in progress, either through the mobile network or locally via the optical probe.

- **TEST:** This indicator indicates that the test mode is activated, resulting in an increased number of decimal places in the energy display.
- **FF:** If this indicator is on, it suggests a potential meter error or fraud. To identify the specific issue, it is recommended to read the error register (OBIS code: 97.97.0) and review the event logs.
- **CLK:** This indicator blinks when the meter's clock time is invalid, indicating the need for time synchronization.
- **LR:** This indicator signifies whether the displayed value originates from a metrologically relevant or legally irrelevant part of the firmware.
- **SET:** This indicator represents the status of the switch. If the indicator is on, the switch is on. If the indicator is blinking, the switch should be turned on manually by pressing and holding the unsealed button.

Meter Display and Settings
The meter's display is designed to be easily readable under various lighting conditions, ensuring clarity even in poorly lit environments.

Phase Presence:
The meter visually indicates the presence of each phase on the display. If the phase voltage drops below 50% of the nominal value, the meter detects an absence of that phase. This threshold can be customized to suit specific requirements, with the default setting at 50%.

Decimal Places and Leading Zeros:
The number of decimal places displayed can be configured to meet specific preferences. Additionally, the display can be set to show leading zeros, providing enhanced readability.

Default Settings
The meter's default settings for decimal places and leading zeros vary depending on the connection type:

Direct Connection:
- **Energy:** 6 integers, 2 decimal places
- **Power:** 6 integers, 2 decimal places

Transformer Connection:
- **Energy:** 6 integers, 2 decimal places
- **Power:** 5 integers, 3 decimal places

Figure 19 - Display, decimal places

Decimal Place Customization
The meter allows for individual adjustment of decimal places for energy, power, current, and voltage. This flexibility enables users to tailor the display to their specific needs and preferences.

OBIS Codes for Decimal Place Configuration
To configure the decimal places for each parameter, use the following OBIS codes:

- **Energy:** 1.0.129.1.51.255
- **Power:** 1.0.129.1.52.255
- **Voltage:** 1.0.129.1.61.255
- **Current:** 1.0.129.1.62.255

Displayed Data Units

The meter displays data using the following units:

- **Active Energy:** Kilowatt-hours (kWh)
- **Reactive Energy:** Kilovolt-ampere reactive hours (kvarh)
- **Apparent Energy:** Kilovolt-ampere hours (kVAh)
- **Active Power:** Kilowatts (kW)
- **Reactive Power:** Kilovolt-amperes reactive (kVAh)
- **Apparent Power:** Kilovolt-amperes (kVA)
- **Current:** Amperes (A)
- **Voltage:** Volts (V)

The decimal place settings for the meter are typically configured at the factory during manufacturing. This configuration can't be modified after delivering the meter to the Distribution System Operator (DSO)

Note:
While the default setting is for factory-configured decimal places, some advanced meter models may offer limited on-site customization options. However, this would require specific technical knowledge and potentially the use of specialized tools or software. It's essential to consult the meter's documentation or contact the manufacturer for information on any customization possibilities that may be available.

Consumption	Object 1.0.1.8.1.255	Display on the meter
11000 Wh	Scaler Unit: [ ] 10^x Wh 0	kWh 11.0
11035 Wh	Scaler Unit: [ ] 10^x Wh 2	kWh 110.35

Table 3 - Decimal places on Display

Display Test mode

The "Test mode" on Sx402 meters is activated through the "Methods" tab of the parametrization software. Activating the display test mode can be done through any communication interface, usually with the Management Client or Technician Client, depending on the meter's roles.

In the Method Tab, find the object "Test mode activation script table" and in the "Execute" field write 1. After that, press the "Write" button to save the configuration to the meter. These steps successfully activate "Test Mode".

The purpose of the "Test mode" is to increase the number of decimals in the energy on the display. When this mode is activated, the resolution of all energy measurements on display (for all objects already existing in "General display readout" or "Alternate display readout")

changes to Wh (kWh to 3 decimal places) or varh (kvarh to 3 decimal places). That is the only purpose of the "Test mode". It doesn't have a separate list of objects to be shown on the meter display. To check if the "Test mode" is activated check the "TEST" indicator on the meter display. Duration for Display Test Mode can be changed in object 0.0.96.34.10.255. Value in this object is set to 3600s. After 3600 seconds passed from activation meter will automatically change back from "Test mode" to "Normal mode".

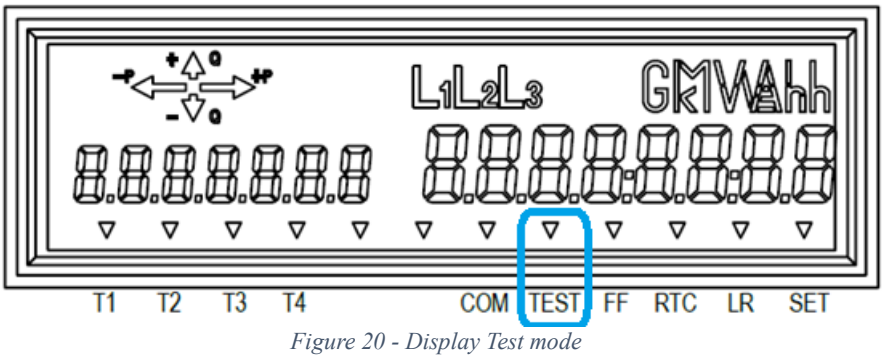

Figure 20 - Display Test mode

Display Element Sizes
The meter features clear and legible digits with the following dimensions:

- **Measuring Values:** 8 mm x 3.75 mm
- **OBIS Codes:** 5.5 mm x 2.75 mm

Blinking Frequency
Certain display elements blink at a frequency of 1 Hz, providing visual cues for specific conditions or statuses.

Backlight
The display can optionally be equipped with a backlight feature, enhancing visibility in low-light conditions or environments with limited ambient lighting.

Default Language
The default language for the meter's display is English.

4.1.1.1.1. OBIS codes

Example of OBIS codes on the meter display (configurable):

OBIS CODE	DATA DESCRIPTION
96.1.0	Meter serial number
96.1.1	Utility ID (utility serial number)
0.9.1	Time
0.9.2	Date
1.8.0	Total received active energy (A+)
15.8.0	Total absolute active energy |A|
1.8.T	Received active energy in tariff T (T=1,2,3,4)
15.8.T	Absolute active energy in tariff T (T=1,2,3,4)

OBIS CODE	DATA DESCRIPTION
2.8.0	Total transferred active energy (A-)
2.8.T	Transferred active energy in tariff T (T=1,2,3,4)
1.6.1	A+ received max demand in the first phase (T1)
1.6.2	A+ received max demand in the second phase (T2)
1.6.3	A+ received max demand in the third phase (T3)
1.6.4	A+ received max demand in the fourth phase (T4)
2.6.1	A- transferred max demand in the first phase (T1)
2.6.2	A- transferred max demand in the second phase (T2)
2.6.3	A- transferred max demand in the third phase (T3)
2.6.4	A- transferred max demand in the fourth phase (T4)
32.7.0	The effective value of voltage Phase 1
52.7.0	The effective value of voltage Phase 2
72.7.0	The effective value of voltage Phase 3
31.7.0	The effective current value of Phase 1
51.7.0	The effective current value of Phase 2
71.7.0	The effective current value of Phase 3
33.7.0	Demand factor in Phase 1
53.7.0	Demand factor in Phase 2
73.7.0	Demand factor in Phase 3
3.8.0	Total received reactive energy
3.8.T	Received reactive energy in tariff T (T=1,2,3,4)
4.8.0	Total transferred reactive energy
4.8.T	Transferred reactive energy in tariff T (T=1,2,3,4)
5.8.0	Received inductive reactive energy (Q1) total
5.8.T	Received inductive reactive energy (Q1) in tariff T (T=1,2,3,4)
6.8.0	Transferred capacity reactive energy (Q2) total
6.8.T	Transferred capacity reactive energy (Q2) in tariff T (T=1,2,3,4)
7.8.0	Transferred inductive reactive energy (Q3) total
7.8.T	Transferred inductive reactive energy (Q3) in tariff T (T=1,2,3,4)
8.8.0	Received capacity reactive energy (Q4) total
8.8.T	Received capacity reactive energy (Q4) in tariff T (T=1,2,3,4)
34.7.0	Voltage frequency in phase 1
54.7.0	Voltage frequency in phase 2
74.7.0	Voltage frequency in phase 3
96.6.3	Battery voltage for backup supply of the clock
1.7.0	Positive active instantaneous demand A+
2.7.0	Negative active instantaneous demand A-
3.7.0	Reactive instantaneous demand R+
4.7.0	Reactive instantaneous demand R-
97.97.0	Status and error register
25.6.0	Communication Signal Quality

Table 4 - Possible OBIS codes on the display

Display Sequence Value Limits

Note:
Both the automatic and manual display sequences are limited to a maximum of 64 values. This means that the meter can simultaneously display up to 64 different measurements or data points.

4.1.1.1.2. Status and Error Register

In addition to displaying measurement values, the meter can also indicate the status and error conditions of the device. When such conditions occur, the OBIS code in the lower left corner of the display will be replaced with "F.F."

Error Register (OBIS Code: 0.0.97.97.0.255)

The meter's error register is a 32-bit register that stores information about irregular events. The individual bits within this register are interpreted as outlined in Table 2.

Note:
To provide a comprehensive explanation, please provide Table 2, which should list the specific bits and their corresponding meanings.

Name	Error
Clock error	0x00000001
Calibration error	0x00000008
Phase L1 no voltage	0x00000100
Phase L2 no voltage	0x00000200
Phase L3 no voltage	0x00000400
Measuring part operating error (CE)	0x00000800
Flash memory legally relevant error	0x00010000
Initialization error	0x00040000
Season errors not defined	0x00100000
Possibility of the wrong clock due to a weak battery	0x00200000
Battery must be changed	0x00800000
Removed terminal block cover	0x01000000
Removed meter cover	0x02000000
Low battery voltage	0x04000000
Strong magnetic field	0x08000000
Reset WDT legally relevant	0x10000000
Bits controlled by legally non-relevant software are:	
FRAM energy CRC error	0x00000002
MAX average demand CRC error	0x00000004

Name	Error
Reset WDT legally non-relevant	0x00004000
Flash memory legally non relevant (LNR) error	0x00008000
Initialization error	0x00040000
Tariff errors not defined	0x00080000
Inverse energy direction in phase L1	0x20000000
Inverse energy direction in phase L2	0x40000000
Inverse energy direction in phase L3	0x80000000
Phase voltage asymmetry	0x00000010

Table 5 - Error register

4.1.1.2. Use of display and keyboard

Meter Display and Operation
The ST402x meter adheres to VDEW specifications for display information and DLMS/COSEM recommendations for parameters and measurement results. It also employs appropriate OBIS codes for data identification.

Automatic Display Mode
In autonomous operation, the meter automatically displays values selected in the General Display Readout (OBIS code: 0.0.21.0.1.255). These values, including date, time, status register, and consumption per tariff, are updated at intervals of 8 seconds (or a configurable value, OBIS code: 1.0.129.1.10.255).

Manual Display Mode
Users can enter manual display mode to access additional data collected during the meter's operation. To activate the manual mode, the consumer simply presses the keyboard. To return to automatic mode, the right button must be held for longer than 7 seconds, or the meter will automatically revert if the button remains inactive for a specified duration.

Auto Diagnostic Display Mode
The meter incorporates an auto-diagnostic display mode, which aids in visually verifying the accuracy of display characters. This mode is utilized as a part of the overall auto-diagnostic function.

Meter Buttons and Functions
The meter features two buttons located in the upper right corner: an unsealed button and a sealed button. The unsealed button is always accessible and is used for navigating the meter's menu.

Unsealed Button Functions:

- **Scrolling (S):** Press the unsealed button for up to 2 seconds to scroll through menu options or parameter lists.
- **Enter (E):** Press the unsealed button for 2 to 5 seconds to confirm a selection or enter a menu option.
- **F (Lower Cover Opened):** Press the unsealed button for 2 to 5 seconds when the lower cover is open to access specific functions or settings.

- **Back (B):** Press the unsealed button for 5 to 7 seconds to return to the previous menu level.
- **Master Back (MB):** Press the unsealed button for longer than 7 seconds to initiate a master back operation, typically returning the meter to a default state or auto-scroll mode.
- **Manual Reconnect (MR):** Press the unsealed button for longer than 10 seconds to perform a manual reconnect of the bistable interlock.
- **Power On (No Supply):** Press the unsealed button for at least 4 seconds when the meter is without power to switch it on using the battery supply.

Command Usage:

- **S:** Used for listing options in menus and parameters.
- **E:** Used for confirming selections or entering menu options.
- **B:** Used for exiting sub-menus or parameter lists.
- **MB:** Typically used to activate auto-scroll mode.
- **MR:** Used for annual switching on of the bistable interlock.

4.1.1.2.1. Menu tree

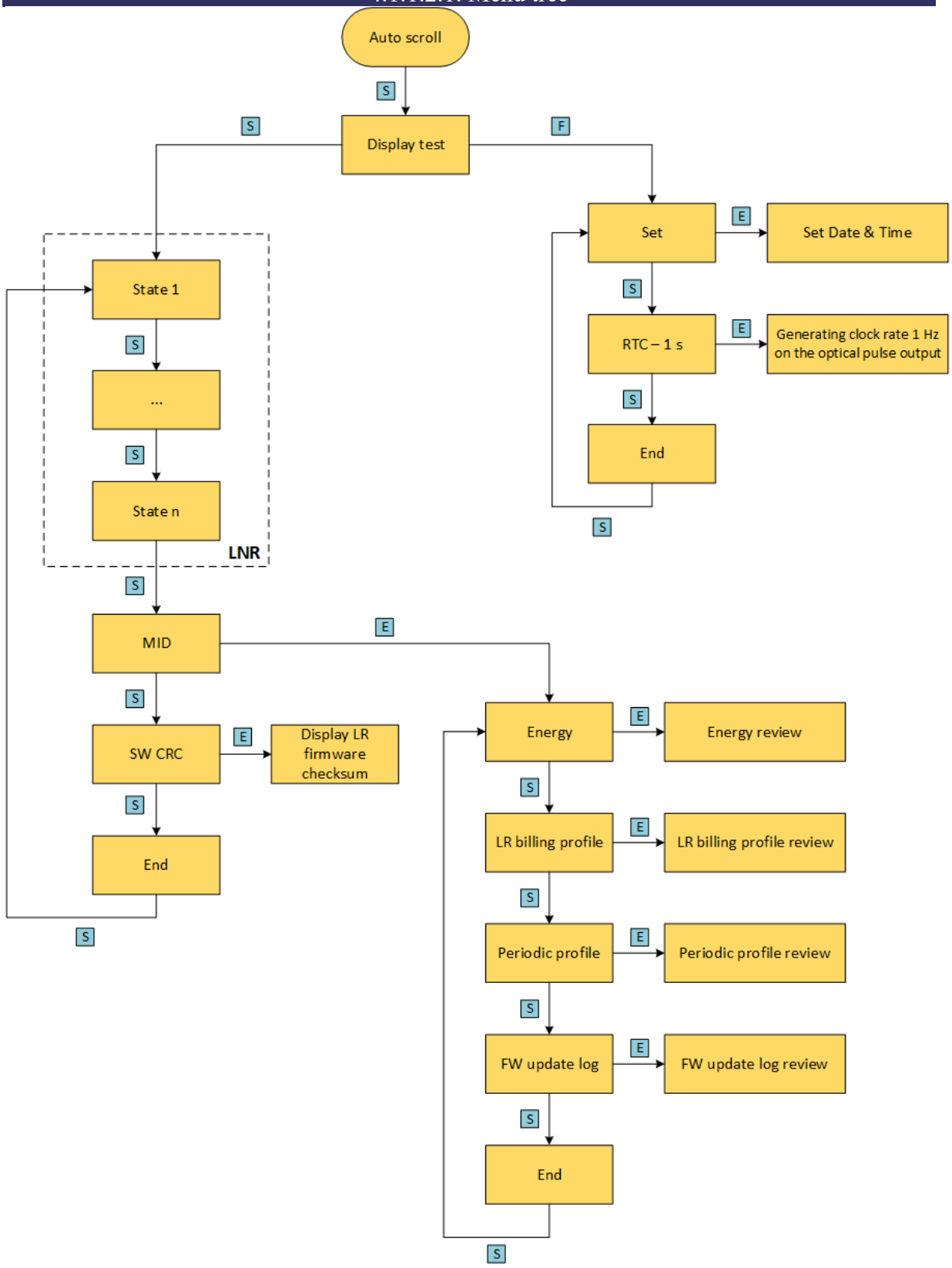

Figure 21 - Menu tree ST402 meters

4.1.1.3. Optical LED Pulse Outputs

The meter's front panel features two red LED diodes that serve as optical LED pulse outputs for meter accuracy testing. These outputs comply with IEC 62052-11 and EN 50470-1 standards.

LED Blinking Frequency
The blinking frequency of the LED diodes varies depending on the load being measured and the meter's constant (pulses per kilowatt-hour for active energy and pulses per reactive kilowatt-hour for reactive energy).

Meter Constant
The meter constant, which defines the number of pulses per unit of energy, adheres to IEC 62053-21/22 and EN 50470-3 standards. The available meter constants are:

- **Active Energy (Direct Meter):** 1.000 pulses/kWh, 3.200 pulses/kWh, or 4.000 pulses/kWh (optional)
- **Reactive Energy (Direct Meter):** 1.000 pulses/kvarh, 3.200 pulses/kvarh, or 4.000 pulses/kvarh (optional)
- **Active Energy (Transformer Meter):** 10.000 pulses/kWh
- **Reactive Energy (Transformer Meter):** 10.000 pulses/kvarh

These meter constants allow flexibility in adapting the pulse output to different metering applications and requirements.

Note:
The meter constant must be mutually agreed by the client and manufacturer before the commencement of deliveries.

4.1.2. Cellular communication modem

Integrated GPRS / 3G / LTE / NB IoT Module
The ST402x meter types incorporate a built-in GPRS/3G/LTE/NB IoT/CAT M1 module that facilitates communication between the meter and a remote control system via the GSM network. This enables remote meter reading capabilities.

Figure 22 - LTE, NB-IoT

Modem Components
The integrated modem consists of the following components:

- **GSM Module:** The core component responsible for handling GSM network communication.
- **SIM Holder:** A slot for inserting a SIM card, providing network access.
- **GSM Antenna:** Ensures reliable signal reception for the GSM module.

Power Supply
The modem is powered directly from the meter's internal power supply, eliminating the need for an external power source.

Additional Options
In addition to the standard GPRS/3G/LTE module, versions with NB IoT and CAT M modem technology are also available, offering alternative communication options with specific benefits tailored to different network environments and applications.

Technical Characteristics: Cellular Connectivity
The meter supports a wide range of cellular network bands, ensuring compatibility with various network infrastructures:

- **Penta-band LTE:** B1 (2100 MHz), B3 (1800 MHz), B7 (2600 MHz), B8 (900 MHz), B20 (800 MHz)
- **NB IoT, NB IoT2, and CAT M1 Bands:** B28 (700 MHz), B20 (800 MHz), B8 (900 MHz), B3 (1800 MHz)

These frequency bands enable reliable and efficient communication with the remote control system, even in areas with limited network coverage or specific frequency restrictions.

Output Power and Technical Specifications
The integrated GPRS/3G/LTE module offers the following output power levels:

- **GSM 900:** 2W, Class 4
- **GPRS 1800:** 1W, Class 1
- **LTE 2100/2600:** 0.2W, Class 3

Technical Specifications

- **LTE:** FDD (Frequency Division Duplex), compliant with 3GPP Edition 14
- **Fallback Support:** Supports GSM/EDGE and UMTS/HSPA networks as fallback options in case of LTE signal loss.
- **GPRS/EGPRS:** Multi-slot Class 33 for efficient data transmission.

These specifications ensure reliable and efficient communication performance across different network conditions and data transmission requirements.

Modem Restart and Self-Reboot
The meter regularly performs periodic modem restarts to maintain stable communication and prevent prolonged periods without connectivity. The restart interval can be configured to suit specific requirements.

Self-Reboot Functionality
The meter supports complete self-reboots, allowing it to automatically restart and recover from system errors or software issues.

Transparent Communication
The modem operates transparently, ensuring seamless communication between the meter and the data collection center without interfering with the data transmission process.

Hardware Components

The module includes a GSM antenna connector and a SIM holder. The SIM holder is of the "push-push" type, enabling easy SIM card replacement. It is accessible from beneath the meter's lower cover.

Power Supply

The modem's power supply is provided by the meter itself, eliminating the need for an external power source.

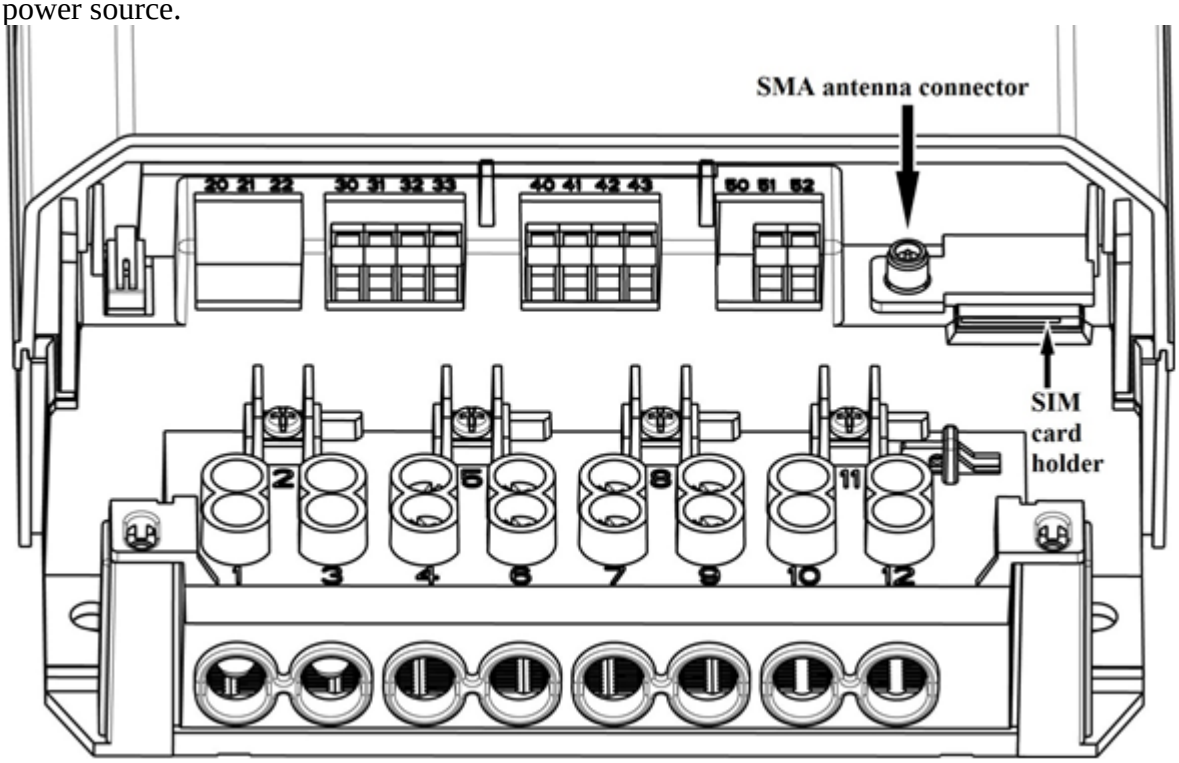

Figure 23 - SIM card slot and SMA antenna connector

Communication Methods

The remote-control system for meter readout can communicate with the meters using two independent methods:

1. **GPRS Connection:** The system operates on a client-server architecture.
    - **Static IP:** If the SIM card has a static IP address, the modem acts as a server, waiting for incoming connections.
    - **Dynamic IP:** If the SIM card has a dynamic IP address, the system initiates communication by obtaining the IP address from the modem.
2. **COSEM Wrapper:** A specialized protocol described in the DLMS standard (Green Book).

Additional Protocol: RADIUS

The modem also supports the RADIUS protocol, which is commonly used for network access control and authentication.

Communication Module Settings

Communication module settings can be configured using the following objects:

Object / Attribute Name	OBIS code	Default value
TCP-UDP setup	0.0.25.0.0.255	TCP-UDP port: 4059

Object / Attribute Name	OBIS code	Default value
		Inactivity Time Out: 180 (seconds)
IPv4 setup	0.0.25.1.0.255	
MAC address setup	0.0.25.2.0.255	
PPP setup	0.0.25.3.0.255	PAP login: Username: Password:
GPRS modem setup	0.0.25.4.0.255	APN: PIN code:
GSM diagnostic	0-0:25.6.0.255	
Auto connect	0.0.2.1.0.255	Mode: 101 (the device is permanently connected to the communication network)
Auto Answer	0.0.2.2.0.255	
Modem Information	0.0.94.10.4.255	[S0] - IMSI [S1] - IMEI [S2] - MSISDN [S3] - ICCID
LTE Monitoring	0-1:25.11.0.255	
LTE Monitoring Profile	1.0.99.1.2.255	
LTE Connection rejection	0.0.94.10.3.255	
LTE Cat M1/NB-IoT config	0.0.94.10.5.255	Mode: 0 - automatic (Cat-M1 preferred) 1 - automatic (NB-IoT preferred) 2 - Cat-M1 only 3 - NB-IoT only

Table 6 - Communication Module Settings

SIM Card Information:

- **APN and PIN Number (0.0.25.4.0.255):** If required, enter the APN and PIN number for the SIM card.

GPRS Connection Settings:

- **Username and Password (0.0.25.3.0.255):** Set the username and password for the GPRS connection.
- **Authentication Methods:** Supported methods include PAP and CHAP-MD5.
- **IP Address and Port (0.0.25.1.0.255):** Configure the IP address and port of the data collection system.

Push Message Settings (0.x.25.9.0.255):

- **Scheduled Time:** Configure the scheduled time for sending push messages.
- **Monitor Threshold Exceeded:** Define the threshold values for triggering push messages based on alarm monitoring.
- **HES Triggered (Wake-up):** Specify the conditions under which the HES will trigger push messages.

Push Message Configuration Objects:

- **Interval_1 (0.0.25.9.0.255):** Define the content, destination, and medium for push messages triggered by Interval_1.
- **Interval_2 (0.2.25.9.0.255):** Define the content, destination, and medium for push messages triggered by Interval_2.
- **Interval_3 (0.3.25.9.0.255):** Define the content, destination, and medium for push messages triggered by Interval_3.
- **On Alarm (0.4.25.9.0.255):** Define the content, destination, and medium for push messages triggered by alarms.
- **On Connectivity (0.0.25.9.0.255):** Define the content, destination, and medium for push messages triggered by connectivity changes.
- **On Installation (0.7.25.9.0.255):** Define the content, destination, and medium for push messages triggered during installation.

Transport Service Address and System Port:

- **TCP:** If TCP is selected as the transport service, specify the IP address and port in the format "ip_address:port" (e.g., "129.0.2.21:4059").

GPRS Connection Timeout:

- **Inactivity Time-out (0.0.25.0.0.255):** Set the timeout in seconds before the modem considers the GPRS connection disrupted. The default value is 15 seconds.

System Port with Static IP Addresses:

- **TCP-UDP Port (0.0.25.0.0.255):** Specify the system port that the modem listens to for incoming connections when operating with static IP addresses. This value is ignored when operating with dynamic IP addresses.

Operation Mode:

- **TCP (2, 3, 6, 7):** The modem operates using the TCP protocol. UDP is no longer supported.

Cellular Communication Diagnostic (0.0.25.6.0.255):

- **Signal Strength:** Read the signal strength of the cellular network.
- **Cell ID Info:** Obtain information about the cell ID.
- **Bit Error Rate (BER):** Read the bit error rate of the communication channel.

SIM Card Information:

- **IMSI (1.0.129.1.28.255):** International Mobile Subscriber Identity
- **IMEI (1.0.129.1.29.255):** International Mobile Equipment Identity
- **ICCID (1.0.129.1.30.255):** Integrated Circuit Card Identifier

Modem Technical Specifications:

- **Power Supply:** Complies with EN50160 for boundary conditions.
- **Safety Requirements:** Complies with EN62053-31 for GPRS/EDGE (Class 10) and LTE (Category 1).
- **Communication Status:** The COM indicator on the display indicates the communication status (Off, On, Blinking).

Note:
To ensure accurate and complete configuration, please refer to the specific documentation for your meter model and communication system.

4.1.2.1. Antenna

Antenna Options
The meter is supplied with a suitable antenna for optimal performance. Two antenna types are available:

1. **Extended Cable Antenna**: Features a cable length of 1.5 or 2 meters and a magnetic stand for outdoor mounting flexibility.
2. **Rod Antenna:** Designed for indoor installation.

Figure 24 - Antenna

Antenna Specifications

- **Gain:** 5 dB
- **Impedance:** 50 Ω

These specifications ensure efficient signal reception and transmission, contributing to reliable communication between the meter and the remote control system.

4.1.3. RS-485 Port

The ST402x meters offer up to two RS-485 ports for local communication, enabling data reading and meter parameterization. The RS-485 bus operates in half-duplex mode with A and B connectors.

Supported Protocols and Speed

- **DLMS:** The primary supported communication protocol for data exchange.
- **Direct HDLC:** An optional protocol for IEC HDLC setup (OBIS code: 0.1.22.0.0.255).
- **IDIS Specification:** One of the RS-485 ports can be configured for one-way communication with an In-Home Display (IHD) according to the IDIS specification.

Data Transmission

- **DLMS/COSEM:** Data sent to the In-Home Display adheres to the DLMS/COSEM standard.

Note:
The specific configuration options for the RS-485 ports may vary depending on the meter model and intended use case. It's recommended to consult the detailed technical documentation for more information.

RS-485 Communication Interface
The RS-485 communication interface typically adheres to the IEC 62056-46 protocol, allowing for the connection of up to 99 meters to an RS-485 master device (communicator or modem).

HDLC Addresses
Each meter in the RS-485 network must have a unique HDLC (High-Level Data Link Control) address assigned to it. The available HDLC addresses range from 17 to 116.

Connection Limitations

- **Device Limit:** The number of devices connected to the RS-485 network is hardware-limited.
- **Simultaneous Communication:** Only one meter can communicate with the RS-485 master at a time; simultaneous communication with multiple meters is not possible.

Maximum Distance
The maximum distance between the master device and the last meter in the RS-485 Master-Slave connection is up to 1000 meters.

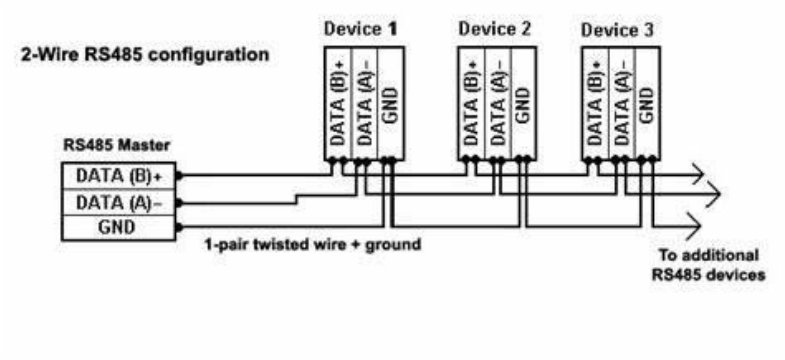

Figure 25 - RS485 Master-Slave

Note:
These limitations and specifications are important to consider when designing and implementing an RS-485 network for meter communication.

Steps to Connect Multiple Slave Devices to an RS485 Network

1. Wiring the Network:
   - Use a twisted pair cable for the A and B lines.
   - Connect the A line of the master device to the A line of all slave devices.
   - Connect the B line of the master device to the B line of all slave devices.
   - Ensure that the ground (GND) is also connected between all devices to maintain a common reference.
2. Termination Resistors:
   - Place a termination resistor (typically 120 ohms) at both ends of the RS485 bus to minimize signal reflections.
3. Addressing the Slave Devices:
   - Assign a unique address to each slave device. This is usually done through DIP switches or software configuration.
4. Configuring the Master Device:
   - Set up the master device to communicate with the slave devices using their unique addresses.

- Configure the communication parameters (baud rate, parity, stop bits) to match across all devices.

5. Testing the Network:
   - Power on the network and use the master device to send commands to each slave device.
   - Verify that each slave device responds correctly.

4.1.4. Optical Port

The optical port provides a convenient method for local communication with the meter, allowing for data reading and parameterization. It is strategically located in the center of the meter's upper cover, directly beneath the LCD display.

Supported Protocol and Speed

- **DLMS:** The primary supported communication protocol for data exchange.
- **Communication Speed:** 9600 bit/sec

Standards Compliance

- **SRPS EN 62056-21:** The optical port adheres to this standard for optical communication interfaces.

Optical Probe Connection

The optical port uses an optical probe for connection, enabling reliable and simultaneous communication over both optical and electrical interfaces on the meter.

Direct HDLC Protocol (IEC Local Port Setup)

The meter supports the Direct HDLC protocol (OBIS code: 0.0.20.0.0.255) for local port configuration.

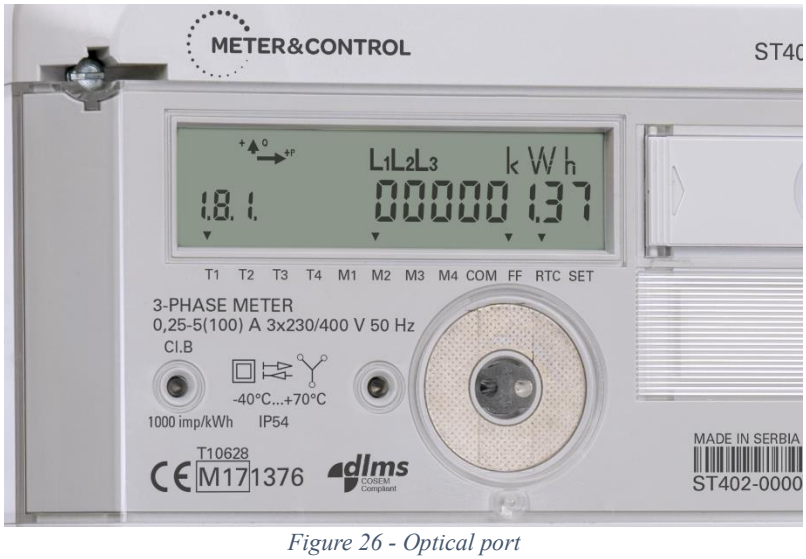

Figure 26 - Optical port

Note:
The optical port offers a flexible and efficient way to interact with the meter for various local communication tasks.

4.1.5. Wired M-Bus

The meter incorporates a wired M-Bus interface, designed in compliance with EN 13757-2, EN 13757-4, and EN 13757-3 standards. This interface enables data collection from water, gas, and heat meters. When a wired M-Bus is present, the meter can have a maximum of one additional RS-485 port.

Note:
The wired M-Bus module is an optional feature and may not be included in all meter models.

4.1.6. Wireless M-Bus

Figure 27 - Wireless M-Bus

The wireless M-Bus (WMBUS) is an optional module that can be integrated into the meter's PCB. It serves as a wireless communication channel for data collection from water, gas, and heat meters. Additionally, the meter utilizes the WMBUS port to send calculation and service data to a wireless in-home display (HAN communication), located within the consumer's apartment. The WMBUS implementation adheres to the EN13757-4 standard.

Note:
The wireless M-Bus module is an optional feature and may not be included in all meter models.

4.1.7. Support for the connection of water meters, gas meters, and calorimeters (Multi-utility metering)

M-Bus Integration and Data Storage
The meter incorporates an M-Bus interface (wired or wireless) for connecting and communicating with other measuring devices (water, gas, heat meters).

Device Data Storage
The meter reserves memory to store billing profiles for each connected M-Bus device.

- **Billing Period:** The billing period can be configured for intervals of 5, 10, 15, 30, 60 minutes, or daily.
- **Memory Capacity:** Each device has a memory capacity of 300 records.
- **Data Storage:** All data from M-Bus devices is stored in the associated profiles.

M-Bus Load Profiles

- **Profile 1 (0.1.24.3.0.255):** Capacity of 680 records.
- **Profile 2 (0.2.24.3.0.255):** Capacity of 680 records.
- **Profile 3 (0.3.24.3.0.255):** Capacity of 680 records.

- **Profile 4 (0.4.24.3.0.255):** Capacity of 680 records.

M-Bus Event Logs
The meter includes M-Bus event logs to store data from connected devices.

- **M-Bus Event Log (0.0.99.98.3.255):** Capacity of 340 records.
- **M-Bus Event Log 1 (0.1.24.5.0.255):** Capacity of 340 records.
- **M-Bus Event Log 2 (0.2.24.5.0.255):** Capacity of 340 records.
- **M-Bus Event Log 3 (0.3.24.5.0.255):** Capacity of 340 records.
- **M-Bus Event Log 4 (0.4.24.5.0.255):** Capacity of 340 records.

Data Storage and Retrieval
The meter has implemented algorithms for reading data from M-Bus devices and storing it in the associated profiles. This functionality can be adapted to meet the specific requirements of the utility.

Note:
The M-Bus integration allows the meter to collect and store data from multiple devices, providing a comprehensive view of energy consumption and usage.

5. Meter functions

5.1. Billing Profile

The meter generates and stores a billing profile containing registered energy and demand values per tariff (OBIS code: 0-0:98.1.255). This profile can hold up to 310 billing periods (months), depending on the number of monitored values (channels). The billing profile is organized in a First-In-First-Out (FIFO) manner.

Billing Value Selection and Storage

- **Configurable Selection:** The meter allows for the configuration of up to 40 different billing values (channels) to be monitored.
- **Monthly Recording:** These values are recorded monthly, with the entry date and time customizable.
- **Storage:** Billing data is stored in the meter's Flash memory.

Data Retrieval

Billing data can be accessed in several ways:

- **Local Display:** Review billing data directly on the meter's display.
- **Personal Computer:** Connect the meter to a PC and use appropriate software to retrieve billing data.
- **Remote Access:** Access billing data remotely from an AMM center.

Current Billing Data:

Current billing data can be read via the optical interface.

Billing Profile Types

- **Billing Profile 1 (0.0.98.1.0.255):** Stores billing data in chronological order, starting from the last billing period. This profile automatically resets the maximum demand indicator at the end of each billing period.
- **Billing Profile 2 (Load Profile 5 - 1.0.99.130.0.255):** Stores up to 850 records of billing data, including timestamps and A+ values in two tariffs. This profile is primarily used for fraud detection and does not reset the maximum demand indicator.

5.2. Load Profile

The load profile represents a collection of recorded measurement values gathered over a specified period. The meter supports the recording of four distinct load profiles.

Recording Period Configuration

The recording period for each of the four load profiles is independent and can be programmed to any of the following values:

- 0 – No Registration
- 300 – 5-minute recording period
- 600 – 10-minute recording period (default value of Load profile with period 4)
- 900 – 15-minute recording period (default value of Load profile with period 1)
- 1800 – 30-minute recording period

- 3600 – 1 hour recording period
- 86400 – 1 day recording period (default value of Load profile with period 2)

The capture period is a variable, which defines the time distance between two captured data.

Load Profile Organization

All load profiles are organized in a First-In-First-Out (FIFO) manner.

Recorded Values

The following values can be recorded in the load profiles:

- Date and time
- Average demand
- Energy counters
- Maximum demand measurement and origin time
- Instantaneous voltage and current values
- Demand factor for all three phase conductors
- Frequencies for all three phase conductors
- Total Harmonic Distortion (THD) for voltages and currents
- Error object
- Profile status register
- RTC battery voltage

Profile Status

The profile status is a 1-byte value where each bit represents a specific meaning.

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

Load Profile Details

Load Profile 1 (0-0:99.1.0.255):

- **Capture Channels:** Records energy values in 10 channels (A+, A-, R1, R2, R3, R4, average 15-minute load, timestamp, communication signal quality).

- **Storage Capacity:** Stores the last 60 days of entries (with 10 channels and a 15-minute recording period).
- **Default Period:** 15 minutes, capturing new entries at xy:00, xy:15, xy:30, and xy:45 minutes.

Load Profile 2 (0-0:99.2.0.255):

- **Default Period:** 1 hour, storing 3484 entries with 10 channels.
- **Configurable Period:** Can be set to other periods (daily, 15 minutes, 10 minutes) with corresponding changes in the maximum number of records.
- **Recorded Values:** Includes all energies, powers, profile status, active energy combined (15.8.0), and active energy net (16.8.0).

Load Profile 3 (1-0:99.3.0.255):

- **Default Period:** Daily, storing 5762 entries with 10 channels.
- **Configurable Period:** Can be set to other periods (daily, 15 minutes, 10 minutes) with corresponding changes in the maximum number of records.

Load Profile 4 (1-0:99.129.0.255):

- **Default Period:** 10 minutes
- **Primary Use:** Recording phase currents and voltages.
- **Channels:** Typically recorded in 7 channels, storing 1080 records for 7.5 days.

Note:
The specific number of records stored in each load profile may vary depending on the configured recording period and the number of channels being monitored.

5.3. Power Management

The ST402 meter incorporates power management capabilities implemented through two mechanisms:

1. **Integrated Disconnector:** A built-in device that can interrupt the power supply to the entire meter.
2. **Bistable Relay:** A relay capable of controlling individual power circuits within the meter.

These power management features provide flexibility and control in managing the meter's power consumption and operation.

5.3.1. Integrated Disconnector

Disconnector Functionality
The ST402 meter, designed for direct connection to the power supply network, incorporates a disconnector that allows for the remote or local switching off of consumers from the electrical distribution network.

Switch-Off and Switch-On Conditions

- **Remote or Local Control:** The disconnector can be activated or deactivated using remote or local communication with the meter, depending on the meter's configuration.

- **Demand Limit Exceed:** The meter can automatically switch off a consumer if the allowed demand limit is exceeded.
- **Penalty Time Expiration:** After a specified penalty time, the meter can automatically switch on the consumer.
- **Demand Limit Adjustment:** The allowed demand limits can be modified remotely with a resolution of 1W.

Fraud Detection

As an optional feature, the meter can check for the presence of voltage on the load side while the disconnector is in the open (disconnected) state. If voltage is detected, it indicates a potential fraud event.

Disconnector Specifications

- **Simultaneous Switching:** The disconnector switches off or on all three phase conductors simultaneously
- **Neutral Conductor:** The disconnector does not control the neutral conductor.
- **Safe Cut-Off:** Three separate disconnectors (one for SM40y) provide a safe cut-off for currents up to 100 A with a guaranteed number of up to 1,000,000 commutations.
- **Switching Time:** The switch-off/switch-on time is less than 15 milliseconds.
- **Standards Compliance:** The disconnector characteristics comply with the IEC 62055-31 Annex C UC3 category.

Relay Immunity

The relays used in the disconnector are immune to external DC magnetic fields, preventing unwanted switching. If an external magnetic field does influence the switch, the event is recorded in the measuring integrity log book. Once the magnetic field is removed, the relays return to their previous connection state.

Disconnector Activation Methods

The disconnector can be activated (switched on or off) in the following ways:

- **Remotely:** By sending a command from the AMM center.
- **Locally:** As a result of:
  - Power limit activation
  - Code red activation

Power Management Categories (Groups)

The meter supports the creation of power management categories (groups) to which it can belong. This allows for centralized management and control of multiple meters within the same group.

- **Group-Wide Adjustments:** Power limits can be adjusted simultaneously for all meters within a group, and disconnectors can be switched off or on for all meters in the group.
- **Group-Wide Status Changes:** Meters within the same group can be set to a "red code" or returned to normal operation collectively.

Local Switch-On

If a consumer is switched off from the electrical power network locally, repeated switch-on (closure of the disconnector contacts) can be done manually:

- **Meter Front Panel:** Press and hold the button on the front panel for longer than 10 seconds.

- **External Switch:** Use an external switch connected to the meter's S0 input (typically used in long-distance measuring points).

Remote Switch-On

If a consumer is switched off remotely by the AMM center, the switch-on can be done automatically upon receiving the corresponding command or manually, depending on the selected limitation mode.

Note:
The specific procedures and options for local and remote switch-on may vary depending on the meter model and configuration. It's essential to consult the detailed technical documentation for accurate instructions.

Disconnector Operating Modes and Transitions

The disconnector operates as a machine with three possible states:

1. **Connected:** The consumer is connected to the electrical power distribution network.
2. **Ready for Reconnection:** The consumer is disconnected but can be reconnected.
3. **Disconnected:** The consumer is disconnected from the power network.

Transitions between these states occur through eight possible paths (a to h) as illustrated in Figure below.

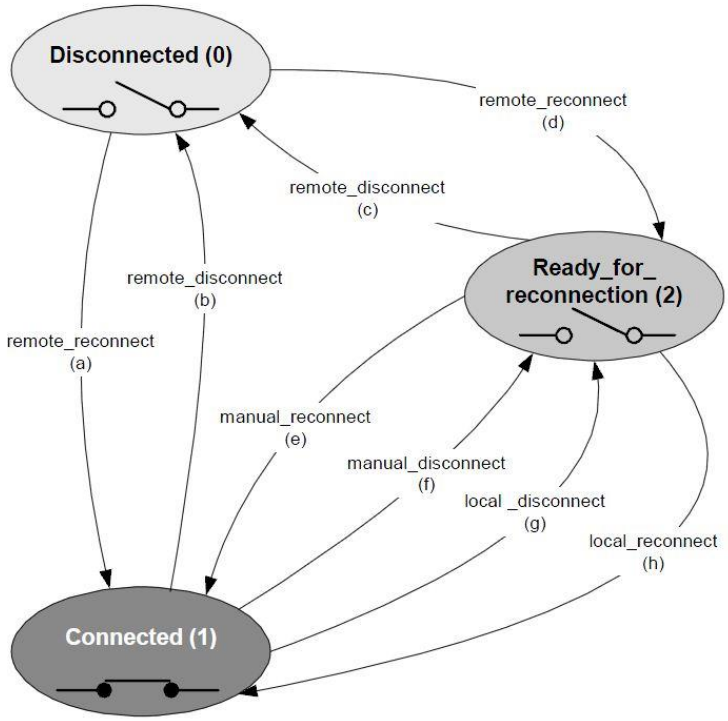

Figure 28 - Machine showing disconnector condition

Disconnector Control Methods

The disconnector can be controlled in three ways:

1. **Locally:** Using transitions g and h.
2. **Remotely:** Using transitions a, b, c, and d.
3. **Manually:** Using transitions e and f.

Remote Control Channels
Remote control of the disconnector can be achieved through any available communication channel, such as the optical port or GPRS.
Manual Control
Manual control of the disconnector is performed using the unsealed button on the meter.
Disconnector Modes
The disconnector can operate in seven different modes. Each mode supports or restricts certain transitions between the three states.

control mode	Disconnection				Reconnection			
	Remote		Manual	Local	Remote		Manual	Local
num:	(b)	(c)	(f)	(g)	(a)	(d)	(e)	(h)
(0)	-	-	-	-	-	-	-	-
(1)	x	x	x	x	-	x	x	-
(2)	x	x	x	x	x	-	x	-
(3)	x	x	-	x	-	x	x	-
(4)	x	x	-	x	x	-	x	-
(5)	x	x	x	x	-	x	x	x
(6)	x	x	x	x	x	-	x	x
(7)	x	x	-	x	-	x	x	x
(8)	x	x	-	x	x	-	x	x

Table 7 - Disconnector control mode

Disconnector Condition Storage
In the event of a power failure, the meter stores the instantaneous disconnector condition in its permanent memory (FRAM). This ensures that upon a meter reset, the disconnector's previous state can be retrieved and the disconnector can be reinitialized accordingly.

Note:
This feature provides a reliable mechanism for maintaining the disconnector's status even after a power outage, preventing unexpected changes or disruptions in the consumer's power supply

Disconnector Control Script Table
The OBIS code for the disconnector control script table is 0.0.10.0.106.255. This table contains the configuration and settings related to the disconnector's operation.

Remote Disconnection and Reconnection
If a disconnection command is sent remotely from the AMM center, the reconnection can be performed in two ways:

1. **Automatic Reconnection:** The meter may automatically reconnect the consumer upon receiving the disconnection command, depending on the configured disconnector mode.
2. **Manual Reconnection:** The consumer may need to manually reconnect by using the appropriate method (e.g., pressing a button or using an external switch), depending on the disconnector mode.

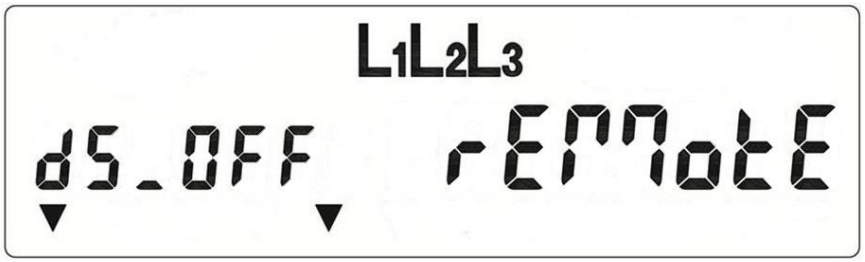

Figure 29 - Display when the meter is disconnected remotely

Conditional Reconnection Message

When in conditional reconnection mode, the display will show a message indicating that the conditions for reconnection exist.

Mode Selection

- **Automatic Reconnection:** Modes 2 or 4 are used.
- **Conditional Reconnection:** Modes 1, 3, 5, or 6 are used.

The appropriate mode is selected based on the disconnection method (remote, manual, or by limitation).

Figure 30 - Message on the display that exists message for reconnection

Future Disconnector Activation

The meter allows for the future activation of the disconnector (OBIS code: 0.0.15.0.1.255). This feature enables pre-scheduling of disconnector operations.

Bistable Relay Output

The ST402 meter may optionally include bistable relays, which are used to manage individual power circuits for consumers. These relays are suitable for loads with currents up to 5 A and normal voltages of 230 V or 120 V.

Relay Management Modes

Relay management for 230 V, 5 A relays can be configured to operate in two modes:

1. **Command-Based:** The relay is controlled through commands (OBIS codes 0.1.96.3.10.255 and 0.2.96.3.10.255).
2. **Tariff-Based:** The relay's operation is determined by the current tariff.

Mode 4 (Command-Based)

When mode 4 is activated, the state of the relay can be changed using the following methods:

- **OBIS Code 0.1.96.3.10.255:** For relay 1
- **OBIS Code 0.2.96.3.10.255:** For relay 2

These codes allow for controlling the relay's on/off state based on specific commands or instructions. The figure below shows a representation from the PaMet software's Method tab.

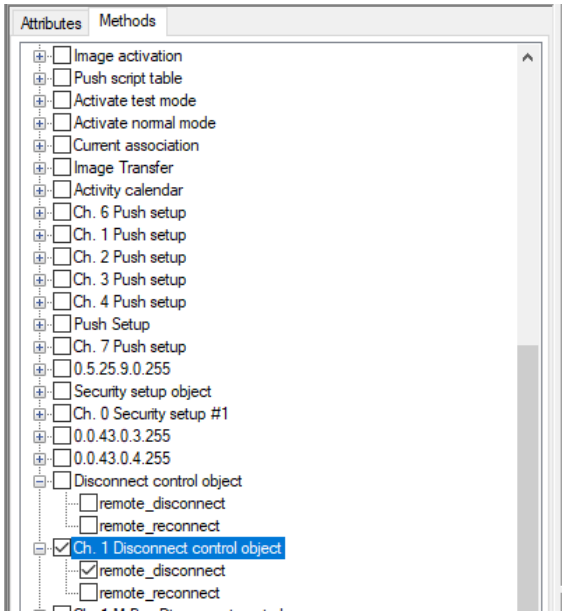

Figure 31 - Method (Disconnect control object)

Mode 6 (Tariff-Based Operation)

When mode 6 is activated, the operation of the relays is defined through the Tariffication Script Table (OBIS code 0-0:10.0.100.255). In this mode, the user can specify whether each relay should be open or closed during the defined tariffs.

0 | 0 | 10 | 0 | 100 | 255

Script Id	Service	Object	Index	Parameter	Type
1	write attribute	(Register Activation) Register activation - Energy {0.0.14.0.1.255}	4	0001	octet-string
1	write attribute	(Register Activation) Register activation - Maximum Demand {0.0.14.0.2.255}	4	0001	octet-string
1	write attribute	(Disconnect control) Ch. 1 Disconnect control object {0.1.96.3.10.255}	3	2	enum
2	write attribute	(Register Activation) Register activation - Energy {0.0.14.0.1.255}	4	0002	octet-string
2	write attribute	(Register Activation) Register activation - Maximum Demand {0.0.14.0.2.255}	4	0002	octet-string
2	write attribute	(Disconnect control) Ch. 1 Disconnect control object {0.1.96.3.10.255}	3	1	enum
3	write attribute	(Register Activation) Register activation - Energy {0.0.14.0.1.255}	4	0003	octet-string
3	write attribute	(Register Activation) Register activation - Maximum Demand {0.0.14.0.2.255}	4	0003	octet-string
3	write attribute	(Disconnect control) Ch. 1 Disconnect control object {0.1.96.3.10.255}	3	2	enum
4	write attribute	(Register Activation) Register activation - Energy {0.0.14.0.1.255}	4	0004	octet-string
4	write attribute	(Register Activation) Register activation - Maximum Demand {0.0.14.0.2.255}	4	0004	octet-string
4	write attribute	(Disconnect control) Ch. 1 Disconnect control object {0.1.96.3.10.255}	3	1	enum

Figure 32 - Tariffication script table

Parameter Interpretation

- **Parameter 1:** Indicates that the relay will be on (connected) during the specified tariff.
- **Parameter 2:** Indicates that the relay will be off (disconnected) during the specified tariff.
- **Script ID:** Defines the desired tariff (1-8).

Activity Calendar (OBIS code 0.0.13.0.0.255)

The meter supports the measurement, storage, and display of measured energy according to the Activity Calendar.

Relay State Changes

Even in mode 6 (tariff-based operation), it's possible to change the relay's state through commands. However, if a disconnection command is sent while the relay is in mode 6 and the user later wants to reconnect the relay, the relay must first be returned to mode 4. This is

because remote reconnection commands are not allowed in mode 6 according to the DLMS-supported transitions.

Relay Control
Relay control can be performed both locally and remotely from the (HES).

5.3.2. Limiter

Limiter Functionality
Beyond the hardware current limitation provided by fuses, the ST402 meter offers an optional software-based current limitation feature.

Power Limit Settings
To activate the power limit, the user must enter the desired power limit value (B) and the corresponding period (A) into the dedicated object in the meter's memory.

- **Power Limit (B):** Programmable from 1 to 75 kW with a resolution of 1 W.
- **Period (A):** Programmable from 30 seconds to 3600 seconds with a resolution of 1 second.

Disconnector Activation
If the average power consumption during period A exceeds the power limit B, the disconnector will switch off the consumer (open the contacts).

Penalty Period (C)
After the consumer is switched off due to the current over-limit, the disconnector will remain in the open state for a penalty period (C).

- **Penalty Period (C):** Programmable from 30 seconds to 3600 seconds with a resolution of 1 second.

Reconnection
Once the penalty period has expired and the consumer has corrected their consumption, the disconnector can be manually or automatically switched on, depending on the working mode.

Current Limitation
Similar to power limitation, the meter also supports current limitations using the same principles and settings.

Limitation Log
The meter maintains a special log book with timestamps and disconnector status, recording at least the last 315 power-off, and power-on due to limitator activation, code red function, or remote AMM center commands.

OBIS Code
The OBIS code for the limiter object is 0-:0.17.0.0.255.

Display Message
When the limiter is active (due to power or current limitations), a specific message will be displayed on the meter.

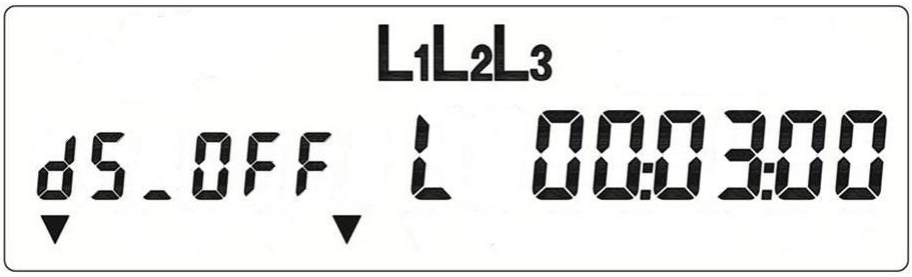

Figure 33 - The meter display message during power/current limitation when the disconnector is off

Limitation per current is done via Fuse Supervision objects for each of the three phases according to the IDIS 2 standard.

5.3.3. Code Red

Code Red Functionality
The ST402 meter offers an optional Code Red function, which is a tool for managing consumption during periods of high demand or energy scarcity (e.g., summer air conditioning usage or winter heating).

Code Red Activation and Implementation

- **Integration:** Code Red functionality becomes available after the meter is integrated into the AMM system (with a communication modem and connection to the AMM center).
- **Broadcast:** A Code Red message is broadcast to all meters.
- **Targeted Response:** Only meters belonging to the specified group (based on consumption category or contract) will respond to the message and take appropriate action.

Consumption Limit
During a Code Red situation, the total consumption of the targeted group is limited by setting a new demand limit (Threshold Emergency) that is lower than the normal demand limit.

Disconnector Activation
If the average measured demand value exceeds the Code Red demand limit (Y) during the specified time interval (X), the disconnector will switch off the consumer.

- **Time Interval (X):** Programmable from 0 to 130 years with a resolution of 1 second.
- **Demand Limit (Y):** Programmable from 1 to 100 kW with a resolution of 1 W.

Penalty Period (Z)
After the disconnector is activated due to exceeding the Code Red demand limit, it will remain in the open state for a penalty period (Z).

- **Penalty Period (Z):** Programmable from 0 to 130 years with a resolution of 1 second.

Reconnection
Once the penalty period has expired and the consumer has corrected their consumption, the disconnector can be switched on.

Current Limitation

In addition to power-based limitations, Code Red can also be implemented based on current limits, using the same principles and settings.

Note:
The Code Red function provides a valuable tool for managing energy consumption during critical periods, helping to ensure grid stability and prevent overloading

5.4. Event Log

The meter maintains an event log in its permanent memory (FLASH) to record various events related to measurement, adjustments, and meter management. Each event entry includes the event type, timestamp, and meter status at the time of the event. A checksum is used to ensure data integrity.

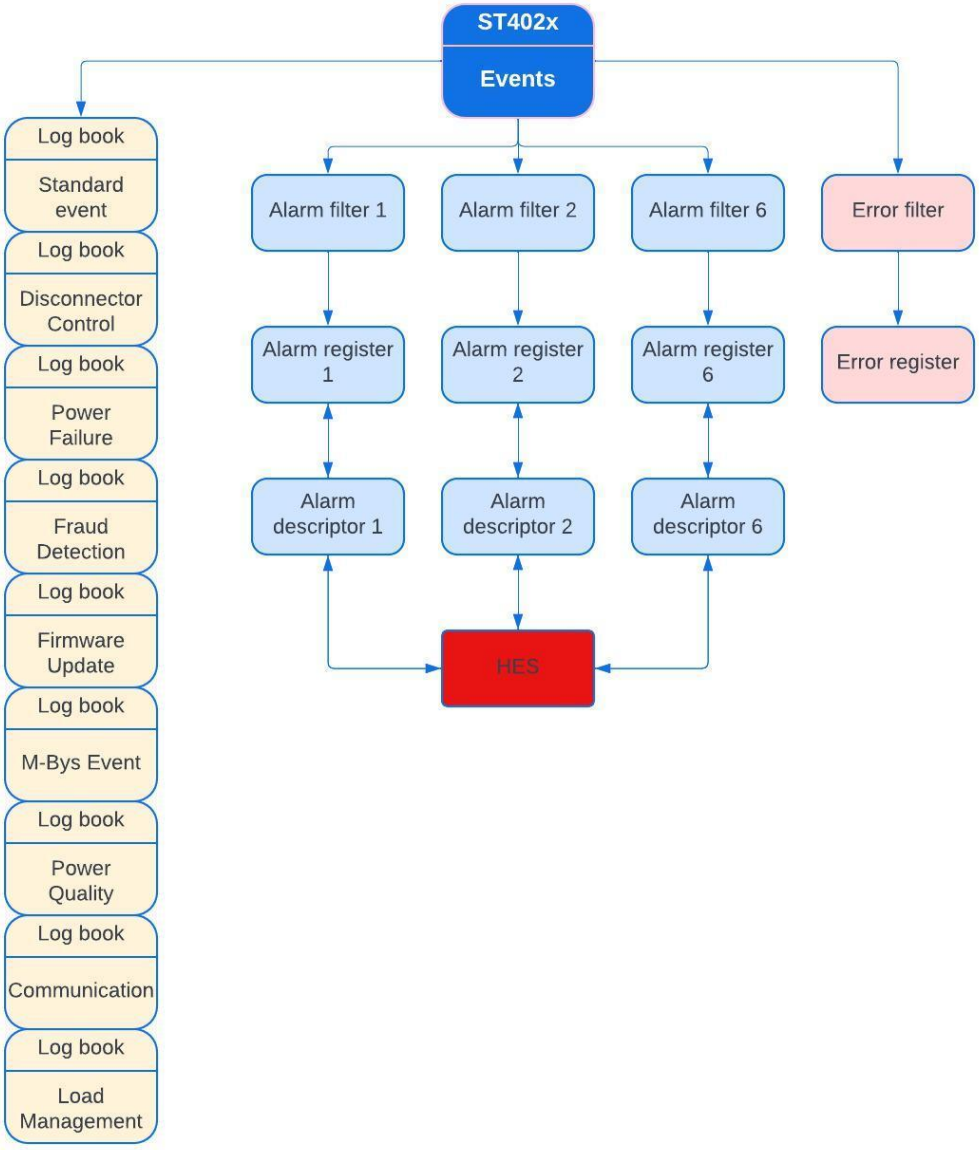

Figure 34 - Event Logs

Event Log Types

The meter supports multiple event log types:

- **Standard Event Log (0-0:99.98.0.255):** Records up to 500 general events.
- **Disconnector Control Log (0-0:99.98.2.255):** Records up to 500 events related to disconnector control.
- **Power Failure Event Log (1-0:99.97.0.255):** Records up to 500 power failure events.
- **Fraud Detection Log (0-0:99.98.1.255):** Records up to 500 fraud detection events.
- **Firmware Update Log (0-0:99.98.6.255):** Records up to 500 firmware update events.
- **M-Bus Event Log (0-0:99.98.3.255):** Records up to 500 events related to M-Bus communication.
- **Power Quality Event Log (0-0:99.98.4.255):** Records up to 500 power quality events.
- **Communication Event Log (0-0:99.98.5.255):** Records up to 500 communication events.
- **Load Management Event Log (0-0:99.98.6.255):** Records up to 500 load management events.
- **MBUS Control Logs (0-1:24.5.0.255, 0-2:24.5.0.255, 0-3:24.5.0.255, 0-4:24.5.0.255):** Records up to 227 events each for M-Bus control.

Standard Event Log Entries

The standard event log records the following types of events:

- Power down
- Power up
- DST enabled or disabled
- Clock adjusted
- Clock invalid
- Battery replace
- Battery voltage low
- TOU activated
- Error register cleared
- Alarm register cleared
- Program memory error
- RAM memory error
- Non-volatile memory error
- Watchdog error
- Measurement system error
- Firmware ready for activation
- Firmware activated
- Passive TOU programmed
- External alert detected

Note:
The specific event types recorded may vary depending on the meter model and configuration

Communication Event Log (0-0:99.98.5.255)

The meter's communication event log records events related to communication activities. The following types of communication events may be supported:

Id	Name	Description
140	No connection timeout	There has been no remote communication on the application layer for a predefined period; 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. The detection of the SIM card status is supported by the corresponding AT commands as listed in 3GPP TS 27.007
143	SIM Card ok	SIM card has been correctly detected
144	GSM registration failure	The modem's registration on the GSM network was not successful
145	GPRS registration failure	The modem's registration on the 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	The modem restarted by SW reset
150	Modem HW reset	Modem restarted by HW reset (this event is not issued after a general power resume)
151	GSM outgoing connection	The modem is successfully connected, and initiated by an outgoing call.
152	GSM incoming connection	The 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) ("+CPIN?", "+CSQ", "+CREG?", "+CGREG?", "+COPS?", "+CGACT?", "+CPMS?") is invalid or ERROR or no response received.
155	User initialization failure	The modem's initialization AT command(s) – specified in attribute 3 of the modem configuration object - is invalid. Error message or no response from the modem.
156	Signal quality low	Signal strength too low, not known, or not detectable
157	Auto Answer Number of calls exceeded	The number of calls has exceeded (in mode(1) or mode(2)) the values given in the attribute number_of_calls.
158	Local communication attempt	Indicates a successful communication on any local port has been initiated.

Table 8 - Communication Event Log (0-0:99.98.5.255)

Firmware Update Event Log (0-0:99.98.6.255)

The firmware update event log is specifically designed to capture events related to the measurement part of the firmware. It records the following values:

- **Timestamp:** The time at which the event occurred.
- **Event Code:** A unique code identifying the specific type of event.
- **FW Version:** The firmware version involved in the event.

For each recorded event, an entry is generated in the log, including the event type, timestamp, and firmware version. A checksum is applied to ensure data integrity and validity.

Event Log Codes

Please provide the table of event log codes specific to the firmware update log. This will allow users to interpret the recorded events accurately.

Id	Name	Description
17	Firmware ready for activation	Signaling that the new software is successfully accepted and verified, i.e. ready for activation
18	Firmware activated	Signalling that the new software is activated
51	FW verification failed	Failed software verification
204	Image transfer aborted	Attempt to image transfer while image transfer already occurs
205	Image transfer aborted via optical port	Attempt to image transfer via optical port while image transfer already occurs
240	Update attempt with firmware for another type of meter	Marks that the firmware which was sent for update, is not for this type of meter
241	Firmware image incorrect signature	Marks that firmware was sent for an update, has an incorrect signature
242	Firmware ready for activation via optical port	Signaling that the new software is successfully accepted via optical port and verified, i.e. ready for activation
243	Firmware activated via optical port	Signalling that the new software is activated via the optical port
244	FW verification failed via optical port	Failed software verification via optical port
245	Update attempt with firmware for another type of meter via optical port	Marks that the firmware which was sent for update via optical port, is not for this type of meter
246	Firmware image incorrect signature via optical port	Marks that firmware was sent for update via the optical port, has an incorrect signature
255	Event log cleared	Marks that it is the first event in meter

Table 9 - Firmware Update Event Log (0-0:99.98.6.255)

Fraud Detection Log (0-0:99.98.1.255):

Unauthorized Access Detection and Fraud Prevention

The meter incorporates features to detect and record unauthorized access attempts, known as fraud detection. These features include:

- **Cover Opening Detection:** Sensors monitor the opening of the meter's measuring part cover and terminal block cover.
- **Password Entry Attempts:** Failed attempts to change meter parameters using incorrect passwords are recorded.
- **Magnetic Field Detection:** The meter is resistant to normal magnetic fields. However, if exposed to a strong magnetic field (as defined by IEC 62052-11 or EN50470-1), an event is recorded.

Event Logging and Indicators

- **Event Log:** All detected unauthorized access events are recorded in the event log with timestamps.
- **Fraud Indicator:** The "FF" register on the display indicates a potential fraud event.

Event Log Storage

Records for cover openings and unauthorized access attempts are stored in the event log even when the meter is in non-voltage mode.

Event Log Codes

The following codes are used to record unauthorized access events:

- **255:** Event log cleared (first record)
- **40:** Terminal cover removed
- **41:** Terminal cover closed
- **42:** Strong DC field detected
- **43:** No strong DC field anymore
- **44:** Meter cover removed
- **45:** Meter cover closed
- **46:** Association authentication failure (incorrect password)
- **49:** Decryption or authentication failure
- **50:** Replay attack

Note:
The meter's ability to detect and record unauthorized access attempts helps maintain the security and integrity of the metering system.

M-Bus Log Books

The M-Bus log books store data from other measuring devices connected to the meter's M-Bus port.

Event Log Codes

The following table provides an overview of the event codes recorded on the meter, along with the corresponding event log where they are stored:

Event Code	Event Description	Event Log
EVENT LOG CLEARED	255	All logs
POWER DOWN	1	Standard Event Log
POWER UP	2	Standard Event Log
DST ENABLED OR DISABLED	3	Standard Event Log
CLOCK ADJUSTED OLD VAL	4	Standard Event Log
CLOCK ADJUSTED NEW VAL	5	Standard Event Log
CLOCK INVALID	6	Standard Event Log
REPLACE BATTERY	7	Standard Event Log
BATTERY VOLTAGE LOW	8	Standard Event Log
TOU ACTIVATED	9	Standard Event Log
ERROR REGISTER CLEARED	10	Standard Event Log
ALARM REGISTER CLEARED	11	Standard Event Log

Event Code	Event Description	Event Log
NV MEMORY ERROR	14	Standard Event Log
WATCHDOG ERROR	15	Standard Event Log
FIRMWARE READY FOR ACTIVATION	17	Standard Event Log
FIRMWARE ACTIVATED	18	Standard Event Log
PASIVE TOU PROGRAMED	19	Standard Event Log
TERMINAL COVER REMOVED	40	Fraud Detection Log
TERMINAL COVER CLOSED	41	Fraud Detection Log
STRONG DC FIELD DETECTED	42	Fraud Detection Log
NO STRONG DC FIELD ANYMORE	43	Fraud Detection Log
METER COVER REMOVED	44	Fraud Detection Log
METER COVER CLOSED	45	Fraud Detection Log
N TIMES WRONG PASSWORD	46	Fraud Detection Log
PARAMETRIZATION	47	Standard Event Log
GLOBAL KEY CHANGED	48	Standard Event Log
		Security Log
DECRYPTION OR AUTHENTICATION FAILURE	49	Fraud Detection Log
		Security Log
REPLAY ATTACK	50	Fraud Detection Log
		Security Log
FW VERIFICATION FAILED	51	Standard Event Log
UNEXPECTED CONSUMPTION	52	Standard Event Log
READY FOR MANUAL RECONNECTION	59	Disconnector Control Log
MANUAL DISCONNECTION LOG	60	Disconnector Control Log
MANUAL RECONNECTION LOG	61	Disconnector Control Log
REMOTE DISCONNECTION LOG	62	Disconnector Control Log
REMOTE RECONNECTION LOG	63	Disconnector Control Log
LOCAL DISCONNECTION LOG	64	Disconnector Control Log
LIMITER THRESHOLD EXCEEDED	65	Disconnector Control Log
LIMITER THRESHOLD OK	66	Disconnector Control Log
LIMITER THRESHOLD CHANGED	67	Disconnector Control Log
DISCONNECT RECONNECT FAILURE LOG	68	Disconnector Control Log
LOCAL RECONNECTION LOG	69	Disconnector Control Log
SUPERVISION MONITOR 1 THRESHOLD EXCEEDED	70	Disconnector Control Log
SUPERVISION MONITOR 1 THRESHOLD OK	71	Disconnector Control Log
SUPERVISION MONITOR 2 THRESHOLD EXCEEDED	72	Disconnector Control Log
SUPERVISION MONITOR 2 THRESHOLD OK	73	Disconnector Control Log

Event Code	Event Description	Event Log
SUPERVISION MONITOR 3 THRESHOLD EXCEEDED	74	Disconnector Control Log
SUPERVISION MONITOR 3 THRESHOLD OK	75	Disconnector Control Log
SAG A LOG ENTRY	76	Power Quality Event Log
SAG B LOG ENTRY	77	Power Quality Event Log
SAG C LOG ENTRY	78	Power Quality Event Log
SWELL A LOG ENTRY	79	Power Quality Event Log
SWELL B LOG ENTRY	80	Power Quality Event Log
SWELL C LOG ENTRY	81	Power Quality Event Log
PHASE1 MISSING VOLTAGE	82	Power Quality Event Log
PHASE2 MISSING VOLTAGE	83	Power Quality Event Log
PHASE3 MISSING VOLTAGE	84	Power Quality Event Log
PHASE1 NORMAL VOLTAGE	85	Power Quality Event Log
PHASE2 NORMAL VOLTAGE	86	Power Quality Event Log
PHASE3 NORMAL VOLTAGE	87	Power Quality Event Log
PHASE SEQUENCE REVERSAL	88	Standard Event Log
MISING NEUTRAL	89	Standard Event Log
CURRENT REVERSAL	91	Fraud Detection Log
BAD VOLTAGE QUALITY L1	92	Power Quality Event Log
BAD VOLTAGE QUALITY L2	93	Power Quality Event Log
BAD VOLTAGE QUALITY L3	94	Power Quality Event Log
COMMUNICATION ERROR M BUS CHANNEL 1	100	M-Bus Event Log
COMMUNICATION OK M BUS CHANNEL 1	101	M-Bus Event Log
NEW DEVICE INSTALLED M BUS CHANNEL 1	105	M-Bus Event Log
COMMUNICATION ERROR M BUS CHANNEL 2	110	M-Bus Event Log
COMMUNICATION OK M BUS CHANNEL 2	111	M-Bus Event Log
NEW DEVICE INSTALLED M BUS CHANNEL 2	115	M-Bus Event Log
COMMUNICATION ERROR M BUS CHANNEL 3	120	M-Bus Event Log
COMMUNICATION OK M BUS CHANNEL 3	121	M-Bus Event Log
NEW DEVICE INSTALLED M BUS CHANNEL 3	125	M-Bus Event Log
COMMUNICATION ERROR M BUS CHANNEL 4	130	M-Bus Event Log
COMMUNICATION OK M BUS CHANNEL 4	131	M-Bus Event Log

Event Code	Event Description	Event Log
NEW DEVICE INSTALLED M BUS CHANNEL 4	135	M-Bus Event Log
IRREGULAR LR PART RESET	200	Manufacturer-specific - Standard Event Log
CHANGE FROM EXTERNAL TO INTERNAL	201	Manufacturer-specific - Standard Event Log
CHANGE FROM INTERNAL TO EXTERNAL	202	Manufacturer-specific - Standard Event Log
IMAGE TRANSFER ABORTED	204	Manufacturer-specific - Firmware Update Log
OPT IMAGE TRANSFER ABORTED	205	Manufacturer-specific - Firmware Update Log
REMOTE BILLING CAPTURE	209	Manufacturer-specific - Standard Event Log
MANUAL BILLING CAPTURE	210	Manufacturer-specific - Standard Event Log
POWER FACTOR UNDER LIMIT	214	Manufacturer-specific - Power Quality Event Log
POWER FACTOR OVER LIMIT	215	Manufacturer-specific - Power Quality Event Log
ELECTRIC SHOCK FRAUD	218	Manufacturer-specific - Fraud Detection Log
REGULAR BILLING CAPTURE	223	Manufacturer-specific - Standard Event Log
CURRENT WITHOUT VOLTAGE PHASE1	228	Manufacturer-specific Power Quality Event Log
CURRENT WITHOUT VOLTAGE PHASE2	229	Manufacturer-specific Power Quality Event Log
CURRENT WITHOUT VOLTAGE PHASE3	230	Manufacturer-specific Power Quality Event Log
UNUSUAL LONG SIGNAL PROCESSING	236	Manufacturer-specific - Standard Event Log
FIRMWARE IMAGE INCORRECT TYPE	240	Manufacturer-specific - Standard Event Log
FIRMWARE IMAGE INCORRECT SIGNATURE	241	Manufacturer-specific - Fraud Event Log
OPT FIRMWARE READY FOR ACTIVATION	242	Firmware Update Log
OPT FIRMWARE ACTIVATED	243	Firmware Update Log
OPT FW VERIFICATION FAILED	244	Firmware Update Log
OPT FIRMWARE IMAGE INCORRECT TYPE	245	Firmware Update Log
OPT FIRMWARE IMAGE INCORRECT SIGNATURE	246	Fraud Event Log
SUCCESSFULL USER AUTHENTICATION	249	Security Log

Event Code	Event Description	Event Log
PHASE BYPASS WITH NEUTRAL PRESENT	251	Manufacturer-specific - Fraud Event Log
BILLING PROFILE CLEARED	254	Standard Event Log
LOAD PROFILE 1 CLEARED	254	Standard Event Log
LOAD PROFILE 2 CLEARED	254	Standard Event Log
LOAD PROFILE 3 CLEARED	254	Standard Event Log
LOAD PROFILE 4 CLEARED	254	Standard Event Log
LOAD PROFILE 5 CLEARED	254	Standard Event Log
LOAD PROFILE CLEARED	254	Standard Event Log
MBUS LOAD PROFILE 1 CLEARED	254	M-Bus Event Log
MBUS LOAD PROFILE 2 CLEARED	254	M-Bus Event Log
MBUS LOAD PROFILE 3 CLEARED	254	M-Bus Event Log
MBUS LOAD PROFILE 4 CLEARED	254	M-Bus Event Log

Table 10 - Event Log Codes

5.5. Time of Use (Tariff Program)

The meter's internal clock allows for the implementation of complex daily and weekly tariff structures, accommodating multiple seasons throughout the year.

Tariff Structure Flexibility:

- **Seasons:** Up to 8 seasons can be defined within a year.
- **Weekly Programs:** Up to 8 weekly programs can be configured.
- **Day Types:** Up to 24 different types of days can be specified.
- **Holidays:** Up to 31 holidays can be defined.
- **Tariff Changes:** Up to 48 tariff changes can occur within a day.

Special Tariff Activation

The meter supports the activation of a special tariff during critical network conditions. This tariff is triggered by the detection of low frequency, indicating potential network issues.

Special Days Table

The OBIS code for the special days table is 0.0.11.0.0.255. This table allows for the configuration of specific days and their associated tariffs.

Note:
The ability to define complex tariff structures and activate special tariffs provides flexibility in managing energy consumption and costs based on time-of-use and network conditions.

5.6. Daylight Saving Time (DST)

The meter incorporates a Daylight Saving Time (DST) functionality that automatically transitions between winter and summer time calculations. This feature adheres to Directive 2000/84/EC.

Transition Methods:

- **Algorithm-Based:** The transition occurs automatically on the last week of the selected month and hour.
- **Fixed Date:** The transition is set to a specific date defined in a table.

DST Status:
The DST functionality can be either active or inactive, depending on the user's preference or regional requirements.

Note:
The meter's ability to automatically adjust for DST ensures accurate timekeeping and billing calculations throughout the year.

5.7. Power Quality Supervision

The ST402 meter adheres to the EN 50160 standard for power quality monitoring. This means it is equipped to assess and track various power quality parameters, ensuring compliance with industry regulations and identifying potential issues that may affect the quality of electricity delivered to the consumer.

5.7.1. Voltage Level

Voltage Level Monitoring
The meter continuously monitors and records the quality parameters of the power supply, including voltage levels. Voltage measurements are taken for each phase with a sampling period of 1 second.

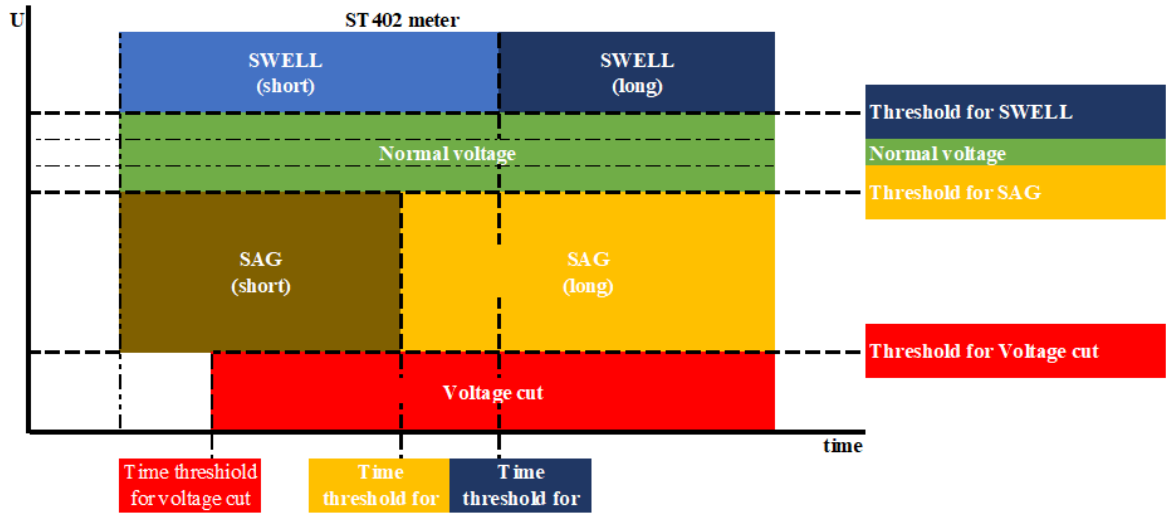

Table 11 - Voltage Levels

Voltage Level Classification
The meter categorizes voltage levels into seven defined ranges. As voltage measurements are recorded, the corresponding register for the appropriate voltage level is incremented.

Voltage Level Analysis
By analyzing the registered voltage values and their durations, it is possible to gain insights into the voltage levels experienced during the previous period. This information is valuable for assessing power quality and identifying any voltage-related issues.

Note:
The specific voltage level ranges and their corresponding register values may vary depending on the meter model and configuration. The meter's documentation will provide detailed information on the specific voltage level classification used.

5.7.2. Voltage Cut

Voltage Cut Registration
The meter maintains specific registers to record the number and total duration of voltage cuts. These registers differentiate between long (longer than 3 minutes, configurable) and short (shorter than 3 minutes, configurable) voltage cuts for each phase, any phase, and all three phases.

Long Voltage Cut Event Log
The meter includes an event log that records long voltage cuts (longer than the configured minimum duration). This log can store up to 227 entries, each containing the timestamp, occurrence time, and duration of the voltage cut.

Voltage Cut Threshold
A separate object within the meter defines the voltage threshold below which a voltage cut is announced for each phase (1-0:12.39.0.255). This threshold also affects the switching on and off of the phase indicator (L1, L2, L3) on the meter display.

Voltage Sags and Swells
The meter records voltage sags and swells (maximum and minimum voltage values). The voltage threshold for registering these events can be configured using devices 1-0:12.35.0.255 and 1-0:12.31.0.255. The default values are 0.8Un for sags and 1.15Un for swells.

Event Log Codes
When a voltage sag or swell event occurs and meets the defined threshold, an entry is generated in the power quality log. The event log includes a timestamp and a code indicating the type of voltage event.
The following codes are recorded:

- **255:** Event log cleared (first record in the log book)
- **76:** Undervoltage L1
- **77:** Undervoltage L2
- **78:** Undervoltage L3
- **79:** Overvoltage L1
- **80:** Overvoltage L2
- **81:** Overvoltage L3
- **82:** Missing voltage L1 (below Umin for a prolonged period)
- **83:** Missing voltage L2 (below Umin for a prolonged period)
- **84:** Missing voltage L3 (below Umin for a prolonged period)
- **85:** Voltage L1 normal
- **86:** Voltage L2 normal
- **87:** Voltage L3 normal
- **92:** 7 days of bad voltage L1
- **93:** 7 days of bad voltage L2
- **94:** 7 days of bad voltage L3

5.7.3. Monthly Maximum, Minimum, and Average Values

The meter incorporates objects to store monthly maximum and minimum values for voltage and current per phase. These objects are duplicated to track data for both the current and previous billing periods.
Additionally, the meter includes objects to store average 10-minute voltage values.

5.8. Push

Push Mechanism for Data Transmission
The meter supports a push mechanism that allows for sending specific data to the HES when certain triggers occur.
Triggers and Push Setup Objects

- **Interval Triggers:** Push setup objects for Interval 1, Interval 2, and Interval 3 (0.1.25.9.0.255, 0.2.25.9.0.255, 0.3.25.9.0.255) can be configured to trigger data pushes based on specified intervals.
- **Alarm Trigger:** The "Push setup - On Alarm" object (0.4.25.9.0.255) triggers data pushes when alarms occur.

- **Connectivity Trigger:** The "Push setup - On Connectivity" object (0.0.25.9.0.255) triggers data pushes when the LTE modem connects to the cellular network and is ready for data transfer.
- **Installation Trigger:** The "Push setup - On Installation" object (0.7.25.9.0.255) triggers data pushes after the meter is set up in the field, invoking the corresponding push action.

Push Action Scheduler
The push action scheduler objects (0.1.15.0.4.255, 0.2.15.0.4.255, 0.3.15.0.4.255) are used to configure the intervals for triggering push mechanisms associated with the respective push setup objects.

Alarm Types
Some alarms that can trigger push messages include:

- Voltage loss (L1, L2, L3)
- Voltage below limit (L1, L2, L3)
- Fatal errors (memory, switch, clock)
- Fraud alarms (terminal cover removal, meter cover removal, meter communication)

Data Push Destinations
In addition to pushing data via the cellular network, the meter can also push data to the customer's LCD or a similar device. The data is sent using the same format as for cellular network pushes.

One-Way Push Communication
The meter supports one-way push communication for data transmission to the home display or other equipment. This functionality is available on either RS-485 port 1 or RS-485 port 2, depending on the configuration. The list of attributes to be pushed is configured using the "Push setup - Consumer information" object (0.0.43.0.1.255).

Note:
The push mechanism provides a flexible way to send relevant data to the HES or other devices based on predefined triggers and configurations. This can be valuable for monitoring meter performance, detecting issues, and providing timely information to the user.

5.9. Alarm

Alarm Triggers and Event Logs
Certain events can trigger alarms within the meter. When an alarm occurs, the corresponding flag in the alarm registers is set, and an alarm is raised through the communication channel.

Alarm Register Structure
The alarm registers contain a summary of all active and inactive alarms at a given time. Each bit in the alarm registers represents a different alarm. A set bit (logical 1) indicates an active alarm.

Alarm Filtering

Alarm filters can be programmed to mask out unwanted alarms. The structure of the alarm filters is identical to the structure of the alarm registers. To mask an alarm, the corresponding bit in the alarm filter should be set to logical 0.

Alarm Process

The alarming process follows the guidelines described in the IDIS package 2.

Note:
The specific alarm types and their corresponding bit positions in the alarm registers will depend on the meter model and configuration. It's essential to refer to the meter's documentation for detailed information on the available alarms and their associated settings.

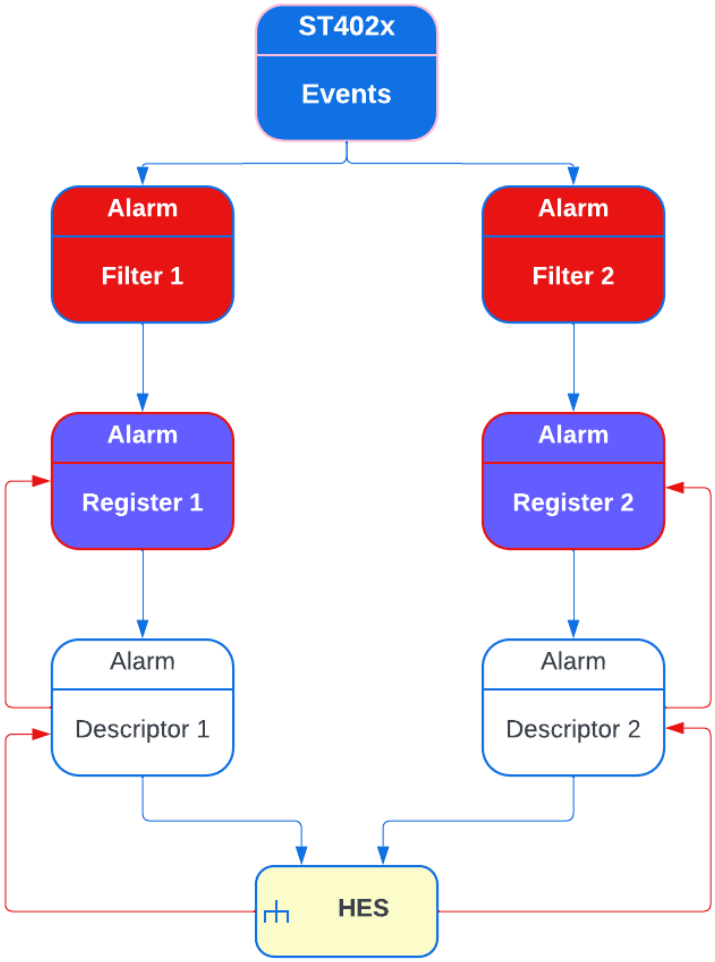

Figure 35 - Alarm process

COSEM objects supporting Alarms are:

Object / Attribute Name	OBIS code
Alarm Register 1	0-0:97.98.0.255
Alarm Filter 1	0-0:97.98.10.255
Alarm Descriptor 1	0-0:97.98.20.255
Alarm Monitor 1	0-0:16.1.0.255
Alarm Register 2	0-0:97.98.1.255

Object / Attribute Name	OBIS code
Alarm Filter 2	0-0:97.98.11.255
Alarm Descriptor 2	0-0:97.98.21.255
Alarm Monitor 2	0-0:16.1.1.255

Bit	Alarm filter 1	Alarm filter 2
bit0	Clock invalid	Power down
bit1	Battery voltage low	Power Up
bit2	reserved for future use	Missing voltage L1
bit3	reserved for future use	Missing voltage L2
bit4	reserved for future use	Missing voltage L3
bit5	reserved for future use	Voltage L1 normal
bit6	reserved for future use	Voltage L2 normal
bit7	reserved for future use	Voltage L3 normal
bit8	Program memory error	Missing neutral
bit9	RAM error	Phase Asymmetry
bit10	NV memory error	Current Reversal
bit11	Measurement system error	Phase sequence reversal
bit12	Watchdog error	Unexpected consumption
bit13	Fraud detection	Global key changing attempt
bit14	reserved for future use	Bad Voltage Quality L1
bit15	reserved for future use	Bad Voltage Quality L2
bit16	Modem Initialization failure	Bad Voltage Quality L3
bit17	SIM Card failure	External alert detected
bit18	GSM registration failure	Local communication attempt
bit19	GPRS registration failure	Remote communication attempt
bit20	PDP context failure	Certificate changing attempt
bit21	Diagnostic failure	reserved for future use
bit22	User initialization failure	reserved for future use
bit23	reserved for future use	reserved for future use
bit24	reserved for future use	reserved for future use
bit25	reserved for future use	reserved for future use
bit26	reserved for future use	reserved for future use
bit27	reserved for future use	reserved for future use
bit28	reserved for future use	reserved for future use
bit29	reserved for future use	reserved for future use
bit30	reserved for future use	reserved for future use
bit31	reserved for future use	Disconnect/Reconnect failure

Table 12 – Alarm filters

5.10. No-Power Reading

The meter offers the ability to read and configure its parameters even when it is not connected to the power supply. An integrated lithium battery with a high capacity enables this functionality.

Battery-Powered Features

- **Optical Probe Communication:** The battery allows for communication through an optical probe (recommended model: OS30, produced by Meter&Control).
- **LCD Display and Button Control:** The display and button controls remain operational for at least 50 hours.

Battery Conservation
To conserve battery power, the meter limits the duration of no-power reading to a maximum of 2 minutes. Additionally, the no-power reading mode is automatically switched off after 15 seconds of inactivity.

Accessing No-Power Mode
To enter no-power reading and parameterization mode, press and hold the unsealed button for an extended period. This feature is optional and may not be available on all meter models.

Note:
The availability and duration of no-power features may vary depending on the meter's specific configuration and battery capacity. It's recommended to consult the meter's documentation for detailed information.

5.11. Internal Clock

Internal Clock Functionality
The internal clock serves several essential purposes within the meter:

- **Tariff Switching:** Enables the implementation of complex tariff structures based on time of day and day of the week.
- **Peak Load Registration:** Facilitates the calculation and recording of peak load values during specified integration periods.
- **Time of Use Functionality:** Supports flexible tariff policies that vary based on time of day and other factors.

Clock Operation
The Real-Time Clock (RTC) operates using a 32.768 kHz crystal oscillator. Its accuracy and characteristics comply with IEC 62052-21 and IEC 62054-21 standards.

Time Settings and Corrections
Time settings and corrections for the internal clock can be made using the same methods as for configuring electrical values and through communication ports (OBIS code: 0.0.1.0.0.255).

Internal Calendar
The internal clock provides an internal calendar that supplies information about the year, month, day, day of the month, hour, minute, second, and whether it's a leap year.

Power Supply

- **Primary Supply:** The clock's primary power source is the mains.
- **Backup Supply:** A lithium battery or supercapacitor provides backup power.
- **Lithium Battery:** The lithium battery has a minimum life expectancy of 15 years. It undergoes regular testing at power-up and midnight. A low battery voltage is indicated by a corresponding bit in the FF register and recorded in the event log.

- **Supercapacitor (Optional):** The supercapacitor can provide backup power for up to 168 hours in non-voltage mode.

Note:
The internal clock is a critical component of the meter, ensuring accurate timekeeping and enabling essential functions like tariff calculations and event logging.

5.12. Active Power Measurement and Display

The meter measures and displays the current active power on the LCD as needed.

Maximum Demand Measurement
The meter also measures and displays the maximum demand per tariff. The codes for maximum demand registers adhere to SRPS EN 62056-61 (registers 1.6.x).

Integration Period
The integration period for maximum demand calculations is programmable and can be reviewed on the LCD or remotely. The default integration period is 15 minutes.

Maximum Demand Reset

- **Manual Reset:** Manual resetting of the maximum demand value is generally not possible using the unsealed button. However, it may be configurable to allow manual resets using the sealed button.
- **Fraud Prevention:** To prevent fraudulent resets, the meter can be configured to restrict manual resets to no more than once per 24 hours.

Note:
The specific configuration options for maximum demand reset may vary depending on the meter model. It's recommended to consult the meter's documentation for detailed information.

5.13. Prepaid Features

The meter supports a prepaid option, which can be activated by setting attribute 2 of the 0.0.19.0.0.255 object to the value 020216021602.

Prepaid Functionality and OBIS Codes

- **Prepaid Definitions:** All prepaid features and OBIS codes are implemented according to DLMS/COSEM prepaid definitions.
- **Credit Recharge:** Credit recharging is performed through remote communication with the HES. Local credit recharge using a keyboard or card is not supported.
- **Tariff Pricing:** The user can define different prices for different tariffs by setting attribute 6 of class 113. The OBIS codes for tariff 1 and tariff 2 prices are 0.0.19.20.0.255 and 0.0.19.20.1.255, respectively.
- **Price Activation Timing:** Attribute 7 of the same objects defines the activation time for these prices.

- **Current Active Price:** Attribute 5 of the same objects presents the currently applied (active) price.

Low Credit Warning

When the credit level is low, the meter displays an appropriate warning. The threshold for this low credit warning can be set using attribute 5 of the 0.0.19.10.0.255 object (class 112 Credit).

Emergency Credit Activation

The prepaid feature allows for the activation of emergency credit. A message appears on the screen prompting the user to press the right meter button (located below the lever next to the left meter button) for less than 5 seconds to activate emergency credit.

Note:
The specific OBIS codes and configuration options for prepaid features may vary depending on the meter model and implementation. It's recommended to consult the meter's documentation for detailed information.

Figure 36 - Message on meter display for manual activation of emergency credit

Figure 37 - Left button for activation of emergency credit

When emergency credit is activated, the meter displays a message:

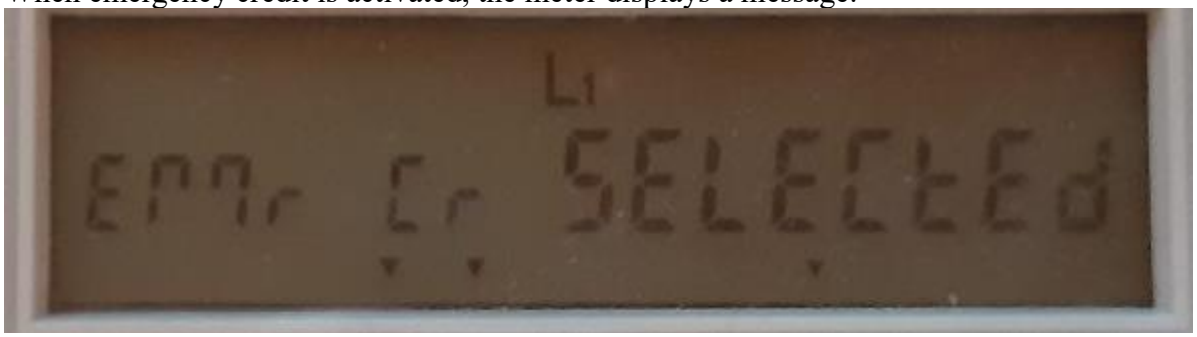

Figure 38 - Message on display after emergency credit is selected (activated)

Emergency Credit Configuration

- **Available Credit:** The value of available emergency credit can be set by modifying attribute 9 of the 0.0.19.10.1.255 object (class 112 Credit).
- **Activation Threshold:** The threshold for activating emergency credit can be set by modifying attribute 10 of the same object (0.0.19.10.1.255).

Emergency Credit Usage and Debt

- **Debt Indication:** When emergency credit is activated and used, the meter will display the outstanding debt that needs to be settled to return the credit status to 0.
- **Debt Visibility:** The debt amount is presented in object 129.0.5 and is visible on the meter display.

Note:
These settings allow for customization of the emergency credit feature, enabling the user to control the available emergency credit amount and the conditions under which emergency credit is activated.

6. Meter security system

Meter Security Measures
The meter incorporates robust security measures to protect against unauthorized access and fraud:

Physical Security:
- **Cover Detection:** Sensors monitor the opening of the measuring part cover and terminal block cover.
- **Magnetic Field Detection:** A sensor detects strong magnetic fields, which could indicate tampering attempts.

Communication Security:
- **Access Rights:** The meter implements a hierarchical system of access rights for different client roles (Public, Pre-Established, Management, Client Level 1, Client Level 2, Client Level 3).
- **Password Protection:** Client-specific passwords are used to authenticate access.
- **Encryption:** Data is encrypted using AES-128 GMAC to protect against unauthorized access and tampering.
- **Security Policy:** The meter supports various security policies, including authentication, encryption, or a combination of both.
- **Frame Counter:** A frame counter is used to prevent replay attacks and unauthorized disconnections.

Data Protection:
- **Non-Volatile Memory Encryption:** The non-volatile memory is encrypted to protect data integrity and prevent unauthorized access.
- **Security Suite 0:** The meter supports Security Suite 0, which provides a baseline level of security.
- In addition to Security Suite 0, the meter may support Security Suite 1 and Security Suite 2. These higher-level security suites offer enhanced protection and features.

Client Roles and Access Rights:
- **Public Client:** Has limited access rights and can only read basic parameters.
- **Pre-Established Client:** Can send broadcast messages but cannot open or close the COSEM connection.
- **Management Client:** Has the highest access rights, including local and remote access, read/write permissions for most objects, and firmware update capabilities.
- **Client Level 1 (Low Right):** Can read all data, set time remotely or via optical port, but cannot change other settings.
- **Client Level 2:** Can read all objects, set time, and TOU remotely or via optical port.
- **Client Level 3:** Can read all objects, set TOU, time, and other meter settings locally.

Security Policy Configuration
The data transport security policy can be configured using the "Security policy" attribute of the "Security Setup" object. The available options are:
- **No Security:** No security measures are applied.
- **All messages are authenticated:** Only authenticated messages are accepted.
- **All messages are encrypted:** All messages are encrypted.

- **All messages are authenticated and encrypted:** Both authentication and encryption are applied.

Key Management
The meter securely saves and exchanges keys using key encryption.

Authentication Mechanism
The "Authentication_mechanism_name" attribute of the "Current Association" object can be set to 1 or 5 to configure the authentication mechanism.

- **1:** LLS (Low-Level Security)
- **5:** HLS GMAC (High-Level Security)

Additional Security Features
The meter may implement additional security features, such as intrusion detection, anomaly detection, or secure boot mechanisms. These features can help further enhance the meter's security and protect against various threats.

Note:
The specific security features and configuration options may vary depending on the meter model and implementation. It's essential to consult the meter's documentation for detailed information on the available security measures and how to configure them.

7. The procedure of connecting the meter to the mains and checking the status

7.1. The procedure for connecting ST402

Meter Connection and Status Checking

Direct Connection:

- **Cable Connection:** For direct connection meters, a 3-phase 4-wire cable is used to connect the meter to the mains. The wiring connection is located on the terminal cover, inside the meter.
- **Screw Tightening:** Ensure that the screws are tightened with a torque of 2.5 Nm.

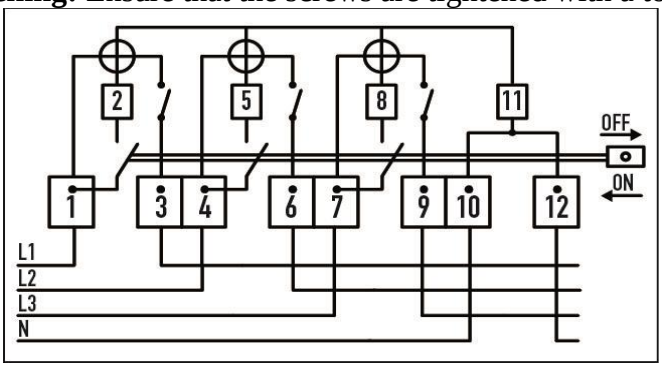

Figure 39 - Connection diagram for the direct meter

Optional Sliding Voltage Divider Switch:

Direct connection meters may optionally include a sliding voltage divider switch for quick and easy separation of the current and voltage circuits during calibration or accuracy testing.

- **Separation:** The switch simultaneously separates all three voltage phases.
- **Position Indication:** The ON/OFF positions of the switch are indicated on the wiring diagram.
- **Operating Position:** The switch is in the left (ON) position for normal operation, allowing current and voltage circuits to be connected.
- **Calibration Position:** The switch is in the right (OFF) position for calibration or accuracy testing, disconnecting the current and voltage circuits.

Figure 40 - Sliding Voltage Divider Switch

Transformer Type Meters

In transformer-type meters, the current and voltage circuits are always separated from each other.

Note:
The specific wiring diagram and switch positions may vary depending on the meter model. It's essential to consult the meter's documentation for accurate instructions and diagrams.

Transformer Meter Connection and Operation
Connection:

- **Mains Connection:** The transformer meter connects to the low voltage mains through a 3-phase 4-wire connection.
- **Current Transformer:** The current is connected to the current terminal block using an external measuring current transformer.
- **Wiring Diagram:** The wiring diagram is located on the inside of the terminal block cover.
- **Screw Tightening:** The M4 screws on the current terminal block should be tightened with a torque of 2.5 Nm.

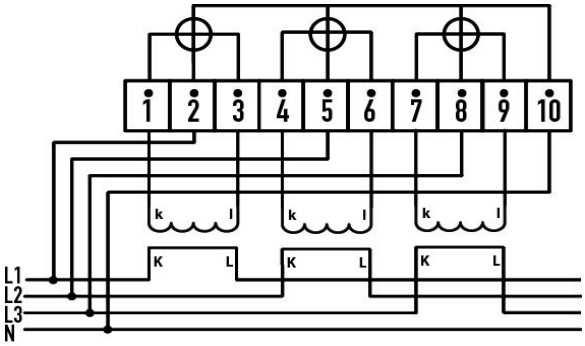

Figure 41 - Connection diagram for the transformer meter

Phase Connection and Indicators:

- **Phase Order:** The order of phase connection (input-output) does not affect measurement accuracy.
- **Phase Indicator:** If a phase is connected incorrectly, the corresponding phase indicator on the display will blink at 1 Hz.
- **Energy Direction:** The meter measures and records energy for each phase, regardless of the direction of energy flow.
- **Neutral Intersection:** If the neutral conductor intersects with any phase, the L1, L2, and L3 indicators will blink at 1 Hz.
- **Missing Phase:** If a phase is missing, the corresponding indicator will be missing on the display. However, the meter maintains accuracy for the remaining phases.
- **Missing Neutral:** The meter can operate without a neutral conductor, but accuracy may not be guaranteed. Reconnecting the neutral will restore the declared accuracy class.

Meter Mounting

- **Mounting Standard:** The meter is mounted according to DIN 43857-2.
- **Enclosure:** The meter enclosure is fixed using 3 screws.
- **Mains Connection:** The meter is connected to the mains as shown on the wiring diagram on the terminal cover. Screws are tightened with 2.5 Nm torque.

Checking Indicators

- **All Indicators Present (L1, L2, L3):** This indicates the presence of all three phases.
- **Missing Indicators:** If any L1, L2, or L3 indicators are missing, it means the phase voltage is missing for that phase. Check the phase conductor connection.
- **Blinking Indicators:**
  - **All blinking:** Indicates a neutral conductor intersection.
  - **Some blinking:** Indicates a reverse energy flow (input and output switched) on the blinking phase.

Additional Checks

- **Date and Time:** Verify the date and time settings. If the year is 2001, it indicates that the clock was not set up previously.
- **Push Buttons:** Check if the push buttons are functioning correctly.
- **Terminal Cover Sealing:** After completing the checks, seal the terminal cover.

Note:
These instructions provide a general overview of the meter connection and setup process. It's essential to consult the specific meter model's documentation for detailed instructions and any model-specific variations.

8. Equipment for meter reading and meter parameterization

Meter Programming and Data Reading Equipment
The manufacturer recommends the following equipment for service programming, data reading, and field maintenance of the ST402 meter:

8.1 Service Programming and Data Reading

- **PaMet Application:** Developed by Meter&Control, this application is used for data exchange and parameterization. It supports Windows XP, Vista, 7, 8, and 10 operating systems.
- **Optical Probe:** An OS30 optical probe (produced by Meter&Control) is recommended for reading data via the IR port.
- **PC or Laptop:** A computer running a compatible operating system is required.

This equipment is typically used by authorized personnel in the field or testing laboratories.

8.2 Field Meter Reading and Parameterization

- **uPaMet Application:** This internal application for meter parameterization is suitable for all types of handheld terminals (Palmtop PCs) running Windows CE.
- **PaMet Application and Laptop:** An alternative option is to use the PaMet application on a laptop running Windows 7, 8, 10, Vista, or XP.
- **Optical Probe:** An OS30 optical probe is necessary for communication with the meter.

Note:
The specific software and hardware requirements may vary depending on the meter model and the desired functionalities. It's recommended to consult the meter's documentation for the most accurate and up-to-date information.

9. Maintenance of the meter

Meter Maintenance
The ST402 meter is designed for minimal maintenance throughout its 15-year lifespan. The applied measuring techniques, high-quality components, and controlled production processes contribute to its long-term stability, eliminating the need for recalibration.

Operating and Storage Temperature

- **Operating Temperature:** -40°C to +70°C
- **Storage Temperature:** -40°C to +80°C

Periodic Checks
It is recommended to perform the following periodic checks:

- **Meter Condition:** Ensure the meter is clean and dry, paying attention to the display and optical port.
- **Normal Function:** Verify that the meter is operating as expected.
- **Seal Integrity:** Check the condition of the seals for any damage.
- **Internal Diagnostics:** Review the internal auto-diagnostic records for any error entries in the status register (FF register).
- **Energy Counter Functionality:** Verify that the energy counters are functioning correctly and recording logical changes in energy amounts.

Note:
Regular maintenance checks help identify and address any potential issues early on, ensuring the meter's continued accurate and reliable operation

10. Table review of technical characteristics of the meter

BASIC MEASURING CHARACTERISTICS	
Accuracy class	
❖ Active energy	1 or 2 (IEC 62053-21); A or B (EN50470-3)
❖ Active energy – transformer meter	0.5S (IEC 62053-22); C (EN 50470-3)
❖ Reactive energy	2 or 3 (IEC 62053-23)
Nominal current I_n	5 A for max current 80A or 100 A
Nominal current I_n – transformer meter	5 A for max current 6A or 1 A for max current 10 A
Minimal current I_{min}	0,04 In
Minimal current I_{min} – transformer meter	0,01 In
Nominal voltage, U_n	3x (110/240) V or 3x (230/-400) V
Voltage range	0,8 Un – 1,15 Un
Frequency	50 or 60 Hz
Meter constant (LED)	1.000, 3.200 or 4.000 imp/kwh (kvarh)
Meter constant (LED) – transformer meter	10.000 imp/kwh (kvarh)
Working temperature range	-40ºC to +70ºC
Relative humidity operation	95 % in period 24h
Storage temperature	-40ºC to +80ºC
Internal RTC	
❖ standard	Physical layer according to IEC 62054-21
❖ Frequency of the quartz	32.768 kHz
EXCHANGE DATA WITH THE METER	
LCD	according with VDEW
Interfaces (PHY)	
❖ Optical port	IEC 62056-21
❖ Wired M-Bus	EN 13757-2
❖ RS485 port	RS485
❖ GPRS – meter type ST402	GPRS/3G/LTE/NB IoT/CAT M1
Communication protocols	
❖ Optical port	IEC 62056-46 (DLMS)
❖ Wired M-Bus	EN 13757-3
❖ RS485 port	RS485
❖ GPRS – meter type ST402	DLMS/COSEM
SWITCHING DEVICE (INTEGRATED)	
❖ Max switching current	3 x 100 A
❖ Short circuit current	30 Imax
❖ Utilization category	IEC 62055-31, UC3
❖ Mechanical lifetime	1.000.000
INPUTS	
control inputs, for tariff control	Tariff inputs, 230 V or 120 V
SO input	Alarm input, relay control by a switch
OUTPUTS	
Relay outputs	Output with bistable relay (230 V or 120 V, 5 A)
Pulse outputs	Transistor pulse output (IEC 62053-31 class B)
Electromagnetic compatibility (EMC)	
Self-consumption (voltage circuit)	According to IEC/EN 62053-21/22/23, IEC/EN 62053-61, EN 50470-3
Self-consumption (current circuit)	According to IEC/EN 62053-21/22/23, IEC/EN 62053-61, EN 50470-3
AC test	4 kV, 50 Hz, 1 min.
Surge voltage	6 kV, 1,2/50µs, according to IEC 62052-11, EN 50470-1
METER ENCLOSURE	
Dimensions (mm)	302x178x81
Weight (kg)	Approximately 1,8
Ingress protection	IP54, according to IEC 60529

Table 13 - Table review of technical characteristics of the meter

11. Firmware update (upgrade)

11.1. Firmware Signature

Firmware Signature

- **Code Separation:** The ST402 meter employs code separation, meaning it contains two distinct software components: legally relevant and legally non-relevant.
- **Signature Calculation:** Each software component has its own signature, which is a 16-byte value representing the program checksum (Flash) memory of the microcontroller.
- **Checksum Calculation:** The checksum is calculated upon each meter power-up and stored in the microcontroller's RAM. This process may take approximately 1 minute.
- **Checksum Reading:** While the checksum calculation is in progress, reading the checksum via a communication port will return a value of 0.
- **Checksum Display:** During the calculation, the display will show "CALC" and the percentage of the calculation progress (e.g., "CALC 50").
- **OBIS Code:** The checksum can be read using the OBIS code 1.0.0.2.8.255.
- **Display:** The checksum is also displayed in the autonomous regime auto scroll sequence and may be visible in a separate part of the display menu.

11.2. Firmware Version

- **IDIS Specification:** The firmware identification follows the IDIS specification.
- **Format:** V03xxyy, where:
  - V: Represents "Version"
  - 03: Indicates a three-phase meter
  - xx: Represents the major firmware release (two digits)
  - yy: Represents the minor firmware release (two digits)
- **Example:** V030202

Storage Locations

- **Legally Relevant Firmware Version:** 1.0.0.2.0.255
- **Legally Non-Relevant Firmware Version:** 1.1.0.2.0.255

Note:
The firmware signature and version information are essential for verifying the integrity and authenticity of the meter's software.

11.3. Firmware Update Procedure

The ST402 meter supports firmware updates via the DLMS protocol, allowing for changes to its software while maintaining operational functionality. This process complies with WELMEC 7.2 standards.

Key Features:

- **Preservation of Meter Characteristics:** Firmware updates are designed to maintain the meter's measurement characteristics, stored data, and configuration parameters.
- **Update Methods:** Firmware can be updated locally through the optical port or remotely through a management system.
- **Image Identifier:** The firmware update is initiated by sending an image identifier to the meter. The identifier format is MAC-ST402y-LR-HWz.k-FWu.v.w, where:
  - x: Communication module type (1, 2, or 5)
  - y: Connection type (D or C)
  - z.k: Hardware version
  - u.v.w: Legally relevant firmware version
- **Firmware Download and Verification:** The meter downloads the firmware in segments, stores it in non-volatile memory, and verifies its integrity using a checksum.
- **Delayed Updates:** The meter supports delayed firmware updates, allowing for scheduling the update at a specific date and time.
- **Image Transfer Object:** The 0.0.44.0.0.255 object enables firmware upload, verification, and activation using a digital file.
- **Checksum Verification:** After the update, the meter calculates the checksum of the new firmware and compares it to the stored value of the old version. If there's a discrepancy, the update is discarded.

Access Restrictions

The firmware update option is accessible only to the management client.

Note:
The firmware update process ensures the integrity and safety of the meter's operation while allowing for software upgrades and improvements.

12. Auto diagnostic function (self-check)

Auto-Diagnostic Function
The meter incorporates an auto-diagnostic function that regularly checks and verifies key parameters of the meter.

Parameters Checked
The auto-diagnostic process assesses the following parameters:

- Memory Integrity.
- Status and alarms.
- Display functionality.
- Battery status.
- Communication status.
- Presence of phase voltages.

Trigger Points

- **Meter Initialization:** The auto-diagnostic is performed when the meter is connected to the mains and after firmware downloads or updates.
- **Continuous Monitoring:** The meter's parameters are continuously monitored during operation.

Local Initiation
The auto-diagnostic can be initiated locally by an authorized user.

Self-Check
The self-check of the meter's software (each software version has a unique checksum) is performed at the following times:

- When the meter is connected to the mains
- After returning to power
- After a firmware download or update

Diagnostic Results
The diagnostic results are stored in the standard event log and the integrity book. These results can be accessed both locally and remotely.

Display Indication
The results can be displayed on the meter's screen when the FF register is set to be shown during meter parameterization.

FF Register
The FF register is a status register where each error has a unique code. The list of codes is provided in chapter 4.1.1.1.1 of the manual.

Note:
The auto-diagnostic function is a valuable tool for monitoring the meter's health and identifying any potential issues. Regular self-checks help ensure the meter's accurate and reliable operation.

13. Type designations

ST402D-22A43R55-4GR1OS00020-scbg			
(The meter type – measuring – interfaces – functions)			
Meter types:	**Measuring characteristics**	**Interfaces**	**Functions**
❖ **ST** – *3-phase meter* ❖ **SM** – *1-phase meter* ❖ **401** – *meter with PLC modem* ❖ **402** – *meters with the cellular modem* ❖ **405** – *meter with RS485 port* ❖ **D** – *direct connection* ❖ **C** – *transformer connection (via current transformers)*	❖ **10** – *In = 1A, Imax = 10A* ❖ **15** – *In = 5A, Imax = 6A* ❖ **19** – *In = 5A, Imax = 60 A* ❖ **20** – *In = 5A, Imax = 80 A* ❖ **22** – *In = 5A, Imax = 100 A* ❖ **23** – *In = 5A, Imax = 120 A* ❖ **A** – *active energy* ❖ **R** – *reactive energy* ❖ **3** – *accuracy class 0.5S* ❖ **4** – *accuracy class 1* ❖ **5** – *accuracy class 2* ❖ **6** – *accuracy class 3* ❖ **7** – *accuracy class MID A* ❖ **8** – *accuracy class MID B* ❖ **9** – *accuracy class MID C* ❖ **1** – *measuring A+* ❖ **3** – *measuring A+, A- and |A|* ❖ **5** – *measuring* R+, R-, R1, R2, R3, R4 ❖ **6** – *measuring* R1	❖ **2G** – *cellular 2G (GPRS) modem* ❖ **3G** – *cellular 3G (UMTS) modem* ❖ **4G** – *cellular 4G (LTE or LTE-M NB IoT) modem* ❖ **R1** – One RS485 port ❖ **R2** – Two RS485 ports ❖ **O** – Optical port ❖ **M** – *Optical port, wired M-Bus* ❖ **S** – *Integrated switching device* ❖ **V** – *230 V or 120 V power supply output for external modem* ❖ **W** – *Wireless M-Bus* ❖ **C** – *Current Loop interface* ❖ **00020** – *no of tariff inputs 230 V or 120V, no of OPTOMOS outputs, no of pulse outputs, no of relays 5A, no of S0 inputs*	❖ **w** - *"no power" reading battery* ❖ **s** – *Supercap for RTC backup* ❖ **c** – Support for Customer information unit ❖ **m** – *Multi-utility metering* ❖ **g** – *Last gasp functionality* ❖ **n** – *Measurement element for measuring neutral current (bypass detection)* ❖ **b** – *Display backlight* ❖ **z** – *Detection of impedance downstream of meter switching device (disconnector)* ❖ **v** – *Detection of voltage downstream of meter switching device (disconnector)*

Table 14 - Type designations

15. Safety

This chapter offers safety guidelines for handling, installing, and disposing of the ST402 electricity meter and its accompanying parts. It's important to remember that this chapter doesn't cover every single safety precaution needed for using the device. However, it contains essential information that must be followed to protect yourself and prevent property damage. The information is clearly marked and illustrated to indicate the level of risk involved.
Only qualified electrotechnical professionals authorized by the utility company may install, commission, and operate the device described in this user manual. For the purpose of this document, qualified electro-technical professionals are people who can demonstrate technical qualifications and competencies as electrician (hereinafter referred to as “installers”). The installer is obligated to perform the installation procedure following the national legislation and internal norms of the utility. Local jurisdiction may impose regulatory restrictions (e.g., minimum age, required training, licensing, etc.) concerning electrical installation work. Aside from local regulations, the following requirements should also be assessed to determine an individual’s technical qualifications and competencies:

- Training to an appropriate level in electrical engineering to develop the required knowledge and skills, especially knowledge of installation procedures, awareness of potential hazards and precautions to be observed; and ability to assess the safety in proceeding with a task at any point of time.
- Experience in achieving a suitable standard in similar work.
- Regular re-assessment. People who do not demonstrate the required technical qualifications

Response:

- **Restricted Access:** Only qualified electrotechnical professionals authorized by the utility company are allowed to install, commission, and operate the device.
- **Qualifications:** "Qualified electrotechnical professionals" must possess technical qualifications and competencies as electricians.
- **Legal Compliance:** Installation must adhere to national legislation and utility-specific guidelines.
- **Local Regulations:** Local jurisdictions may have additional requirements like minimum age, training, or licensing.
- **Technical Competencies:** To be considered qualified, individuals should have:
  - Appropriate electrical engineering training
  - Relevant work experience
  - Regular skill assessment

Owner Responsibilities:

- **Safety Training:** The meter owner is responsible for ensuring that all authorized personnel who work with the meter read and understand the safety sections of the User Manual and Installation and Maintenance Manual.
- **Qualified Personnel:** Only qualified and authorized personnel should handle the meter installation and maintenance.
- **Safety Regulations Adherence:** Personnel must strictly follow all safety regulations and operating instructions outlined in the manuals.
- **Safety Measures:** The meter owner is responsible for protecting personnel, preventing material damage, and providing necessary training.

Safety Regulations:

- **De-energization:** Before installation or opening the meter, ensure that the power supply is disconnected. Contact with live parts can be dangerous. Remove and store main fuses in a safe place until work is completed.
- **Local Regulations:** Adhere to all local safety regulations and requirements. Only qualified and trained personnel are authorized to install meters.
- **Safe Handling:** Handle the meter with care to prevent injuries during installation.
- **Damaged Meters:** Do not install meters that have been dropped or damaged. Return them for testing and repair.
- **Cleaning:** Avoid cleaning the meter with running water or compressed air to prevent short circuits.
- **Careful Unpacking:** When taking the device out of its packaging, handle it with care to avoid dropping it.
- **Risk of Damage:** Dropping the device can lead to personal injuries or damage to the device itself.
- **Return for Inspection:** If the device falls despite precautions, it should not be installed. Instead, it should be returned to the manufacturer for inspection and further testing.

Note:
These safety regulations are essential for protecting personnel, preventing damage, and ensuring the safe and proper installation and operation of the meter. Always prioritize safety and follow the guidelines provided in the manuals.

16. Standards

The ST402 meter is designed following the international standards:

- **EN 13757-2**: Metering systems. Part 2: Data exchange between meters and meter reading systems
- **EN 13757:** Communication systems for meters and remote reading of meters:
  - Part 3: Dedicated application Layer
  - Part 4: Wireless meter readout (Radio Meter reading for operation in the 868–870 MHz SRD band)
  - Part 7: Transport and security services
- **EN 50160**: Voltage characteristics of electricity supplied by public electricity networks;
- **EN 50470:** Electricity metering equipment (a.c.):
  - Part 1: General requirements, tests, and test conditions - Measuring equipment (accuracy classes A, B, and C);
  - Part 3: Particular requirements - Static meters for active energy (class indexes A, B and C);
- **EN 60695-2-11:** Fire hazard testing - Part 2-11: Glow / hot wire test methods;
- **IEC 60529:** Degrees of protection provided by enclosures (IP code);
- **IEC 61000:** Electromagnetic compatibility (test and measurement methods):
  - Part 4-2: Electrostatic discharge test;
  - Part 4-3: Resistance test to radiated radio frequency electromagnetic fields;
  - Part 4-4: Resistance test to electrical fast burst transients;
  - Part 4-5: Burst surge resistance test;
  - Part 4-6: Resistance test to guided interference by radio frequency fields;
- **IEC 62052-11:** Electricity metering equipment (a.c.) - general requirements, test and test conditions (part 11: Metering equipment);
- **IEC 62053:** Electricity metering equipment (a.c.) - Particular requirements:
  - Part 21: Static meters for active energy (classes 1 and 2));
  - Part 22: Static meters for active energy (classes 0.2S and 0.5S);
  - Part 23: Static meters for reactive energy (classes 2 and 3);
  - Part 24: Static meters for reactive energy (classes 0.5 and 1);
  - Part 31: Pulse output devices for electromechanical and electronic meters (two wires only);
- **IEC 62054:** Electricity metering (a.c.) - Tariff and load control:
  - Part 11: Particular requirements for electronic ripple control receivers;
  - Part 21: Particular requirements for time switches;
- **IEC 62056**: Electricity metering data exchange - The DLMS/COSEM suite:
  - Part 4-7: DLMS/COSEM transport layer for IP networks;
  - Part 5-3: DLMS/COSEM application layer;
  - Part 6-1: Object Identification System (OBIS);
  - Part 6-2: COSEM interface classes;
  - Part 7-6: The 3-layer, connection-oriented HDLC-based communication profile;
- **IEC 62056-21**: Data exchange for meter reading, tariff, and load control – Direct local connection (3rd edition of IEC 61107);
- **RoHS Directive 2011/65/EU:** Banning the use of certain hazardous substances in electrical and electronic equipment;

- **DIN 43857-2:** Watt-hour meters in molded insulation case without instrument transformers, up to 60 A rated maximum current; principal dimensions for poly-phase meters;
- **BS EN 13757:** Communication system for and remote reading of meters:
  - Part 2: Physical and link layer;
  - Part 3: Dedicated application layer;
  - Part 4: Wireless meter readout (radio meter reading for operation in the 868-870 MHz SRD band);
  - Part 7: Part 7: Transport and security services;
- **DLMS UA 1000-2 Ed.8, 2014:** Green Book, DLMS/COSEM Architecture and Protocols;
- **DLMS UA 1002: Ed.1, 2003**: White Book, COSEM Glossary of Terms;
- **DLMS UA 1000-1 Ed.12, 2014**: Blue Book, COSEM Identification System and Interface Classes;
- **DLMS UA 1001-1 Ed.5, 2015**: Yellow Book, DLMS/COSEM Conformance Testing Process.

********** The end of document **********