1. Instrument

The three-phase energy meters IE38MS, IE38MM and IE38MD are intended for energy measurements in a three-phase or single-phase network. The meters measure energy directly in three-phase 4-wire connection (3W4), single-phase connection (1W), three-phase 3-wire 3 system connection (3W3) or three-phase 3-wire 2 system connection (2W3 Aron connection) according to the principle of fast sampling of voltage and current signals. A built-in microprocessor calculates active energy, active/reactive/apparent power, current, voltage, THD, frequency, power factor, power angle and frequency (for each phase and total sum) from the measured signals. Microprocessor also controls LCD, LED, IR, M-bus, NFC and RS 485 communication. The meters can measure in both directions.

This EU type examination certificate covers only on the active energy measurement.

General hardware features	IE38MS	IE38MM	IE38MD
Pulse output S01	✓	✓	✓
Pulse output S02	✓	×	×
Tariff input	✓	✓	✓
Infrared (optical) communication - IR	✓	✓	✓
MODBUS comm. Protocol RS485	×	×	✓
M-bus serial comm.	×	✓	×
NFC communication	✓	✓	✓

2. Design of the instrument

2.1 Construction

1. Current terminals – to load
2. AUX terminals (options):
- RS485 (MODBUS)
- M-BUS
- Pulse output (S01,2)
3. NFC
4. Information display
5. DIN-Rail fitting
6. IR communication port – on side
7. LED indicator
8. Cap touch
9. Tariff input
10. Neutral input
11. Current terminal – source (max 80 A)

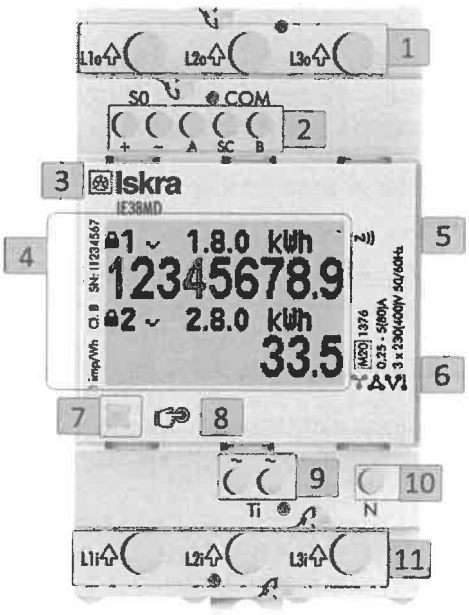

Figure 1: IE38MD Meter parts

2.2 Sensor

For a current input the shunt resistor is applied. Voltage is measured by the resistor voltage divider.

2.3 Measurement value processing

2.3.1 Operating principle

The meter is connected via terminal block to the network. The metering elements consist of a current sensor (shunt) and a voltage sensor, which signals are fed to the metering integrated circuit. The microcontroller acquires signals from the metering element, processes them and calculates values of measured energy. Results are stored in registers and can be seen on the LCD.

There are also two different modes for import – export evaluation in case of opposite energy flow in different phases. This can be evaluated as the sum of phases (vector) or evaluation regarding the individual phases (arithmetic).

Import – export evaluation:
P1 = P, P2 = P, P3 = -P
Evaluation as the sum of phases – summated power P_{reg} registered
$P_{reg} = P1 + P2 + P3 = P + P - P = P_{(+)}$ Active power $P_{(+)}$ registered in counter A+.

Evaluation regarding individual phases:
$P_{reg} = P_{(+)} + P_{(+)} + P_{(-)} = 2P_{(+)} + P_{(-)}$ Active power $2P_{(+)}$ registered in counter A+
Active power $P_{(-)}$ registered in counter A-

Connection and import – export evaluation are specified in the installation process by the user.

2.3.2 Hardware

IE38MS, IE38MM and IE38MD use three phase measuring modules each with independent capacitor power supply. Current and voltage are measured in measurement system. A shunt resistor is used for current sensor. Measuring mains voltage is applied with a resistor voltage divider.

Main power supply unit is based on configuration. IE38MD has switching power supply, which assures also galvanically insulated power supply for RS485 interface. IE38MS and IE38MM have non-insulated capacitive power supply.

When the meter is used for single-phase measurement in two wire network, it shall be connected only in phase L3.

The method for sampling voltage and current is based on A/D conversion. The microprocessor unit is used for signal and measurement processing.

Basic meter data, parameters and calibration constants are stored in EEPROM.

IE38MS, IE38MM AND IE38MD energy meters do not have any adjustable elements (potentiometers), which assures a better long-term stability.

LCD is driven directly from the main microprocessor and is used for displaying various parameters, energy registers, and actual electrical parameters (voltage, current, frequency, active, reactive and apparent power and power factor).

2.3.3 Software

The main microprocessor STM32L452 is used to process the RMS voltage, RMS current, active, reactive and apparent power, power factor, U-I phase angle, first harmonic of voltage, first harmonic of current, the DC voltage, DC current, peak to peak voltage, peak to peak current, THD of voltage and THD of current from the phase modules. It calculates the total active, reactive and apparent power, frequency and updates all energy registers, LED and pulse output. The internal temperature and supply voltage is measured also. All measurements are updated every two periods of 40 Hz to 70 Hz signal. The averaging of all the measurements are calculated also. All measurements are stored in the RAM and can be read from the functional part of the software. The energy registers are stored in the

EEPROM every 20 minutes and at the power down. They are restored from the EEPROM to the RAM at the power up.

The measuring part of the software includes the serial interfaces interrupt handlers also. These interrupt handlers transfer data to the receiver buffers and from the transmit buffers. The other communication tasks are done in the functional part of the software except the software upgrade function.

FW identification window and MID relevant counters:

LCD display at start up:
SN: serial number
M: Version and CRC of Part 1 main FW
F: Version and CRC of Part 2 main FW
H: Hardware version
m. : CRC of phase measuring modules FW
Run: Operational time (days hours minutes)

LCD display in Info menu:
SN: serial number
MID: Version and CRC of Part 1 main FW
U: Upgrade counter of Part 1 main FW
FUN: Version and CRC of Part 2 main FW
L: Counter of unlock actions
HW: Hardware version
m. : CRC of phase measuring modules FW
Run: Operational time (days hours minutes)

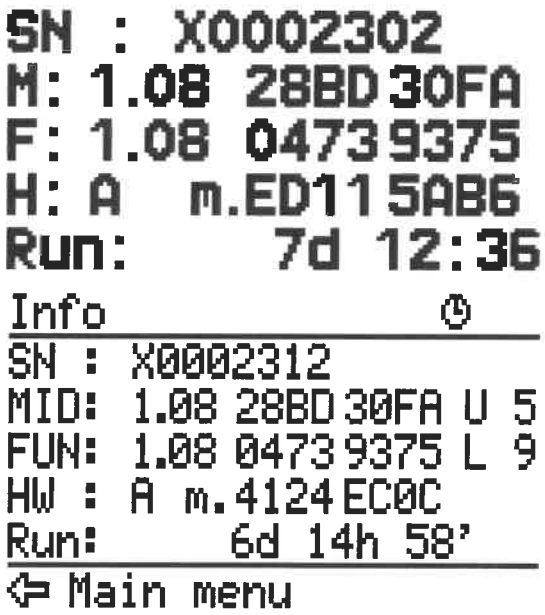

Figure 2: IE38MS, IE38MM and IE38MD identification and FW identification

2.4 Indication of the measurement results

Energy meters have LCD display of matrix type 128 x 64. Display illuminates in white for normal operation and in red for alarm indication.

There are two sets of energy registers – four non-resettable registers which can be assigned for active energy (MID approved), reactive energy (subject to national approval) or apparent energy (no approval). The meter with MID approval should have at least one register with active energy measurement. There are additional 16 energy registers which can be parameterized by the user regarding type of energy, active quadrants, direction of counting and tariff and they can also be reset using MODBUS command or cap touch. Tariff management for MID approved registers is possible only for two tariffs using tariff input. In case MID approved registers are parameterized as cumulative registers (all 6 tariffs) active tariff setting is opened for modification. 16 additional registers can be parametrized for 6 tariffs and tariff managed using RS485 communication.

Indication of four non-resettable registers on the LCD is driven directly from the measuring part of SW.

On the LCD up to two energy counters are displayed. There is the lock sign for the fixed legally relevant non-resettable counters, the counter designation, the sign of currently active register, an additional code and the unit. For the code the user can choose between the OBIS code or letter description code. The 9-digit numerical number shows the value of the energy. The decimal dot is fixed and resolution is fixed to 100 Wh. The screen is displayed for the pre-set cyclic period.

Legally relevant non-resettable registers are designated with letters 1 to 4 after the lock sign, while legally non-relevant resettable registers are designated with 01 to 16. The code is specified in the Table 1.

Table 1: Register description for approved unresettable counters

Register description 1 to 4	OBIS code	Letter description code
Active energy Q1+Q4 – all tariffs	1.8.0	A.I.0
Active energy Q1+Q4 – tariff 1 or 2	1.8.1 or 1.8.2	A.I.1 or A.I.2
Active energy Q2+Q3 – all tariffs	2.8.0	A.E.0
Active energy Q2+Q3 – tariff 1 or 2	2.8.1 or 2.8.2	A.E.1 or A.E.2
Active absolute energy– all tariffs (Abs(Q1+Q4) + abs(Q2+Q3))	15.8.0	A.A.0
Active absolute energy– tariff 1 or 2 (Abs(Q1+Q4) + abs(Q2+Q3))	15.8.1 or 15.8.2	A.A.1 or A.A.2
Reactive energy – Q1+Q2 - all tariffs	3.8.0	r.I.0
Reactive energy – Q1+Q2 - tariff 1 or 2	3.8.1 or 3.8.2	r.I.1 or r.I.2
Reactive energy – Q3+Q4 - all tariffs	4.8.0	r.E.0
Reactive energy – Q3+Q4 - tariff 1 or 2	4.8.1 or 4.8.2	r.E.1 or r.E.2
Reactive absolute energy– all tariffs	95.8.0 (manufacturer specification)	r.A.0
Reactive absolute energy– tariff 1 or 2	95.8.1 or 95.8.2 (manufacturer specification)	r.A.1 or r.A.2
Apparent absolute energy-all tariffs	9.8.0	S.A.0
Apparent absolute energy- tariff 1 or 2	9.8.1 or 9.8.2	S.A.1 or S.A.2

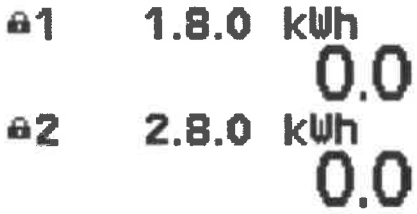

Figure 3: IE38MS, IE38MM and IE38MD example of displayed measured energy

Displayed quantities and scroll time can be set via communication by MiQen software.

2.5 Permissible functions and devices

Measured quantities subjected to approval:
- Energy measurements (active),
- 2 tariffs using tariff input.

2.6 Technical documentation

The valid technical documentation is kept by MIRS in the reference file 6413-6/2020.

2.7 Integrated equipment and functions not subjected to approval

- Reactive and apparant energy measurement
- Active, reactive and apparent power measurement
- Voltage measurement
- Phase to phase voltage
- THD measurement in voltage and current
- Current measurement
- Power factor and angle measurement
- Frequency measurement
- Reference frequency 60 Hz
- 6 tariff management using communication interface

3 Technical data

Reference voltage:	3 x 230 V/400 V or 1 x 230 V on phase L3
Reference current/Max. current:	5 A/ 80 A
Reference frequency:	50 Hz and 60 Hz
Accuracy class:	B
Starting current:	20 mA
Minimum current:	250 mA
Transitional current:	0,5 A
Meter LED constant:	1000 imp/kWh
Meter pulse constant:	500imp/kWh
Dust/water protection	IP50*
Protective class of insulation:	II
Environment / influence quantities:	
Climatic environment:	From -25 °C to +70 °C (non-condensing humidity, closed location)
Mechanic environment:	M1
Electromagnetic environment:	E2
Minimum measuring time	10 s

* For IP51 it should be installed in appropriate cabinet.

4. Interfaces and compatibility conditions

4.1 Interfaces

The meter is equipped with the following interface modules:
- IR optical communication with MODBUS RTU protocol for all models
- $S0_1$ pulse output – active energy
- $S0_2$ 2nd multifunction pulse output (only for IE38MS)
- RS485 Serial communication (only for IE38MD)
- NFC enables an easy setting and downloading meter data via mobile app
- M-bus Serial communication (only for IE38MM)
- Tariff input (230 V AC)
- LED diode
- A capacitive touch button

5. Requirements on production, putting into use and consistent utilization

5.1 Requirements on production

Electronic three-phase and single-phase (L3) electricity meters must be constructed in accordance with the requirements of the section 2 of this certificate.

For built-in sensor the requirements of section 2.2 of this certificate shall be fulfilled.

5.2 Requirements on putting into use

Before the first application, the following steps have to be performed:
- Visually check the compliance with the approved type
- Check the operation of the measuring instrument without load
- Check starting current
- Check correct operation of a pulse transmitter in comparison with energy registers
- Energy measurement accuracy - maximum permissible error (MPE)

For the confirmation of the compliance of an individual meter during the verification procedure, putting into operation or inspection of compliance with the maximum permissible errors (MPE), Table 2, Annex V (MI003) "Active electrical energy meters" of Directive 2014/32/EU of the European Parliament

and Council, a measurement error as a combined error of measuring accuracy at reference conditions and contributions of influence quantities is defined. The error at reference conditions is defined, in testing procedures for an individual meter. In continuation, a factor of contributions of influence quantities for the temperature range from +5 °C to +30 °C, voltage and frequency are stated (table 2 and 3). The factor is considered when defining a common measurement error for a certain meter type.

A sum of squares of individual quantities is stated, and calculated by formula in the tables below:

$$\sqrt{\delta_T^2(T,I,\cos\varphi)+\delta_U^2(U,I,\cos\varphi)+\delta_f^2(f,I,\cos\varphi)}$$

Table 2: Three phase connection

I	phase	PF	Min t [s]	$\delta(T,U,f)=SQRT(\delta_t^2(T,I,\cos\varphi)+\delta_u^2(U,I,\cos\varphi)+\delta_f^2(f,I,\cos\varphi))$ [%]
Active energy - reception				
I_{min}	L1L2L3	1	10	0,10
I_{tr}	L1L2L3	1	10	0,07
$10I_{tr}$	L1L2L3	1	10	0,07
I_{max}	L1L2L3	1	10	0,06
I_{tr}	L1L2L3	0,5L	10	0,11
$10I_{tr}$	L1L2L3	Q,5L	10	0,06
I_{max}	L1L2L3	0,5L	10	0,05
I_{tr}	L1L2L3	0,8C	10	0,12
$10I_{tr}$	L1L2L3	0,8C	10	0,11
I_{max}	L1L2L3	0,8C	10	0,13
I_{tr}	L1	1	10	0,14
$10I_{tr}$	L1	1	10	0,05
I_{max}	L1	1	10	0,11
I_{tr}	L2	1	10	0,08
$10I_{tr}$	L2	1	10	0,07
I_{max}	L2	1	10	0,08
I_{tr}	L3	1	10	0,35
$10I_{tr}$	L3	1	10	0,29
I_{max}	L3	1	10	0,36
I_{tr}	L1	0,5	10	0,15
$10I_{tr}$	L1	0,5	10	0,04
I_{max}	L1	0,5	10	0,11
I_{tr}	L2	0,5	10	0,12
$10I_{tr}$	L2	0,5	10	0,10
I_{max}	L2	0,5	10	0,13
I_{tr}	L3	0,5	10	0,26
$10I_{tr}$	L3	0,5	10	0,29
I_{max}	L3	0,5	10	0,26
Active energy - generation				
I_{min}	L1L2L3	1	10	0,12
I_{tr}	L1L2L3	1	10	0,09
$10I_{tr}$	L1L2L3	1	10	0,10
I_{max}	L1L2L3	1	10	0,06
I_{tr}	L1L2L3	0,5L	10	0,06
$10I_{tr}$	L1L2L3	0,5L	10	0,04
I_{max}	L1L2L3	0,5L	10	0,05
I_{tr}	L1L2L3	0,8C	10	0,13
$10I_{tr}$	L1L2L3	0,8C	10	0,34

I	phase	PF	Min t [s]	$\delta(T,U,f)=SQRT(\delta_t^2(T,I,cos\varphi)+\delta_u^2(U,I,cos\varphi)+\delta_f^2(f,I,cos\varphi))$
I_{max}	L1L2L3	0,8C	10	0,36
I_{tr}	L1	1	10	0,35
$10I_{tr}$	L1	1	10	0,29
I_{max}	L1	1	10	0,36
I_{tr}	L2	1	10	0,11
$10I_{tr}$	L2	1	10	0,07
I_{max}	L2	1	10	0,08
I_{tr}	L3	1	10	0,07
$10I_{tr}$	L3	1	10	0,07
I_{max}	L3	1	10	0,09
I_{tr}	L1	0,5	10	0,26
$10I_{tr}$	L1	0,5	10	0,29
I_{max}	L1	0,5	10	0,24
I_{tr}	L2	0,5	10	0,18
$10I_{tr}$	L2	0,5	10	0,08
I_{max}	L2	0,5	10	0,16
I_{tr}	L3	0,5	10	0,12
$10I_{tr}$	L3	0,5	10	0,26
I_{max}	L3	0,5	10	0,10

Table 3: Single phase connection

I	PF	Min t [s]	$\delta(T,U,f)=SQRT(\delta_t^2(T,I,cos\varphi)+\delta_u^2(U,I,cos\varphi)+\delta_f^2(f,I,cos\varphi))$ [%]
A+			
I_{min}	1	10	0,05
I_{tr}	1	10	0,06
I_{tr}	0.5L	10	0,07
I_{tr}	0.8C	10	0,06
$10I_{tr}$	1	10	0,06
$10I_{tr}$	0.5L	10	0,09
$10I_{tr}$	0.8C	10	0,05
I_{max}	1	10	0,08
I_{max}	0.5L	10	0,09
I_{max}	0.8C	10	0,09
A-			
I_{min}	1	10	0,07
I_{tr}	1	10	0,05
I_{tr}	0.5L	10	0,08
I_{tr}	0.8C	10	0,07
$10I_{tr}$	1	10	0,05
$10I_{tr}$	0.5L	10	0,09
$10I_{tr}$	0.8C	10	0,06
I_{max}	1	10	0,07
I_{max}	0.5L	10	0,09
I_{max}	0.8C	10	0,09

5.3 Requirement for consistent utilization

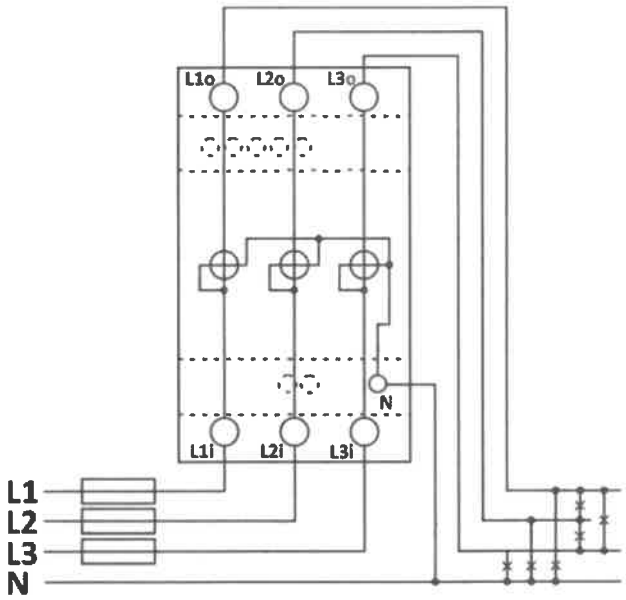

Figure 4: Three-phase connection diagram in four wire network (3W4).

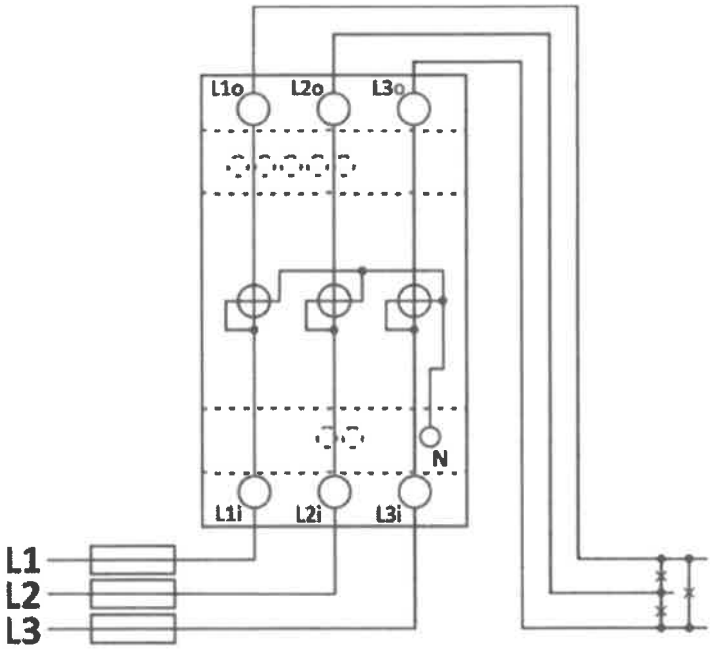

Figure 5: Three-phase connection diagram in three wire network (3W3).

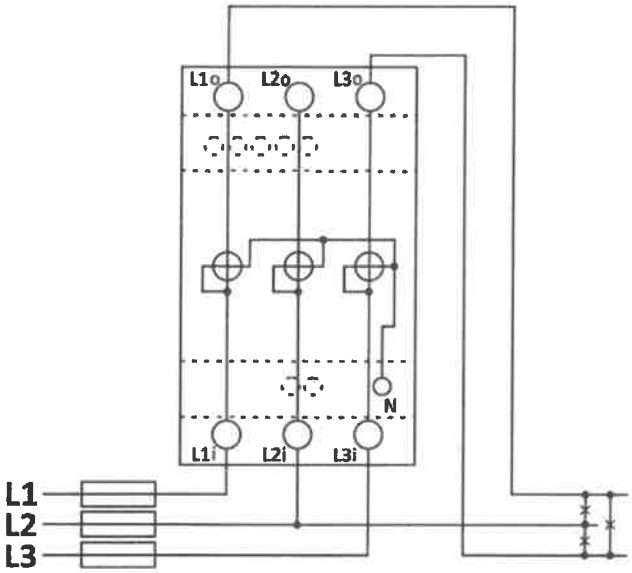

Figure 6: Three-phase 3-wire 2 system connection diagram (2W3).

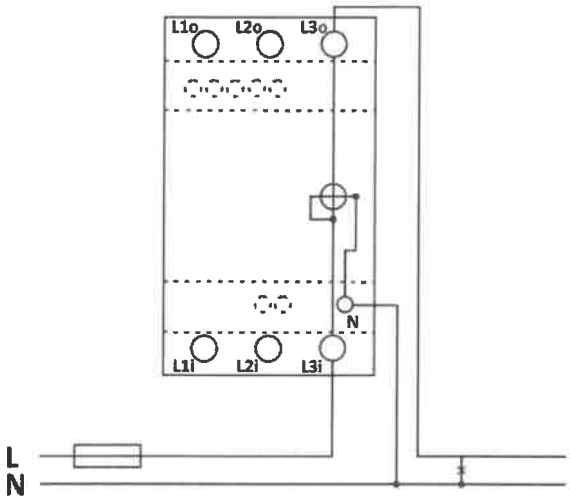

Figure 7: Single phase connection diagram in two wire network.

6. Surveillance of the instrument in use

6.1 Documentation necessary

- Annex to the EU type examination certificate,
- User manual.

6.2 Special equipment or software

The following tools for service meter programming and local data download used:
- MiQen 2.1 (Iskra software)
- Optical adapter WM-USB
- Personal computer

The tool is intended for the operators who service or reprogram the meters in the laboratory or read-out the meters in the field.

6.3 Identification of software

Identification – SW version can be read from LCD or using RS485 or IR communication. The complete legally relevant FW is identified with check sum (CRC) of a main processor firmware and check sum of the program of phase measuring modules. Functional part of SW has its own version and check sum. The check sums (CRC-32) of complete firmware are calculated during initialization. The SW version and check sum and CRC of measuring modules are displayed after power up. They can be read later from LCD Info menu or MODBUS registers. If CRC for code is changed and does not correspond to the initial CRC an ERROR is detected during startup and Error 2 is shown on the LCD. This is checked after every restart of the meter and in 64 seconds interval during operation.

Version Part 1 Register: 30070	Check sum main processor – Part 1 Registers: 30082(HI), 30071(LOW)	Check sum – measuring modules Registers: L1 30083(HI), 30064(LOW) L2 30084(HI), 30065(LOW) L3 30085(HI), 30066(LOW)
1.08	28BD 30FA	4124 EC0C

6.4 Identification of hardware

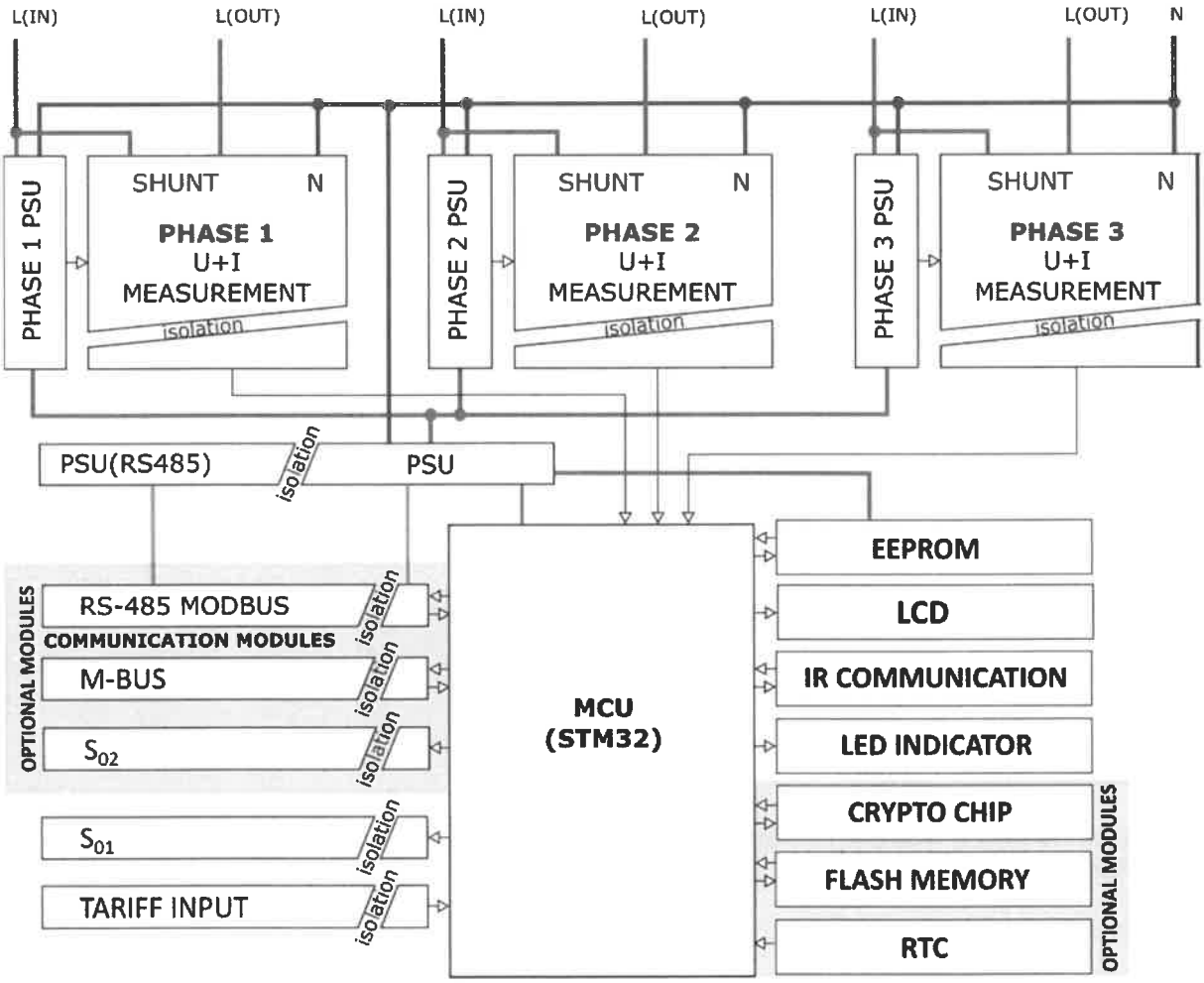

Figure 8: Block diagram of signal conversion and processing

Complete IE38MS, IE38MM and IE38MD assembly:
- Three individual phase measuring units
- Power supply unit
- Processing unit (MCU) with IR communication, LED indicator, LCD support
- RS 485 communication module
- EEPROM for parameter and energy register storage

6.5 Adjustment

The meter casing is sealed. Adjustment is performed only during the production. Later adjustment during the meter life span is not expected.

7. Security measures

The meters are sealed at the following places:
- sealing label on the edge of the meter cover.

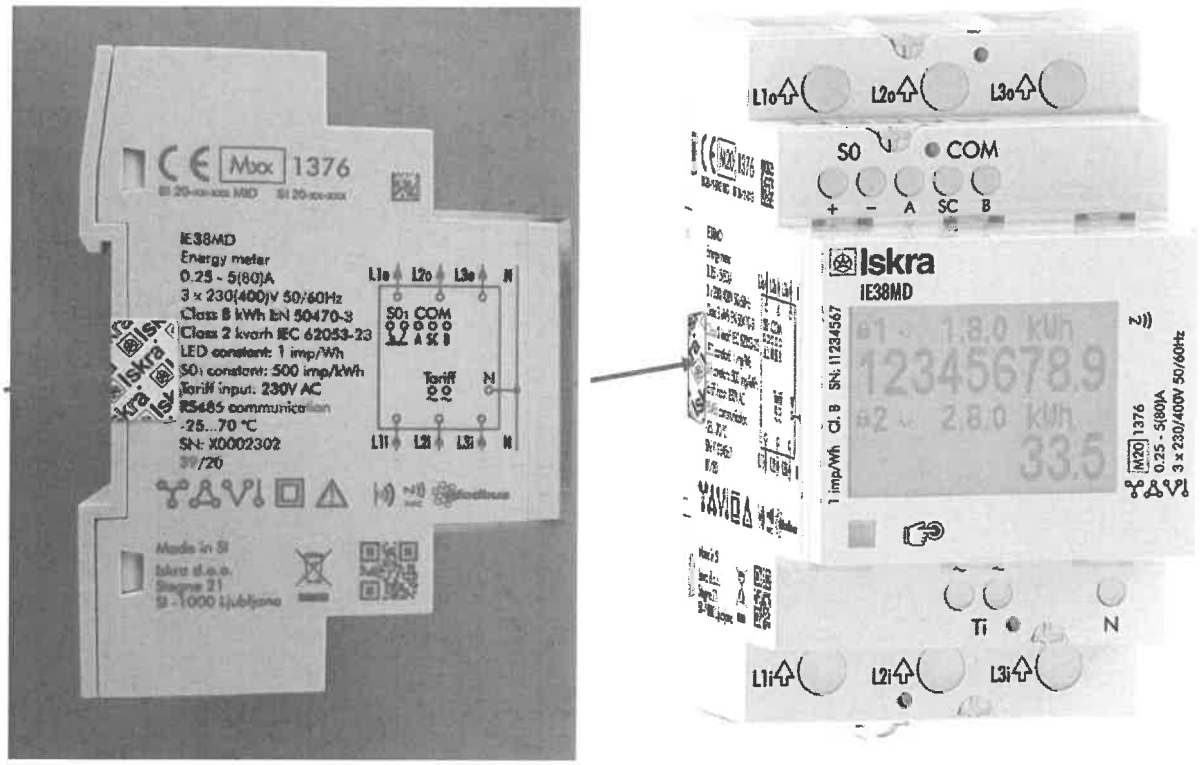

Figure 9: Location of sealing in the form of label (IE38MD), side/front view.

8. Markings and inscriptions

- CE marking and supplementary metrology marking
- Manufacturer's name and address
- Accuracy class
- Reference voltage
- Climatic environment
- Output constant
- Meter identification type designation
- Serial number
- Temperature range