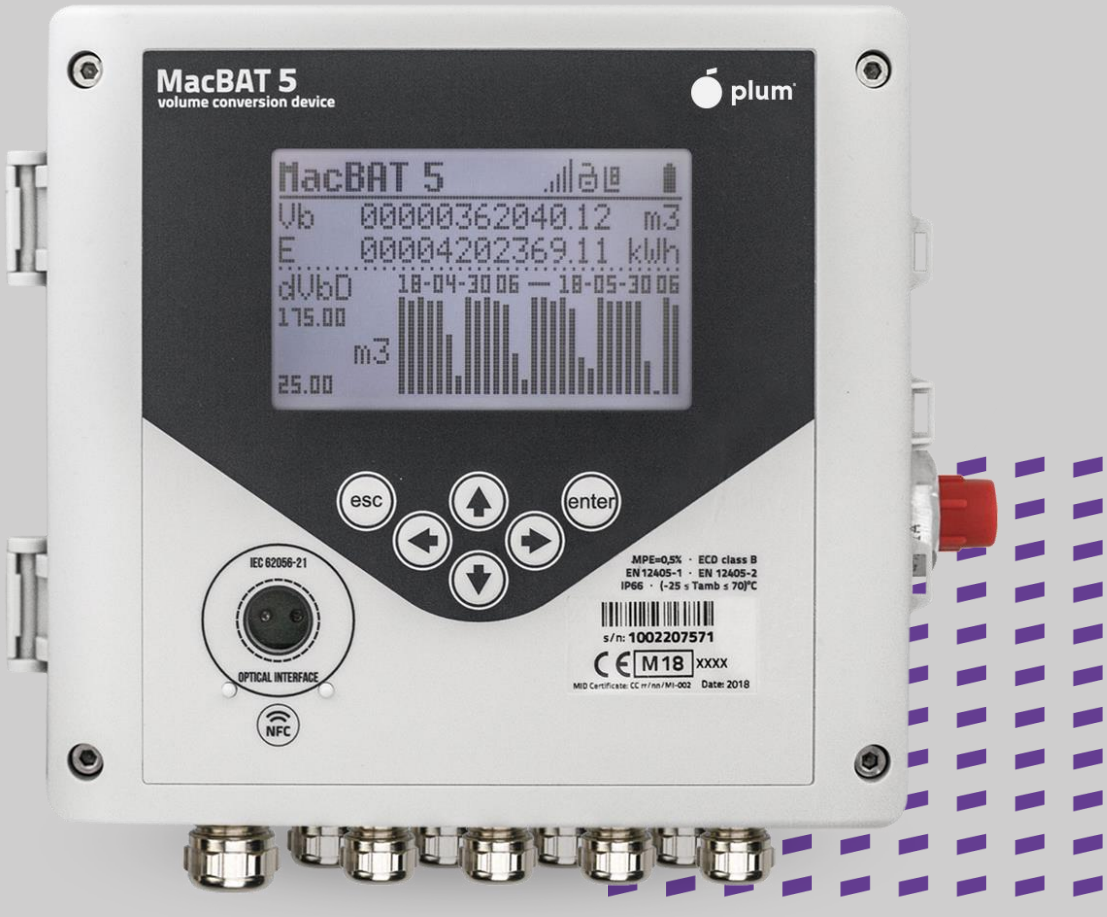
plum GAS

MacBAT 5

Gas-volume conversion device

User manual



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1. Introduction and safety rules

Compliance with all safety information and instructions for use contained in this operating manual is a prerequisite for safe working processes and proper use of the device. Furthermore, the valid guidelines, standards, local accident prevention regulations, and general safety regulations must be complied with for the respective area of application of the device.

This manual forms a constituent part of the product and must be stored within the immediate vicinity of the device and always be accessible to installation, service, maintenance, and cleaning personnel. The graphic illustrations used in this manual serve as a visual representation of the described processes and are therefore not necessarily to scale and may deviate from the actual design of the device.

Main used marks:

This mark is related to the significant security or safety information*.

This mark means the information related to product usage or the important technical matter*.

* The used marks does not determine finally the type of information.

Customer service:

For the customer technical support regarding installation or usage of this product please contact Manufacturer Technical Support Channel.

PLUM Technical Department
Phone: +48 (85) 749-71-63
E-mail: support@plum.pl

Safety measures

This measurement device can be operated only by an operator trained in compliance with the technical terms, safety regulations, and standards. It is necessary to consider any other legal and safety regulations stipulated for special applications. Similar measures also apply for special applications. Similar measures also apply for using the accessories.

The information in this manual does not have the power of a legal obligation from the manufacturer’s side. The manufacturer reserves the right to implement changes. Any changes in the manual or in the product itself can be performed at any time without any previous alert, with the goal of improving the device or fixing any typographical or technical mistakes.

ATEX, IECEx safety and health

This device is an equipment protected by intrinsic safety “i" intended for use in potentially explosive atmospheres according to the ATEX and IECEx Certificate. Carefully read the whole documentation**.**

Radio equipment safety and health

There are versions of this device equipped with a modem and or NFC becoming radio equipment according to RED.

Directives:

MID - Directive 2014/32/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to the making available on the market of measuring instruments

ATEX - DIRECTIVE 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres

RED - Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonization of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC

According to Directive WEEE 2012/19/UE:

Purchased product is designed and made of materials of highest quality. The product meets the requirements of the Directive 2012/19/EU of 4 July 2012 on waste electrical and electronic equipment (WEEE), according to which it is marked by the symbol of crossed-out wheeled bin (like below), meaning that product is subjected to separate collection.

Responsibilities after finishing a period of using product:

- dispose of the packaging and product at the end of their period of use in an appropriate recycling facility,
- do not dispose of the product with other unsorted waste,
- do not burn the product.

By adhering obligations of waste electrical and electronic equipment controlled disposal mentioned above, you avoid harmful effects on the environment and human health.

1.1. Device description

Gas volume conversion device MacBAT 5 is a device used for measurements of gas volume at base conditions and energy. It is designed to be used on gas measuring stations and pressure reduction-measuring stations. It can cooperate with rotary and turbine gas meters.

MacBAT 5 according to standard EN 12405-1 is a gas volume conversion device type 1.

The device could be equipped with (not all options can be available at once):

- analogue input (pressure P1 – metrological channel)
- analogue input (temperature T – metrological channel)
- up to 5 configurable potential-free contact inputs (DI1 to DI5):
  - Measuring inputs LF1, LF2 (inputs DI3, DI4) – frequency up to 2 Hz (on demand up to 60 Hz) with the possibility of cooperation with Wiegand transmitters, detection of flow direction (when using two LF inputs with phase shifted pulses)
  - TS input – default tamper switch, normally closed (input DI5),
  - Up to 5 digital inputs (inputs DI1, DI2, DI3, DI4, DI5)[1]
- up to 2 configurable NAMUR inputs (inputs DI6, DI7):
  - 2 HF pulse inputs, frequency (0 ÷ 5000) Hz, detection of flow direction available using two HF inputs with phase shifted pulses,
  - HF2 (DI7) input can work with NAMUR encoder,
  - Up to 2 NAMUR digital inputs[1]
- SCR input for SCR encoder (optionally, interchangeable with DI8 potential-free digital input, depends on hardware configuration)
- up to 4 outputs of „open collector" type:
  - DO1, DO3, DO4: binary
  - DO2: configurable – binary or frequency (1 ÷ 5000) Hz,
- communications:
  - COM1 (optional) – one of: RS-485 (default) or RS232[2] (option) standard, active when external power supply is on,
  - COM2 - RS-485 standard, active on battery power only when the casing is opened and active when external power supply is on,
  - COM3 – optical interface, IEC 62056-21 standard,
  - Mobile modem, standards GSM/UMTS/LTE cat.1/LTE-M/NB-IoT (optional, not all at once),
  - NFC - near field communication radio interface (optional).
- input of external power supply,
- additional absolute pressure or overpressure sensor P2 (optional)

[1] – Number of digital inputs depends on the configuration of the counting inputs
[2] – the existence of RS232 depends on the hardware configuration. If the COM1 port have the both standards built-in, only one could be used at a time because of the online data collisions.

The device can be configured using the provided Software. This software also enables reading, displaying and archiving of both direct measured values and the contents of the device's internal archives.

1.2. Function principle – general characteristics

- The measurement is based on counting of the volume at measurement conditions, based on amount of pulses from the low frequency input - LF or the high frequency input - HF sensor mounted in the head of the gas meter or from direct readout of gas meter counter with use of its built-in encoder.
- With its sensors, the device measures pressure and temperature of the gas.
- The device converts the counted gas volume at measurement conditions to the volume at the base conditions (according to EN 12405-1) and, based on the pre-set gas parameters, calculates the energy value (EN 12405-2).
- In addition to measuring and calculating current parameters, the device also archives the selected parameters and the information about occurring alarm states –for later reading.
- Built-in display and keyboard enable monitoring of current measurement data, peak values, and alarms as well as adjustment of basic operating parameters, such as time and date, measurement input limits, transmission parameters, etc. Any modification of parameters both by transmission and using of the keyboard requires authorization.

- The device is powered by internal battery, but it can also be powered by external power supply. In the standard version, at typical operating conditions (1-2 readings per month) 1 piece of battery allows for over five years of service life.
- The device has functions that allow it to be used in control and telemetry systems. When using these features, it is necessary to connect the appropriate type of AC power supply adapter that ensures the separation of intrinsically safe circuits. The AC power adapter is an optional accessory.

Some parameters of the device (e.g., Vb, Vm, dVb, dVm, dVb.ph, dVm.ph) are particularly important for the billing process. The correct operation of these parameters has been confirmed during the relevant type-approval tests. The parameters can be marked as "**VERIFIED**" by adding the symbol of paragraph **§** on the display, the symbol precedes the parameter name e.g., **§Vb**.

The device consists of two boards:

- Main board in the lower part of the case, containing the processor, input/output connectors (including pulse inputs, temperature sensor input, signaling inputs, digital outputs, communication ports, power supply terminal), terminal for internal pressure sensor, batteries (main and backup), SIM tray for optional modem. Connectors related to metrological functions are protected by special covers, which are secured with metrological seals.
- Display board in the top cover of the device, with LCD display and 6 (or 18) button keyboard, optical communication interface and NFC. Also includes switches for metrological and configuration locks.
- Optionally, the device can be equipped with mobile communication modem, see the point *Technical data*.

1.3. Definitions

Whenever certain terms are referred to in this document, they are referred to in the following definitions:

- **EVC, Electronic Volume Converter, Converter**, **Device** – MacBAT 5 Electronic Volume Converter
- **Firmware** – program which is uploaded to EVC
- **Software** – ConfIT! application, installed on PC with Windows® system, for reading and configuring of EVC
- **App, Application, Mobile app** – ConfIT! mobile application, installed on smartphone with Android system, for readout and configuration of EVC
- **Kit, mounting kit** – mounting plate adjusted to install EVC in both version with its usage to the gas pipe
- **Extension module** – EM-1, EM-2 or EM-2Ex extension modules for extending the functionalities of EVC
- **Interface** – transmission interface for the RS485 communication between the PC and EVC
- **Optical head / Opto** – Optical Interface according to IEC 62056-21 to read the EVC through infrared
- **Barrier** – INT-S3 barrier for signals separation between Normal zone and Ex Zone
- **Valve** – three way valve used to provide safe way of delivering pressure from pressure receiving point in gas meter to the EVC pressure sensor port with minimizing the risk of pressure burst on the sensor
- **DP Table** – table of parameters stored in the EVC. It contains whole configuration of the device listed in the table with names, descriptions, units, and values.
- **ZD Table** – table of events appearing in the device during its lifetime. It contains whole device history listed in the table with names and dates of beginning and end.
- **Modem** – unit integrated in the EVC used for remote data transmission
- **MID** – compliance with the MID directive and the harmonized EN 12405-1 standard, corresponding to the quality of the device in the measurement range

1.4. Subsidiary documentation

For full acknowledgement and understanding of the EVC work and maintenance it is necessary to make use of the following documents in some certain steps, which are mentioned in further part of this document. All the mentioned documents can be obtained from the manufacturer upon request.

- **ConfIT! User manual** – manual for the ConfIT! software, which is configuration program for EVC and other products which enables configuration, readout, and firmware upgrade of the EVC
- **User data structure** – document with listed and explained every parameter in DP table, along with events list and description
- **Default ModBUS map** – document with listed and explained Modbus registers in default order
- **INT-S3 user manual** – manual for the INT-S3 which is the signal barrier also utilizing functionality of external power supply source for EVC
- **OptoBTEx user manual** – optical interface for readout and communication

Documents not related to the usage of the product:

- **Installation manual** – shortened version of user manual focused only on mechanical installation and configuration part
- **EU Declaration of Conformity** – document confirming approvals for the device
- **Conformity check certificate** – document paired with the single device, with the information about test results, uncertainties, as a final customer approval document

2. Safety

2.1. General safety

The manufacturer's declaration of the IP66 housing tightness class will be valid only if cables with appropriate diameters for the cable bushings are used, the bushings are properly tightened, and ensuring proper placement of gasket and tightening of the housing cover to the device casing.

EVC is intrinsically safe device. It should be used in accordance with the requirements of this documentation and the conditions specified in the ATEX, IECEx certificate.

For the connection of external circuits is required to use cables with circular cross-section and an external diameter adequate to the internal diameter of used cable gland.

Applies to the version with a metal housing: the metal housing is made of light metal alloys. When using the product in the Z0 explosion hazard zone, the housing must be protected against impacts and abrasions.

Internal intrinsically safe circuits, including pressure and temperature sensors internal circuits, do not stand 500V test given in EN60079-11 to earthed or isolated metal parts of its enclosure. The type of protection does not depend on the separation. Metal bushings of product and metal parts of its pressure sensors are galvanically connected. It can be installed as fully floating or bonded. It must be considered during installation.

The person installing the device is responsible for checking the continuity of protective connections.

Applies to the version with a plastic housing: under certain extreme circumstances, the plastic enclosure or plastic parts of the enclosure may store an ignition-capable level of electrostatic charge. The product should not be installed in a location where the external conditions are conducive to the build-up of electrostatic charge. The product shall only be cleaned with a damp cloth.

The function and parameters of some inputs/outputs depend on the product version, details are given in this document.

The unit should not be installed in the vicinity of strong electromagnetic fields.

Unauthorized opening of the device, installation inconsistent with this documentation or any changes in the device design may lead to the loss of intrinsically safe features and / or metrological characteristics and / or characteristics of radio devices. Damage to any seal means loss of confirmation of: metrological features, intrinsic safety, compliance with the requirements for radio devices.
Under no circumstances the construction of the device must not be modified.
Any of the above events excludes the manufacturer's liability, including warranty liability.

The EVC can be ordered with cellular network modem or NFC functionality, such device becomes a radio equipment and fulfills the requirements of the Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonization of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC (RED).

Use of the device is only allowed where the working radio does not interfere with the operation of other equipment (e.g., medical).
This equipment because of a Radio Frequency radiation exposure should be installed and operated with minimum 20cm distance between the antenna and your body.

Only devices with the same serial number on the name plate on the housing cover and electronic name plate (displayed on LCD) are allowed.

The EVC can be ordered to be complied of the requirements of the Measuring Instruments Directive 2014/32/EC of European Parliament and Council (MID) which apply to volume conversion devices intended for residential, commercial, and light industrial use.

The EVC compliant with MID, on the name plate, next to the "CE" sign has the supplementary metrology marking consists of capital letter "M" followed by last two digits of the year of its affixing, surrounded by a rectangle.

According to MID directive it is permissible to use terminal boxes, surge suppressors and Zenner barriers in systems of measurement circuits. It is required that these components are designed to be sealed.

To connect the EVC with the gas meter or transducer, it is necessary to use cables appropriate with used in gas meter or transducer explosion-proof cable glands. Before installing always refer to the technical documentation of gas meter/transducer, which should contain a detailed information on the conditions and methods of installation, types of cables etc.

Connection of measurement circuits LF, HF, Encoder, and digital inputs:

The intrinsically safe circuits used in the EVC shall meet all conditions for intrinsically safe circuits specified in EN 60079-14 and in particular:

- **For intrinsically safe measuring circuits connect cables with separated two wires or use multi-core type A or type B cables according to point 12.2.2.8 of directive EN 60079-14.**
- Cables and wiring of intrinsically safe circuits must be kept separate from the cables and wires of non-intrinsically safe circuits.
- Cables and wiring of intrinsically safe circuits should be permanently mounted and protected from the possibility of mechanical damage.
- Cables of intrinsically safe circuits are recommended to be marked with blue color.

Connect the cable shield to the housing gland. This way grounding of the cable shield of intrinsically safe circuits will occur at one point – next to the EVC. During use of measuring transducers, cable shield should be insulated.

2.2. Ex marking and parameters

Device is approved for usage in potentially explosive atmospheres.

Marking: **II 1G Ex ia IIB T4 Ga**

Certificate: **FTZU 17 ATEX 0047X**

Operating environment:

Device is approved to be used at the 0, 1 and 2 zones threatened with explosion of mixture of: vapors, gases and explosive vapors with air which are placed in IIB or IIA explosive group and temperature class T1, T2, T3, T4.

External power supply (POWER SUPPLY) – Terminals 2 (VIN) to 1 (GND):
Ui=6,51 V; Pi=3,5 W; Ii=1,1 A; Li=0; Ci=12 µF

External power supply of communication ports (COM SUPPLY) – Terminals 4 (VIN) to 3 (GND)
Ui=6,51 V; Pi=0,8 W; Ii=0,4 A; Li=0; Ci=2,64 µF

Port COM1 (RS485) – Terminals 5 (D-), 6 (D+) to GND
Port COM2 (RS485) – Terminals 7 (D-, Rx), 8 (D+, Tx) to GND
Uo=6,51 V; Io=0,8 A; Po=1,1 W; Pi=0,66 W; Li=0; Ci=0
Gas Group IIA: Lo=800 µH; Co=500 µF
Gas Group IIB: Lo=200 µH; Co=25 µF

Port COM1 (RS232) – Terminals CTS/PWR_232, TX, RX, to GND
Ui = 20 V Pi = 0,66 W; Ii = 0,15 A; Li = 0; Ci = 0,75 µF
Gas Group IIA: Lo = 16 mH; Co = 4,7 µF
Gas Group IIB: Lo = 8 mH; Co = 0,6 µF

(The given parameters Lo, Co are valid when:
1. the external circuit does not contain a combined concentrated inductance Li and concentrated capacitance Ci greater than 1 % of the above values, or
2. the inductance and capacitance are distributed as in a cable, or
3. the external circuit contains only focused inductance or only focused capacitance in combination with the cable.

In any other situation, such as when the external circuit contains focused inductance and focused capacitance, up to 50% of each of the L and C values is allowed).

External DIGITAL SENSOR – Terminals 10 (VOUT) to 9 (GND)
Uo=6,51 V; Io=0,29 A; Po=0,47 W; Li=0; Ci=0
Gas Group IIA: Lo=2 mH; Co=500 µF
Gas Group IIB: Lo=1 mH; Co=25 µF

Outputs DIGITAL OUTPUTS – Terminals 11 (DO1+), 12 (DO2+), 13 (DO3+), 14 (DO4+)
Ui=15 V; Ii=0,123 A; Pi=0,33 W; Li=0; Ci=0; Uo=6,51 V
Gas Group IIA: Lo=18 mH; Co=7 µF
Gas Group IIB: Lo=10 mH; Co=1,7 µF

Contact inputs – Terminals 16 (DI1+), 18 (DI2+), 20 (DI3+), 22 (DI4+), 24 (DI5+) to GND and 26 (DI6+), 28 (DI7+), 30 (DI8+), 29 (DI8-) to GND
Ui=6,51 V; Li=0; Ci=120 nF
Gas Group IIA: Lo=800 mH; Co=500 µF
Gas Group IIB: Lo=400 mH; Co=25 µF
Additionally, only for contact input – Terminal 24 (DI5+) to GND
Po=27 mW; Uo=6,51 V; Io=16,5 mA

NAMUR inputs (HF1, HF2) – Terminals 26 (DI6+) to 25 (DI6-), 28 (DI7+) to 27 (DI7-)
Uo=9,6 V; Io=33 mA; Po=78 mW; Li=0; Ci=0
Gas Group IIA: Lo=800 mH; Co=100 µF
Gas Group IIB: Lo=400 mH; Co=13 µF

Input SCR ENCODER – Terminals 30 (DI8+), 29 (DI8-) to GND
Uo=9,6 V; Io=0,021 A; Po=0,48 W; Li=0; Ci=0
Gas Group IIA: Lo=2 mH; Co=500 µF
Gas Group IIB: Lo=1 mH; Co=25 µF

Sensor Pt1000 – Terminals 32 (I+), 31 (I-), 34 (U+), 33 (U-) to GND
Ui=6,51 V; Li=0; Ci=250 nF;

External pressure sensor – Terminal 36 (PS1), 38 (PS2), 40 (PS3), 37 (PS4), 39 (PS5) to 35 (GND)
Ui=6,51 V; Li=0; Ci=200 nF;

3. Technical data

3.1. General data

Housing material	Polycarbonate (plastic) or aluminum casting (AlSi, metal)
Dimensions (L x W x H)	(206 x 194 x 75) mm - polycarbonate (210 x 170 x 90) mm – aluminum
Weight	1,5 kg – polycarbonate // or 2,4 kg – aluminum
Ambience temperature range	(-25 ÷ 70) °C, battery Saft LS33600, Tadiran SL2780 (-25 ÷ 50) °C, battery EVE ER34615
Humidity	Max 95 %. The device can operate in condensing or non-condensing humidity
Housing protection class	IP 66
Keyboard	6 buttons – polycarbonate // 18 buttons - aluminum
Display	LCD - graphic 128x64 pix. with backlight
Operating environment	Approved to use at the 0, 1 and 2 zones threatened with explosion of mixture of: vapors, gases and explosive vapors with air which are placed in IIB or IIA explosive group and temperature class T1,T2,T3,T4.
Ex housing marking	II 1G Ex ia IIB T4 Ga, certificate FTZU 17 ATEX 0047X

Inputs	• Up to 5 configurable potential-free contact inputs:
	  ○ Measuring inputs LF1, LF2 (DI3, DI4) – frequency up to 2 Hz (optionally up to 60 Hz), one with the possibility of operating with Wiegand transmitters,
	  ○ TS input – tamper switch, normally short (input DI5),
	  ○ Up to 5 digital inputs (DI1, DI2, DI3, DI4, DI5),[1]
	• Up to 2 configurable NAMUR inputs (inputs DI6, DI7):
	  ○ 2 HF pulse inputs, frequency (0 ÷ 5000) Hz,
	  ○ HF2 (DI7) input can work with a NAMUR encoder,
	  ○ Up to 2 NAMUR digital inputs,[1]
	• SCR input for SCR encoder (optionally, interchangeable with DI8 potential-free digital input, depends on hardware configuration),
	• Absolute pressure p1 sensor. In the standard version, a built-in sensor with measurement range of 6 bar is installed. Sensor is finished with metric thread M12 × 1.5,[2]
	• Thermometer Pt1000 type CT6A,
	• Absolute pressure or overpressure p2 sensor (optional), [2]
	[1] – Number of inputs acting as digital depending on the configuration of the counting inputs
	[2] – Pressure sensors p1 or p2 can be built into the device or both be external or mixed (1 internal and 1 external)

Control outputs	• Up to 4 outputs of „open collector” type:
	  ○ DO1, DO3, DO4: binary
	  ○ DO2: configurable – binary or frequency (1 ÷ 5000) Hz,

Internal supply	• Main batteries. 1 ÷ 3 lithium-thionyl batteries (3,6 V) size D, types:
	  ○ LS33600 (SAFT),
	  ○ SL2780 (Tadiran),
	  ○ ER34615 (EVE).
	• Backup battery (hardware H1.8.0). Coin cell (3 V), types:
	  ○ CR1620 (GP batteries),
	  ○ CR1632 (RENATA batteries)

External supply	Source of power supply with 5.7 V nominal output voltage (max. 6.51 V, 3.5 W)

Transmission ports	• **COM1** - RS-485 standard with optionally additional RS-232 standard, active with external power supply (if both standards are present – only one should be used at a time), • **COM2** - RS-485 standard, galvanic insulated, typically active with external power supply, active on battery power when the casing is opened, • **COM3** – optical interface, IEC 62056-21 standard, • **Mobile modem**, standards GSM/UMTS/LTE cat.1/LTE-M/NB-IoT (optional, not all at once) with external or internal antenna, • **NFC** (optional) – radio interface ISO/IEC 14443 A (nominal frequency 13,56 MHz).
Transmission protocols	GAZMODEM, GAZMODEM2, GAZMODEM3, MODBUS RTU, MODBUS TCP, MODBUS ENRON
Earthing	Internal intrinsically safe circuits, including pressure and temperature sensors internal circuits, do not stand 500V test given in EN60079-11 to earthed or isolated metal parts of its enclosure. The type of protection does not depend on the separation. Metal bushings of product and metal parts of its pressure sensors are galvanically connected. It can be installed as fully floating or bonded. It must be considered during installation.
Mechanical environment conditions class	**M2** - unit can be installed at places exposed to vibrations and shocks with considerable and high level of intensity generated by mechanical devices, close passing vehicles, heavy machinery, transmission belts, etc.
Electromagnetic environment conditions class	**E2** - unit can be installed at places exposed to typical industrial disturbances
Environment class	**O** – unit can be installed outdoors
Base conditions	Base pressure (absolute) **pb**, default 1,01325 bar, Base temperature **Tb**, default 273,15 K (0 °C), Combustion temperature **T1**, default 298,15 K (25 °C).
The maximum permissible error (MPE) according to standard EN 12405-1	0,5 % at reference conditions
	1 % at nominal operating conditions
Ranges of using SGERG-88 and SGERG-mod-H2 methods	Gas pressure **p1** ≤ 120 bar Gas temperature **t** in range: (-10,15 ÷ 64,85) °C Gas pressure **p1** ≤ 35 bar Gas temperature **t** in range: (-15 ÷ 65) °C Gas pressure **p1** ≤ 25 bar Gas temperature **t** in range: (-20 ÷ 65) °C Gas pressure **p1** ≤ 15 bar Gas temperature **t** in range: (-25 ÷ 65) °C
Range of using AGA8-92DC method	Gas pressure **p1** in range (0 ÷ 650) bar Gas temperature **t** in range (-48 ÷ 77) °C
Range of using AGA NX-19mod method	Gas pressure **p1** in range (0 ÷ 7,5) bar Gas temperature **t** in range (-30 ÷ 70) °C
Types of computations	Computation as a function of pressure and temperature according to compression factor (PTZ), function of temperature according to compression factor (TZ) or constant compression factor (PT) (point 4.3 according to EN 12405-1:2018)

Parameters of alternative types of cellular technology modems (see the list of types in the point Radio equipment identification)	Legend: Class no. / (maximum power) / additional info **(3) model 03, standards LTE cat.1, GSM; EU bands** • **Class 4** (33 dBm ±2 dB) for GSM850/EGSM900 • **Class 1** (30 dBm ±2 dB) for DCS1800/PCS1900 • **Class 3** (23 dBm ±2 dB) for LTE-FDD; B1/B3/B5/B7/B8/B20/B28 **(4) model 04, standards LTE cat.1, GSM; LA bands** • **Class 4** (33 dBm ±2 dB) for GSM850/EGSM900 • **Class 1** (30 dBm ±2 dB) for DCS1800/PCS1900 • **Class 3** (23 dBm ±2 dB) for LTE-FDD; B2/B3/B4/B5/B7/B8/B28/B66 **(9) model 09, standards LTE-M, NB-IoT, GSM; EU/US bands** • **Class 5** (+21 dBm +1,7/-3 dB) for LTE HD-FDD bands: **LTE-M1:** B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/B20/B25/B26 /B27/B28/B66/B85 **LTE-NB2:** B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/B20/B25/B28 /B66/B71/B85 • **Class 4** (33 dBm ±2 dB) for GSM850 • **Class 4** (33 dBm ±2 dB) for EGSM900 • **Class 1** (30 dBm ±2 dB) for DCS1800 • **Class 1** (30 dBm ±2 dB) for PCS1900 • **Class E2** (27 dBm ±3 dB) for GSM850 8-PSK • **Class E2** (27 dBm ±3 dB) for EGSM900 8-PSK • **Class E2** (26 dBm ±3 dB) for DCS1800 8-PSK • **Class E2** (26 dBm ±3 dB) for PCS1900 8-PSK
Modem, external antenna	Antenna with connector type FME. Formally, the length of the antenna cable is unlimited, but the usable length of the antenna cable is still determined by cable loss and signal strength at the installation site. From the MID and EMC side, the permissible length of the antenna cable is over 10 m.
Expected time of keeping metrological features – 5 years.	

3.2. Radio equipment identification

Each Device equipped with radio emission unit – integrated modem or NFC – is marked with special label describing the radio equipment type.

Markings: "**code: NO MODEM**" or no label means no radio, NFC or modem.

Principle of marking is: **zGCxyyLw**, where capital letters are constant, lower cases are positions with variable digits depending on the equipment type, according to the next presented table.

Position	Description	Remarks
zG	z - symbolic marking of the main modem's technology (this is not a part of the formal marking) 2 – 2G (GSM) technology 4 – 4G (LTE cat.1, LTE-M, NB-IoT) technology	Cellular technology modems with various bands and standards support. See below.
Cxyy	x – presence of NFC module: 0 – NO 1 – YES yy – type of cellular network modem model for remote data transmission: 00 – no modem 03 – standards LTE cat.1, GSM; EU bands; (main tech. 4G) 04 – standards LTE cat.1, GSM; LA bands; (main tech. 4G) 09 – standards LTE-M, NB-IoT, GSM, EU/US bands; (main tech. 4G)	EU-European Union, LA-Latin America, US-United States

Lw	L – letter – antenna type: A – external HSA-0918-TCQ5 FME HONGSENSE TECHNOLOGY CO. ,LTD B – internal antenna type 1 w – digit – type of antenna connector: 0 – internal antenna, no outer connector 2 – external FME connector	

Example code: "**code: mod. 4GC103A2**"

In details: 4G modem, NFC present, modem with support of EU bands, external antenna.

3.3. Temperature measurement

The temperature sensor **CT6A** (Optional: Pt1000/2w or Pt1000/4w/Class A) is part of the each EVC. The sensor is available in 2 types of sheath length: fixed length "50" and adjustable length "140,160,180". Each piece of sensor is checked at the manufacturer's laboratory to meet the accuracy class requirements.

Length of sensor sheath needs to be adjusted to diameter of gas pipeline.

Technical data:

- Measurement range: (-40 ÷ 80) °C,
- Transducer - platinum resistor Pt1000 class A,
- Connection cable with 4- or 2- wires, 2 m (standard), max 10 m,
- Measuring resistor is galvanically isolated from the housing (functionally),
- Connector with M20×1.5 thread used to mount the sensor in the thermometer sleeve (default).

Mounting of the temperature sensor with the usage of supplied connector provides protection against penetration of moisture, liquids, and dust into the thermometer sleeve. This protection meets the requirements of the degree of protection IP54 in accordance with EN 60529.

The CT6A temperature sensor must always be attached to the gas pipeline in closed thermowell sleeve. Do not insert the sensor directly into the gas pipeline.

Only temperature sensors whose serial number on the name plate is identical like the one presented on device display are allowed to operate. Name plate of the sensor is affixed to the cable and secured by additional foil jacket. Do not damage the plate during installation and operation of the device.

Measuring range	Maximum permissible errors for measurements of t[1]	
	Ambient temperature	
	20 °C (± 3 °C)	(-25 ÷ 70) °C
Measurement of gas temperature **t**		
(-30 ÷ 70) °C	± 0,1 %	± 0,2 %

1 – values of errors referred to correct values of temperature, expressed in [K].

3.4. Pressure measurement

Measuring ranges	Maximum permissible errors for measurements of p1 and p2	
	Ambient temperature	
	20 °C (± 3 °C)	(-25 ÷ 70) °C
Measurement of gas pressure **p1** (for billing) or **p2** (auxiliary, optional)		
(0,8 ÷ 6) bar abs (0,8 ÷ 10) bar abs (2 ÷ 10) bar abs[2] (4 ÷ 20) bar abs[2]	± 0,2 % of measured value	± 0,5 % of measured value

(7 ÷ 35) bar abs[2] (4 ÷ 70) bar abs[2] (10 ÷ 70) bar abs[2] (10 ÷ 100) bar abs[2]		
Standard ranges for pressure **p2** measurement (auxiliary, optional)		
(0 ÷ 100) mbar G	± 0,5 mbar	±1 mbar
(0 ÷ 300) bar G		
(0 ÷ 1) bar G	± 0,2 % of range	± 0,4 % of range
(0 ÷ 6) bar G		
(0 ÷ 10) bar G		
(4 ÷ 20) bar G[3]		
(7 ÷ 35) bar G[3]		
(5 ÷ 55) bar G[3]		
(10 ÷ 70) bar G[3]		
(10 ÷ 100) bar G[3]		

[2] – range of indications from 0,9 bar to p1 max

[3] – range of indications to atmospheric pressure

Devices with sensors measuring low gauge pressure (ranges up to 1 bar) show significant effect of mechanical stress on the indication of the pressure p2. To achieve the declared accuracy, after installation of the device on the target location, it is necessary to perform a procedure of zeroing pressure sensor indications.

3.5. Compressibility calculation

The EVC is designed to work with listed calculation methods of compressibility factors:

Value of **ConfAlgZ**	Calculation method
0	AGA8-92DC (full gas composition)
1	SGERG-88 (Hs-d-XCO2-XH2 or full gas comp.)
2	AGA8-G1 (Hs-d-XCO2-XH2 or full gas comp.)
3	AGA8-G2 (d-XCO2-XH2-XN2 or full gas comp.)
4	AGA NX-19mod (d-XCO2-XN2 or full gas comp.)
5	K1=const.
8	SGERG-mod-H2 (Hs-d-XCO2-XH2 or full gas comp.)

When using methods SGERG-88, SGERG-mod-H2, AGA8-G1, AGA8-G2, AGA NX-19mod and K1=const., device requires programming of parameters values such as calorific value Hs and relative density d to be adequate for currently set base conditions (Tb and pb) for volume calculation and reference conditions for combustion (T1 and P1, here always P1=pb). Set of base conditions in many European countries: pb=1,01325 bar; Tb=273,15 K; T1=298,15 K. When programming full gas composition, no further recalculations are necessary.

Despite fact, that methods AGA8-G2 and AGA NX-19mod are not using calorific value Hs for calculation of compressibility factor, it must be programmed, because it is necessary for correct computing of energy counter.

According to selected computing method, device requires programming full gas composition or few specific gas parameters. Permissible ranges of these parameters are mentioned in tables mentioned on the next page.

3.5.1. Ranges of using gas composition parameters

Gas composition (molar fraction) must be in following ranges:

Parameter	Name	unit	value in range	
			basic	extended*
Hs	calorific value	MJ/m^3	30 .. 45	20 .. 48
d	relative density		0,55 .. 0,8	0,55 .. 0,9
C1	methane, CH_4	%	70 .. 100	50 .. 100
C2	ethane, C_2H_6	%	0 .. 10	0 .. 20
C3	propane, C_3H_8	%	0 .. 3,5	0 .. 5
nC4	n-butane, n-C_4H_{10}	%	sum (nC4 + iC4) in range 0 .. 1,5	sum (nC4 + iC4) in range 0 .. 1,5
iC4	i-butane, i-C_4H_{10}	%		
nC5	n-pentane, n-C_5H_{12}	%	sum (nC5 + iC5 + neoC5) in range 0 .. 0,5	sum (nC5 + iC5 + neoC5) in range 0 .. 0,5
iC5	i-pentane, i-C_5H_{12}	%		
neoC5	neo-pentane, n-C_5H_{12}	%		
C6H14	n-hexane, n-C_6H_{14}	%	0 .. 0,1	0 .. 0,1
C7H16	n-heptane, n-C_7H_{16}	%	0 .. 0,05	0 .. 0,05
C8H18	n-octane, n-C_8H_{18}	%	sum (C8H18 + C9H20 + C10H22) in range 0 .. 0,05	sum (C8H18 + C9H20 + C10H22) in range 0 .. 0,05
C9H20	n-nonane, n-C_9H_{20}	%		
C10H22	n-decane, n-$C_{10}H_{22}$	%		
H_2	hydrogen	%	0 .. 10	0 .. 10
N_2	nitrogen	%	0 .. 20	0 .. 50
CO_2	carbon dioxide	%	0 .. 20	0 .. 30
H_2O	water	%	0 .. 0,015	0 .. 0,015
H_2S	hydrogen sulphide	%	0 .. 100**	0 .. 100**
CO	carbon oxide	%	0 .. 3	0 .. 3
He	helium	%	0 .. 0.5	0 .. 0.5
Ar	argon	%	0 .. 100**	0 .. 100**
O2	oxygen	%	0 .. 100**	0 .. 100**
C6+	hexane & higher hydrocarbons	%	0 .. 0,2	0 .. 0,2

* using extended range, standard EN 12213 provides increased uncertainty during computation of compressibility factor

** when programming full gas composition, sum of components must be equal to 100 %, additionally from gas composition are calculated: calorific value and relative density, which must be in defined ranges

During programming of gas composition using keyboard, sum of components must be equal to 100.000 %. It is also possible to do remote modification of gas parameters using transmission protocols. In case of remote modification, default permissible deviation from 100 % of components sum is 0.001 %.

Gas parameter must be in following ranges:

Parameter		Algorithm					
		SGERG-88 ConfAlgZ=1	**AGA8-G1** ConfAlgZ=2	**AGA8-G2** ConfAlgZ=3	**AGA NX-19mod** ConfAlgZ=4	**K1=const** ConfAlgZ=5	**SGERG-mod-H2*** ConfAlgZ=8
XCO2	[%]	(0÷30)			(0÷15)	---	(0÷30)
XH2**	[%]	(0÷10)			---	---	(0÷100)***
d	-	(0,55÷0,9)	(0,554÷0,87)		(0,554÷0,75)	(0,07÷2)	(0,06÷0,9)
Hs	[MJ/m^3]	(20÷48)	(18,7÷45,1)	---	---	(0÷66)	(6÷48)
XN2	[%]	---		(0÷50)	(0÷15)	---	---
K1	-	---			---	(0÷2)	---

* The method has been defined in "DVGW Technical report PK 1-5-3"

** Typically, pipeline quality gas does not contain any hydrogen.

*** Maximum amount of hydrogen can be set in range (10÷100) %, by default is set to 30 %.

3.5.2. Gas compositions with higher amount of hydrogen

The method AGA8-92DC in standard implementation lets to calculate compressibility factors of mixtures with component hydrogen which amount is up to 10 % - all properties in ranges listed in point 3.5.1. The parameter **XH2ExtOn** lets to enable / disable using the method in extended range of hydrogen (up to 100 %). By default, the extended range of hydrogen is enabled. In extended range few properties of gas are widen:

Parameter	Name	unit	value in range
Hs	calorific value	MJ/m^3	6 .. 48
d	relative density		0,06 .. 0,9
H_2	hydrogen	%	0 .. 100*
C1	methane, CH_4	%	0 .. 100

* the allowable maximum value is limited by parameter XH2ExtMax, by default 30 %

The methods SGERG-mod-H2 and AGA8-92DC let to effectively calculate compressibility factors of mixtures of natural gas with artificially added hydrogen in amount up to 100 %. By default, the maximal amount of hydrogen has been limited to 30 % but can be changed by using the parameter **XH2ExtMax**.

3.6. Inputs

In fully equipped device has 8 digital inputs, marked as DI1 to DI8 which can be used as:

- 6 configurable potential-free contact inputs (DI1 to DI5 and DI8):
  - Measuring inputs LF1, LF2 (inputs DI3, DI4) – frequency up to 2Hz (optionally up to 60 Hz) with the possibility to cooperate with Wiegand transmitters, detect flow direction (when using two LF inputs with phase shifted pulses)
  - TS input – tamper switch, normally closed (input DI5),
  - Up to 6 digital inputs (inputs DI1, DI2, DI3, DI4, DI5, DI8)[1]
- 2 configurable NAMUR inputs (inputs DI6, DI7):
  - 2 HF pulse inputs, frequency (0÷5000) Hz, detection of flow direction (when using two HF inputs with phase shifted pulses)
  - HF2 (DI7) input can work with NAMUR encoder,
  - Up to 2 NAMUR digital inputs[1]

[1] – Number of inputs acting as digital (signaling) depends on the configuration of the counting inputs.

3.6.1. Counting inputs

Device can be equipped with following counting inputs:

- LF1 (3) – pulse input for connection with low frequency output of gas meter (connectors 19/20), active in all power modes, i.e., BATT, FULL;
- HF1 (6) – pulse input for connection with high frequency output of gas meter in NAMUR standard (connectors 25/26), active only in FULL power mode;
- EN (9) – digital input for connection with encoder output of gas meter, in NAMUR standard (connectors 27/28) active in all power modes, i.e., BATT, FULL. WARNING! Usage of NAMUR encoder in BATT mode significantly reduces battery life of the device, frequency of readings in BATT mode, which influences battery life, is configurable in parameter ***ENBatPer***;
- SCR (8) – digital input for connection with gas meter's SCR encoder output (connectors 29/30) active in all power modes, i.e., BATT, FULL. WARNING! Usage of SCR encoder in BATT mode significantly reduces battery life of the device, frequency of readings in BATT mode, which influences battery life, is configurable in parameter ***ENBatPer***.

ETL (with 1 battery for EVC)	**NAMUR encoder**	**SCR enc. (2400 bps)**	**SCR enc. (300 bps)**
3 years	*ENBatPer = 2 min*	*ENBatPer = 2 min*	*ENBatPer = 4 min*
5 years	*ENBatPer = 3 min*	*ENBatPer = 3 min*	*ENBatPer = 8 min*
6 years	*ENBatPer = 6 min*	*ENBatPer = 7 min*	*ENBatPer = 20 min*

ETL – estimated time life of the device

Available configurations:

- STOP (00) – counting halted – for e.g., doing preliminary configuration of measuring system;
- LF1 (30) – Vm and main counters are driven from LF1 input, without control input; default
- LF1/LF2 (34) – Vm and main counters are driven from LF1 input, control counter Vm2 driven from LF2 input;
- LF1/HF1 (36) – Vm and main counters are driven from LF1 input, control counter Vm2 driven from HF1 input;
- LF1/SCR (38) – Vm and main counters are driven from LF1 input, control counter Vm2 driven from SCR input;
- LF1/EN (39) – Vm and main counters are driven from LF1 input, control counter Vm2 driven from EN input;
- HF1 (60) – Vm and main counters are driven from HF1 input, without control input;
- HF1/LF1 (63) – Vm and main counters are driven from HF1 input, control counter Vm2 driven from LF1 input;
- HF1/HF2 (67) – Vm and main counters are driven from HF1 input, control counter Vm2 driven from HF2 input;
- HF1/SCR (68) – Vm and main counters are driven from HF1 input, control counter Vm2 driven from SCR input;
- HF1/EN (69) – Vm and main counters are driven from HF1 input, control counter Vm2 driven from EN input;
- SCR (80) – Vm and main counters are driven from SCR input, without control input;
- SCR/LF1 (83) – Vm and main counters are driven from SCR input, control counter Vm2 driven from LF1 input;
- SCR/HF1 (86) – Vm and main counters are driven from SCR input, control counter Vm2 driven from HF1 input;
- EN (90) – Vm and main counters are driven from EN input, without control input;
- EN/LF1 (93) – Vm and main counters are driven from EN input, control counter Vm2 driven from LF1 input;
- EN/HF1 (96) – Vm and main counters are driven from EN input, control counter Vm2 driven from HF1 input;
- Syn-LF1/LF2 (134) – Vm is driven depending on detected direction of flow – indirectly from LF1 input, control counter Vm2 driven from LF2 input (direction independent),
- Syn-HF1/HF2 (167) – Vm is driven depending on detected direction of flow – indirectly from HF1 input, control counter Vm2 driven from HF2 input (direction independent)

3.6.2. Configuration of Encoder counting input (EN, SCR)

Properly configured gas meter equipped with encoder should have synchronized values of encoder's Vo counter and gas meter counter.

After setting configuration of counting inputs with encoder, further modifications of volume counter at measurement conditions are not possible.

Gas meters equipped with encoder output of NAMUR or SCR standard periodically send information with absolute state of gas meter counter. Conversion device with configuration of counting inputs using encoder takes read of encoder's counter Vo and uses it as volume counter at measurement conditions ***Vm*** (***Vm2***).

For installing or replacing gas meter for another one, equipped with encoder, it is required to perform the following procedure:

- stop counting of gas in conversion device by setting special configuration ***ConfImp***=0. Counting of flow from any input will be stopped;
- install / replace gas meter;
- in conversion device – set volume counters at measurement conditions ***Vm*** and ***Vm2*** to value same as one in new gas meter;
- start counting of gas in conversion device by setting appropriate counting configuration.

For additional protection, the device is equipped with function of gas meter installation. The function is activated by change the parameter ***ConfImp***. The function of installation use the first telegram read from encoder for synchronization counters ***Vm*** (***Vm2***) and the second and next telegrams are used for driving the counters.

3.6.3. Reverse flow support

The purpose of this functionality is to ensure conformity of the gas meter counter with a dedicated device counter (***Vm*** or ***Vm2*** and auxiliary ***Vo***) in case of reverse flow situations.

- There are 2 configurations of pulse inputs dedicated to detecting reverse flow from the internal encoder module: D-LF1/LF2 and D-HF1/HF2; A phase shifted signal between two inputs is required.
- In configurations D-LF1/LF2 and D-HF1/HF2, the internal encoder module receives two LF1/LF2 input signals (HF1/HF2) and outputs the processed relative LFs (HFs) counter. This LFs (HFs) counter will increase or decrease depending on the detected flow direction. The auxiliary inputs (***LF2***, ***HF2***) operate only in one direction (they can only grow independently of the direction of flow).
- Failure to detect the sequence (phase shift) results in the lack of volume counting to the ***Vm*** counter - it is possible in the case of e.g., damage to one of the pulse circuits.
- Detection of reverse flow results in immediate resetting of ***Qm*** flow.
- The reverse counter ***VmR*** and the reverse increment ***dVmR*** are driven only when the reverse count is detected on the main counting path, i.e., on the ***Vm*** counter (i.e., in 8 configurations: SCR, SCR/LF1, SCR/HF1, EN, EN/LF1, EN/HF1, D-LF1/LF2, D-HF1/HF2). In other configurations, any gas reversal will be visible only on the ***Vm2*** counter.
- The ***Vm*** counter (or ***Vm2*** and auxiliary ***Vo***) can increase and decrease - to track the counter of the gas meter. Size of reverse flow is represented by the ***dVmR*** increment and the ***VmR*** counter.
- The ***Vb*** counter (similarly ***E***, ***M,*** and their emergency versions) is frozen during the reverse flow. Operation is resumed when the volume ***Vm*** measured in the reverse direction is balanced with the appropriate amount of volume in the forward direction.
- The ***Vm2*** counter is driven from the control input - it always increases (unless it comes from the encoder input enabling reverse flow). When the reverse flow occurs, this will cause permanent non-compliance of the ***Vm*** and ***Vm2*** counters. Unless the user manually resets the counters, there will be compliance: ***Vm2*** = ***Vm***+***VmR***.
- When the main counting input is an encoder (NAMUR or SCR) - the ***Vm*** will react to the forward and reverse drive according to the read out meter of the ***Vo*** encoder (e.g., SCR/LF). Then, the control counter ***Vm2*** will be driven from a conventional (impulse) source, so that each subsequent pulse will increase the value of this counter (e.g., when the gas is reversed, the encoder will give a reverse signal by reducing the counter, but the LF pulse can be generated and drives the counter ***Vm2*** forward).

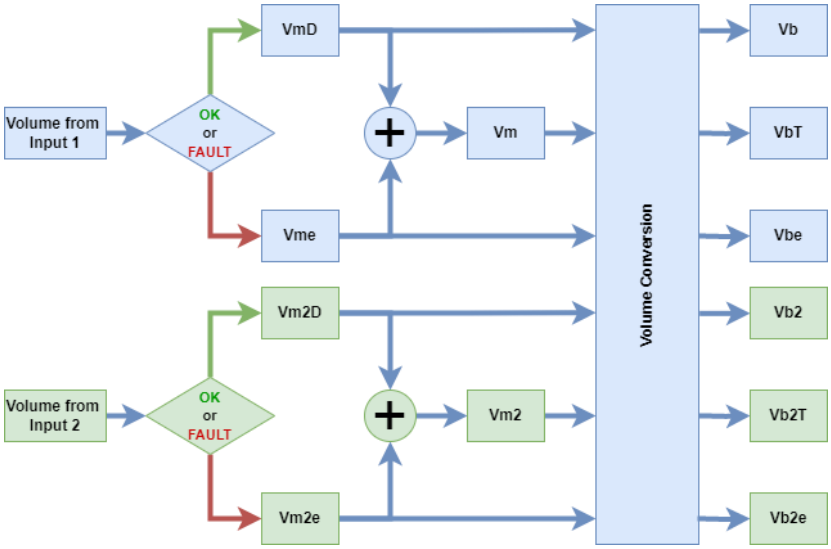
After the reverse flow is detected, a ***Reverse flow*** alarm will be generated. This alarm will be closed when ***dVmR*** reaches 0.

3.6.4. Second run (second stream) support

For the purpose of validation of the correct calculations of Vb and E – the second stream has been implemented. The second stream (run) is defined by the group of parameters, where digit "2" informs that the parameter has been created for the second stream and is an equivalent of main parameter, e.g. Vb2<>Vb, Vb2T<>VbT. Parameters of the second streams: Vb2, Vm2, E2, Vm2e, Vb2e, E2e, Vb2T, E2T. Second stream uses the common correction factor C. The same pressure, temperature and gas analysis values are used for both inputs.

For this functionality proper are all counting inputs with 2 active inputs (e.g. LF1/HF1(36), HF1/HF2(37) etc.). To check available inputs configuration – see the point *Counting inputs*.

Note: All values for the 2nd stream are not MID approved. They are not suitable for use in billing applications. This is additional functionality to validate calculations.



3.6.5. Digital inputs

EVC can be equipped with up to 8 binary inputs, which may – according to chosen configuration of counting inputs – work as digital (signaling) inputs. These inputs are intrinsically safe. Inputs DI1..DI5 and DI8 are adapted to work with potential-free reed contacts. Inputs DI6 and DI7 are adapted to work with inductive NAMUR transmitters. When active state is detected on digital input, appropriate event will be stored in device's memory.

Device allows to change name of digital input, which will be used during record of event. Modification of name is possible by editing parameters ***DI1Desc***÷***DI8Desc***.

Additionally, it is possible to configure polarization of each digital input. It's done at parameter ***DIPol***. Value of this parameter reflects binary state of 8 bit number, in which bits are responsible for polarization of appropriate input (bit0 – DI1, bit1 – DI2, etc.). If bit has value of 1, active state of that input is input shorted.

3.7. Outputs

EVC can be equipped with up to four controlling outputs of „open collector" type, which allow cooperation with external systems of automation and signaling. Outputs are designed as intrinsically safe, so it's required to use Ex barriers when connecting external non-intrinsically safe devices.

Available work modes of outputs:

- output switched off (open) (***DOxMode*** = 0)
- counter output (volume or energy), active – closed (***DOxMode*** = 1)
- status output (active – closed) (***DOxMode*** = 2)
- time output (active – closed) (**DoxMode** = 3)
- output switched on (closed) (***DOxMode*** = 4)
- counter output (volume or energy), active – open (***DOxMode*** = 5)
- status output (active – open) (***DOxMode*** = 6)
- time output (active – open) (**DOxMode** = 7)
- frequency output (only DO2) (***DO2Mode*** = 8)
- events output (active – closed) (***DOxMode*** = 9)
- events output (active – open) (***DOxMode*** = 10)

It is possible to configure properties of output pulses for each output, with parameters ***DOxPulseLen*** (pulse length – high state) and ***DOxPulsePer*** (period duration), "x" – means output number, values 1÷4.

Description of available modes is in next paragraphs.

3.7.1. Counter output

This mode allows to output pulses proportional to increments of selected counter. To use this mode (***DOxMode*** = 1 or 5), index of selected counter must be programmed into ***DOxIdx*** parameter. Pulse factor (***DOxFactor*** – value increase of selected counter per one output pulse) is by default set to 1 if selected counter is from volume group and set to 10 if selected counter is from energy group.

3.7.2. Status / event output

These modes allow for controlling outputs with selected events. There are two types of event-controlled modes:

- status output (modes 2 and 6): when configured (index of selected event is programmed into parameter ***DOxEvt***), output is controlled if selected event is active,
- event output (modes 9 and 10): when configured (index of selected event is programmed into parameter ***DOxEvt***), output is controlled if selected event is active or it's turned off when configured time ***DOEvtTm*** passes, whichever occurs first.

3.7.3. Frequency output

DO2 can be set to frequency mode (***DO2Mode*** = 8), where it can output signal with frequency controlled by selected parameter from the list: ***Qb***, ***Qm***, ***QE***, ***QM***, ***p1***, ***p2***, ***t***, ***p1g***, ***AtmPress***, ***tamb*** – programmed into parameter ***DO2FIdx***.

Range of frequency is (1÷5000) Hz. Configuration of minimum and maximum frequency is done with parameters ***FOMin*** and ***FOMax*** accordingly. Scaling of selected controlling parameter (to match values of these parameters with min and max frequency) is done with parameters ***DO2FMin*** and ***DO2FMax***. Current output frequency is presented on parameter ***FOut***.

3.7.4. Time output

Each of DO can be configured to a time function where pulses appear every full hour. It is possible to set the pulse length from 25 to 255 ms by changing the value of the parameter DOxPulseLen (pulse length), "x" - means the output number, values 1÷4.

3.8. Communication with EVC

3.8.1. Serial communication

In basic configuration EVC is equipped with wireless transmission port COM3 in standard IEC 62056-21 (Optical). Additionally, the device can be equipped with two channels of wired serial transmission: COM1 and COM2 in standard RS-485. Port COM1 can be additionally in standard RS232. These ports are optional. If both standards (RS485 and RS232) are present – only one of them should be used at a time.

Each transmission port works independently and allows for transmission with speed given below.

Settings of parameters for ports COM1, COM2 and COM3:

Port	Transmission baud rate: [bit/s]	Transmission address
COM1:	2400 - 256000	1-65534
COM2:	2400 - 256000	1-65534
COM3:	2400 - 115200	1-65534

3.8.2. NFC transmission

Optionally the device can be equipped with Near Field Communication (NFC) interface working at 13,56 MHz frequency according to the ISO/IEC 14443 standard.

To configure the device, use mobile devices that support the NFC communication standard based on the Android system.

3.8.3. Mobile transmission network

Optionally the device can be equipped with built-in cellular network modem with external or internal antenna. The device supports up to 9 independent work schedules. Each schedule is programmed according to the following rules: selection of the year of occurrence, month selection, selection of days of the month, selection of days of the week, time of occurrence, fixed number of minutes of sending data in relation to the programmed time, and connection type: report sent to the TCP data server or remote readout of data.

Schedules can be configured only using the *PC* Software.

The data sent via the mobile transmission network may contain data such as:

- current data
- data recorded with a programmable registration period
- events and alarms

After performing schedule operations, the device can go into the Call Window mode and wait 20 seconds for next transmission. In this mode it is possible to query the device on demand by superior systems, e.g., SCADA.

The device can be available online when using external power supply. This means that it can be read by external systems on demand, and in the event of an alarm, the service is immediately informed. In this mode, full diagnostics of the device are also available, direct reading of all available parameters, including statistical counters of the device, archived data recorded, a complete list of events. This mode also allows you to reconfigure parameters in real time.

3.8.4. Transmission protocols

Realization of transmission protocols is based on fact that device readout is done by host PC. Commands sent to device are to give in return specific type of information. Information received by and sent from device is organized in functional blocks of programmed length. Optimal length of blocks adapted to quality of connection can have essential influence on efficiency of data sending. Device supports data transmission protocols:

- GazModem – version 3 – this is native protocol of the device
- ModBUS RTU (all communication ports)
- ModBUS ENRON (all communication ports)
- ModBUS TCP (via built-in modem only)

Device recognizes transmission protocol automatically.

Transmission protocols implemented in EVC differ from each other by functionality of remote readout and parameters modification.

3.8.5. Restrictions of remote data access

Device's software allows for restricted remote access to measurement data when using all available transmission protocols. When remote access lock is active, only following readouts are available:

- Nameplate;
- Structure of table with available parameters (DP);
- Structure of events table (ZD);

Readout of current and archival data is prohibited.

Configuration of that function is done with parameter ***LockRead***. When set to 0 – device allows remote readout of all data without limitations. When value is set to 1 – device will automatically lock ability for remote readout when interruption in readouts was longer than set time limit, configurable on parameter ***LogoutTm***.

When lock is active, any readout attempt will cause sending by device:

- in GazModem protocol: response 7D hex with empty data field;

- in ModBUS protocol: response 83 hex with empty data field;

To make readouts possible again, user must send authorization command to device (by using ModBUS or GazModem protocol), which contains login credentials, i.e., account number and password.

3.8.6. Types of transmitted data – GazModem

GazModem protocol allows for: readout of current measurement data, readout of registered data, readout of events and alarms, time synchronization, modification of parameters values.

All data structures are described in document *"User data structure"*.

3.8.7. Types of transmitted data – Modbus

ModBUS protocol allows for readout of current data and modifications of parameters. All of data structures are described in document *"Default ModBUS map"*.

Structure of current and archival data for readout may be customized to suit User's needs. On request of User, Producer may generate ModBUS map, which will determine new order of current data and records of archival data and will assign them to requested ModBUS registers.

To make device work with ModBUS map – prepared map must be uploaded to device with use of software tool. Version of uploaded map may be checked by readout of parameter ***VerDs6***.

To make modifications with use of ModBUS protocol, it is necessary to unlock modification possibility first. To do this, standard authorization data, i.e., account number and password, must be written to register of authorization (0xFFFE) by consecutive two character strings.

Unlocking of modifications possibility in ModBUS RTU will be automatic – when device successfully verifies authorization data. From that point, modification will be unlocked until forced logout (by writing empty character string into register 0xFFFE) or after passing time to automatic logout (configured in parameter ***LogoutTm***).

4. Archives and device memory description

4.1. Archival data with programmable period (registration type R – periodic)

Registration period can be programmed in range from 1 to 60 minutes (only whole divisors of 60), set by ***Dtau*** parameter.

Registration is synchronized by internal clock. Cycle of record registration always contains the beginning of hour. If registration period is programmed to 12 minutes, counting from 12:00, registration records will be as following: 12:00, 12:12, 12:24, 12:36, 12:48, 13:00, 13:12, 13:24 etc.

Memory area is organized in the form of a circular buffer, i.e., when the memory is full, entering the current sample automatically deletes the oldest data fragments.

Registration type R can store up to 36000 records (over 4 years @ 60 min period).

Description of archival data set registered with programmable period is available in document *"User data structure"*.

4.2. Archival data with fixed period (registration type D)

Device is also registering archival data with fixed, predetermined period. These include:

- Hourly data (registration period – clock hour);
  Storage period of hourly data is up to about 11500 records (over 16 months);
- Daily data (registration period – gas day, registration at billing hour, by default set at 06:00);
  Storage period of daily data is up to about 1400 records (about 4 years);
- Monthly data (registration period – gas month, registration at billing hour, by default set at 06:00 and in billing day, by default first day of the month);
  Storage period of monthly data is up to about 450 records;
- Periodic data 2 (registration period configurable with the most often: 1 hour, the rarest: 1 year). By default, 10^{th}, 20^{th}, last gas day of month.
  Storage period of periodic data 2 is up to about 800 records;

Description of archival data sets registered with fixed period is available in document *"User data structure"*.

4.3. Changes of registered data set

Change of registered data set also changes time horizon of stored data in archive memory. Increase in number of registered parameters shortens period of saved data in memory, decreasing this number increases this period. Change in horizon of storing data in memory is proportional to changed set, e.g., if previous set of registered data contained 10 parameters and new set contains 11 parameters, then horizon of stored data will shorten by about 10%.

Change of registered data set type R is done with use of parameters ***AddRegR1*** to ***AddRegR10*** and change of registered data set type D is done with use of parameters ***AddRegD1*** to ***AddRegD10***. To run registration of chosen parameter (excluding parameters in text/string format), one of said parameters must be programmed with index of chosen parameter to register. To remove parameter from registration – the corresponding parameter must be set to value -1.

Before making any changes in registered data sets it is recommended to read all needed archives, because changes in data set could make impossible to access archives before changes in data sets of types R or D.

4.4. Momentary registration

This special type of registration allows for registering changes in defined parameters when step change of given parameter is detected. When such change is detected, registration is done immediately, and next checks of value change are performed with 1 second intervals for next 5 seconds. Parameters recorded in momentary registration are configured on ten parameters ***AddRegC1*** to ***AddRegC10***, where any of them could trigger this type of registration. User can define trigger criteria on parameters ***dRegC1÷dRegC10*** (values of step change) and limits of tracked parameters (***RegCXLMin***, ***RegCXLMax***, where X is a number of tracked parameter, values 1..5) – tracking will be active, when parameter value is outside defined limit.

4.5. Periodic registration 2

This type of registration allows to register parameters from D data set according to configured schedule. User can configure desired registration pattern on binary type parameters: ***RegTWeek*** (days of the week), ***RegTMonth*** (months), ***RegTDay*** (days in month) and ***RegTHour*** (hours). Nearest event of incoming periodic registration is presented on parameter ***RegTNext***.

4.6. Single registration

This function allows to perform registration of all types on request – helpful when e.g., device must be disconnected from current measuring installation to perform maintenance or repair and it's needed to save current state of registration. To use this function, parameter ***SingleReg*** must be programmed with time when such registration should be performed (in UNIX format). If programmed time is older than current time, registration will be performed immediately.

4.7. Alarms and events

System alarms are related to failures, which have influence on measured values used in calculations of increments of main counters. During system alarms, according to alarm type, calculations are made with substitute values. Additionally, states of current and registered values are changed if failure has influence on them. When system alarms are active, main counters (***Vb***, ***E***, ***M***) are stopped and emergency counters (***Vbe***, ***Ee***, ***Me***) are started instead.

Temporary and constant events are related to failures, which do not have influence on correct values of main counters. They do not stop main counters and don't change status of registered and measured data. Exception are events **Device Startup** and **Time changed**, which are changing state of measured and registered data to discontinuity.

In EVC there are 6 types of memory of events and alarms:

- All events memory (FullLOG, FullLOG active);

Memory that contains records for all types of events, alarms and interventions which have occurred in the device. This memory has capacity of approximately 3000 records. If memory is filled, older records are deleted automatically.

- Alarms memory (AlarmLOG, AlarmLOG active);

Memory that contains records for alarms, which are essential from the viewpoint of measurements and calculations accuracy. This memory has capacity of approximately 2000 records. Filling level is presented on parameter ***AlarmLOG*** and if it is at 100 %, system alarm is generated (**AlarmLOG full**) and main counters are stopped. This type of memory requires periodic clearing – acknowledgment of closed alarms (confirmation by operating personnel, that they are acquainted with list of alarms stored in memory). To do clearing, parameter ***AlarmLOG*** should be set to zero.

- Interventions memory (SetupLOG);

Memory that contains records for important interventions from the viewpoint of measurements and calculations accuracy. This memory has capacity of approximately 1000 records. Filling level is presented on parameter ***SetupLOG***. Filling the memory to 100 % does not generate any alarm, device is still working normally, but further important changes in configuration are not possible. Erasing of this memory is possible with at least Metrologist privileges level (7). To do erasing, parameter ***Erasing*** should be set to 4 (to use this function, it should be unlocked first by programming serial number of the device to parameter ***ConfTrig***).

- Important time change memory (***TimeLOG***);

Memory that contains records typically for cases when the hour duration has been damaged by more than ± 30 seconds. The records of hourly registration important for "Load recorder" will be marked with information Time error if the hour duration has been damaged. Hourly increment of ***Vb*** (***Vm***) marked "Time error" is banned to became a peak hour (maximum load) for current period (day, month). This memory has capacity of approximately 4000 records. If memory is filled, older records are deleted automatically.

- Gas changes memory (***GasLOG***);

Memory that contains records of all gas changes made in the device. This memory has capacity of approximately 300 records. If memory is filled, older records are deleted automatically.

- Main counter ***Vb*** changes memory (***VbLOG***);

Memory that contains records of all main counter ***Vb*** changes made in the device. This memory has capacity of 1000 records. If memory is filled, farther changes are suspended. ***VbLOG*** is protected against being cleared.

4.8. Load Recorder and Maximum Load functionalities

The device has the functionalities of load recorder and maximum loads.

Load recorder: the basic functionality is to count typically 24 hourly increments of ***Vb*** (***Vm***) during the gas day (23 or 25 when there is the day of winter<>summer time change). The increments (loads) ***dVb*** (***dVm***) are registered in dedicated archive (menu position **Data** > **Recorder** > **LoadRecorder**) and the current loads are possible to be read in **Data** > **Recorder** > **Current** menu.

Maximum loads: the basic functionality is to select from all hourly increments of ***Vb*** (***Vm***) during the gas day or from all daily increments of ***Vb*** (***Vm***) during the gas month the maximum value and save it together with the time of its occurrence. The maximum loads ***dVb*** (***dVm***) are registered in dedicated archive (menu position **Data** > **Recorder** > **Maximum Loads**) and the current loads are possible to be read in **Data** > **Recorder** > **Current** menu.

The list of maximum loads:

- Hourly peak of volume at base conditions ***Vb*** during the gas day
- Hourly peak of volume at base conditions ***Vb*** during the gas month
- Daily peak of volume at base conditions ***Vb*** during the gas month

- Hourly peak of volume at measurement conditions ***Vm*** during the gas day
- Hourly peak of volume at measurement conditions ***Vm*** during the gas month
- Daily peak of volume at measurement conditions ***Vm*** during the gas month

4.9. Software update

EVC is equipped with function for program updating.

Software update may be locked for user (based on national law). Function of this lock is placed on parameter ***LockFW1***. Value of 1 turns on the lock.

User has possibility to block program update by setting parameter ***LockFW2*** (forced updates from any source, PUSH mode) or ***LockFW3*** (automatic updates from modem, PULL mode). Value of 1 turns the lock on.

Software update is only possible in situation when alarms memory has sufficient space for safe recording of information about update (parameters ***AlarmLOG*** and ***SetupLOG*** must be lower than 95 %).

After program updating, event ***Software update*** is saved in device's memory on alarm list. There is information about user, who authorized program, previous and current program series, and status of the process (***UpCode***=0 means update successful, the other values – a problem has occurred).

4.10. Main counter Vb changes

By default, ***Vb*** changes are blocked in MID-compliant device. If your national regulations let to change ***Vb*** counter during using – please inform Manufacturer to activate this option during production process. If the option of ***Vb*** changes is active – to change of ***Vb*** the hardware switch MET needs to be opened. All changes are saved in the special memory – ***VbLOG*** protected against being cleared.

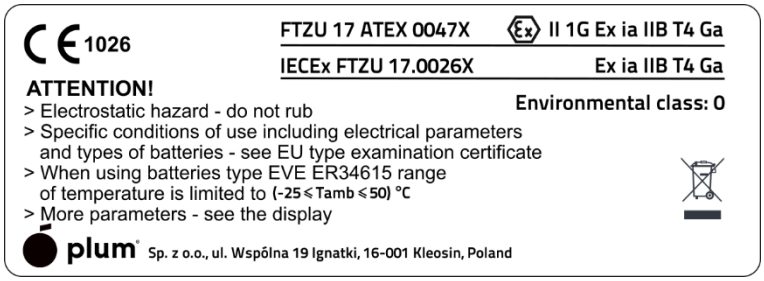
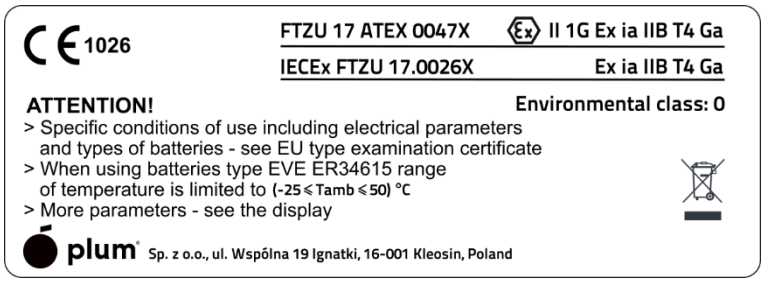
VbLOG is possible to be read by the display (see the menu structure below) or by using dedicated GazModem protocol command.

5. Device labelling and marking

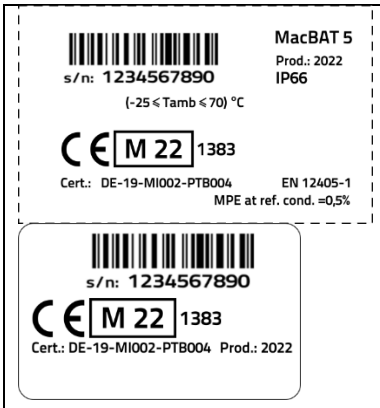
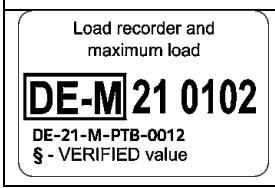
5.1. Labels

Some important information is imprinted directly on the solid elements of the device housing. The specific, additional information contain the plates below.

Examples of ATEX, IECEx information labels:

	ATEX, IECEx label designed for polycarbonate variant of the housing – information about not rubbing the housing. ATEX required data such as: • Ex classification • No. of ATEX certificate • Special usage conditions • Name and address of the manufacturer
	ATEX, IECEx label designed for aluminum variant of the housing

Front door labels (examples):

	MID required label with data such as: • Device serial number • CE marking • MID marking with year of issuing conformity • Notification unit number • MID certificate name • Production number/date Label 1 is designed for the aluminum housing type. Label 2 is designed for the polycarbonate housing type. Missing information on second plate are provided on the front of EVC.
	Load recorder label (optional)

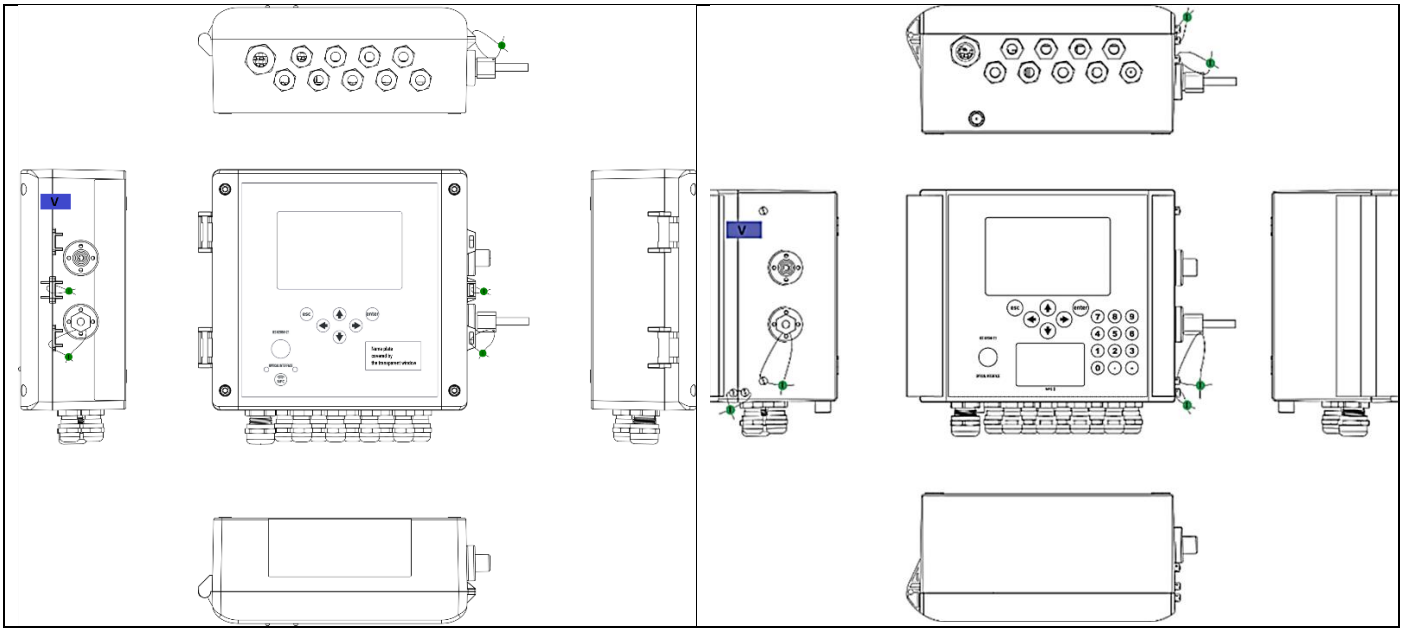
Other types of front door labels:

	Information on the table: • Device serial number • Production number/date Labels used in devices without MID conformity check.

5.2. EVC sealing

EVC as a device for billing, should be protected against unauthorized access. To do this, unit housing is secured with seals like presented on figure below and access to the menu is protected by a password system. Damage of any sealing marks causes loss of confirmation of device's metrological features and certifications. Avoid damaging of seals during installation and operation of the device.

Installation staff is obligated to verify condition of seals before mounting of device. If the seals are damaged, the proper functioning of device must be checked by the manufacturer's authorized service.



I – installer seal, V – temporary seal (for the time of transport).

After mounting of device, installation staff is obliged to place own wire protection seals accordingly to scheme on figures above. During transportation, terminals chamber is protected with temporary seal. Installation staff after checking its condition may remove it.

Unauthorized opening of the device, mounting inconsistent with this documentation or any changes to construction of the device can lead to loss of intrinsically safe features and/or metrological characteristics and/or radio equipment characteristics. Damage of any sealing marks causes loss of confirmation of: metrological, intrinsically safe, radio equipment features of the device.

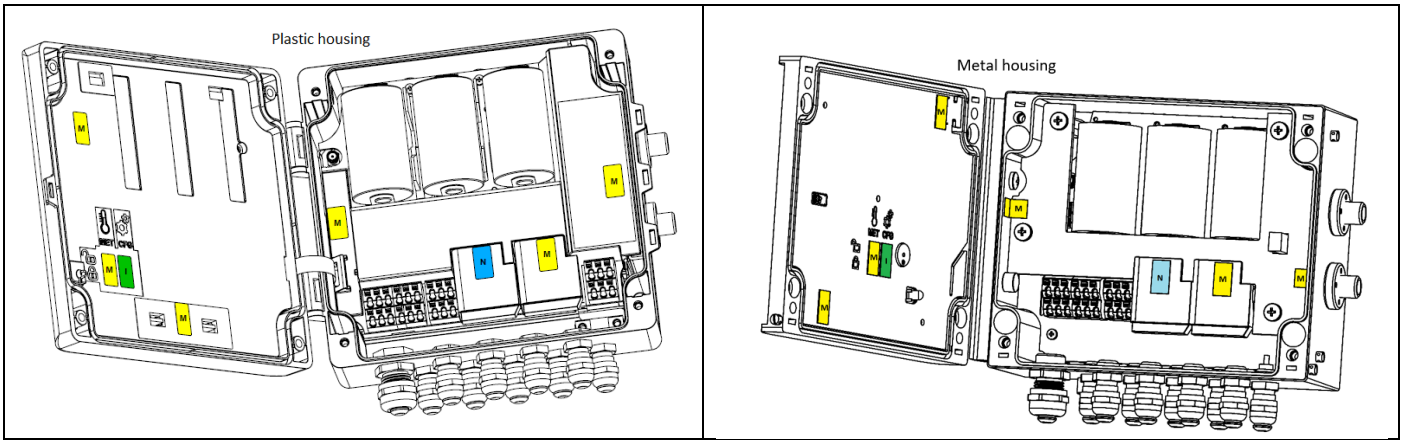
In accordance with the directive RoHS 2011/65/UE, where applicable, it is unacceptable to use lead seals.

Properly sealed device provides certainty of device integrity, warranty, and quality. Each damaged seal can cause the device to be called into questions due to plausible integrity violation.

There are two types of seals inside EVC device.

	MID protective seal. Damaged or missing one of these seals is the factor causing loss of MID conformity check.
	Manufacturer protective seal. This seal ensures device was not manipulated. Warranty is void when this sticker is removed.

Seals location in the device:



M – MID sealing mark, I – installer seal, N – seal according to national regulations

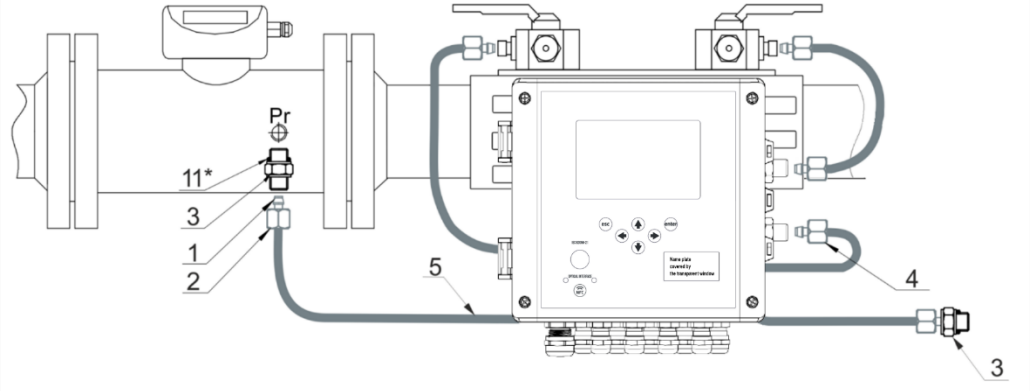
When the device is not assembled and certified with the MID conformity check all seals from above are replaced by manufacturer seals.

6. Device installation

EVC can be mounted on a wall or gas pipeline. After installation, pulse tube should be connected with gas pressure sensor which has metric thread M12 x 1.5. Pulse tube should be equipped with three-way valve that allows cutting off the gas supply to the sensor or connection of an additional calibration device.

Special shelves and mounting plates for installation of EVC with three-way valve are shipped by manufacturer with unit on special request. Gas temperature sensor shipped with unit, needs to be placed in thermometric sleeve in gas pipeline and after that connected to proper inputs.

Device is designed to cooperate only with CT6A type sensors.



6.1. Tools list

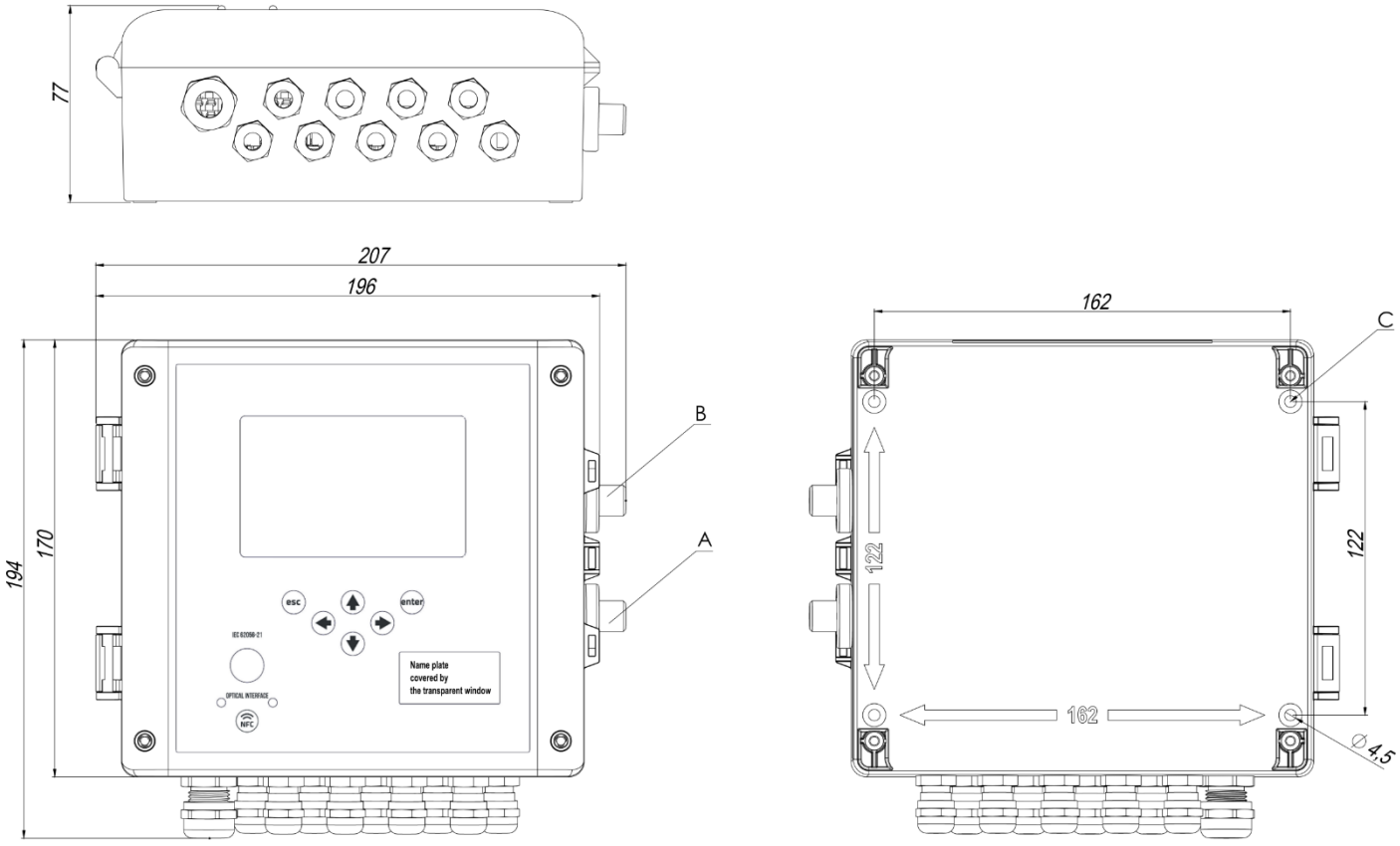
Installation of the device requires set of various tools to perform the process correctly. Below it is listed what tools are required and what is their purpose in the process of installation:

Fork spanners	Tightening the cable glands, pressure sensors ports. Remember to have various sizes of spanners and additionally one adjustable
Philips screwdriver	Opening and closing device housing
Flat-head screwdriver	Releasing the buttons in device terminals to lock the wire inside the terminal Tightening the screws in INT-S3 to secure rigidly the wires
Allen keys	5 mm – to tighten the device to mounting plate, to tighten the three-way valve to the mounting plate
Crimping tool	Crimping tool for insulation sleeves in the end of the wires

Remember to use safe tools when performing installation in vicinity of gas atmosphere

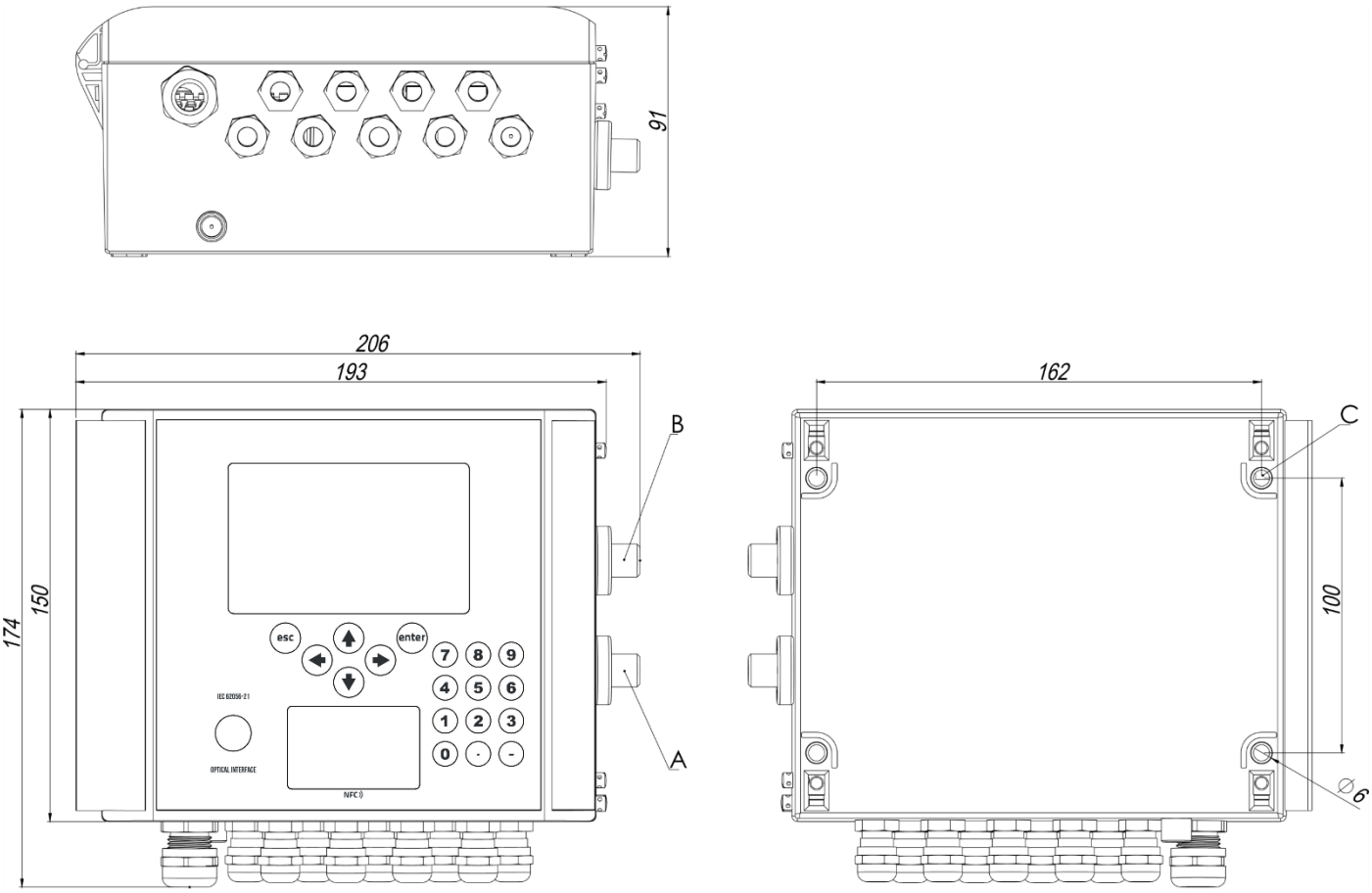
6.2. Device dimensions

Polycarbonate housing dimensions:



A, B – pressure sensors, C – mounting hole

Aluminum housing dimensions:

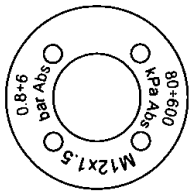


A, B – pressure sensors, C – mounting hole

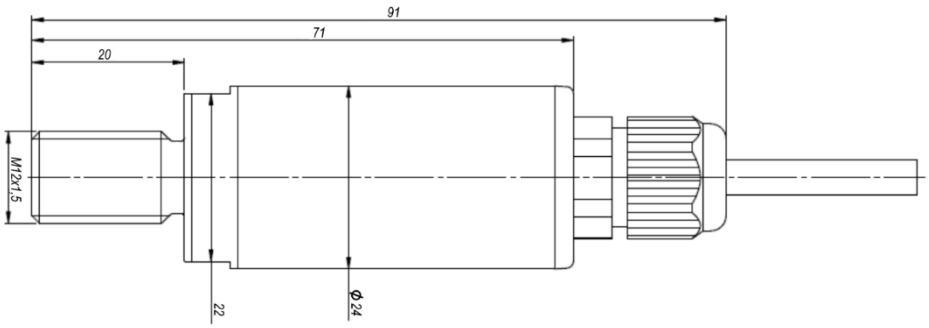
6.3. Pressure sensors types and dimensions

Manufacturer distinguishes various types of pressure sensors installed in the device:

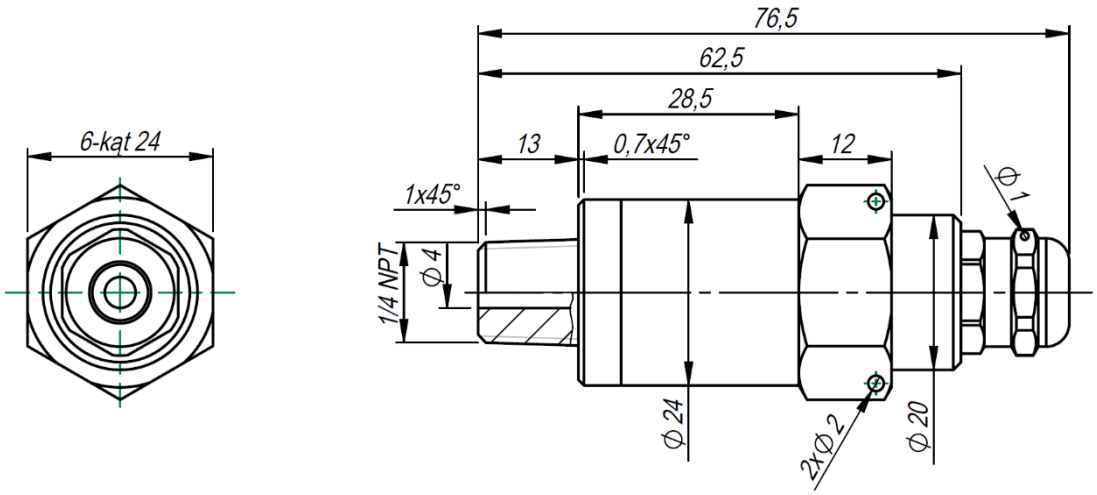
- Internal sensor with M12x1,5 thread. Sensor range is imprinted on the mounting ring.



- External pressure sensor with M12x1,5 thread



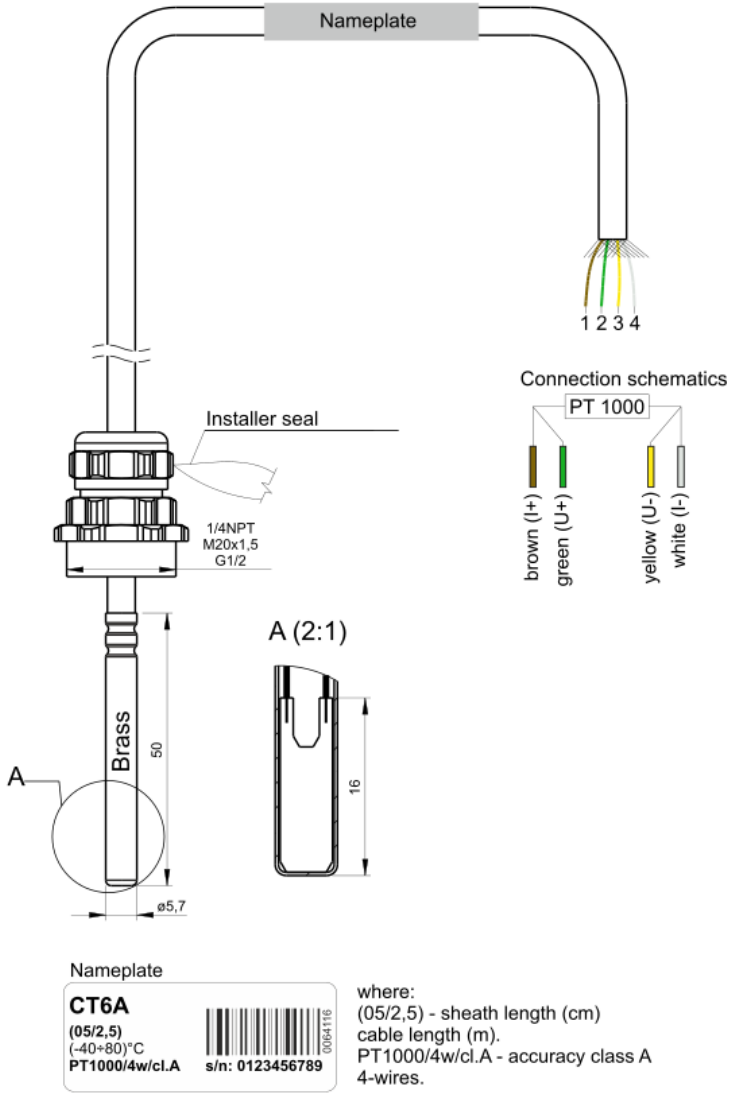
- External pressure sensor with 1/4” NPT thread



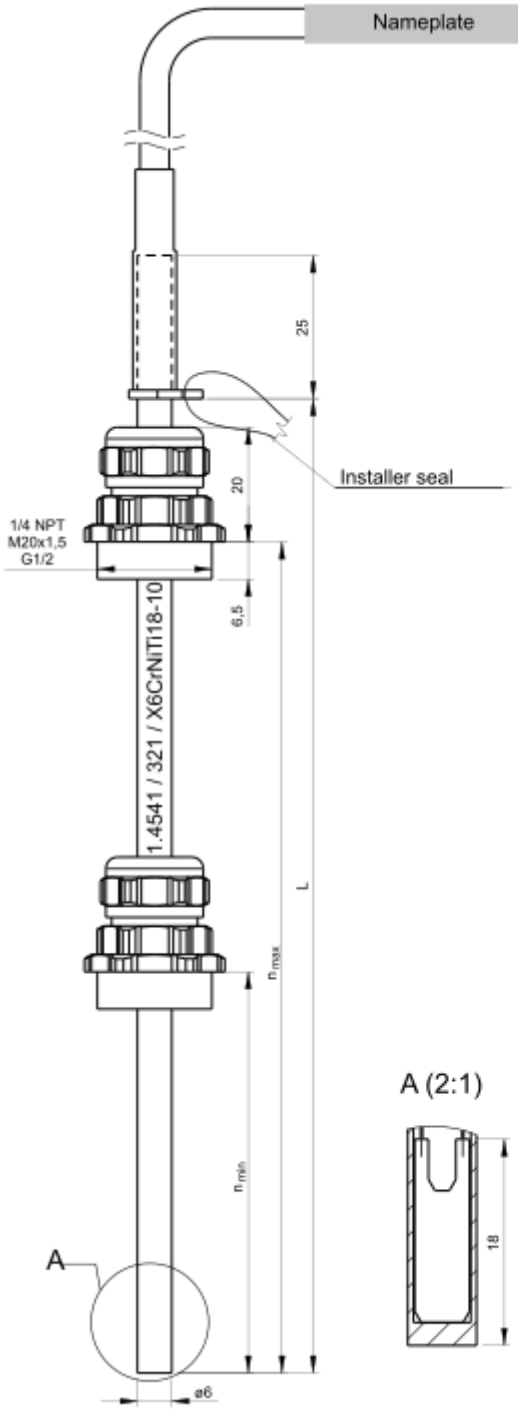
6.4. Temperature sensors types and dimensions

Device can be equipped with one of two available temperature sensors. Temperature sensor is mandatory equipment of every device. Each sensor is examined in Manufacturers Laboratory to ensure the accuracy conformity.

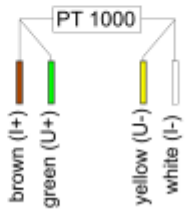
- 50 mm length, 5,7 mm diameter of sensor – mounted in the gas meter socket:



- (140÷180) mm adjusted length, 6 mm diameter – mounted in gas pipe using thermowell



Connection schematics



Nameplate

where:
(14/2,5) - sheath length (cm)
cable length (m).
PT1000/4w/cl.A - accuracy class A
4-wires.

A (2:1)

TYPE	140	160	180
L [mm]	170	190	205
pipe diam.	DN40÷150	DN200	DN250
n min [mm]	70		
n max [mm]	145	165	180

It is permitted to use only the temperature sensor which serial number on the nameplate present on the cable insulation meets the serial number in electronic nameplate of the EVC.

6.5. SIM card installation

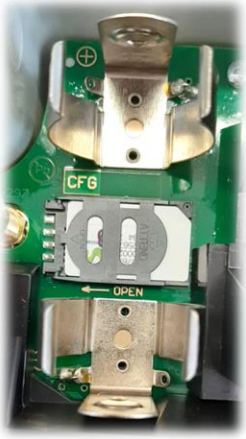
This step can be done in any moment; however, it is recommended to do this in the beginning of the works. When the device is not equipped with modem this step is skipped.

Required SIM card for the device must be size of MINI SIM which complies with ETSI TS 102221 v. 9.0.0 or Embedded-SIM standards

1. Remove the battery B3 – first from the left

2. Open the SIM tray by sliding it left and lift it

3. Place the Mini SIM card keeping its orientation



4. Close the tray, slide it right and place back the battery

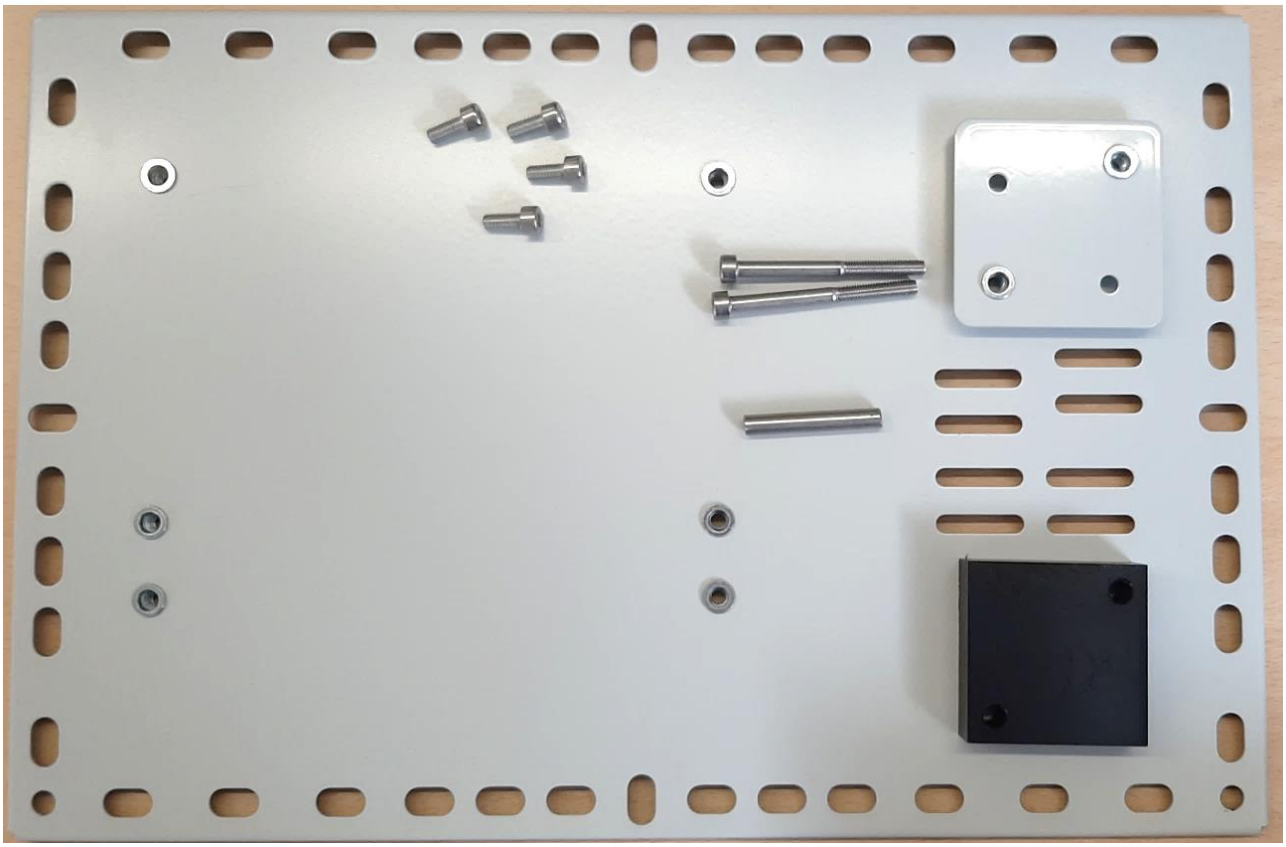
6.6. Installation on mounting plate

Device can be installed on the gas pipe using the universal mounting plate dedicated for both variants, polycarbonate and aluminum.

Mounting plate is designed to be compatible with AZ intec 3MT01 3-way valve. Using other valve may require additional equipment not included in the default set. Mentioned valve is not a part of equipment for the mounting plate.

There are two variants of mounting plates – different for polycarbonate and aluminum housing. Please ensure proper set is used.

Mounting plate set contains:



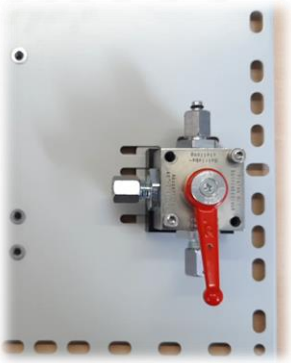
1. Mounting plate 368x240 mm
2. Plate for bottom tightening three way valve – 60x60 mm
3. a) Spacer to adjust the levels of ports in EVC polycarbonate pressure sensor and AZ Intec three way valve – 15mm height.
   b) Spacer 18,45 mm for EVC in aluminum housing
4. a) 4x M5x12 Allen screw to tighten EVC polycarbonate to the plate
   b) 4x M5x30 Allen screws to tighten EVC aluminum to the plate
5. 40mm line of 6mm diameter pipe to connect EVC pressure sensor and three way valve ports

Prepare the mounting plate before installation on the pipe. Tighten the three way valve to the mounting plate using the spacer and the small plate. Use proper holes for various types of device.

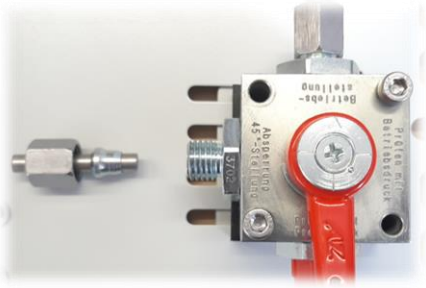
Setting of the small plate for aluminum housing device

Setting of the small plate for polycarbonate housing device

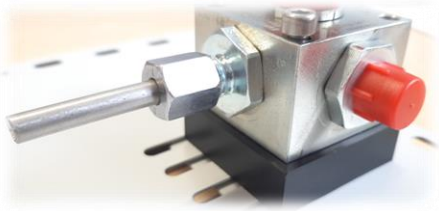
Holding the small plate using the hand tighten preliminary the three way valve, putting a spacer under it. Tighten it just to keep together all the parts allowing for horizontal movement of the valve.



Remember to place the valve with one port to be directed to the left side of the plate.

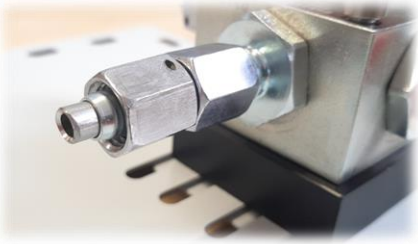


Prepare the short edge of pipe, put inside the cutting ring and the sealable nut.

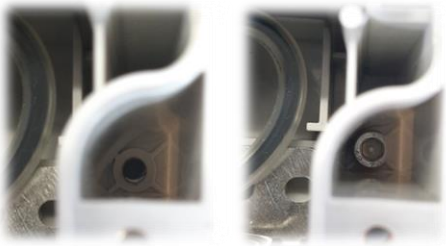


Final placing of the pipe should be as in the picture above.

Install the mounting plate on the gas pipe.

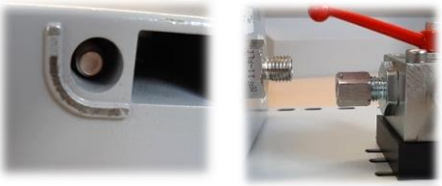


Place the second cutting ring and sealable nut opposite side – thread to the left side of plate

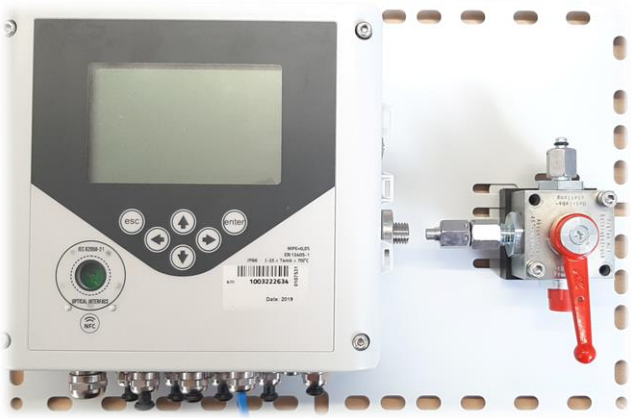


Align device onto plate to fit with the mounting holes with rivet nuts.
Use the attached screws M5x12 to attach the device to plate.

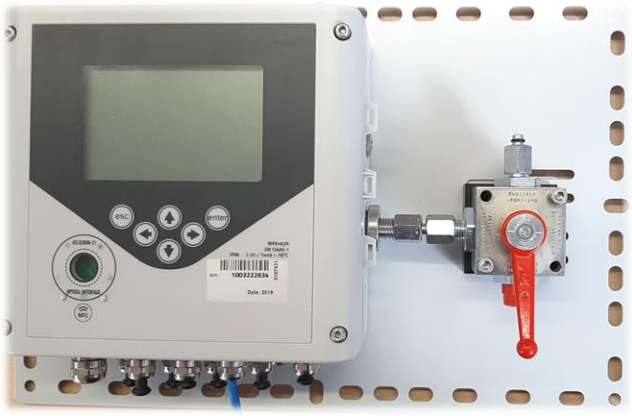
Remember to use proper mounting plate kit designed for the specific version of device. Wrong type of the plate can cause shown incompatibilities



Finish the installation on the plate by connecting the device and three way valve together.



After installation of the device on the plate, slide left the three way valve until the pipe will lean on the pressure ports.



Tighten the sealable nuts and the three way valve putting the whole installation together.

6.6.1. EVC with external pressure sensor

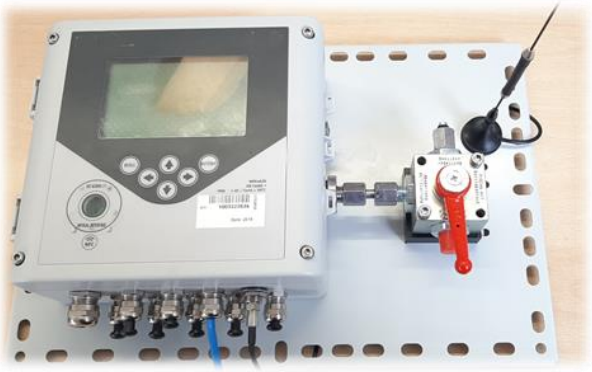
When EVC is equipped with external sensor there are two ways of installation:

1. Repeat step 1 from above section. Tighten the valve on the opposite direction to have one port directed to the right. You can rigidly tighten the valve to the plate in this moment.
2. Tighten the pressure sensor to the port of the three way valve using Female-female M12x1,5 connector, or using the short pipe line attached.
3. OR three way valve can be installed directly on the pressure receiving point, so no need to install it on the plate at all.

6.6.2. Antenna connection

If the device is equipped with the modem and the external antenna, place and screw the antenna in the FME socket to finish the part installation.

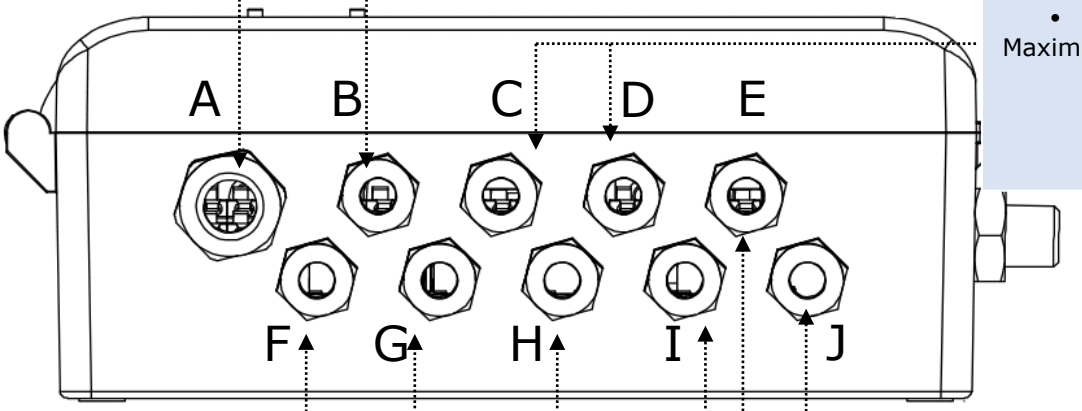
Tighten the antenna in the socket ensuring it will not fall out



Attached antenna has magnetic base so it can be installed on any metal element. Finished installation is presented in the picture above. Device is ready for connection of the pressure and measurement circuits.

6.7. Device wiring

6.7.1. Recommended wires



Measurement inputs: LF, HF, encoder, tamper switch, digital input type NAMUR. Wires:
- LIYCY 2 x 0,25 - 0,5 mm^2.
- LIYCY 4 x 0,25 - 0,5 mm^2.

Maximum length 10 m

Intrinsically safe digital inputs. Wires:
- LIYCY 2 x 0,25 - 0,5 mm^2
- LIYCY 4 x 0,25 - 0,5 mm^2
- LIYCY 6 x 0,25 - 0,34 mm^2

Maximum length 30 m

External pressure sensor.
Maximum wire length: 10 m

Temperature sensor.
Maximum wire length: 10 m

COM1 and COM2 ports, power supply, DO outputs. Wires:
- LIYCY 10 x 0,34 mm^2 – max 100 m
- LIYCY 6..10 x 0,50 mm^2 – max 150 m
- LIYCY 6..10 x 0,75 mm^2 – max 200 m

or paired wires:
- LIYCY-P 2..5 x 2 x 0,34 mm^2 – max 100 m
- LIYCY-P 2..5 x 2 x 0,50 mm^2 – max 150 m
- LIYCY-P 2..5 x 2 x 0,75 mm^2 – max 200 m

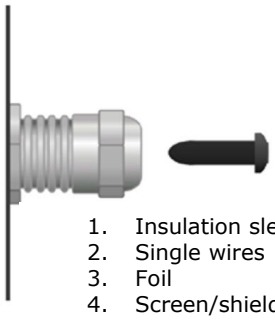
or dedicated wire:
PS-CY-53 2x2x0,34+6x0,34+2x0,75 – max 200m

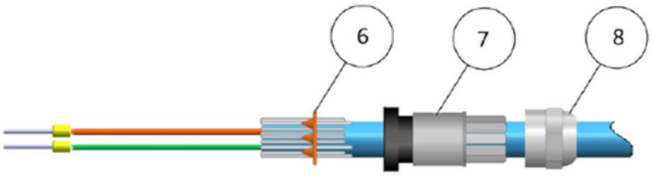
Bushing A has cable diameter range from 4.0 to 8.0 mm (0.16 - 0.30 in, AWG 6 – AWG 1).

Bushings B..G have cable diameter range from 3.0 to 6.5 mm (0.12 - 0.25 in, AWG 9 – AWG 2).

6.7.2. Wires preparation

Wires must be prepared according to instruction presented below. Shielding of the power supply wire should be insulated at the device point and grounded at the power supply point.





1. Insulation sleeves
2. Single wires
3. Foil
4. Screen/shielding on the cable
5. Cable with insulation
6. Formed insulating crown/ring
7. Rubber gland sealing
8. Gland nut

1. Push the black plug into the cable gland until the end – as shown in the picture. This will form the crown (6) to fit into the cable shielding.
2. Untighten the cable gland nut (8), remove the rubber sealing (7) from the gland and place them over the cable.
3. Remove the insulation over the cable for the length around 70 mm. Cut the foil (3) cable shielding (4) for around 10 mm and flip the shielding over the insulation. Place the formed crown over the shielding. Make sure it will stick on the cable.
4. Remove the insulation over the single wires for the length around 8mm. Put the insulation sleeves on the wires and use crimping tool to connect them rigidly to single wires.
5. Put the cable to the terminals chamber and tighten the cable gland. Remember to tighten it rigidly, blocking with second wrench to avoid rotating the cable gland.

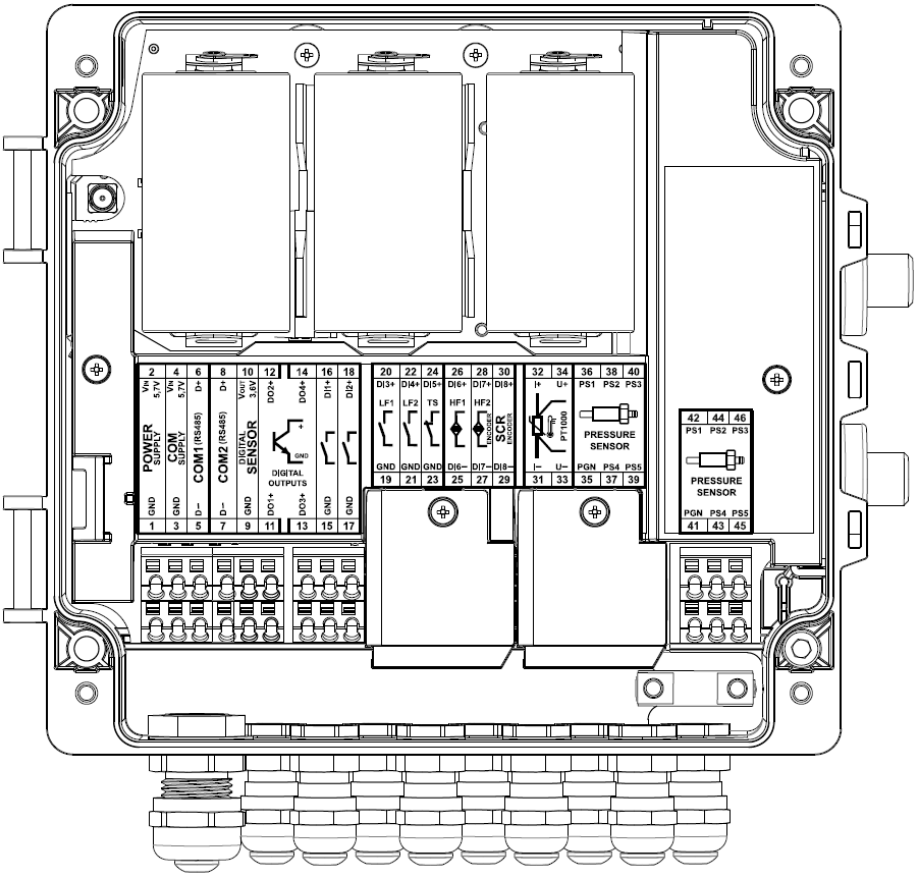
6.7.3. Wires connection

To connect measurement wires, they need to be inserted to terminal strip chamber through adequate cable glands A-J. Cable glands are prepared for grounding of the wires shield.

For connection of external circuits self-tightening connectors are used. After inserting not insulated part of the wire (8 mm length) into connector hole, it clamps itself. To confirm proper connection, pull back wire gently. Stranded wires ends should be clamped in ending sleeve or use other method of wire preparation which is consistent with standard EN 60079-14.

The manufacturer's declaration of the IP66 housing tightness class will be valid, only if cables with appropriate diameters of the cable glands are used, the glands are properly tightened and ensuring proper placement of sealing and tightening the housing cover to the device casing.

Due to the diameter of cable gland and connection clamp, use multi-conductor cables with cross-section from 0,25 to 0,75 mm2.



1, 2 - input of external power supply
3, 4 - input of external power supply for transmission ports,
5..8 - transmission ports COM1 and COM2,
9..10 - power output for external reserve transducers,
11..14 - controlling outputs, "open-collector" type,
15..18 - digital inputs DI1 and DI2,
19..22 - pulse inputs LF1 and LF2 from gas meter (optional digital inputs DI3 and DI4),
23, 24 - tamper switch input from gas meter (optional digital input DI5),
25, 26 - pulse input HF1 from gas meter (optional digital input DI6 in NAMUR standard),
27, 28 **-** pulse input HF2 from gas meter (shared with encoder input and with digital input DI7 in NAMUR standard),
29, 30 - input of SCR encoder or DI8 digital input,
31..34 - Pt1000 temperature sensor terminals
35..40 - terminals for connection of external pressure sensor P1 or P2 (with sealing)
41..46 - terminals for connection of external pressure sensor P1 or P2 (without sealing, terminals available only in plastic housing)

Group of terminals 1..8 is used for connection external power supply and separated transmission circuits in standard RS-485.

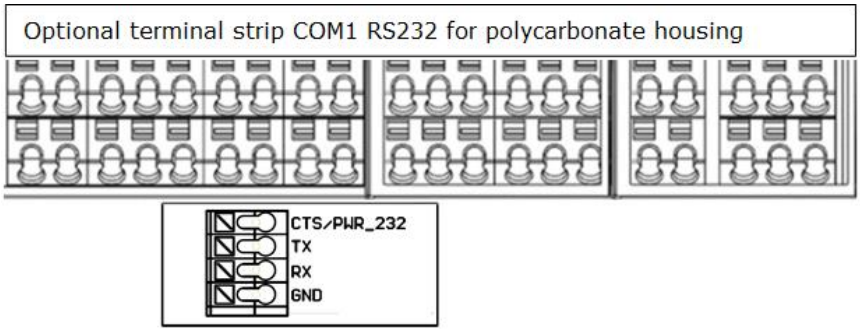
Group of terminals 15..24 is used for connection intrinsically safe digital inputs circuits. Digital inputs supports up to 5 circuits with potential-free connectors (reed type connector).

Group of terminals 25..28 can be used as 2 digital inputs of NAMUR type.

HF1 and HF2 modes of DI6 and DI7 are available only when EVC is externally power supplied

6.7.4. Optional RS-232 terminal strip

Optionally, you can order the device with the RS232 standard port on COM1 (the port is intrinsically safe).



To operate the RS232 port, it is necessary to supply power to the CTS/PWR_232 terminal.

RS232 port has been adapted to work with intrinsically safe separator type MTL5051 manufactured by Eaton Electric Limited (formerly Measurement Technology Limited), Atex certificate BAS01ATEX7158 Issue 1, 2018-12-12.

Terminal connection of devices	
RS232 (COM1)	**MTL5051**
CTS/PWR_232	5V (pin 2)
TX	RX (pin 6)
RX	TX (pin 5)
GND	Common (pin 1)

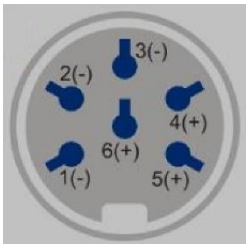
6.7.5. Grounding of the housing

It is not necessary to ground the device.

6.8. Gas meter connection

To connect the signals from gas meter it is required to check its nameplate to obtain the pinout, prepare the plug and make proper connection between the gas meter and EVC terminals.

Example of the gas meter outputs socket:

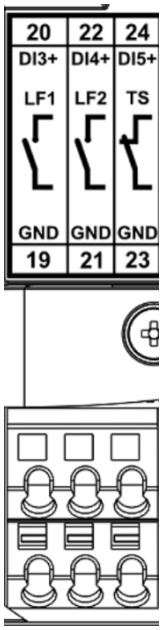


After connection remember to configure properly the pulse inputs options: type, pulse factor of the used inputs. These steps are explained in Pulse inputs configuration or Flow meter / Measuring inputs

Examples of connection:

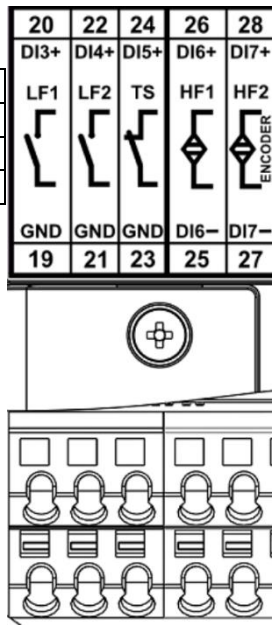
Example 1:

Signal	Pins	EVC
LF1	1-4	19-20
LF2	2-5	21-22
TS	3-6	23-24



Example 2:

Signal	Pins	EVC
LF1	1-4	19-20
HF1	2-5	25-26
TS	3-6	23-24



6.9. INT-S3 connection – intrinsically safe barrier for external power supply and transmission

Description:

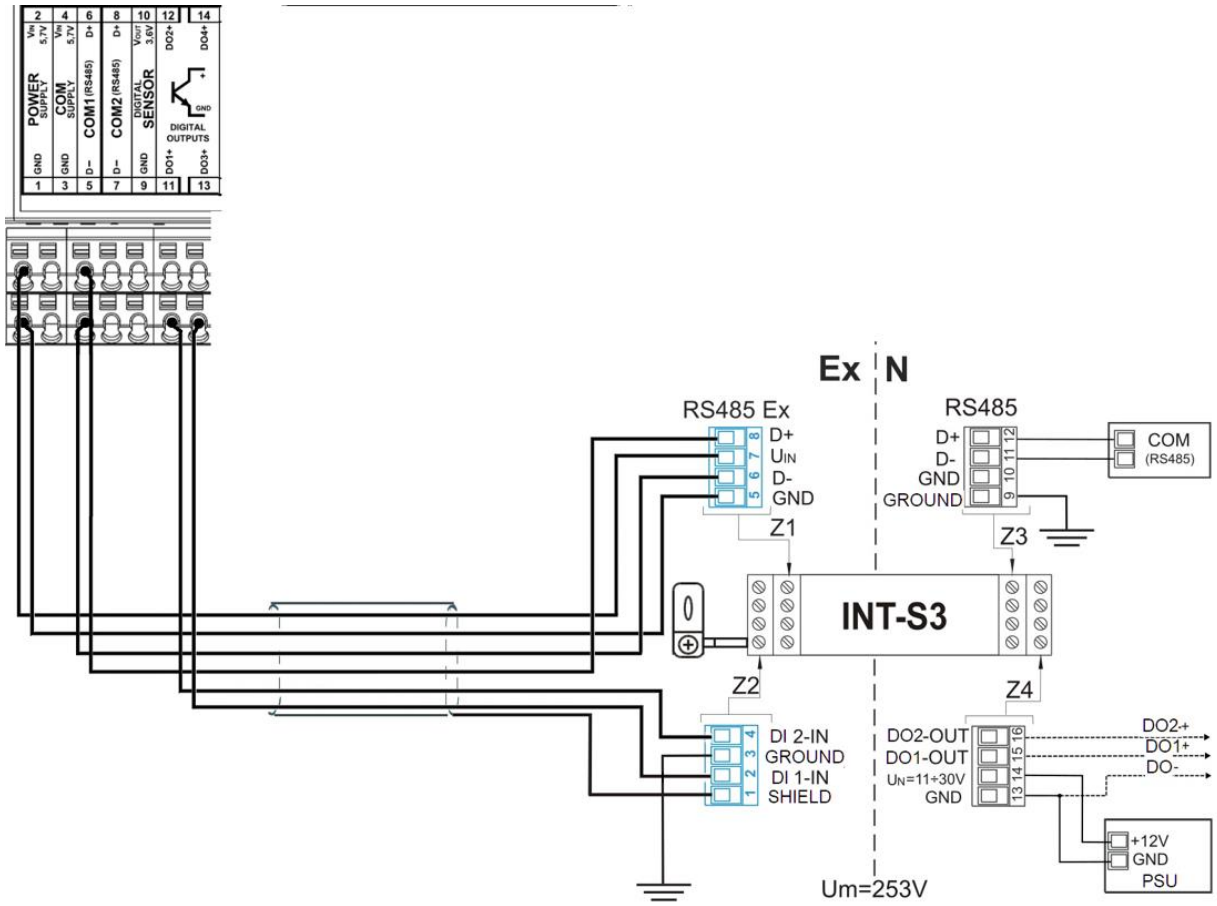
1. There is one single cable coming out from INT-S3 to EVC
2. To ensure transmission on second COM port and/or using another two DOs, another INT-S3 must be used with power supply connected to terminals 13-14. To EVC there should be cable going from terminals 2,4,6,8

When the EVC works in Ex Zone only INT-S3 intrinsically safe circuits can be connected directly to its terminals. Any other equipment must be connected to INT-S3 side marked as N – black terminals.

INT-S3 requires supply voltage (10,5÷30) VDC. Do not connect 230 V mains directly to its terminals!

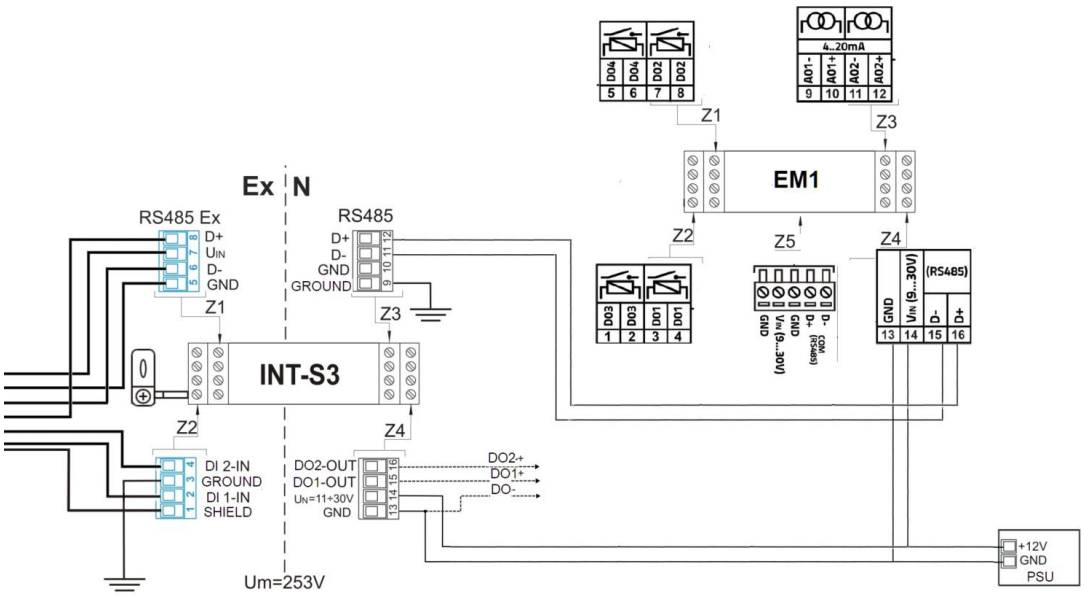
When the EVC is connected to external power supply B1 battery must be inserted in the EVC incessantly. Work or the EVC without battery is forbidden. In case of power loss, the device without battery will not start up again.

For further information refer to INT-S3 user manual.



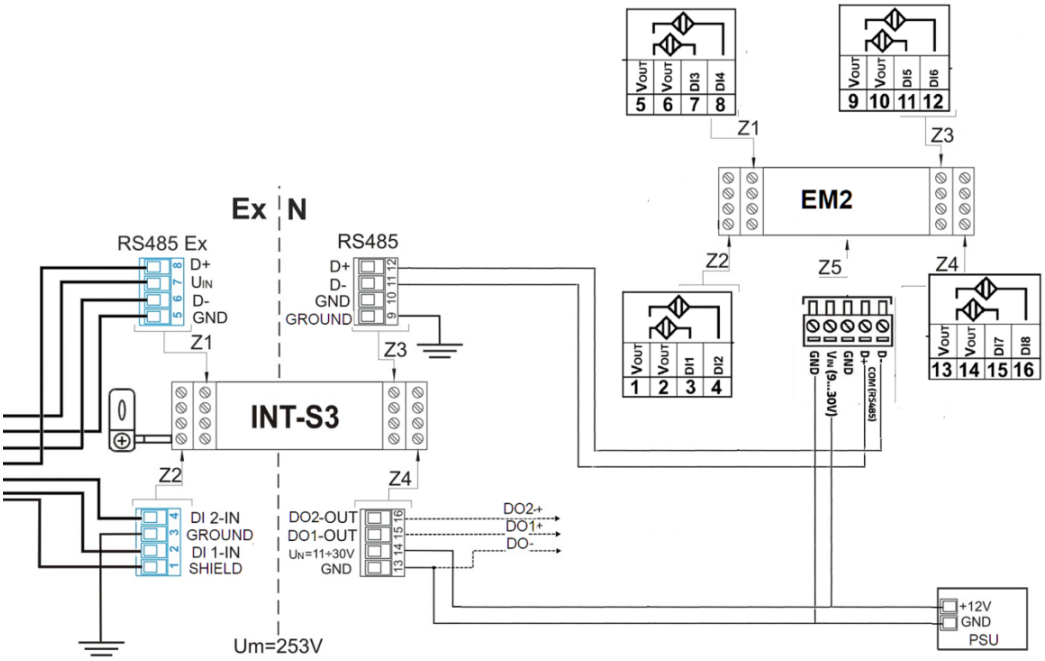
6.10. EM-1 and EM-2 connection – external modules with additional inputs and outputs

Example of connection External Module 1 – additional relay and current (4÷20) mA outputs – EM1.



EM1 is connected to INT-S3 safe side.
INT-S3 from protocol point is transparent. The EVC communicates directly with the module using RS485 protocol.
Z4 and Z5 connectors in EM1 are connected.

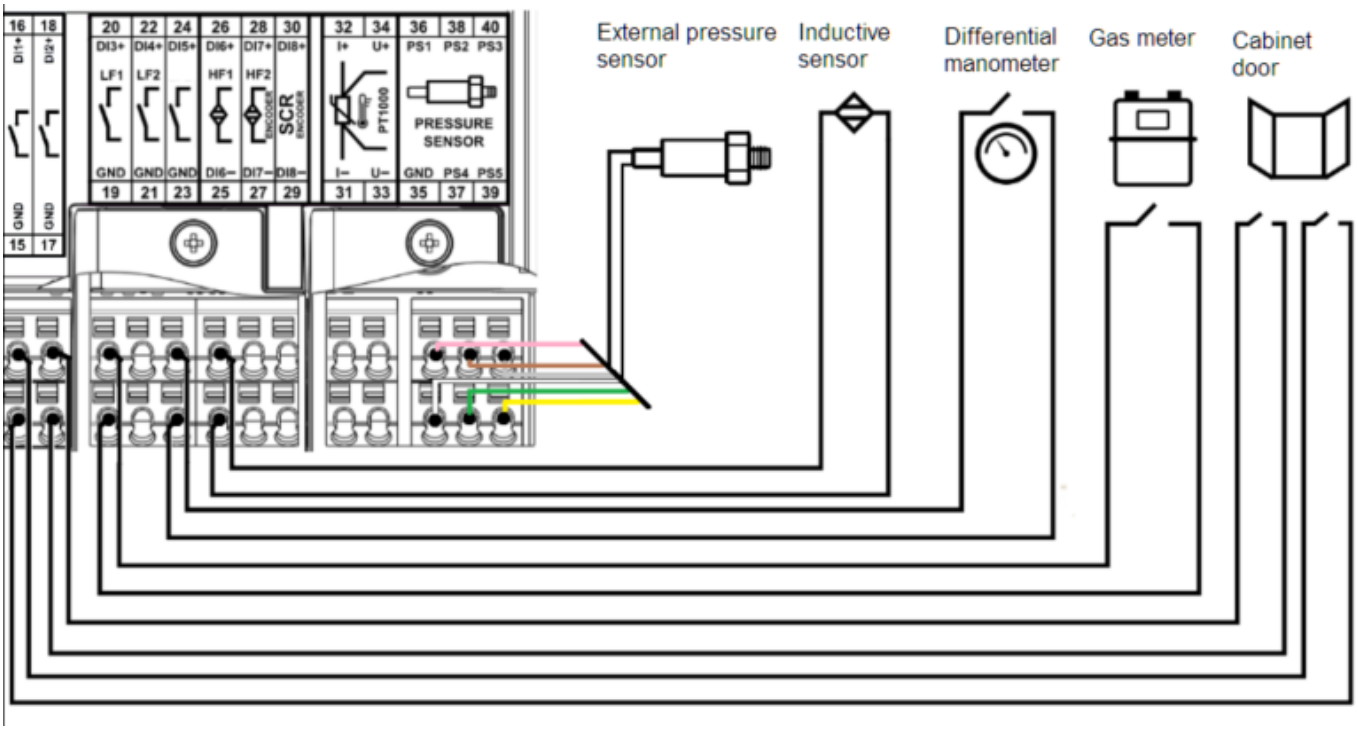
Connection of EM-2 extension module:



EM2 is connected to INT-S3 safe side.
INT-S3 in this moment is transparent. EVC communicates with module directly using RS485.
Connectors 1,2,5,6,9,10,13,14 are internally connected.

6.11. Binary inputs and other equipment connection

Example connection of peripherals. Presented diagram shows only few options available as there are various available devices and apparatus to be connected.

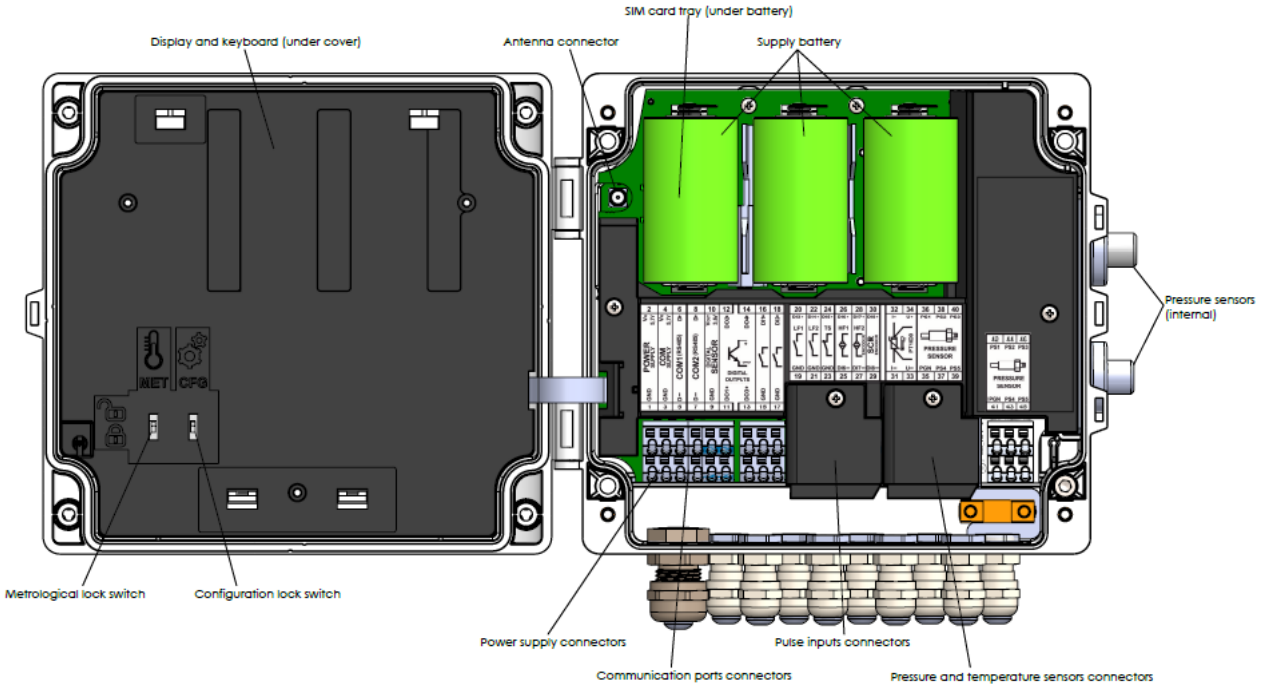


Digital inputs allow for connection:

- DI1-DI5:
  - DI3-DI4 – gas meters pulse outputs with frequency up to 2 Hz – called LF (Low Frequency). In Wiegand configuration they can count pulses up to 60 Hz.
  - Slam shut valves
  - Filter sensors
  - Differential manometers
  - Any reed switches used for door opening
  - Cable continuity sensors (tamper switches)
- DI6-DI7:
  - Gas meters pulse outputs with frequency up to 5000 Hz – called HF (High Frequency)
  - DI7 – gas meter digital output (ENCODER), NAMUR type
  - Proximity sensors with NAMUR standard
- DI8:
  - gas meter digital output (ENCODER), SCR type
  - OR: Switchable with functionalities of binary digital inputs

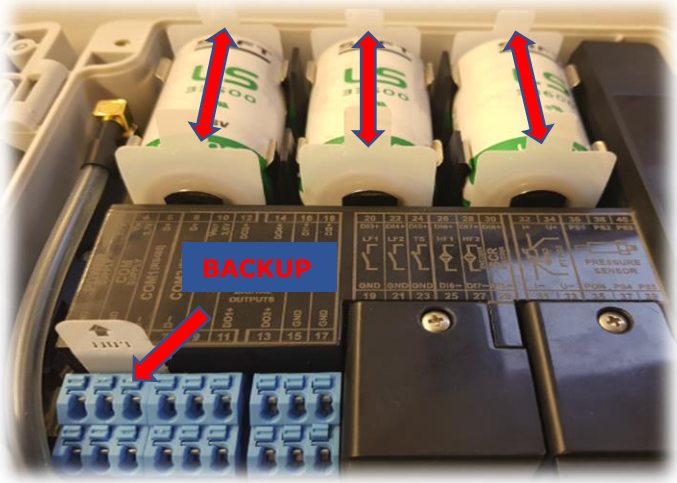
7. Device usage

7.1. Interior overview



7.2. Battery dividers

Once received, EVC can be equipped with the battery dividers which must be removed before use to supply the energy from battery.



For the transport purposes main batteries are disconnected by the dividers. Dividers are inserted between +/- poles of the batteries. This prevents from battery discharging while device is stored. Removing all the dividers ensures proper device work.

Pull the battery dividers both sides simultaneously.

Once batteries are operating, put back the dividers rotated on 90 degrees as shown in the picture. This ensures, if batteries are removed in the future, battery removal parallelly to the battery sockets.

After removing the dividers, please set the device time and date. Wrong date and time will cause in improper timestamping of registered data. Not removing especially BACKUP battery divider will bring unwilling device work only after disconnecting main batteries. Device clock will reset to factory defaults.

Please note that even new certified devices will have Vb counter different than 0. This is related to the requirements of WELMEC Guide 7.2 as device once examined with MID requirements cannot be erased.

7.3. Entering data into the device

Configuration data can be entered into the EVC using device keyboard or by remote transmission.

Remote configuration through digital communication channels (serial ports COM1, COM2, optical, NFC and modem) can be performed with Software available from manufacturer's website.

Configuration can be performed after logging in with adequate authorization level.

Download software from website:
Click here

7.4. Passwords and privileges

Authorization system distinguishes 5 levels of privileges that may be used for logging into device and 2 (levels <=1) informational levels:

(9) PRODUCER
(7) METROLOGIST
(4) ADMINISTRATOR
(3) CUSTOMER
(2) READER
(1) BASIC
(0) LOGOUT

Main features:

a) Higher level grants all privileges of lower level and additional privileges;
b) Accounts of levels 2, 3, 4 are within protection range of hardware configuration lock **CFG**;
c) Account of level 7 is within protection range of hardware metrological lock **MET**;
d) Account of level 9 allows full, fixed access to device configuration (when **MET** is off). Reserved only for manufacturer;
e) Logging on levels 4 and 7 with use of hardware locks is possible only when switches ***SecurLvlAdm***=1 or =3 and ***SecurLvlMet***=3 (see below);
f) Required privileges levels for each configurable parameter available in the device are listed in document *"User data structure"*.

In detail:

- Levels 2-4 and 7 may use up to five fixed accounts (for each level, i.e., 201-205, 301-305, 401-405, 701-740) built into device. By default, one account for each level is active: 201, 301, 401 and 701, with default password: 4096. Adding a user is performed by setting password (different than 0) for that user. Users 401 and 701 cannot be removed.
- Any modification of parameters requires login as selected user with correct password or disabling one of hardware locks. After first login with use of keyboard - next modifications do not require authorization. When entering sleep mode of the device, user is automatically logged out. Next change of parameter requires to login again. Information about active user logon is presented on status bar on main screen. Modification of parameters via transmission requires to enter user identifier and correct password every time.

The privileges system lets use two different protection means:

- software protection (accounts and passwords);
- hardware protection (sealed hardware switches);

Device has ability to configure both protection means to adjust the security system to regulations in local gas market. To configure it are used independently 2 parameters: ***SecurLvlMet*** and ***SecurLvlAdm***.

Each configurable parameter of the device is protected on designed level. Details are descripted in documentation "User data structure". For parameters up to level 9 adjustment of the protections means is possible by using ***SecurLvlMet*** and for parameters up to level 4 - ***SecurLvlAdm***.

Parameter: ***SecurLvlMet*** is possible to configure on values 3 and 4, ***SecurLvlAdm*** is possible to be configured on values 1, 2, 3, 4. Description of each value (level):

- ***Level 4:*** configuration of parameters is possible when:
  - appropriate hardware switch is disabled (MET or CFG);
    AND
  - the customer uses the proper account number with valid password.

- ***Level 3***: configuration of parameters is possible when:
  - appropriate hardware switch is disabled (MET or CFG);

    When hardware locks are disabled but e.g., used transmission protocol expect authorization data then giving account "0" and password "0" is allowable. It is still possible to use proper accounts and passwords in this case.

- ***Level 2***: configuration of parameters is possible when:
  - the customer uses the proper account number with valid password;

    Position (activity) of hardware switch CFG is ignored – it means that the hardware switch is treated as disabled.

- ***Level 1***: configuration of parameters is possible when:
  - hardware switch CFG is disabled;
    OR
  - the customer uses the proper account number with valid password.

    Level 1 expects using at least one mean to confirm access – either hardware switch or account + password. When hardware lock is disabled but e.g., used transmission protocol expect authorization data then giving account "0" and password "0" is allowable. It is still possible to use proper accounts and passwords in this case.

- In addition to described security levels, there is additional setting for enabling configuration of parameters when hardware locks are enabled – but only parameters with low access levels 2 and 3. This setting is performed on parameter ***CustAccess***. Setting it to value 1 will allow such modifications, 0 – blocks it.

All of device's parameters designed for configuration are described in document *"User data structure"*, where are also indications what kind of privileges are required to do modification.

Default settings give following privileges for specific group of users:

- METROLOGIST
  - privileges for data readout
  - privileges for configuration of all device's parameters (including calibration of legally relevant measuring inputs of pressure and temperature)
- ADMINISTRATOR
  - privileges for data readout
  - privileges for configuration of device parameters typically altered during installation process and basic configuration of the device
- CUSTOMER
  - privileges for data readout
  - privileges for configuration of non-metrological parameters, e.g., limits
- READER
  - privileges for data readout
  - privileges for configuration of private permanent password

7.5. Device clock

Device is equipped with real time clock. Synchronization of clock is possible via:

- automatically (any type of available mobile transmission modems is required and must be configured to connect to cellular network periodically)
- PUSH mode – time can be set using any interface (port) to access the device: keyboard, COM1 and COM2, optical interface, NFC and built-in mobile transmission modem.

Information about clock modification is saved into device's events memory (time before and after modification). Access to time modification with use of keyboard is protected by password.

An option is available for automatic change to summer/winter time. Change of time can perform automatically, according to built-in calendar or manually, by setting new time by user.

Change of time both automatic and manual has no influence on gas volume counting in main counters ***Vb*** and ***E***. An event **Time changed** will appear in device memory in case of changing time in configuration of automatic change to summer/winter time.

7.5.1. Clock adjustment modes

There are three modes of clock adjustment:

- **RTCMode**=1 (**URGENT** mode) – all time settings are immediate. This mode is not recommended in normal using of the device because does not protect the registration step (such urgent setting can e.g. jump over the full hour – in effect the hourly record will be lost).
- **RTCMode**=2 (**OPTIMAL** mode) – mode with registration protection and with accelerated step response to clock setting requests. In this mode, the delay of response to time settings is typically relatively short and results only from the protection of periodic and hourly registration.
- **RTCMode**=3 (**FLUENT** mode) – all time adjustments are sent for smooth tuning of the clock. In this case - when the time difference does not exceed maximum permissible deviation - there is no sign of tuning the clock in archives.

If the time change made has damaged the hour duration by more than ± 30 seconds, the information will be saved in TimeLOG.

7.5.2. Data format change

The choice of one of the two date formats is carried out by modifying the parameter DTFormat.

DTFormat=1 YYYY-MM-DD hh:mm:ss;

DTFormat=2 MM-DD-YYYY hh:mm:ss.

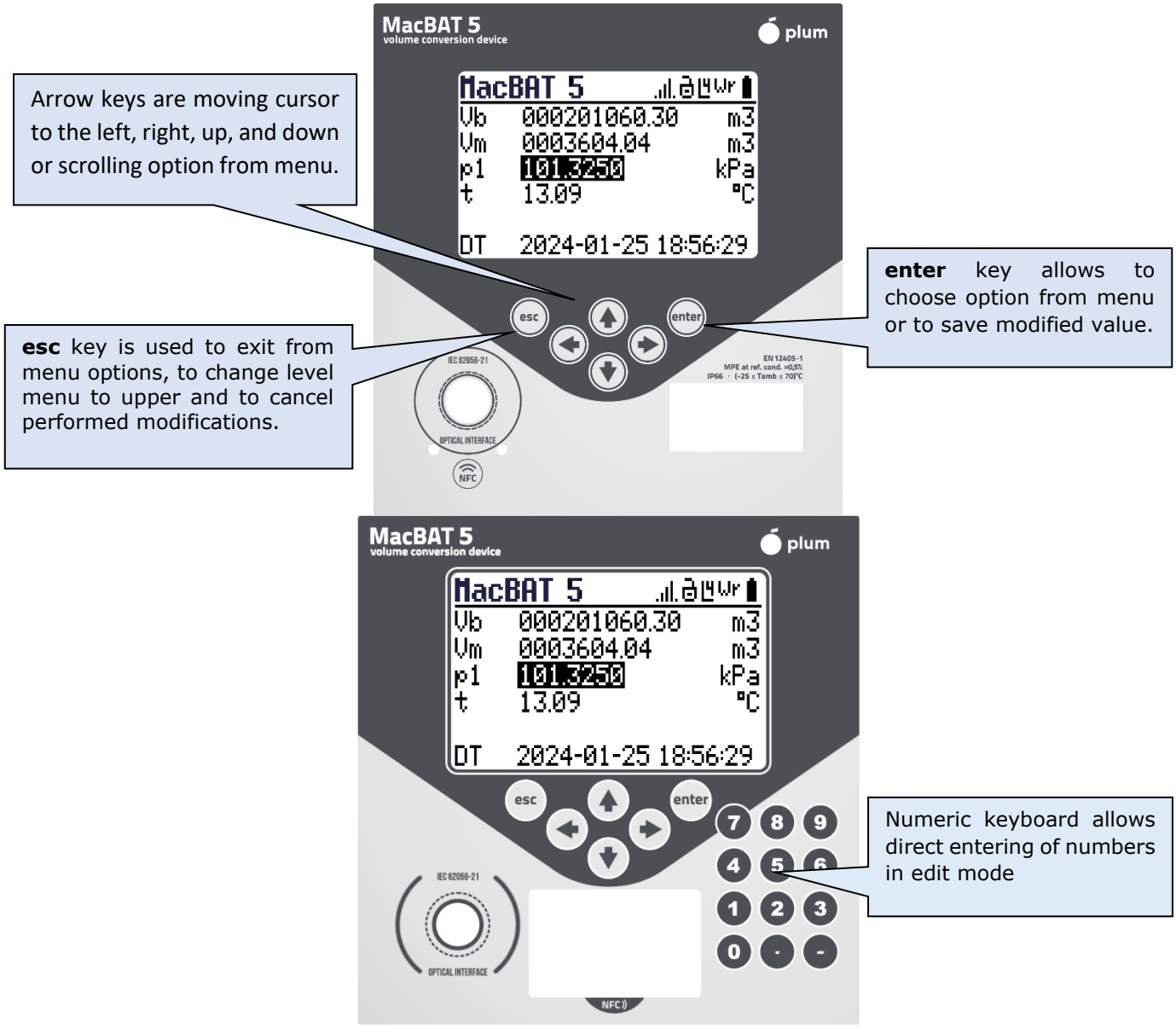
7.6. Device start up

When power supply is connected (internal battery or external), device starts up automatically. Default state of device display is turned off when there are no operations currently performed manually. Pressing any key (except **esc**) will cause display to turn on.

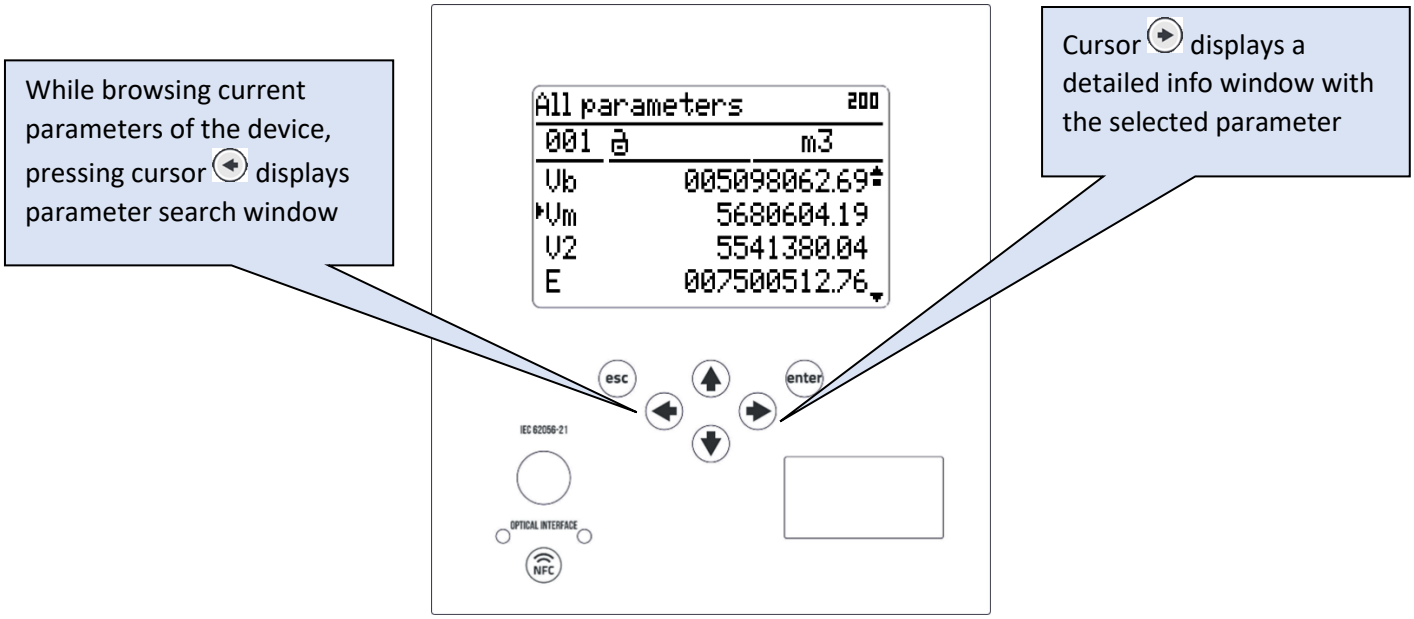
In case of longer storage, it is recommended to disconnect internal batteries.

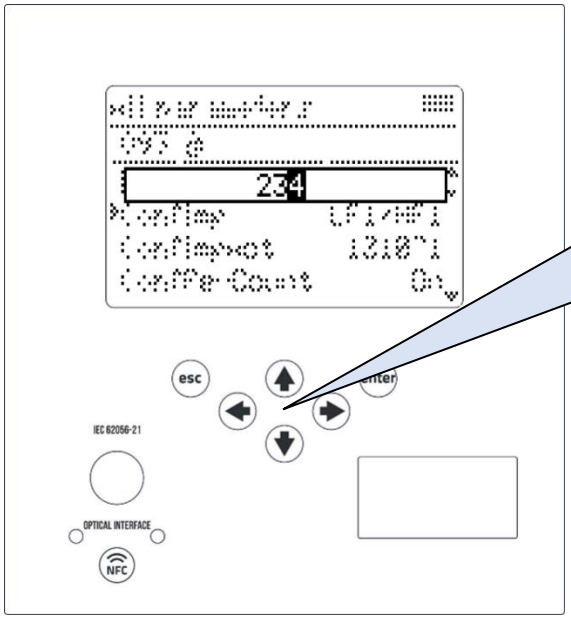
7.7. Keyboard

Local communication between user and device is realized by keyboard and graphic display. Keyboard is equipped with two function keys **enter, esc** and four arrow keys. Optionally, a numeric keypad is available in aluminum version.



When viewing values of parameters, it is possible to go quickly to searched parameter. To do so, it is necessary to know index of searched parameter. For this, please refer to document "User data structure"



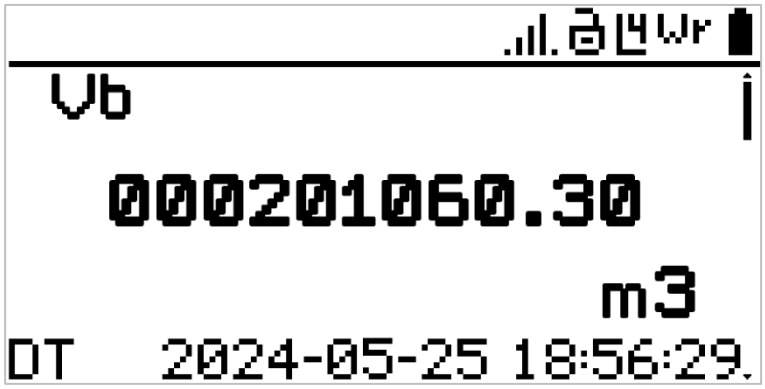


Cursors change the searched parameter's index digit, cursors change value of the digit, **enter** key confirms and **esc** cancels the parameter search

7.8. Display

Display is divided to 7 lines, where 6 can be configured freely. First line is the header bar with status icons. By default, rest of the lines are set to show Vb, Vm, p1, t and current date and time.

7.9. Display in "Scroll list" mode



The display is in the "Scroll list" mode, the parameters are displayed one by one in large font, the sheet is scrolled using the up and down keys, the list is looped. The parameters can be configured by changing the UParamXX.

	Battery 10-100% (the icon changes its filling depending on the percentage of battery charge)
	Battery discharged or close to discharge: <10%
	External supply
	Hardware configuration lock ON (both locks MET and CFG are ON)

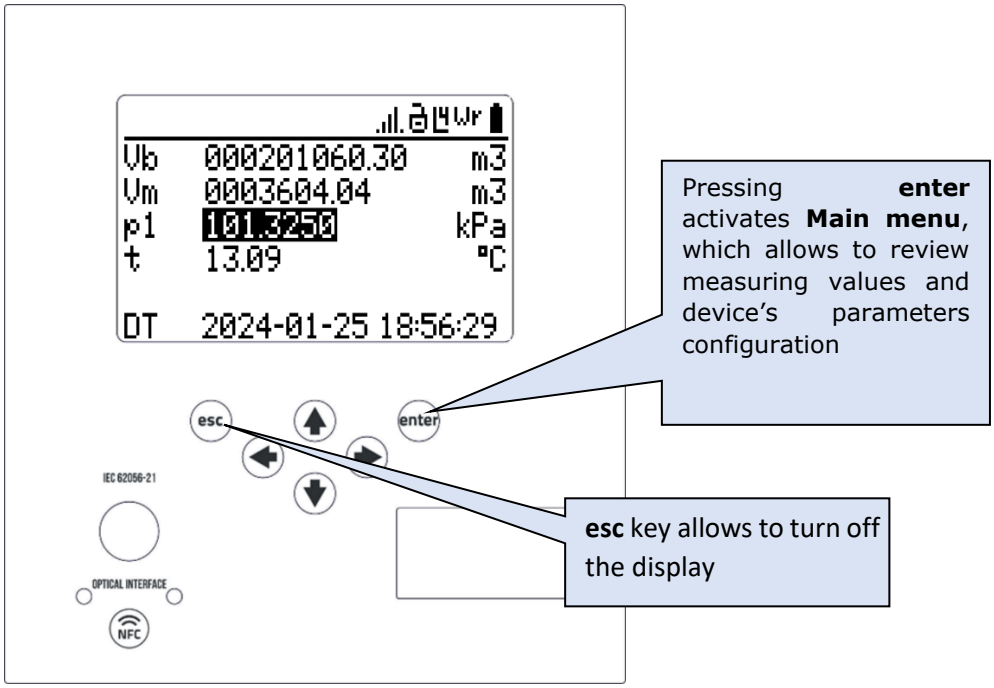
	Hardware configuration lock OFF (MET or CFG is OFF)
L4	User logged locally (in this example – level 4 of privileges)
Er	Active alarms or events, pulsation – new alarms /events
Wr	Active events, pulsation – new events
OK	No active alarms, pulsation – there were unchecked alarms/events that have ended
	Modem signal reception strength (in this example – 4 out of 5 bars)
M	Device has MID-compatible software and has active protection of MID parameters
	Device has MID-compatible software but has inactive protection of MID parameters

7.10. Menu navigation

EVC has user available graphics-text menu which allows for configuration and registered data access. Also, it is a primary way of inputting initial configuration for the device. Parameters possible to configure: gas meter counter, flow rate threshold, pressure and temperature thresholds, transmission parameters, gas composition.

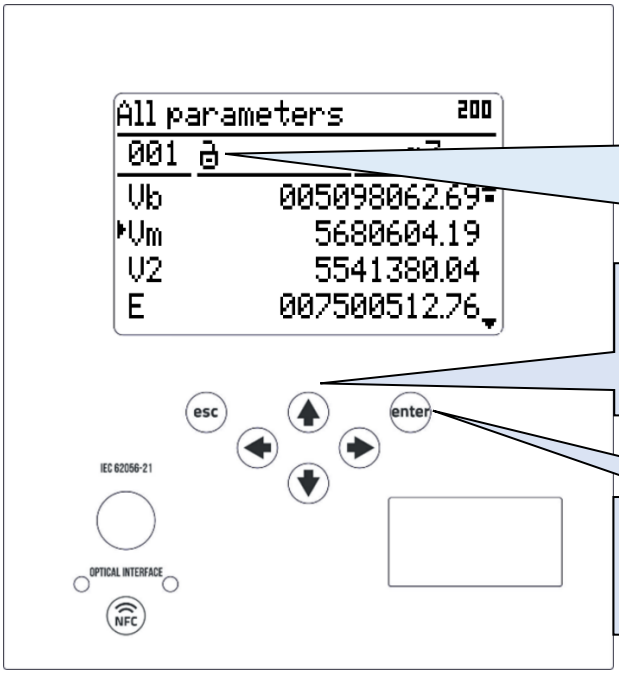
Menu is built as a multi-level, so entering one menu can cause forwarding to sub-menu until the editable parameters will appear.

As standard, display panel is turned off. Pressing any of keys from keyboard (besides **esc**) causes turning the display with main measuring values displayed. Example:



System alarms, which are recorded by device, are cause of displaying - on top of the display at status bar – informational icon "Er" or "Wr". Blinking of this icon means, that new events appeared. If no active alarms are present, then icon "OK" appears. Besides that, if measured value of pressure or temperature is out of range – current value of parameter is displayed with alternating background color.

Modification of parameters with use of keyboard could be performed as follows:

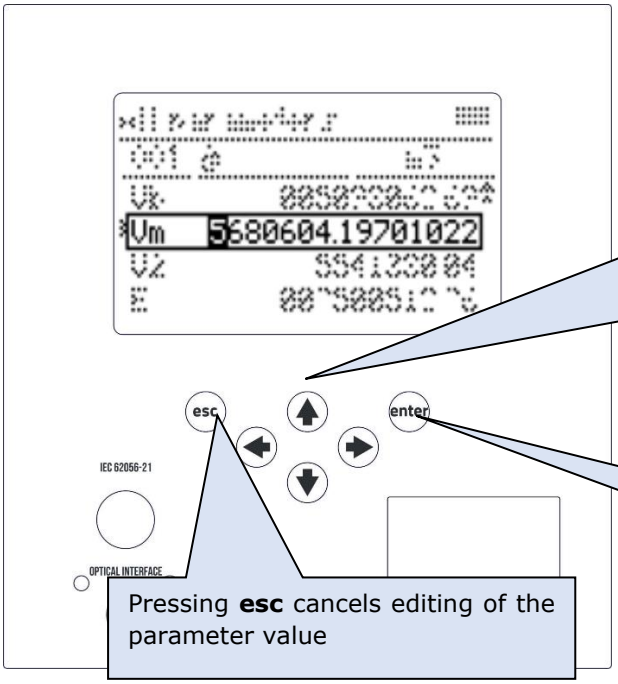


The icon informs that indicated parameter is ready for potential change (unblocked)

The icon "L4" informs that indicated parameter is changeable but still protected and requires level 4 of privileges

When viewing parameters, use the cursors to select the parameter to modify

Press **enter** to select currently highlighted parameter and enter edit mode



In the edit mode of parameter value, the cursors will let to change value of selected digit and the cursors change the modified digit

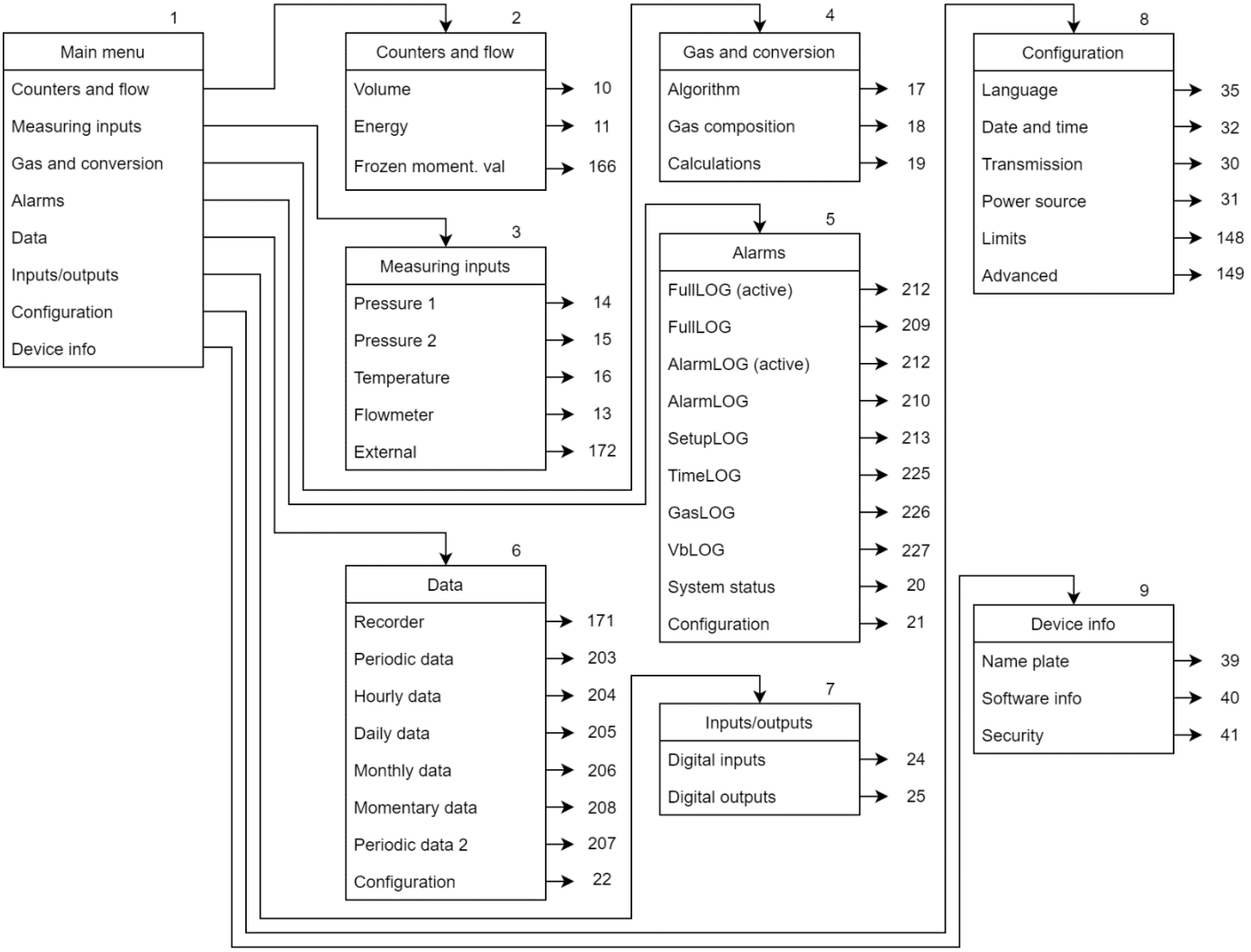
Pressing **enter** validates new value of the modified parameter

Pressing **esc** cancels editing of the parameter value

7.11. Menu structure

The device operation is based on items selected from the menu. Pressing **enter** on main screen will show Main menu, selection of options is done with cursors keys. Next – **enter** on selection will open sub-menu and **esc** will cause jump to previous menu.

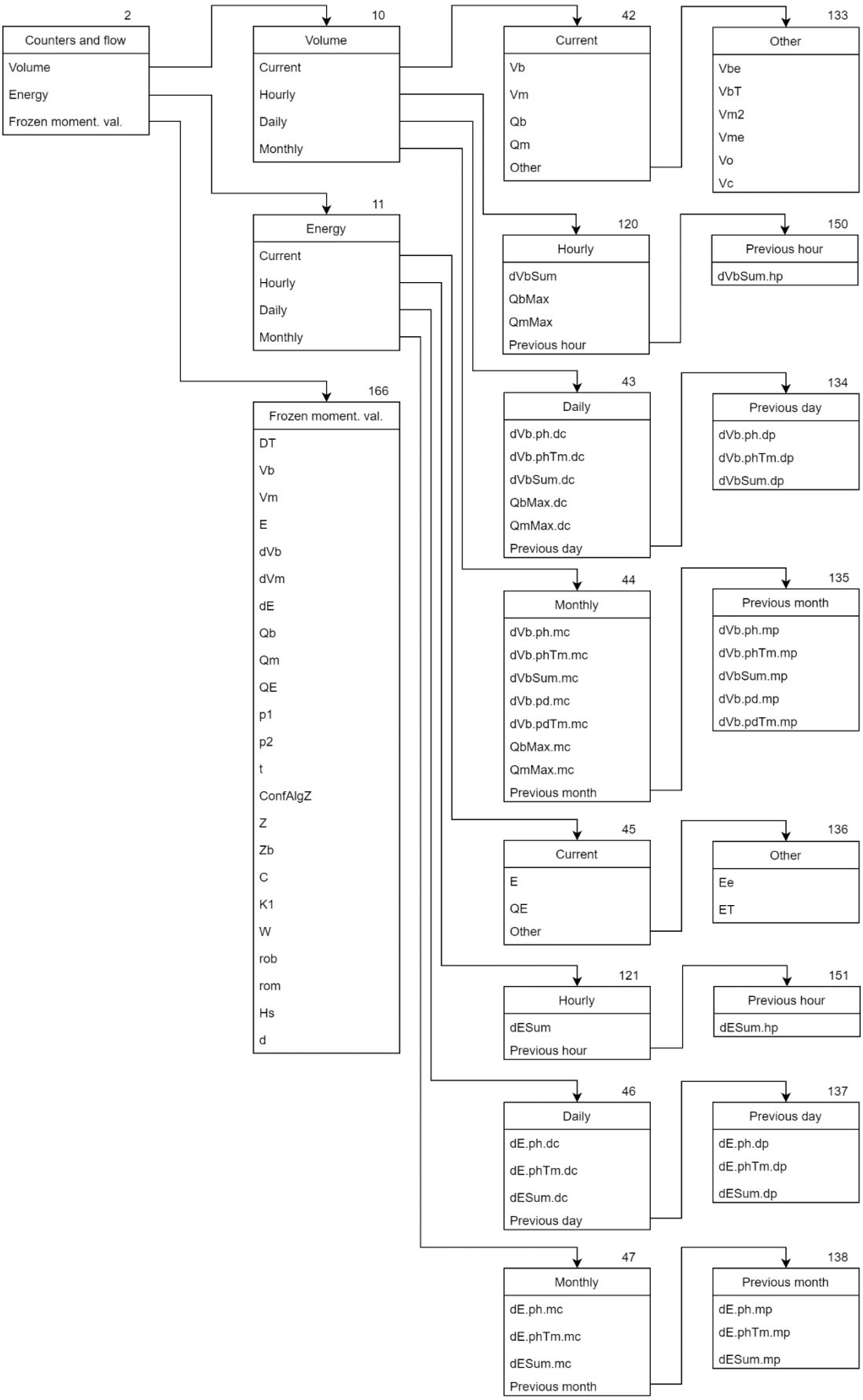
7.11.1. Main menu



This menu consists of following sub-menus:

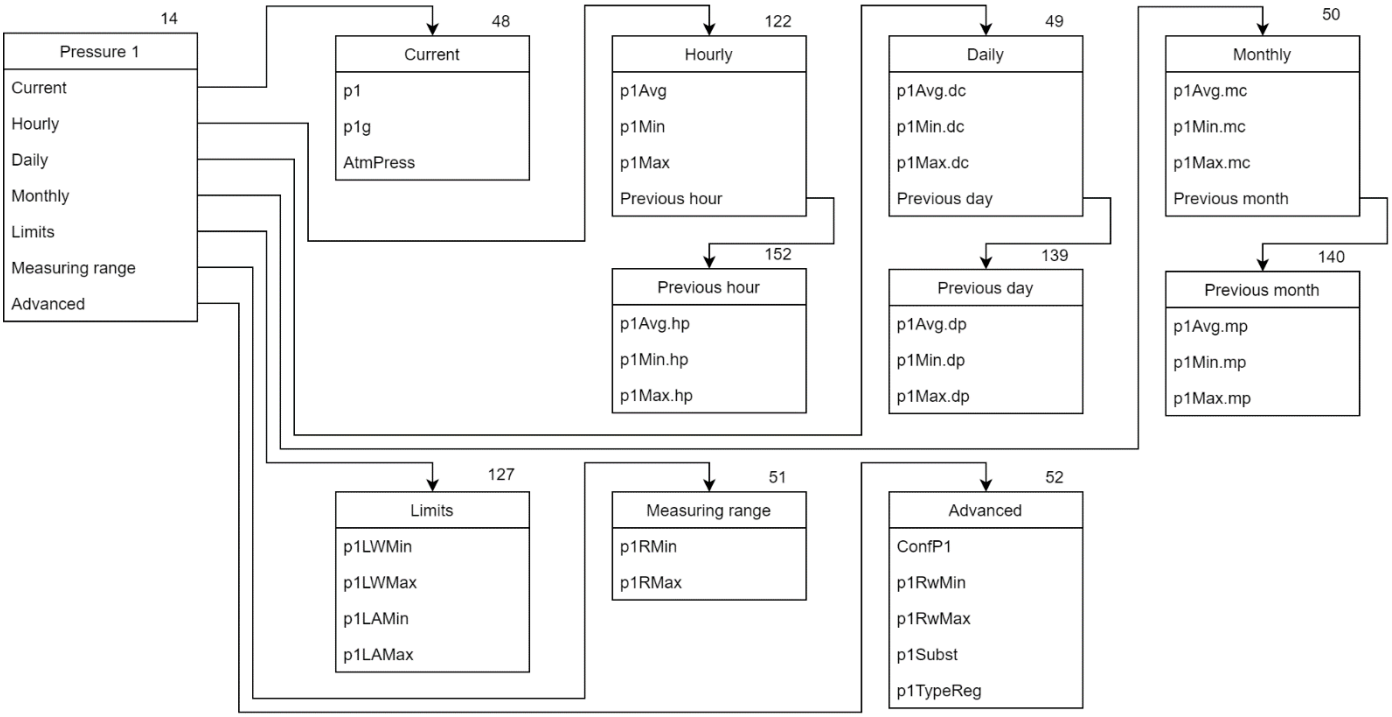
- **Counters and flow** – groups parameters for counting of volume and energy. It allows to view current values and average, minimal and maximal values from hourly, daily, and monthly time periods for increments of volume and energy, also for flow values.
- **Measuring inputs** – groups parameters for measuring sensors: pressure 1, pressure 2, temperature, gas meter (flowmeter) and external inputs. It allows to view current values and average, minimal and maximal values from hourly, daily, and monthly time periods. Configuration of these sensors is possible from this menu.
- **Gas and conversion** – groups parameters for gas composition, algorithm and shows calculated properties of gas.
- **Alarms** – allows access to full set of alarms and events registered in the device.
- **Data** – allows access to full set of registered data recorded in the device.
- **Inputs/outputs** – configuration and current state of available inputs and outputs.
- **Configuration** – allows to set configuration of all device's parts.
- **Device info** – information about device: name plate, software information and current state of security settings.

7.11.2. Counters and flow



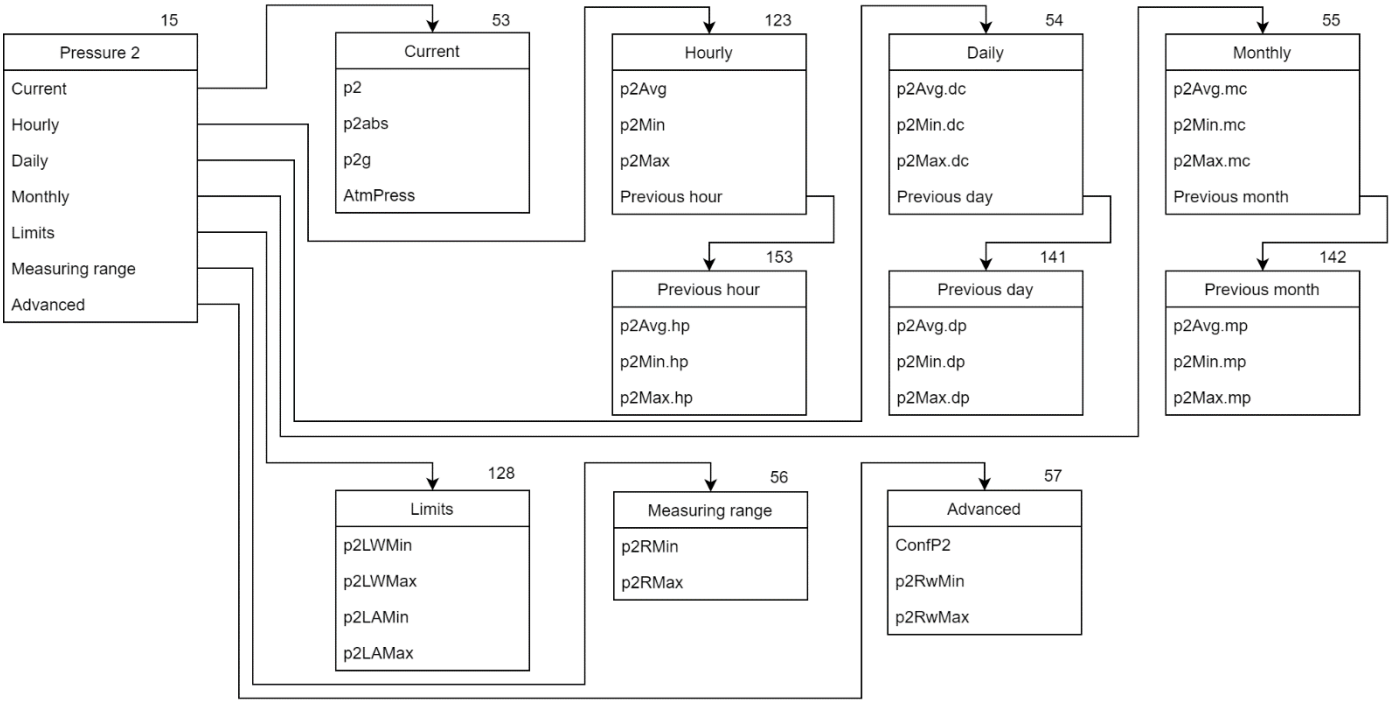
This menu groups parameters for counting of volume and energy. It allows to view current values and average, minimal and maximal values from hourly, daily, and monthly time periods for increments of volume and energy, also for flow values.

7.11.3. Measuring inputs – Pressure 1



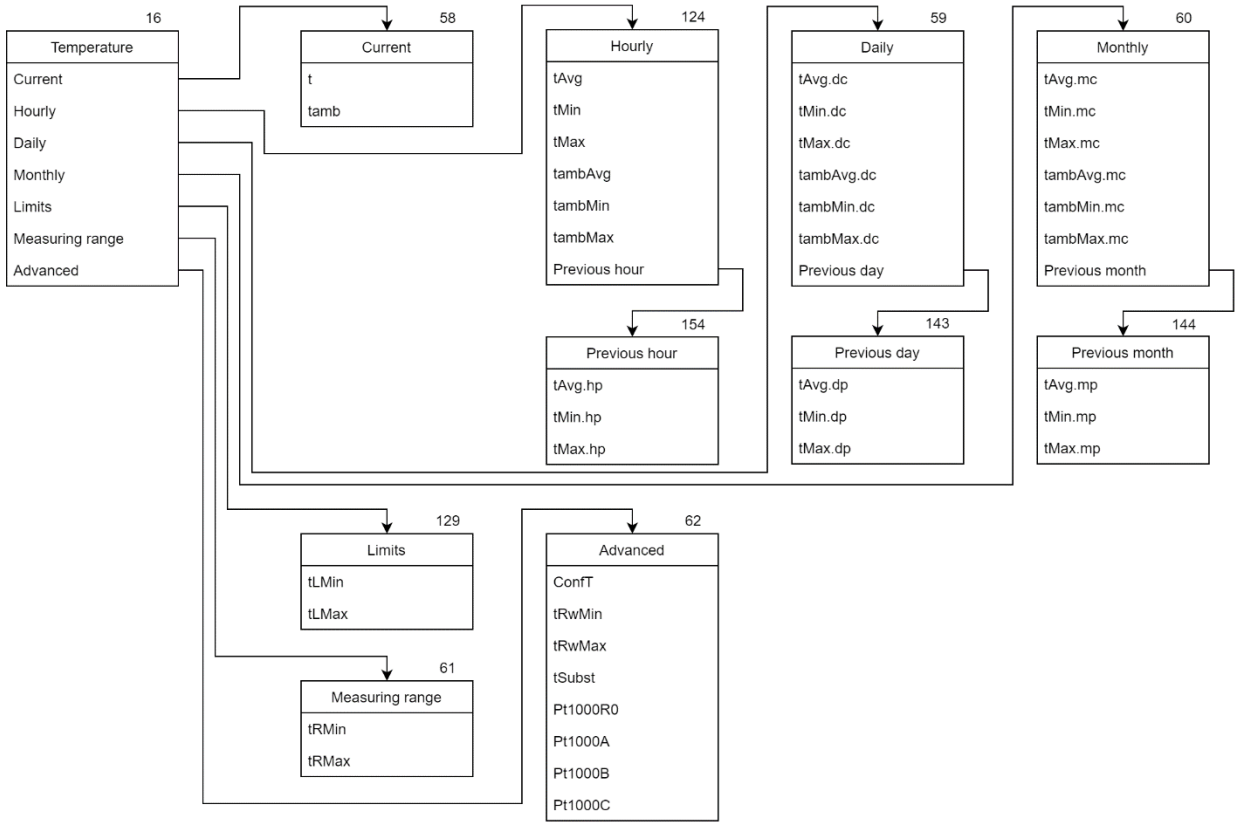
This menu groups parameters for pressure sensor 1. It allows to view current values and average, minimal and maximal values from hourly, daily, and monthly time periods. Configuration of this sensor is possible from this menu.

7.11.4. Measuring inputs – Pressure 2



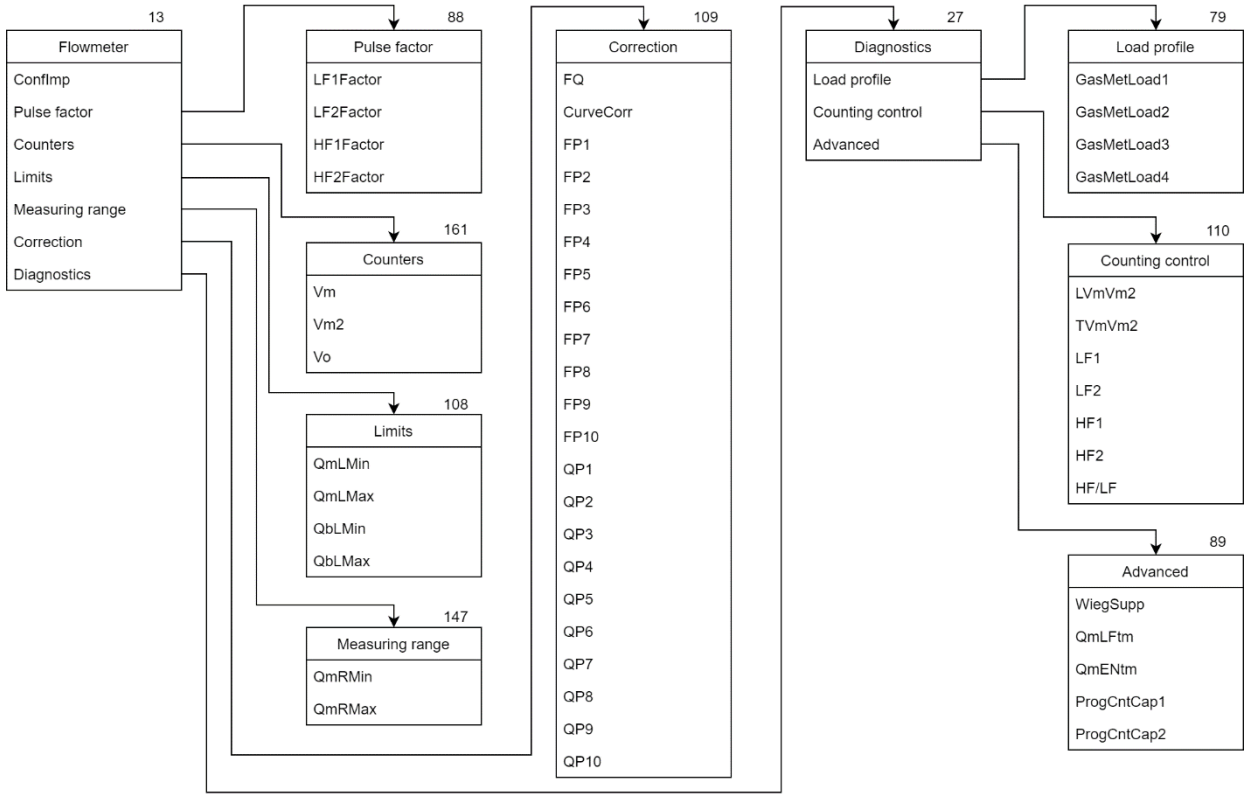
This menu groups parameters for pressure sensor 2. It allows to view current values and average, minimal and maximal values from hourly, daily, and monthly time periods. Configuration of this sensor is possible from this menu.

7.11.5. Measuring inputs – Temperature



This menu groups parameters for temperature sensor. It allows to view current values and average, minimal and maximal values from hourly, daily, and monthly time periods. Configuration of this sensor is possible from this menu.

7.11.6. Measuring inputs – Flowmeter



This menu contains settings for gas meter – basic pulse inputs configuration, flow ranges, correction, counting control and limits of flow. Diagnostics of gas meter are also available.

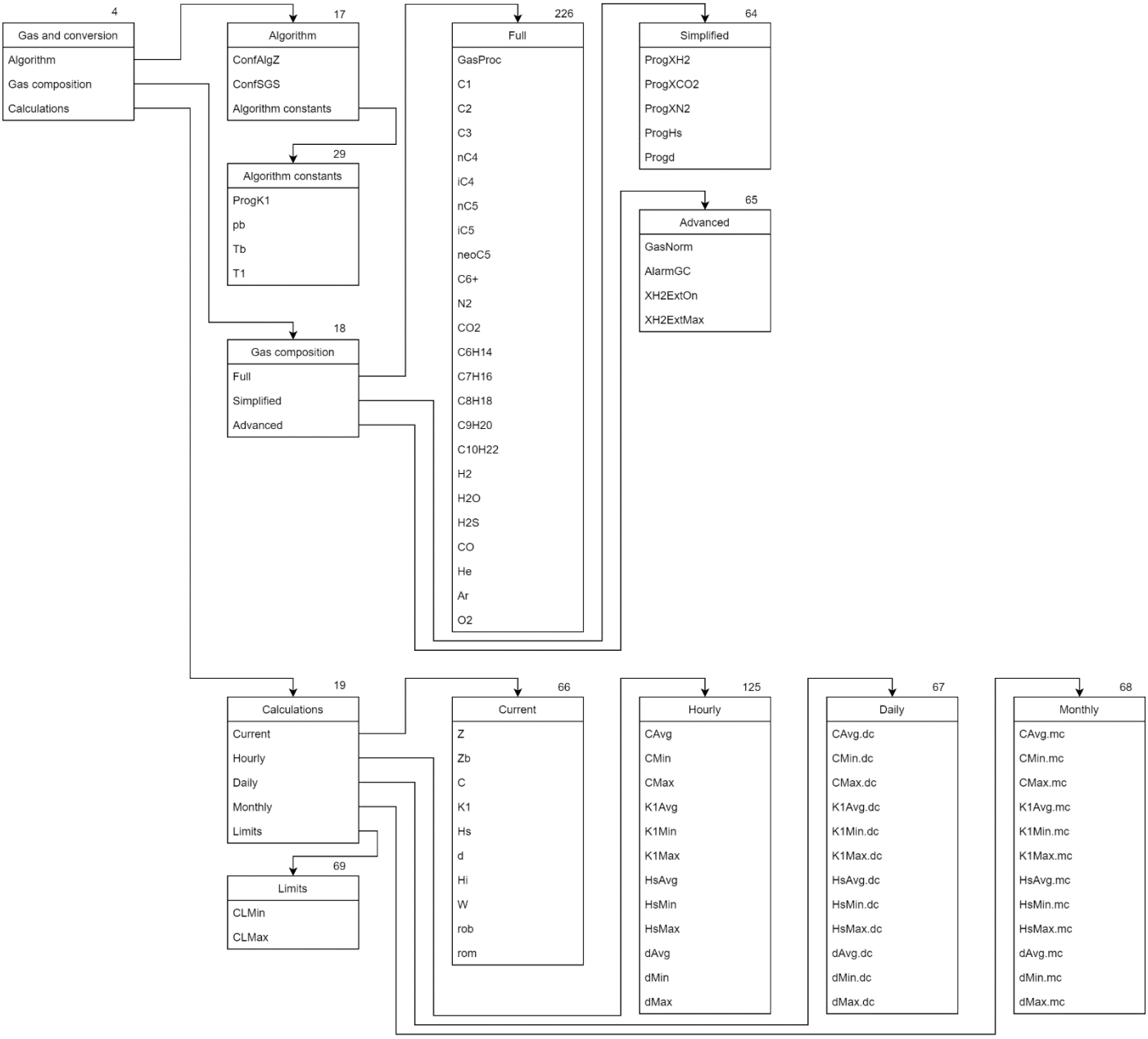
7.11.7. Measuring inputs – External

172

External
EmEnable
EmActive
EmErr
Em1Val
Em1Desc
Em2Val
Em2Desc
Em3Val
Em3Desc
Em4Val
Em4Desc
Em5Val
Em5Desc
Em6Val
Em6Desc
Em7Val
Em7Desc
Em8Val
Em8Desc
Em9Val
Em9Desc
Em10Val
Em10Desc
Em11Val
Em11Desc
Em12Val
Em12Desc
Em13Val
Em13Desc
Em14Val
Em14Desc
Em15Val
Em15Desc
Em16Val
Em16Desc

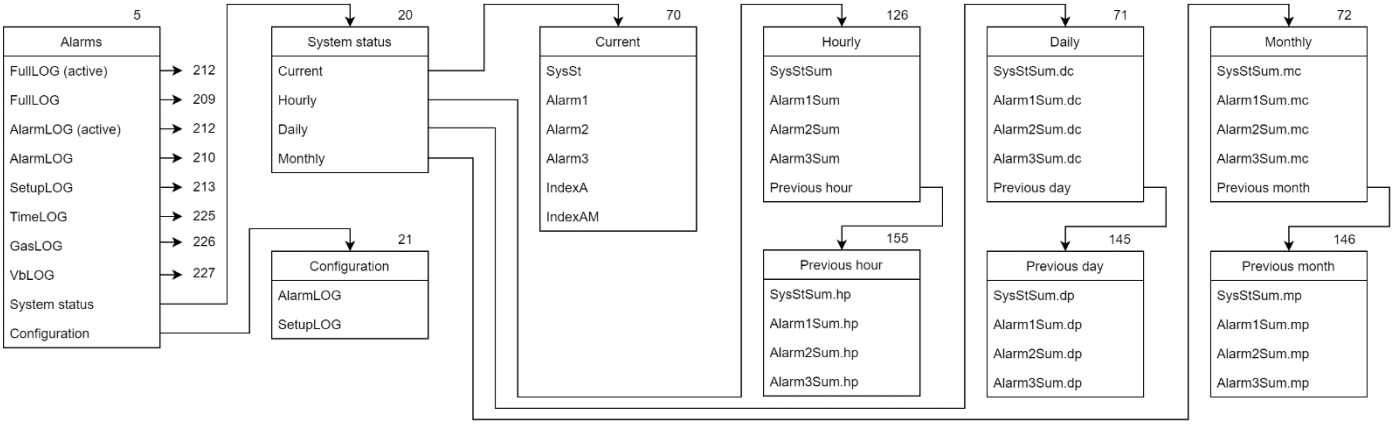
This menu contains list of parameters read from auxiliary external devices.

7.11.8. Gas and conversion



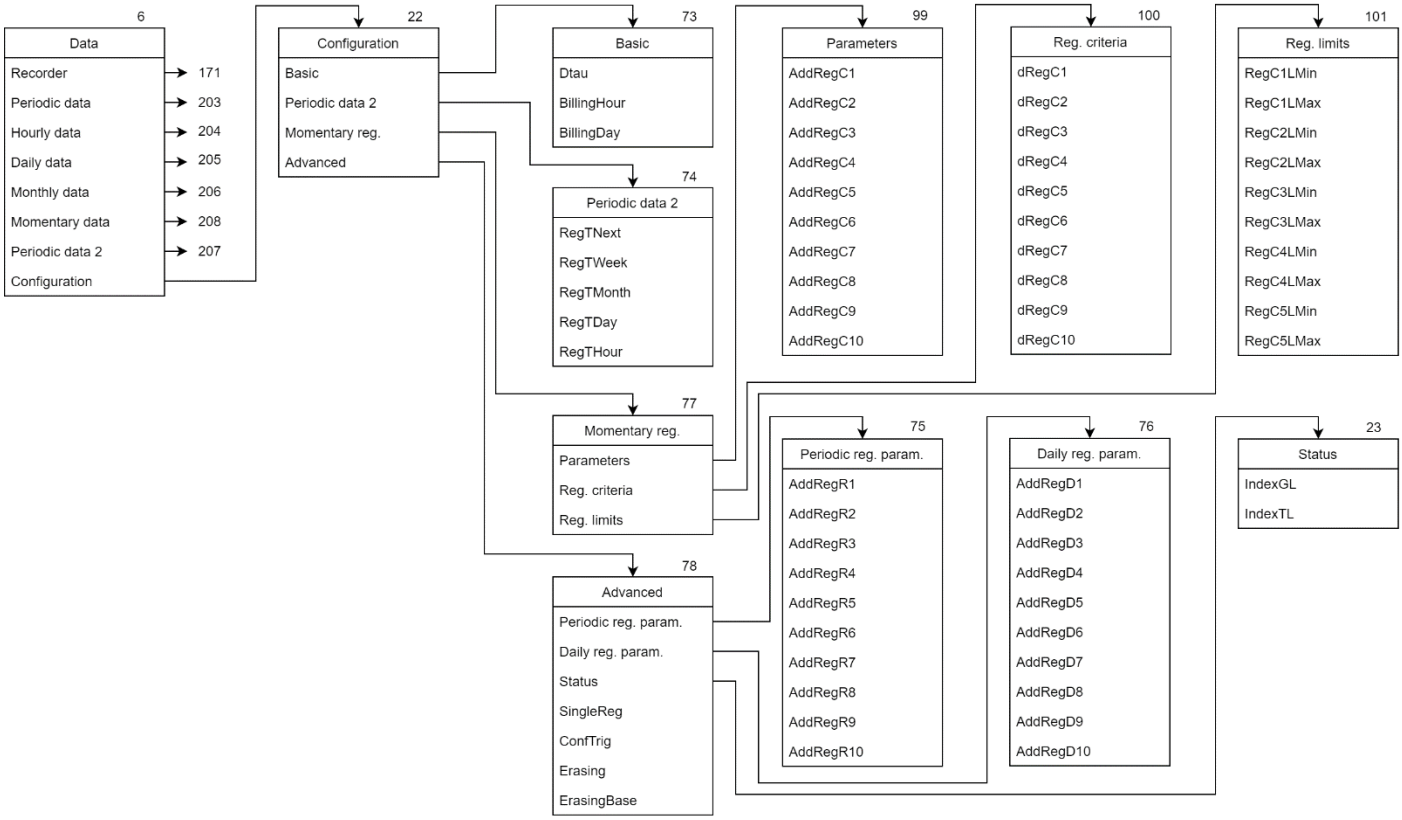
This menu groups parameters for gas composition, algorithm and shows calculated properties of gas.

7.11.9. Alarms



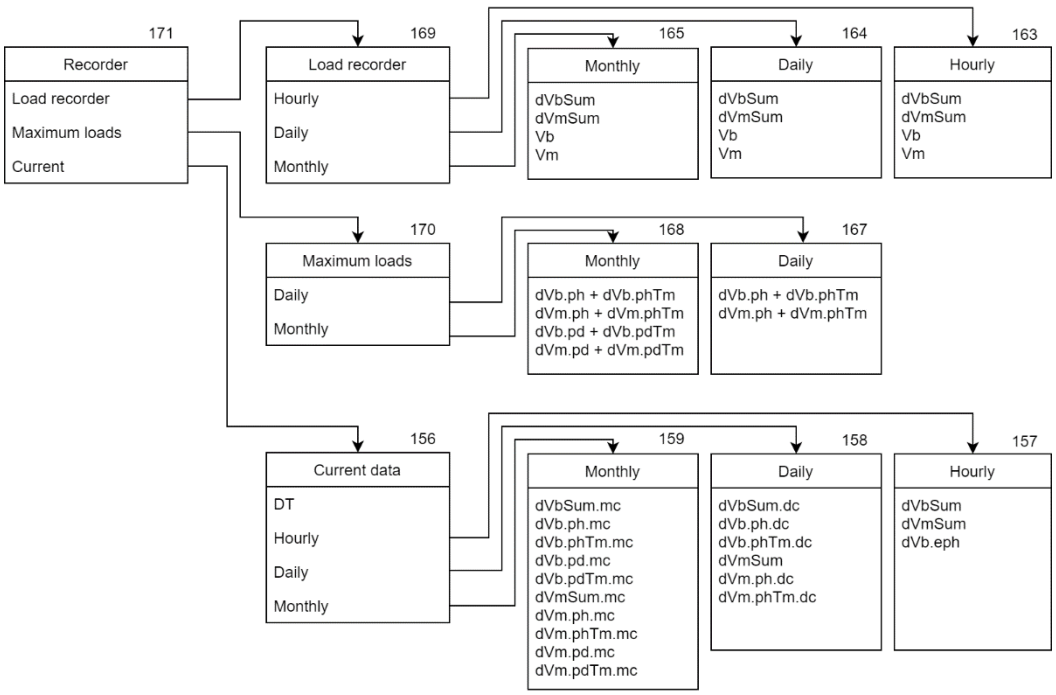
This menu allows access to full set of alarms and events registered in the device.

7.11.10. Data



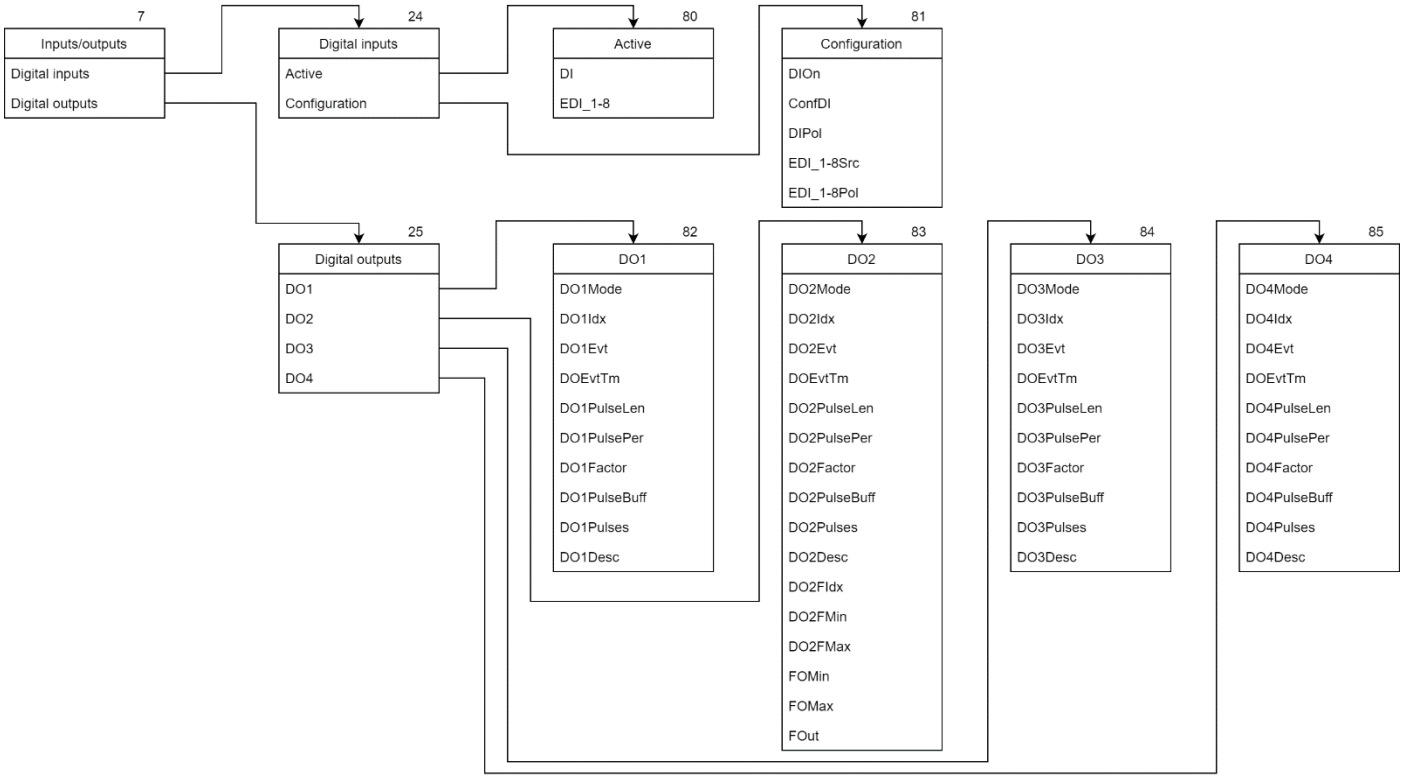
This menu allows access to full set of registered data recorded in the device. Configuration of registered parameters is available here.

7.11.11. Data - Recorder



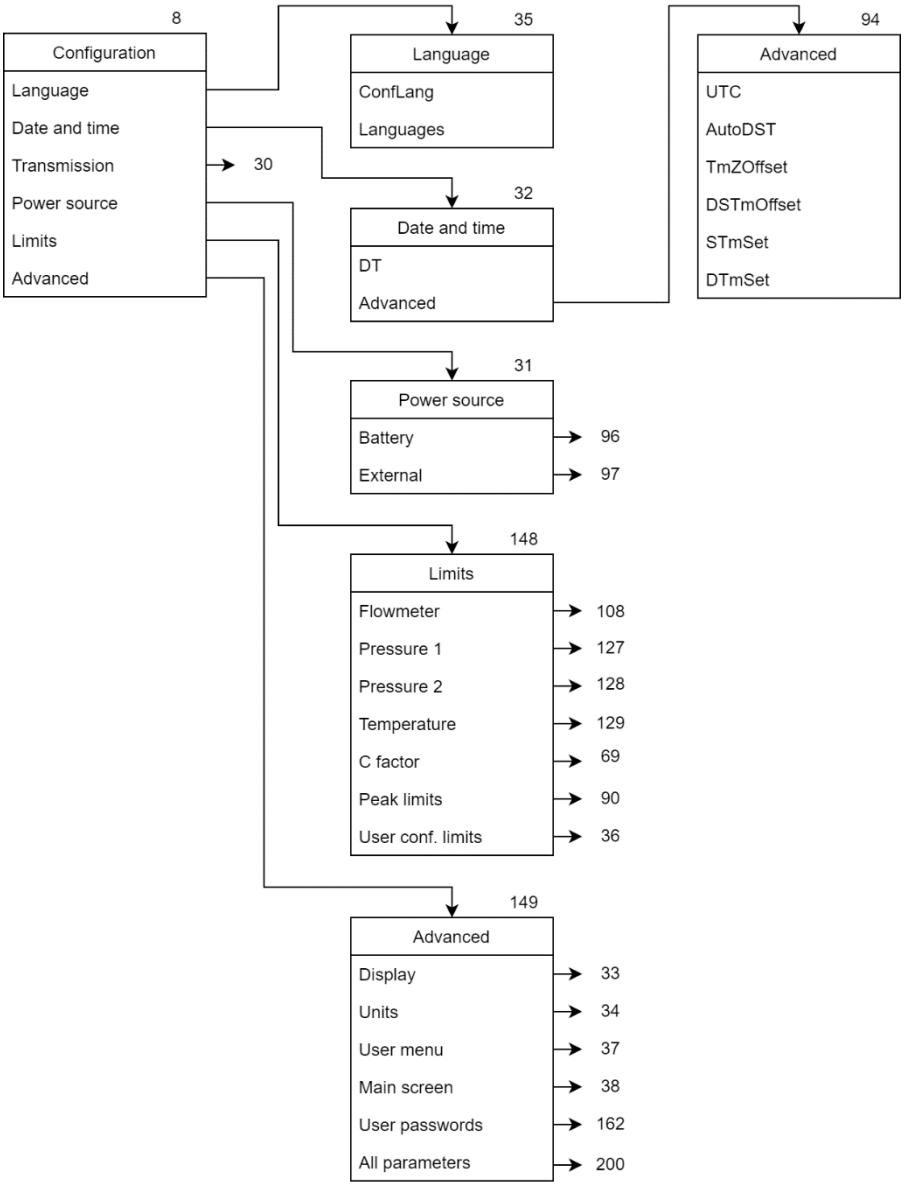
This menu allows access to most parameters important for “Load recorder” and “Maximum loads” functionalities.

7.11.12. Inputs and outputs



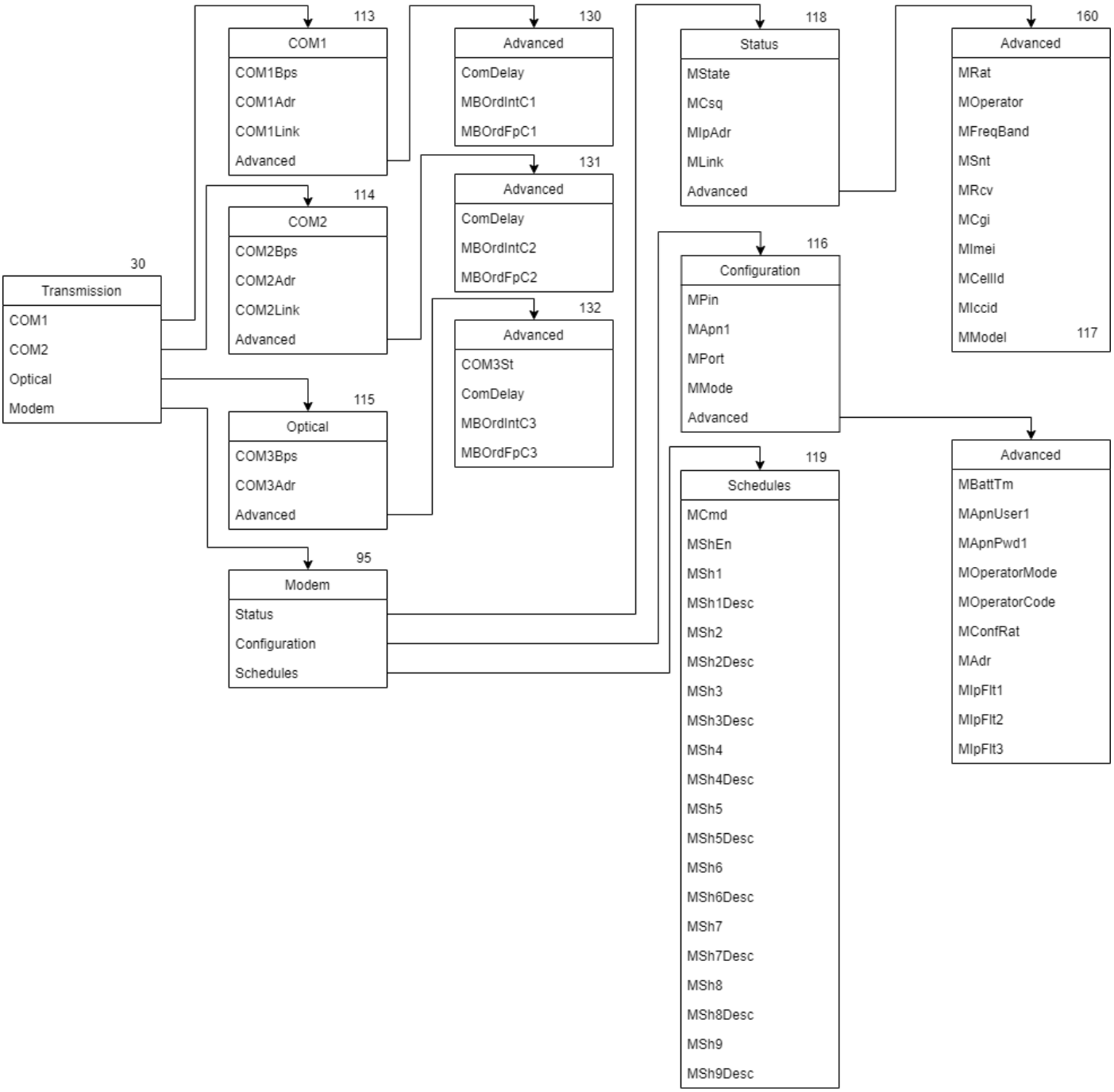
This menu contains configuration and current state of available digital inputs and outputs.

7.11.13. Configuration



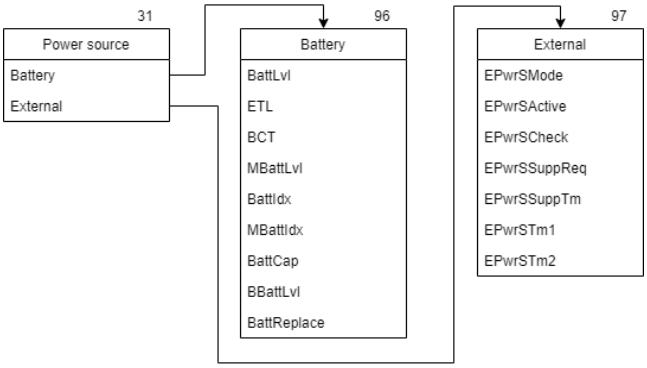
This menu allows to set configuration of all device's parts. Some of sub-menus are expanded below.

7.11.14. Configuration – Transmission



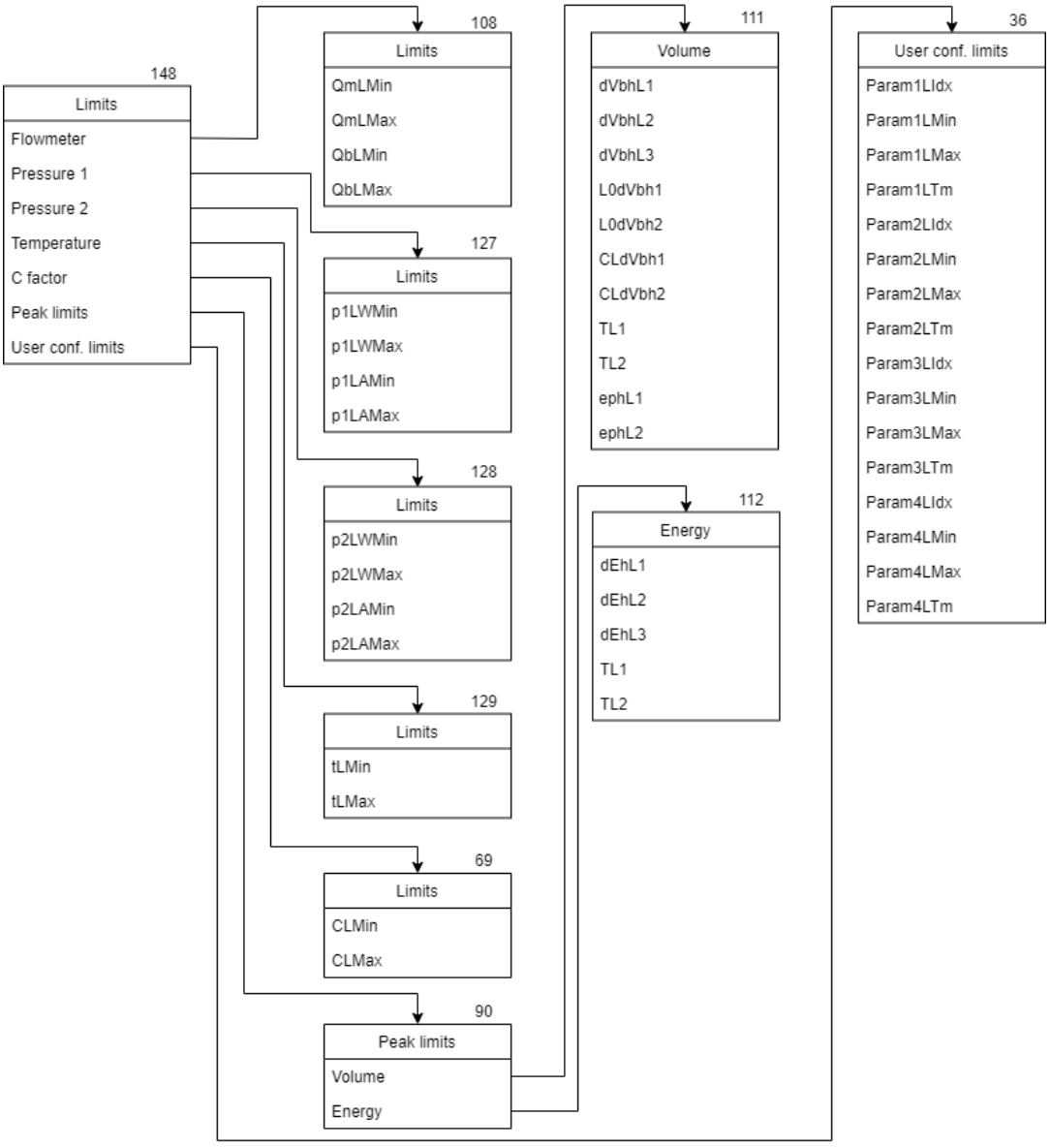
This menu contains settings and current state for transmission interfaces: serial, optical and modem.

7.11.15. Configuration – Power source



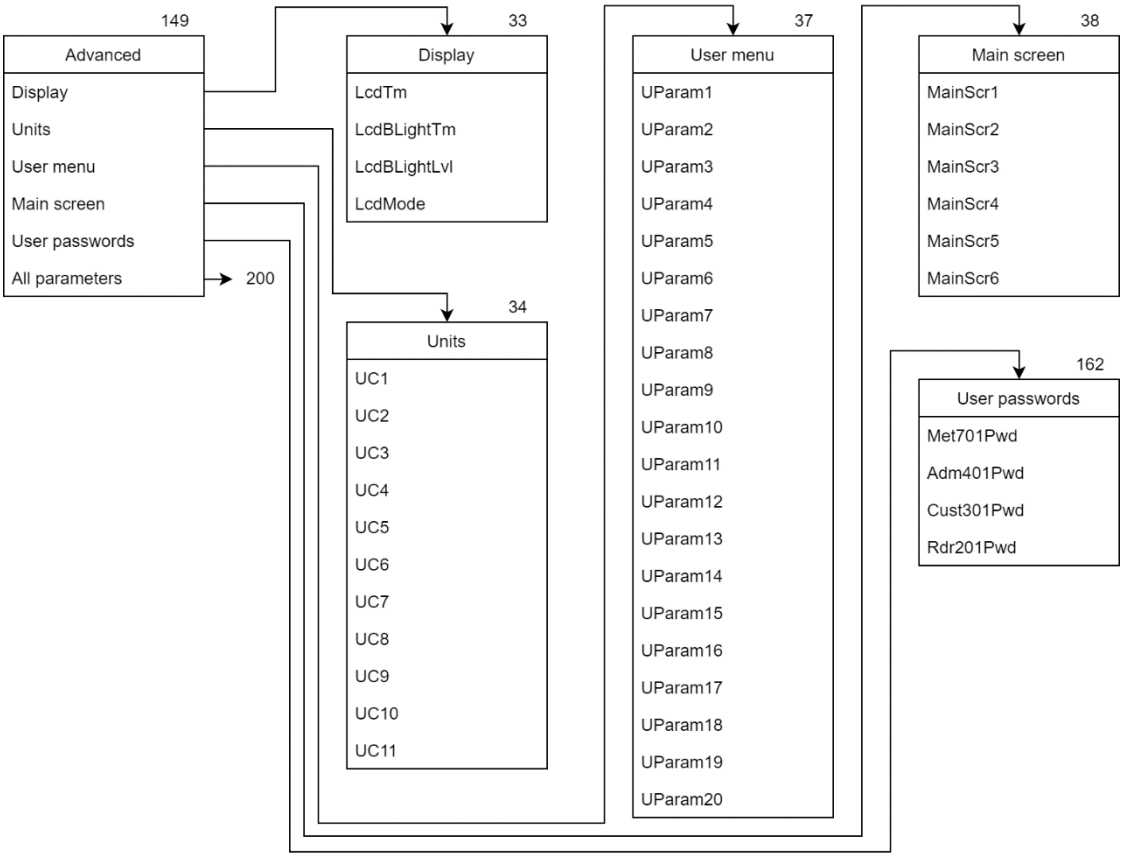
This menu allows to configure parameters for device's power source (battery or external).

7.11.16. Configuration – Limits



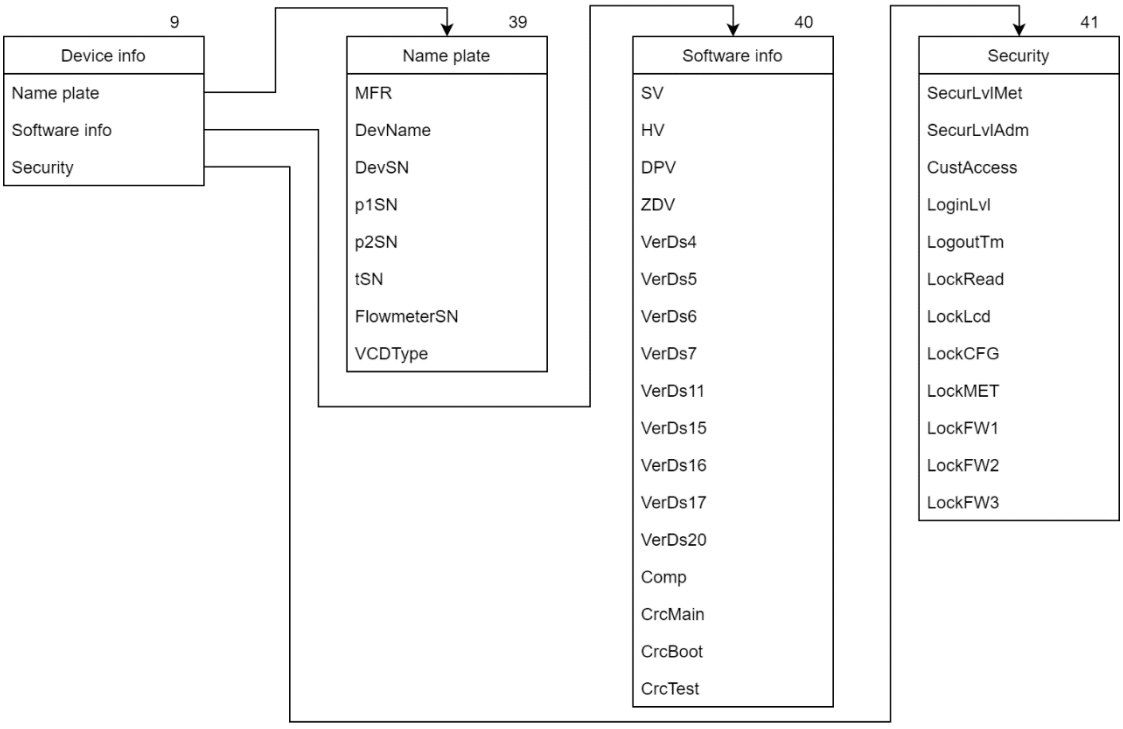
This menu allows to set various limits available in the device.

7.11.17. Configuration – Advanced



This menu allows to configure some advanced settings – display properties, units for values used in the device, set of parameters for user menu and for main screen.

7.11.18. Device info



This menu shows information about device: name plate, software information and current state of security settings.

7.12. Device main batteries

The device is powered from 1 up to 3 lithium batteries (see the list of battery types in point Technical data section Internal supply).

Batteries – depending on Customer order – can be designed to supply:

- complete device, without built-in mobile transmission modem (by default 1 battery);
- built-in mobile transmission modem (optional) (up to 2 batteries, by default 1 battery);

Life time of device equipped with 1 battery is over 5 years, assuming:

- Registration period set on 60 min.
- All of outputs, signalization inputs and transmission ports (wire without terminators) are inactive;
- LCD display is constantly switched off, keyboard not used;
- Operating temperature equals minimum of ambience temperature (-25 °C);
- Provided maximum pulses frequency on LF input (2 Hz);
- Measured gas pressure p1=p1max;
- Measured gas temperature t=tmin;
- Conversion factor recalculation period BCT=30 s;

The operating time of the mobile transmission modem powered by batteries is dependent on the modem usage.

When battery charge reaches 10 % of its remaining capacity, an alarm will be generated (***Battery low***), it's recommended then to start battery replacement procedure by setting the parameter **BattReplacement=1**.

7.13. Device backup battery

The backup battery maintains RTC clock setting in case of discharge or replacement of main battery. The backup battery may be replaced by authorized service after metrological seal is broken.

Only accepted types of backup batteries may be used. Please see the list in the point of Technical data, section Internal supply of this document.

7.14. External power supply

External power supply is required when using:

- HF inputs

External power supply is recommended for cases of high power usage:

- frequent communications
- frequent screen usage
- NAMUR/SCR encoder

Power supply is intrinsically safe type circuit, with intrinsic safety parameters given in paragraph Ex marking and parameters

External power supply of device should be connected to terminals 1, 2 – according to indications on wiring diagram. Parameters of power supply are described in paragraph General data

The cables used must meet requirements for type B cables in accordance with standard EN 60079-14 – in particular, wire insulation should withstand the test voltage 500 VAC and cannot be thinner than 0.1 mm (for insulation of polyethylene 0.2 mm).

7.15. Power modes

There are two available modes for supplying the device, which are described below:

- **BATT** – battery mode, no telemetry equipment, standalone device, no power supply, locally read or through integrated modem in schedules mode. Features of this mode:
  - serial ports COM1 and COM2 are inactive – temporary work of COM2 is available on battery when the device housing is opened – active alarm Case Open – purpose is configuration on site
  - Digital Outputs work only as the binary, refreshing of the state depends on actual set of the device measurement cycle.
  - HF counters are unavailable – DI6 and DI7 can work only as the NAMUR state inputs (and DI7 can also work as NAMUR encoder input)
  - Device measurement cycle is adjustable in range (6 ÷ 60) seconds
  - Modem operational only in Schedules mode

- **FULL** – external power supply mode, connection to INT-S3 or full telemetry cabinet, unlimited device readout and configuration via modem or serial transmission ports
  - serial ports COM1 and COM2 active all the time
  - Digital Outputs work in every mode, refreshing rate up to 1 second
  - HF counters available all the time
  - Device measurement cycle is equal to 1 second.
  - Modem operational in every mode

There is possibility to sustain FULL mode on batteries while mains power supply failures using parameter ***EPwrSTm1***. This parameter range is (0 ÷ 1440) minutes. This mode is temporary due to significant energy consumption while powering the device fully. Battery discharging rate is 0,3 % per hour. Additionally, when power supply is detected as inefficient, then time of sustaining of FULL mode is defined on parameter ***EPwrSTm2***. Usage is similar to ***EPwrSTm1***.

8. Device settings

After device installation and connection according to manual, it is necessary to configure device measurement system parameters. To ensure correct operation, it's recommended to program following parameters:

- Power supply mode
- Gas meter connection type
- Factors of LF and HF pulses – setting of pulse factors must be compatible with description on name plate of a gas meter
- Registration period (archival data saving)
- Gas parameters programming – gas parameters should be compatible with gas supplier analysis
- Volume at measurement conditions – Value of Vm in device should be the same as value of gas meter mechanical counter. Setting of the counter should be done with meter stopped.
- Time setting – current time should be set in the device
- Digital inputs
- Digital outputs
- Transmission parameters
- Zeroing range of pressure input p2 – if device has measurement pressure input with range up to 1.0 bar, it is necessary to do zeroing.
- Activate accounts of users, which will have access to device configuration

It is possible to make also additional settings, not related to device installation, which can be treated as extra features:

- Units change
- User defined parameters – User menu
- Limits
- Bar graphs
- Additional registration

8.1. Power supply mode setting

To setup the power supply mode:

- Go to Main menu by pressing Enter
- Navigate to menu Configuration → Power source → External
- Press enter on parameter ***EPwrSMode*** and choose proper option: BATT/FULL

8.2. Pulse inputs configuration

EVC enables several options for gas meter connection. To check the possibilities of connection, navigate through menu:

- Go to Main menu by pressing enter
- Navigate to menu Measuring Inputs → Flowmeter
- Press enter on parameter ***ConfImp*** and choose the proper option corresponding to the type of used gas meter

Available inputs:

- STOP – counters stopped, mode designed for gas meter replacement or initial configuration doing when the meter is already connected
- LF – Low Frequency input, by default frequency up to 2 Hz (optionally up to 60 Hz - it depends on hardware version of the device), cooperation with Wiegand transmitters
- HF – High Frequency input, frequency up to 5000 Hz
- EN – NAMUR Encoder input – digital communication with gas meter
- SCR – SCR absolute encoder input

Principles:

- Single position like LF1 means only this one input is used for increasing Vm counter, no control input
- Two positions such as HF1/HF2 mean first input is used for increasing Vm counter, second one is used for control counter V2
- Two positions such as D-LF1/LF2 and D-HF1/HF2 mean the volume is increasing or decreasing depending on the flow direction

Please note HF pulse inputs will work only when EVC is connected to external power supply source. Battery powered EVC can supply only LF and SCR input.

Extended description of pulse inputs can be found in Counting inputs

8.3. Pulse factor configuration

Pulse factor setting can be done by navigating through the menus:

- Go to Main menu by pressing enter
- Navigate to menu Measuring Inputs → Flowmeter → Pulse factor
- Press enter on parameter ***LF1/LF2 Factor*** or ***HF1/HF2 factor***
- Set proper value on the display

Please note the pulse factor unit in EVC. It is imp/m3. Some gas meters can have pulse factor expressed in unit m3/imp. For instance: 10 imp/m^3 is equal to 0.1 m^3/imp

8.4. Encoder configuration

Encoder input is designed for establishing uninterruptible communication with gas meter basing on the digital data transmission between gas meters and volume converters. Transmission is done through periodical sending gas meter counter absolute state. EVC saves the value obtained from encoder to Vo counter and rewrites it to Vm counter. It is required to follow certain steps to configure the input in right way.

Properly configured gas meter equipped with encoder should have synchronized counter between EVC – in the meaning of counter Vo – value read from encoder.

When primary gas volume input is set to EN/SCR mode further modifications of Vm counter are not possible.

First – prepare the configuration. After setting the configuration connect the Encoder output to volume converter. Opposite way of work may cause in significant undesirable increase of main counter.

Configuration procedure:

- Set the ***ConfImp*** parameter to STOP
- Set ***Vm*** and ***Vm2*** counters to the ones corresponding to gas meter totalizer.
- Connect the wires responsible for Encoder communication
- Change ***ConfIimp*** parameter to EN/SCR
- Wait until the communication will be established

Encoder usage has influence on battery lifetime. By default, communication with encoder is set to every 5 minutes with possibility to reduce this time to 1 minute. Externally powered device communicates with encoder every 6 seconds.

8.5. Registration period settings

Device allows for changing the registration period of the samples in the memory – available range is from 1 to 60 minutes (full dividers of 60: 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60). More frequent saving data – shorter horizon of data storage in the memory. Another important parameters are gas day start and gas month start.
To change the registration data settings:

- Go to Main menu by pressing enter
- Navigate to menu Data → Configuration → Basic
- Press enter on parameter to change its value

Available options:

- ***Dtau*** – samples registration period in Periodic archive, from 1 to 60 minutes
- ***BillingHour*** – hour of gas day start. By default – 6:00
- ***BillingDay*** – day of gas month start. By default – 1 – 1st day of the month

8.6. Compressibility factor calculation settings

Gas composition and algorithm settings can be uploaded to EVC through the keyboard.

To change the method of compressibility factor calculation:

- Go to Main menu by pressing enter
- Navigate to menu Gas and conversion → Algorithm
- Press enter on parameter ***ConfAlgZ*** to choose one of available method

Available options:

- SGERG-88
- AGA8-G1
- AGA8-G2
- AGA NX19-mod
- AGA8-92DC
- SGERG-mod-H2
- K1=const.

Every algorithm requires gas composition setting in a next step. All of them except AGA8-92DC require simplified gas composition. If there is no simplified gas composition for each of them it is possible to use full gas composition instead if provided.

To switch the gas composition from simplified to full it is necessary to perform action:

- Go to Main menu by pressing enter
- Navigate to menu Gas and conversion → Algorithm
- Press enter on parameter ***ConfSGS*** to change the value

Available options:

- Simpl. – converter will be using simplified gas composition for calculations
- Full comp. – converter will be using full gas composition for calculations

8.7. Gas composition settings

To setup the gas composition:

- Go to Main menu by pressing enter
- Navigate to menu Gas and conversion → Gas composition

Case I: simplified gas composition Gas and conversion → Gas composition → Simplified	Case II: full gas composition Gas and conversion → Gas composition → Full
Press Enter on each parameter to change its value.	Right after selecting this menu, a selection box will appear, to choose between preview/edit of existing composition or to start from scratch. First parameter visible in the menu is ***GasProc*** – this parameter relates to new gas composition percentage consistence. Press Enter on each parameter to set the new value. Press esc to store/discard changes. When new gas parameters will be uploaded ***GasProc*** must equal 100 +/- deviation from 100 % set in Gas and conversion → Gas composition → Advanced → ***GasNorm***

It is highly recommended to set gas composition using software. Keyboard allows for configuration of gas composition; however, the process is time consuming. Manufacturer suggest to use software for taking these steps in configuration.

8.8. Measurement counter Vm setting

To setup the measurement counter (Vm) value:

- Go to Main menu by pressing Enter
- Navigate to menu Counters and flow → Volume → Current
- Press Enter on parameter ***Vm*** to change the value of gas meter

First remember to set proper gas meter inputs variant what is described in paragraph Pulse inputs configuration

In case of using Encoder functionality – ConfImp set to SCR or EN, Vm will be adjusted automatically.

8.9. Limits settings

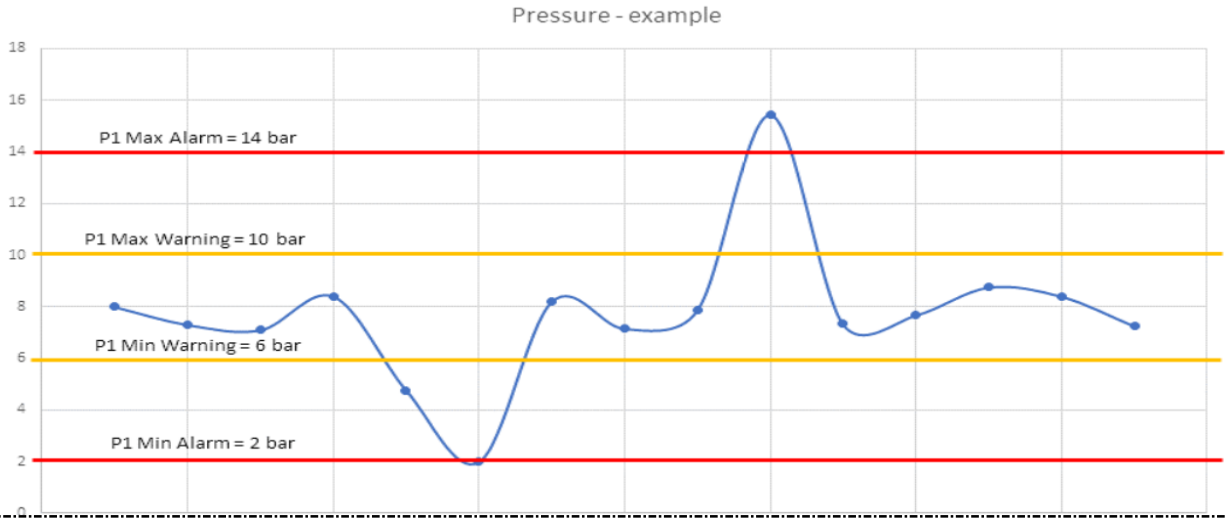
To setup the limits in the device:

- Go to Main menu by pressing Enter
- Navigate to menu Configuration → Limits
- Choose limit to set basing on the category

Available limits:

- Pressure 1 – pressure used for PTZ calculation
- Pressure 2 – secondary pressure used for pressure regulator monitoring
- Temperature – temperature used for PTZ calculation
- Limits of flow – nominal and base flow limits
- C limits – limits for conversion factor
- Peak limits – limits for hourly increments of volume and energy
- User conf. limits - user defined parameters for parameters not included in list above

Every value except for Pressure 1/2 has one low and high threshold for the limits. Pressure 1 has warning and alarm thresholds which are explained in given picture.
Warning – exceeding having not significant impact on gas station work. To monitor, not to react.
Alarm – exceeding of this threshold should indicate gas station supervisors immediate reaction is necessary.



8.10. Substitute values settings

Substitute values for pressure and temperature are the ones taken for PTZ calculation when device works in error conditions, for example pressure out of range, temperature out of range.

Substitute pressure is important for device in variant Temperature corrector. This settings set the pressure for fixed value used constantly for calculation.

To setup the substitute pressure value:

- Go to Main menu by pressing Enter
- Navigate to menu Measurement inputs → Pressure 1 → Advanced
- Press Enter on parameter ***p1subst*** to perform changes

To setup the substitute temperature value:

- Go to Main menu by pressing Enter
- Navigate to menu Measurement inputs → Temperature → Advanced
- Press Enter on parameter ***tSubst*** to perform changes

8.11. Digital inputs configuration

Device is equipped with up to 8 digital inputs which can be adapted as the counters input or binary inputs for gas station supervisory. Some of the inputs are shared with the following counters options, then they cannot be used as the digital input.

	DI1 binary	**DI2 binary**	**DI3 binary**	**DI4 binary**	**DI5 binary**	**DI6 Namur**	**DI7 Namur**	**DI8 binary**
LF			X	X				
HF						X	X	
SCR								X
EN							X	
TS					X			

Example: input configuration is set to LF1/HF1.

Available inputs to be used as DI: 1-2-4-5-7-8

Tamper switch is configured by default on DI5 by Manufacturer.

To setup the digital inputs:

- Go to Main menu by pressing Enter
- Navigate to menu Inputs/Outputs → Digital inputs → Configuration
- Press Enter on parameter to perform changes

Available parameters:

- ***DIOn*** – status of currently available digital inputs – read only.
- ***ConfDI*** – parameter responsible for turning on DIs in the system. Slide left – input turned off. Slide right – input turned on.
- ***DIPol*** – determining polarity of the input. Slide left – DI normally closed. Slide right – DI normally opened.
- ***EDI_1-8Src*** – source of external signaling inputs.
- ***EDI_1-8Pol*** – polarity of external inputs. Slide left – DI normally closed. Slide right – DI normally opened.

8.12. Digital outputs configuration

Device is equipped with up to 4 digital outputs which can be used as binary – single pulses released when certain alarm, or group of alarms are active. Counter outputs – each increment of gas volume or flow makes the device

	DO1	DO2	DO3	DO4
Binary/Event	X	X	X	X
Counter	Vb, Vm, Vm2, E, Vme, Vbe, Ee, VbT, ET	Vb, Vm, Vm2, E, Vme, Vbe, Ee, VbT, ET	Vb, Vm, Vm2, E, Vme, Vbe, Ee, VbT, ET	Vb, Vm, Vm2, E, Vme, Vbe, Ee, VbT, ET
Frequency		p1, p2, t, Qb, Qm, QE, QM, AtmPress, p1g, tamb		

To setup the digital outputs:

- Go to Main menu by pressing Enter
- Navigate to menu Inputs/Outputs → Digital outputs → DO1/DO2/DO3/DO4
- Press Enter on parameters to change their values:

Available options based on DO2:

- ***DO2Mode*** – Event, Counter, Frequency. Determine the work mode of the output
- ***DO2Idx*** – related to Counter mode. Choice of counter corresponding to pulses on the output
- ***DO2Evt*** – related to Event mode. Choice of events code from events table – see the auxiliary document Data Structure
- ***DO2EvtTm*** – related to Event mode. Time of pulse lasting
- ***DO2PulseLen*** – related to Binary/Event/Counter mode. Length of the pulse in milliseconds
- ***DO2PulsePer*** – related to Binary/Event/Counter mode. Period of pulses in milliseconds
- ***DO2Factor*** – related to Counter mode. Pulse output factor. Example, value 1. 1 pulse per $1m^3$
- ***DO2Fidx*** – related to Frequency mode. Determination of parameter corresponding to output frequency.
- ***DO2Fmin/Fmax*** – related to Frequency mode. Setting the frequency range on the output.
- ***FOmin/FOmax*** – related to Frequency mode. Setting the value of frequency corresponding to min and max values of parameter set in ***DO2Fidx***.

8.13. Transmission settings

Device is equipped with up to three transmission ports. COM1: RS485 or RS232, COM2: RS485, COM3: Optical interface.
Another communication port is NFC, which does not require any configuration.

To setup the transmission ports:

- Go to Main menu by pressing Enter
- Navigate to menu Configuration → Transmission → COM1/COM2/Optical
- Press Enter on parameters to change their values

Available options based on COM1:

- COM1Bps – baud rate of serial port (up to 256 kb/s)
- COM1Adr – address of serial port

COM1 and COM2 ports work only while external power supply is connected to terminals 1 and 2 or 3 and 4 – to supply only COM ports. Optical port works uninterruptedly. Using COM on battery is available for COM2 for 5 minutes after opening the device housing.

8.14. Modem settings

It is highly suggested to configure the modem using software. Through keyboard there is possible only to configure basics and check several diagnostics parameters. There is no possibility to configure schedules and any advanced parameters using keyboard input.

To setup the modem:

- Go to Main menu by pressing Enter
- Navigate to menu Configuration → Transmission → Modem → Configuration
- Press Enter on parameters to change their values

Available options:

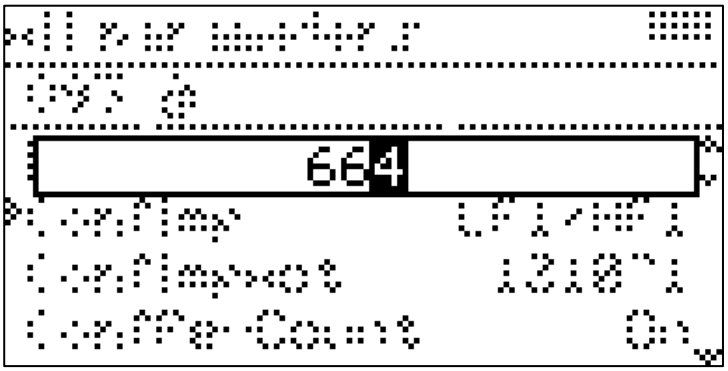
- ***MPin*** – PIN code to the SIM card
- ***MApn1*** – APN for used SIM card
- ***MPort*** – port for connection to the device through TCP/IP
- ***MMode*** – modem work mode. Schedules, Online mode, Online mode with Schedules
- Advanced
  - ***MBattTm*** – time of maintenance online mode on battery in case of mains failure
  - ***MApnUser1*** –APN1 username
  - ***MApnPwd1*** –APN1 password

8.15. New user accounts setting

When adding or removing accounts it is necessary to use at least account with the same level. Using account 70X it is possible to add accounts 70X/40X/30X/20X. Account 30X allows for adding only users 30X and 20X

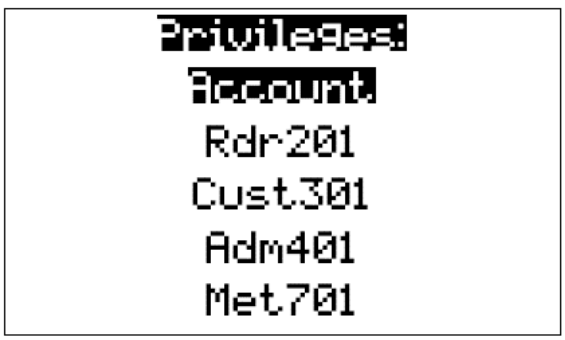
Steps to follow – keyboard:

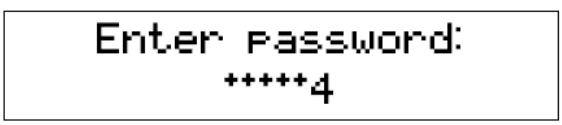
- Go to main menu by pressing Enter
- Navigate to menu Configuration → Advanced → All Parameters
- Press ← in the next window to show the "jump to" parameter box
- Using the Data Structure document navigate to the proper parameter number from the range 659-713 and choose the one corresponding to the managed account



Once enabled, account cannot be chosen from the list of default accounts on the choice list before parameter modification attempt. Account option enables manual input of the account number and password.

To turn off the account in the system password for this account must be changed to 0.



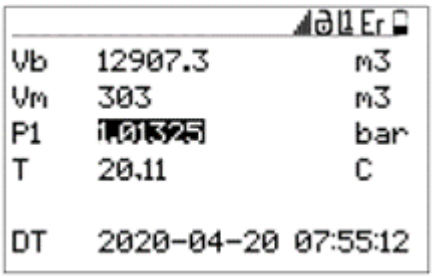


8.16. User defined screen parameters – Main Screen and User Menu

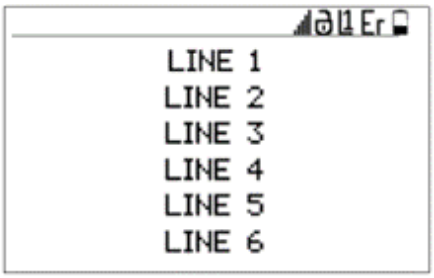
Device allows for unlimited parameters displaying on the main screen and the additional easily accessible user menu.

Default screen contains: Vb, Vm, p1, t, empty line, local date & time.

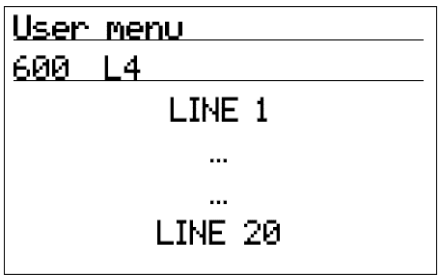
Pressing ↓ opens USER MENU which can contain 20 user adjustable parameters.



Default configuration



Adjustable lines



Menu after pressing ↓ button

Configuration of main screen parameters.

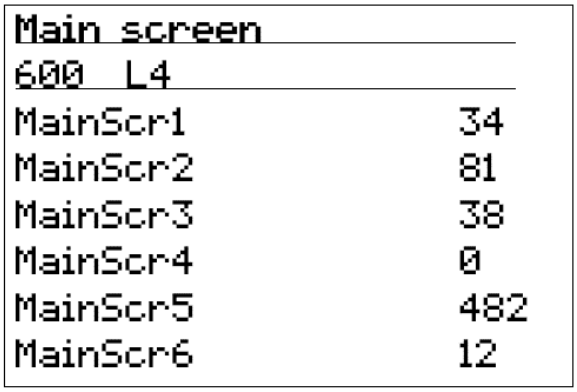
Steps to follow - keyboard:

- Go to main menu
- Navigate to menu Configuration → Advanced → Main screen
- Edit parameters ***MainScr1*** – ***MainScr6***

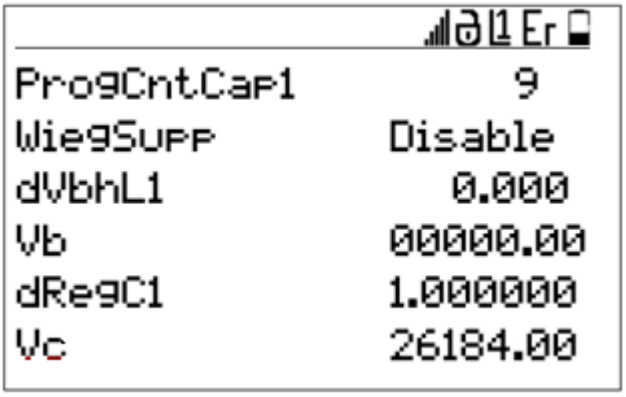
Using document "Data structure" obtain the numbers of the parameters in the DP table and program the desired index into the parameters ***MainScr***

281	p2Max.dc	Maximum value of pressure p2 (current day)
282	tAvg.dc	Average value of temperature t (current day)
283	tMin.dc	Minimum value of temperature t (current day)
284	tMax.dc	Maximum value of temperature t (current day)
285	QmAvg.dc	Average value of flow Qm (current day)

Example:



Setting of MainScr values



Effect on the main screen

Configuration of user menu parameters.

Steps to follow - keyboard:

- Go to main menu
- Navigate to menu Configuration → Advanced → User menu
- Edit parameters ***UParam1*** – ***UParam20***

Procedure regarding this menu is the same as for the main screen parameters – through keyboard type the indexes of the parameters in the fields corresponding to the following lines.

8.17. Base volume counter modification

By default, Vb changes are blocked in MID-compliant device. If your national regulations let to change Vb counter during using – please inform Manufacturer to activate this option during production process. If the option of Vb changes is active – to change of Vb the hardware switch MET needs to be opened. All changes are saved in the special memory – VbLOG protected against being cleared.

VbLOG is possible to be read by the display (see the menu structure below) or by using dedicated GazModem protocol command.

To setup the base counter (Vb) value:

- Go to Main menu by pressing Enter
- Navigate to menu Counters and flow → Volume → Current
- Press Enter on parameter ***Vb*** to change the value of base volume counter.

9. Data review

Device has ability to store measurement data in different periods of time, with possibility to choose set of registered parameters by user.

Device stores parameters containing:

- main and error (disturbance) counters;
- increments of counters (load records);
- peaks of increments of counters (maximum loads) + timestamps;
- measured value of pressure and temperature;
- measured additional and technological parameters;
- information about main properties of programmed gas composition;

9.1. Registered data review

Device allows for review of registered data from display.

To review the registered data:

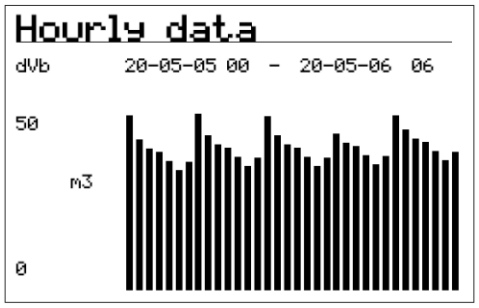
- Go to Main menu by pressing Enter
- Navigate to menu Data
- Press Enter on submenus to go into the different set of data

Available options:

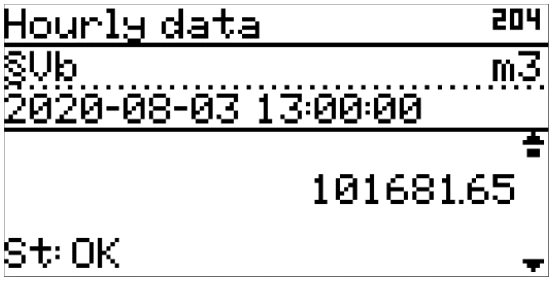
- Recorder – peak data with the time and date of appearing such value
- Periodic data – data saved with registration period
- Hourly data – data saved in the last finished hour
- Daily data – data saved in the last finished day
- Monthly data – data saved in the last finished month
- Momentary data – data saved in the momentary saving mode in error condition
- Periodic data 2 – data saved in previously defined moments of time

Navigation through the data:

↓↑	Moving through the data samples in time
→←	Moving through the types of data, switching between values, moving the bar graphs in time – graph view
Enter	Showing option for graphic presentation of registered data
Esc	Go back to previous menu



An example of archive data window:

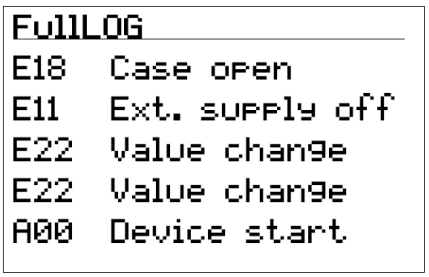


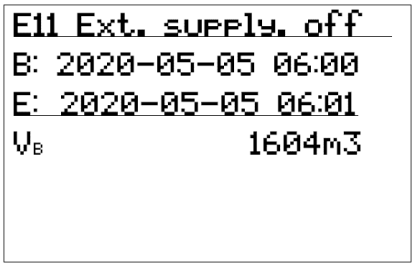
--- Type of data *menu number*
---§Param.name *Param.unit*
--- Timestamp
--- Param.value
--- Status of sample (OK / Err / TimeErr)

If the name of the parameter id preceded by the symbol of **§** - it means that the parameter has status "VERIFIED".

9.2. Alarms and events review

Device allows for review of alarms and events occurred in the device.





To review the alarms:

- Go to Main menu by pressing Enter
- Navigate to menu Alarms

Available options:

- FullLOG (active) – list of active alarms and events in the moment of entering the menu
- FullLOG – complete list of alarms and events – lasting and finished
- AlarmLOG (active) - list of active alarms in the moment of entering the menu
- AlarmLOG – list of Alarms – important from the metrological and accuracy point of view. Activeness of one of this alarms causes **Er** icon flashing on the display in top bar
- SetupLOG – list of alarms reserved for Manufacturer.
- TimeLOG – list of significant time changes
- GasLOG – list of gas composition changes
- VbLOG – list of Vb counter changes
- System status – vector of the alarms
- Configuration – clearing the memory log

Navigation through the alarms:

↓↑	Moving through the alarms in time
→←	Moving through the names of the alarms and beginning date
Enter	Showing details of the alarm
Esc	Go back to previous menu

Full alarm list with complete description available in Data Structure document.

10. Configuration using PC/Windows software

This paragraph presents the software designed for configuration and diagnostic of devices. The user-friendly graphic interface allows basic and extended configuration. Software supports local firmware upgrade in the devices without additional interfaces. It also stores a list of previously connected devices and allows for quick navigation between them.

To connect with the device use serial communication on RS485 ports or Optical interface using Optical Head – e.g., OptoBTEx

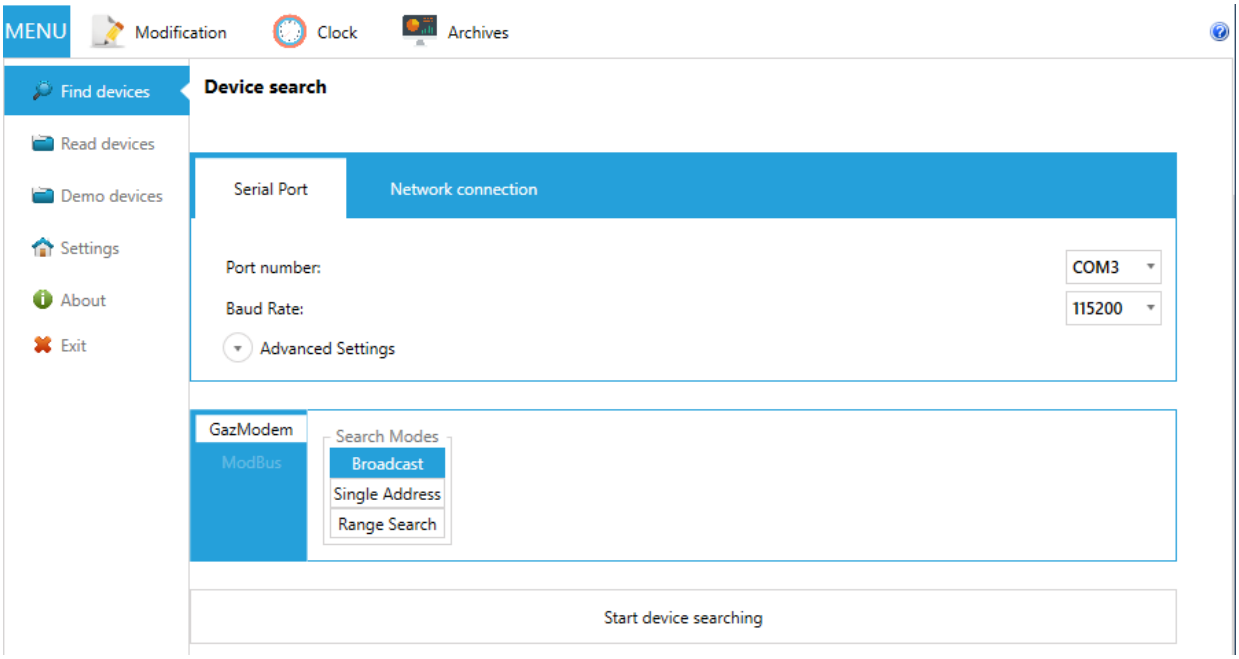
Full manual explaining Software work and principles is available as the auxiliary document. Read the manual before starting device configuration.

When device is working in Ex Zone already – do not connect the RS485 communication interface directly to the device. Connect the interface to safety barrier, e.g., INT-S3 interface.

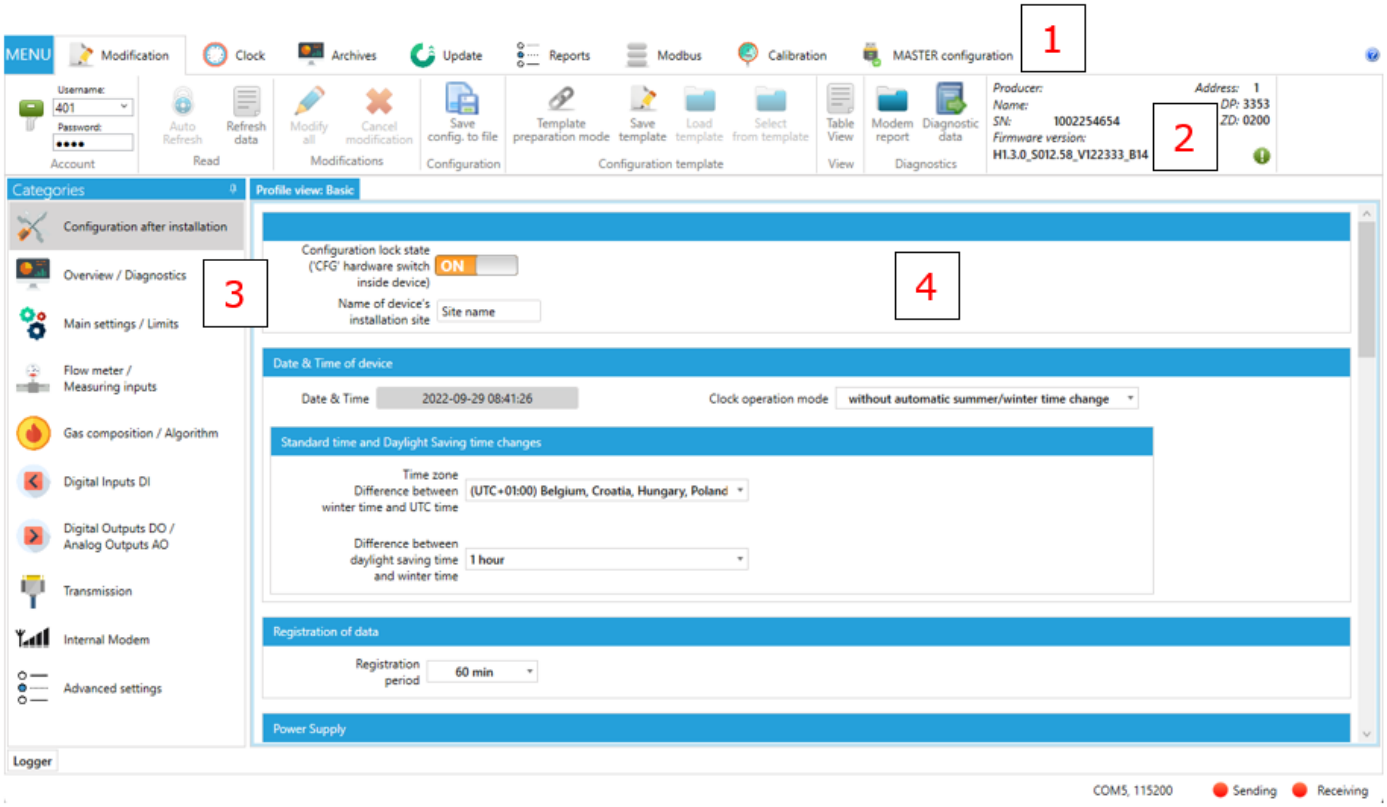
When device is configured on the table it is possible to use e.g., USB-RS485 interface directly with the device. Connect the 5V supply from the interface to terminals 1-2 – POWER SUPPLY to power up the device and start communication with COM ports.

10.1. Device searching and main program view

- Choose proper COM port in computer corresponding to connected interface.
- Adjust the baud rate to the one set in the device configuration
- Click on the button Start device searching



Basic view over the software interface:



1. Main tabs panel – switching between software functions
2. Function buttons
3. Categories with thematically grouped parameters
4. View of parameters inside the category

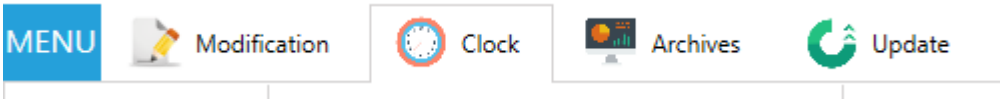
View consisting of 3 & 4 is called later PROFILE

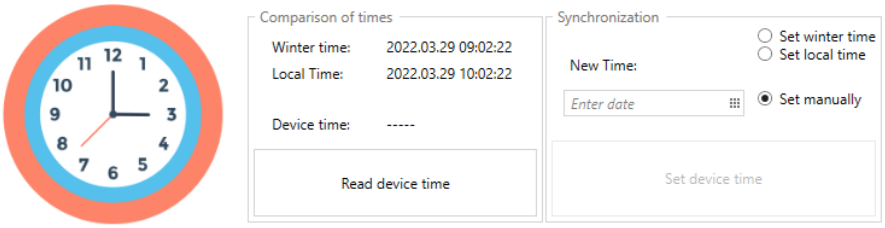
When software does not show the profile for the device, only list of parameters, please inform Technical Staff of Manufacturer.

Remember to use proper username and password when saving the data to the device. Usernames and passwords are described in paragraph **7.4. Passwords and privileges**

10.2. Clock adjustment

First setting which is worth mentioning and important from the point of view of device configuration is clock setting done in Clock tab:





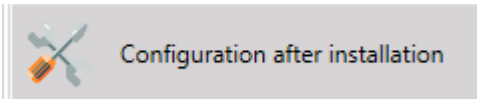
Clock can be set according to following assumptions:

1. Setting local time – downloaded from PC which is used for device configuration.
2. Setting winter time – downloaded from PC which is used for device configuration. Device uses also programmed time shift between winter and daylight saving time to show winter time.
3. Manual time – type the time manually.

Wrong date and time will cause in improper timestamping of registered data and making the modem to execute the schedule in wrong time (correct for EVC, not real time).

10.3. Configuration after installation

First category in the profile is most essential for the successful device configuration. All the parameters from this section are necessary for basic device operation. Configuration process is related to the one presented in **8. Device settings** section with similar order of performing changes.

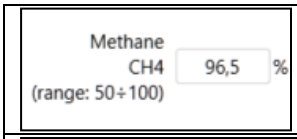


Parameters and fields may repeat between various categories, such as registration period, time zone setting. Reason of that is "Configuration after installation" category is the one where most crucial settings are included and when speaking of simplified device setting, it is set of parameters necessary for just an initial device startup. Rest of the categories may include repeated sections but in extended way.

Values possible to set in this category:

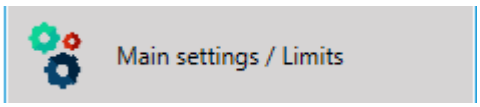
1. State of CFG lock – read only
2. Setting time change mode
   a. Only winter time
   b. Only summer time
   c. Automatic time change
3. Setting time zone
4. Setting registration period of the values in the memory of device – 1 to 60 minutes
5. Setting billing hour
6. Power supply mode:
   a. Battery mode – work only on battery, no external supply connected, no solar, standalone device
   b. External mode – work with telemetry set, possibility of work with HF inputs from gas meters
7. Flow meter connection type – way of volume registration from flow meter
8. Volume measured from flow meter counter – Vm – setting
9. Pulse factor for flow meter
10. Flow meter data – ranges and SN
11. Substitute values for pressure and temperature when error appears
12. Algorithm of gas compressibility factor calculation setting
13. Gas composition setting
14. Transmission setting – COM ports baud rate and address settings
15. Passwords for access accounts

When setting full gas composition there is a checking mechanism which examines is the gas composition equal to 100 % and are the single factors within their ranges given in **3.5.1. Ranges of using gas composition parameters**

	Range of each parameter is presented below the description
	Proper composition – equal 100 % is indicated by the percentage counter on the right top corner.
	Deviation exceeding programmed one will be indicated by red frame over the window.

10.4. Main settings / Limits

Category containing main settings and limits. Except of settings known from Configuration after installation category, there is possibility to set here the general limits for the device.

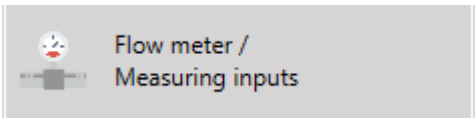


Values possible to set in this category:

1. Device menu language
2. User descriptions – site name, additional notes
3. Date and time settings
4. Registration period, billing hour, billing day
5. Power supply mode – FULL or BATT
6. Battery level setting
7. Measuring cycles setting
8. Passwords for access accounts
9. Clearing alarms memory
10. Limits:
    a. Qm limits
    b. Qb limits
    c. P1 limits
    d. P2 limits
    e. T limits
    f. User defined limits – up to 4.
11. Limits of peak hour values

10.5. Flow meter / Measuring inputs

Category containing measuring inputs in the device. In details: pressure, temperature, volume, communication with external modules.



Values possible to set in this category:

1. Flow meter connection type – way of volume registration from flow meter
2. Volume measured from flow meter counter – Vm – setting
3. Pulse factor for flow meter
4. Flow meter data – ranges and SN
5. Substitute values for pressure and temperature when error appears
6. Ranges of pressure and temperature sensors
7. Calibration of pressure and temperature sensors – coefficients and zeroing
8. Flow meter curve correction setting
9. Communication with external modules – this paragraph is described separately in Master mode configuration – external modules readout

10.6. Gas composition / Algorithm

Category containing settings of gas composition – full and simplified. Choice of compressibility factor calculation algorithm and device base conditions.

Values possible to set in this category:

1. Algorithm of gas compressibility factor calculation setting
2. Gas composition setting
3. Base conditions change – require unlocking MET switch
4. Turning on registering events when GC is changed

10.7. Digital inputs DI

Category containing settings of Digital Inputs in the device.

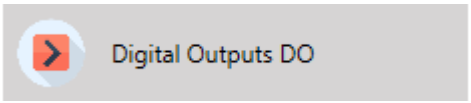
Values possible to set in this category:

1. DI turning on – enabling DI to be used
2. DI polarity – whether it should be NC or NO – reaction on short or break of circuit
3. DI description – up to 14 digits

DI3 and DI4 are shared with LF inputs. DI6 and DI7 are shared with HF inputs. Once the input is reserved for gas meter it cannot be used as the binary. Proper information is showed above the input – see the example of DI3.

10.8. Digital outputs DO

Category containing settings of Digital Outputs in the device.

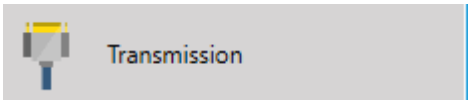


Values possible to set in this category:

1. DO turning on – enabling DO to be used
2. DO mode:
    a. Pulse output controlled by counter – NC/NO
    b. Pulse output controlled by event status – NC/NO
    c. Pulse output controlled by event status in single pulse – NC/NO
3. DO description – up to 14 digits
4. Parameters controlling pulse outputs:
    a. Counter for pulses replication
    b. Event for events signaling
    c. Pulse factors for counters
5. Frequency output settings on DO2:
    a. Parameter controlling frequency output
    b. Range of frequency of frequency output
    c. Range of value to adjust the output frequency
6. Collective alarms for "Event" mode of controlling the output

10.9. Transmission

Category containing general settings of the serial transmission ports. Setting of transmission speed on single one COM port, order of sent bytes in Modbus protocol.

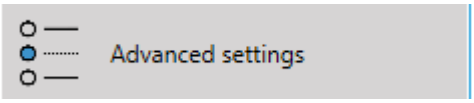


Values possible to set in this category:

1. COM1 settings:
    a. Baud rate
    b. Address on port
    c. Bytes order in transmission

   d. Parity settings
   e. Protocols activated on COM1 port
2. COM2 settings:
   a. COM2 work mode – standard COM port, transmission port used for communication with external devices in Master mode
   b. Baud rate
   c. Address on port
   d. Bytes order in transmission
   e. Parity settings
   f. Protocol activated on COM2 port
3. COM3 (Optical port) settings:
   a. Baud rate
   b. Address on port
   c. Bytes order in transmission
   d. Parity settings
   e. Protocols activated on COM1 port
4. NFC turning on or off, selection of supported protocols
5. Transmission delay on COM ports

10.10. Advanced settings



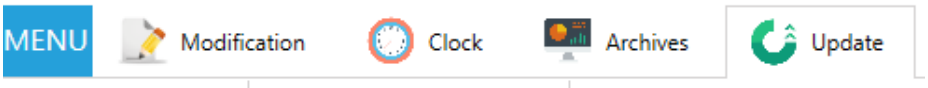
Category containing additional settings not classified in previous chapters of this document, which are related to various device features, not essential to set, however for full device experience it is suggested to review these settings.

Values possible to set in this category:

1. Device units change – MET lock opening required
2. Display settings:
   a. Display on time
   b. Backlight on time
   c. Contrast and brightness
3. Capacity of main counters
4. Main screen parameters and user menu settings – definition of the parameters visible on the screen
5. Additional registration settings – user defined registrered data
6. Passwords for 20x/30x/40x accounts
7. Security settings

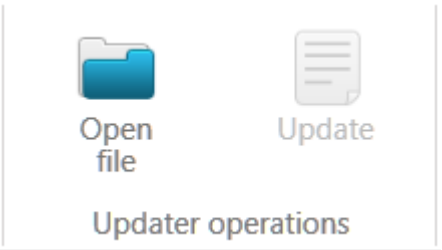
10.11. Firmware upgrade

Device allows for firmware upgrade under certain conditions. To do this it is necessary to use Update tab on the top bar.



Update tab allows for uploading files for the device. These files can include:

- New firmware version
- New Modbus map
- New Menu map



Procedure of uploading new file:

- Click “Open file”
- Navigate to the proper file
- Click on “Update” button and wait for the prompt informing about success of the process

Be aware of the consequences of actions done using this tab. Always use files directly from device Manufacturer technical staff. Do not combine the files from various devices. High risk of device malfunction or work cease.

File extension format accepted by the software - ***.pfp**

10.11.1. Firmware integrity check

Always the firmware provided by manufacturer will be a PACK – which contains at least: firmware engine, resources, parameters and menu map.

It is possible to upgrade the firmware, but downgrade is forbidden.

Upgrade requires level minimum 4 – Administrator.

Each firmware is signed with CrcMain checksum.

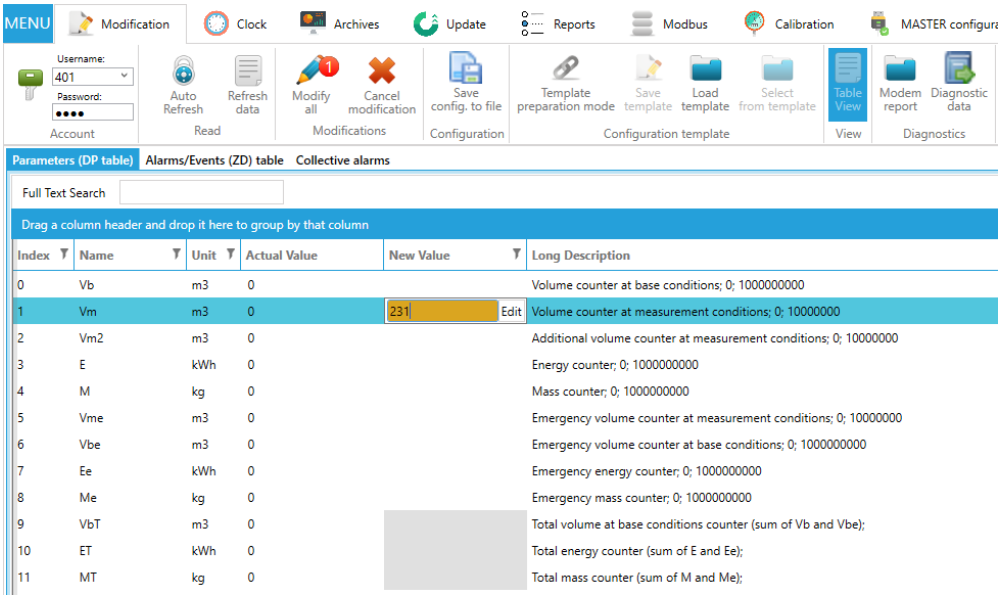
Program CRC is showed on the Conformity Check document. Once CRC does not match, MID conformity check is not valid anymore. For devices without MID Conformity Check this causes loss of warranty due to unauthorized firmware intrusion.

10.12. Table view

PC software allows also for the full configuration over the raw device parameters table.

Modification of parameters through the raw table is burdened with risk of adverse effect. This mode is aimed for advanced users knowing the data structure and meaning of each parameter.

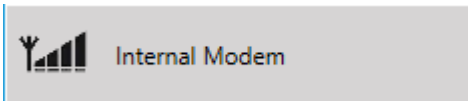
There are no hints or text descriptions of each value. Each modification is done by editing the numeric values representing functions. In some cases, wrong modification can lock the device.



Modification is being done similarly to the one in graphic profile mode. New value must be put in the "New Value" column and left there for modification. Field with changed but not accepted value will be highlighted in orange.

Gray boxes in the New Value column mean this parameter is not modifiable.

11. Internal modem configuration



Internal modem configuration is the paragraph related also to the device configuration using PC / Windows software. However, modem settings is advanced process which require wide description. Internal modem is treated as the additional accessory not necessary for the device to serve with its basic purpose of volume conversion.

Modem configuration has been redesigned in newest firmware revision adding new functionalities such as:

- Autonomous data transfer to eWebTel system and alternate HTTP servers – PUSH mode
- Setting of transferred data
- Data sending immediately out of schedule when collective alarm started.
- Choice of mobile transmission network connection mode
- Choice of preferred mobile network provider (roaming cards)

Values possible to set in this category:

1. General modem settings
    a. APN
    b. PIN to SIM
    c. Network operator selection
    d. Network mode selection
2. Modem operation mode:
    a. Online mode on External power supply
    b. Schedules
    c. Online mode on External power supply + Schedules
3. Collective alarms settings (repeated from Digital Outputs)
4. Protocol supported when modem is online
5. Access Control List setting – permissible IP addresses
6. Modem diagnostics
    a. Modem session status
    b. Modem error status
    c. General connection parameters
7. Modem operation test

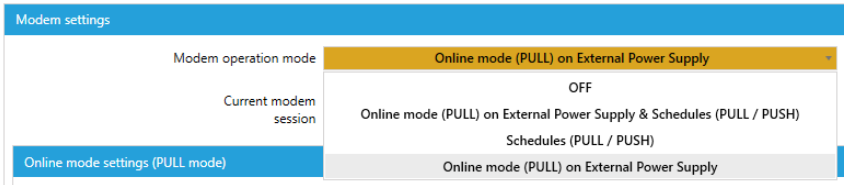
11.1. Configuration of Online mode on External power supply

Assumptions:

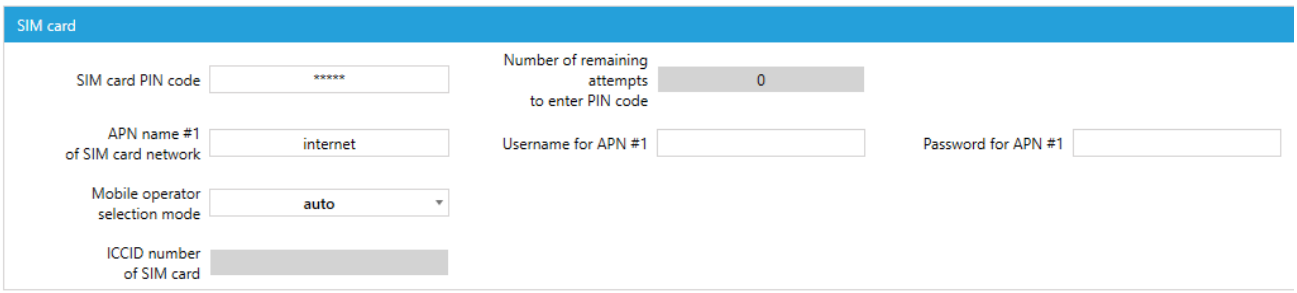
- EVC is used with uninterrupted power supply source which guarantee device operates in FULL mode constantly.
- Used SIM card uses Static IP – does not refresh to new one with each connection
- Device is not sending any data autonomously; it awaits for queries from the reading system

11.1.1. Configuration procedure

1. Choose presented option in "Modem operation mode field"



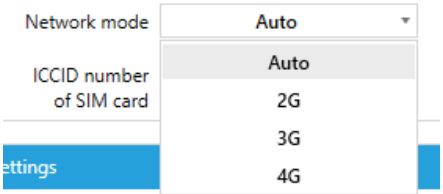
2. Fill the fields with data of SIM used in the EVC

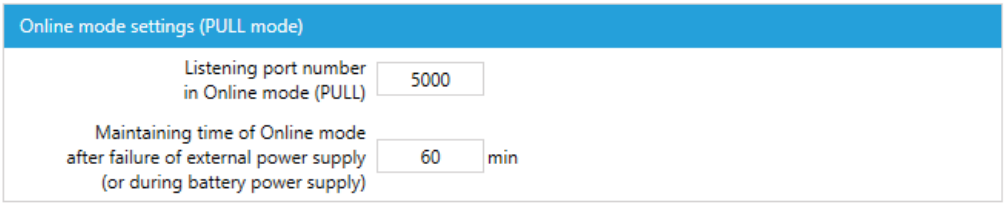


- PIN to SIM card: if not used, leave field unchanged. Even if some value is stored there it is not used when card has PIN turned off.
- APN: access point name for the SIM. APN is usually given with the SIM.
- Username / Password for APN: Especially important for the private type APNs, where access is protected additionally by credentials.
- Mobile operator selection mode – parameter important when using roaming SIM and it is intended to use single operator.
    - Auto – modem connects to a bast available network and transmission technology. Network and technology may be changed automatically during active reporting (even many times) - prolonging reporting time and consumed energy;
    - Manual – modem connects to only one defined network (and transmission technology);
    - Preferred – modem tries to connect to preferred network (and transmission technology) on first priority, but if it fails - continue reporting in Auto mode (**recommended option** because of energy saving);
- Choice of priority mobile network provider is done by typing string called MCC/MNC code. List of these codes can be found on website: https://www.mcc-mnc.com/

We put code as MCC+MNC without space between them. Example below.

- Network mode: depending on the used mobile transmission modem, device can work using different technologies. The higher energy consumption is when using LTE cat.1 standard (4G), so to save the battery energy it is recommended to change standards to any other available (it depends on properties of SIM card, selected cellular base station etc.).

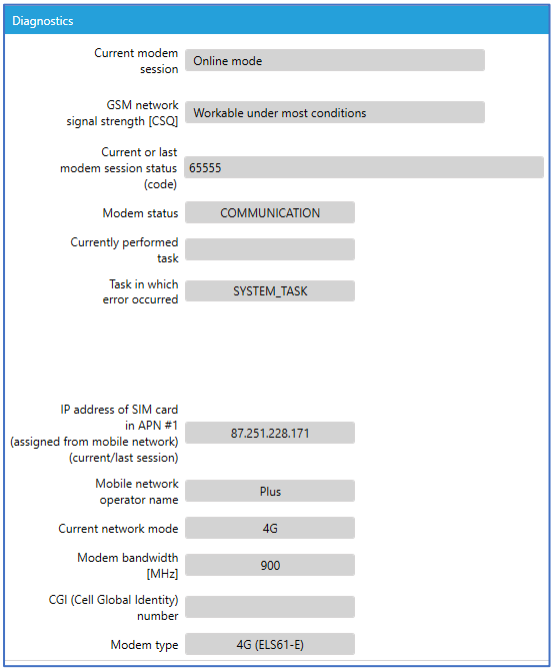




- Listening port number: port on which EVC will be accessible online. Connection address should then have form as following <IP address of SIM>:<Port>, i.e., 192.168.0.1:5000. This whole address is required to establish a connection with EVC.
- Maintaining time of Online mode after external supply failure: as described. In some unexpected conditions of power blackout, device will keep Online mode for defined time. Attention: online mode requires significant amount of energy. Using it on battery leads to quicker battery discharging.
- Used APN: As per description of APN meaning.

3. Once all parameters are programmed, save them, and wait. Modem shall automatically turn on.

In section Diagnostics modem connection should appear as presented:



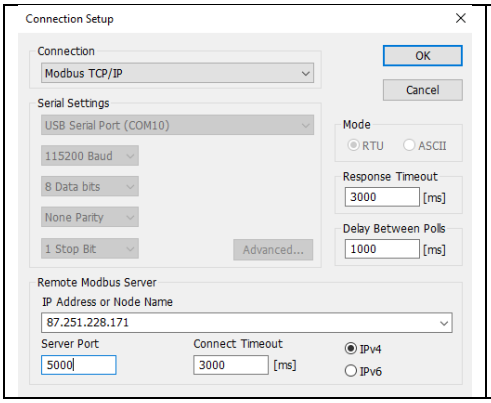
Modem started work in Online mode.

Mobile transmission is presented as workable.

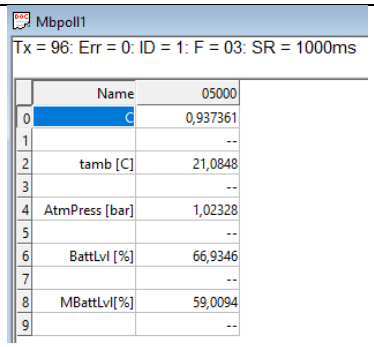
Current system task is presented. For Online Mode constant information "COMMUNICATION" should be visible.

IP address and all network parameters shall be visible in given fields.

Connection test using external software in Modbus protocol:

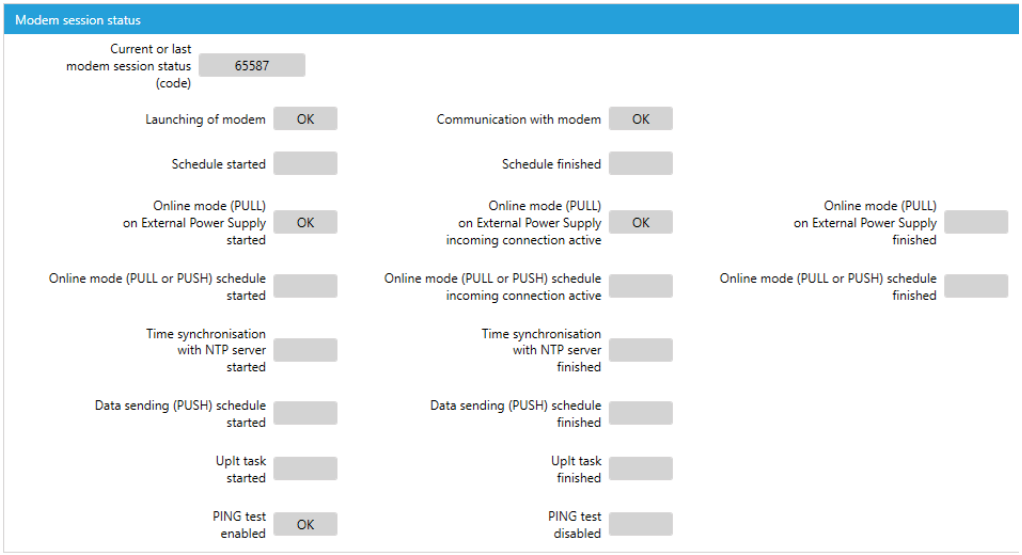


0	5000-5001	C	
1	5002-5003	tamb	'C
2	5004-5005	AtmPress	kPa
3	5006-5007	BattLvl	%
4	5008-5009	MBattLvl	%



11.1.2. Modem session status in Online Mode on External Power Supply

Not every status is enabled during single session. Some of them are used only for certain actions i.e., PUSH mode status will not be enabled when Online mode is turned on.



Successful operations:

1. Modem launched
2. Communication with modem established
3. Online mode started
4. PING successful
5. Online mode – active connection registered

In following scenario, device established the connection well and transmission through modem was possible.

11.2. Configuration of Schedules

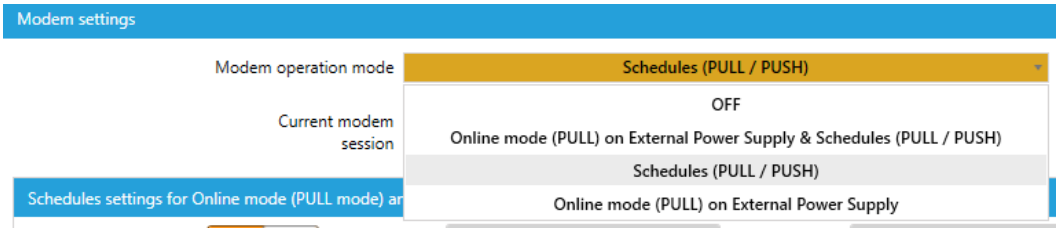
Definition: Schedule is a time window when EVC starts the modem communication with programmed task. Once task is done or schedule lasting period ends, modem disconnects.

Assumptions:

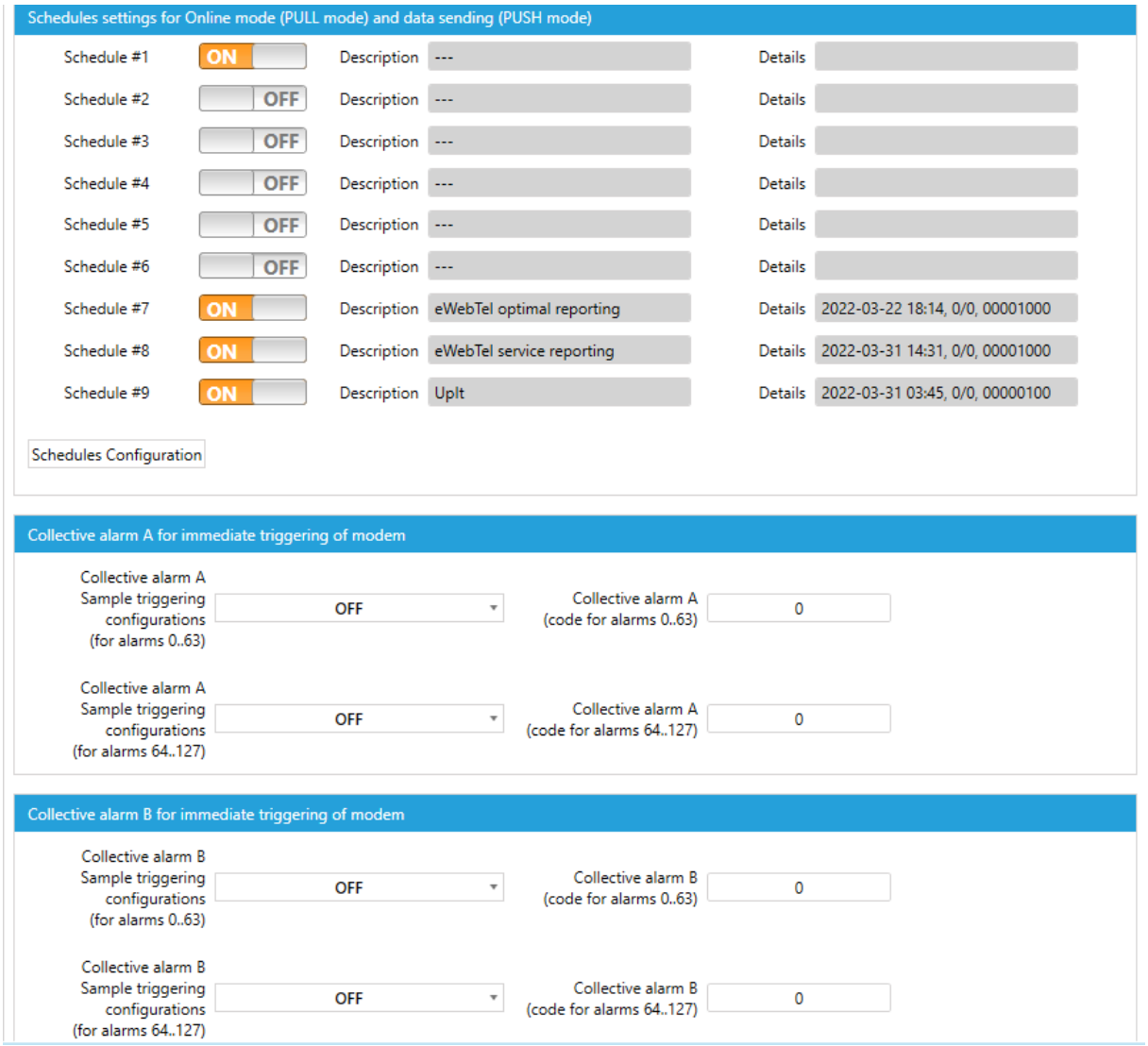
- EVC operates on external power supply or battery power supply.
- Internal modem is turned off most of the time.
- Depending on used mode – Static IP of the SIM card may not be required.
- Multiple schedules can exist parallel without having impact on others.

11.2.1. Configuration procedure

1. Choose presented option in "Modem operation mode field"



2. New window will appear

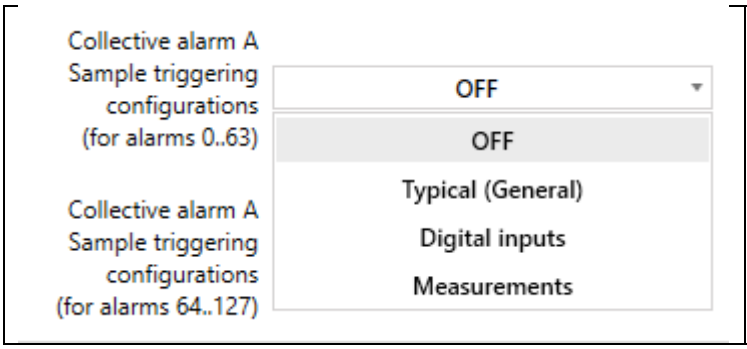


2.1. Optional step – collective alarms

Introduction: Collective alarm is the set of single alarms in the device EVC, which in, if any of the alarms from "Collective" group appear, modem will start transmission regardless of the schedule. Having this information, i.e., when modem is scheduled to start transmission on 8am and data comes on 3:41pm – means some unusual behavior appeared.

For better understanding of the collective alarms, it is required to review the document User Data Structure in chapter 2 – List of alarms.

There are two collective alarms available to be turned on A and B. There are ready sets of the alarms to trigger "Collective" alarm:



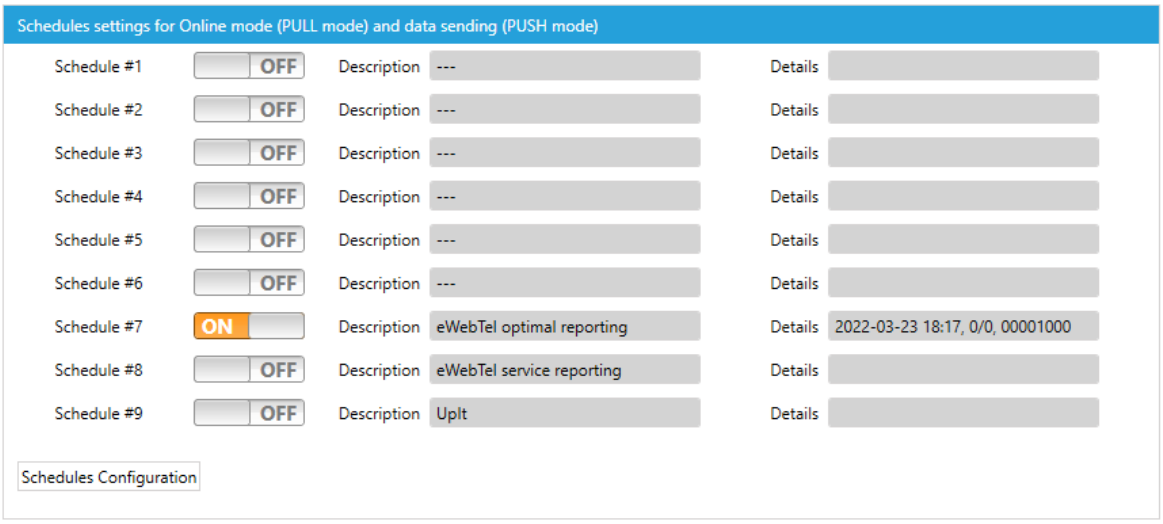
	Typical (General) – events related to general device usage: exceeding measured values, significant devices malfunctions, digital inputs. Digital inputs – events related to digital inputs only Measurements – events related to limits, ranges of sensors, errors in calculations

Choice of any alarm from the list also generates some codename which is a decimal form of binary vector responsible for alarms turning on.

Attention: there are two sections for alarms from 0-63 and 64-127. This is caused by capacity of definition parameter which is 64 bytes.

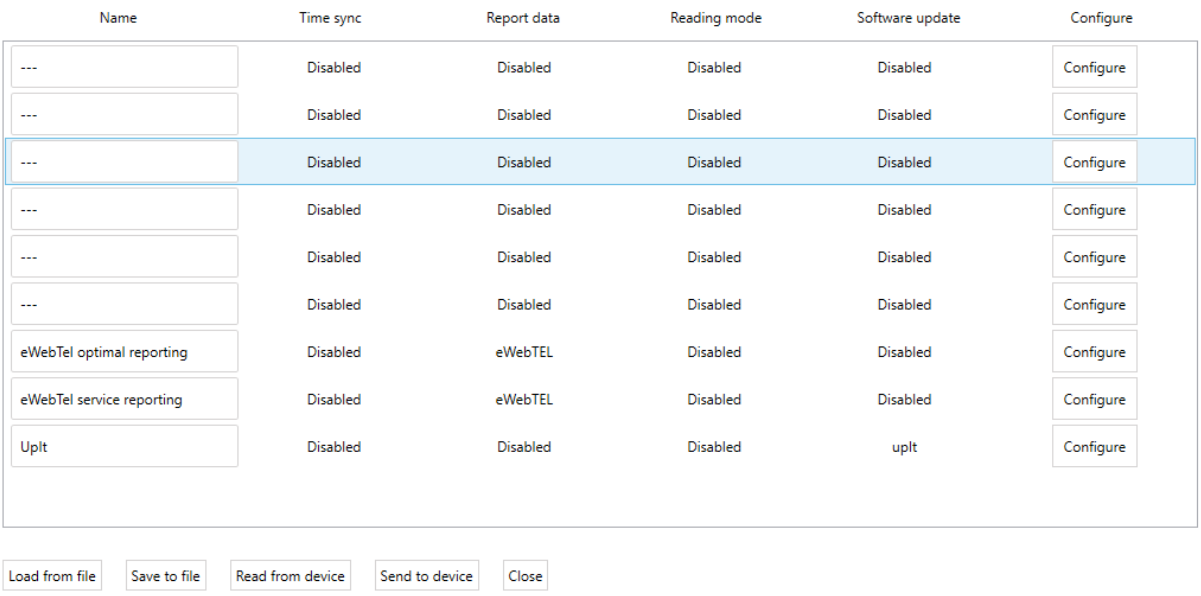
3. Schedule configuration

First view is the list of already defined and turned on or off schedules. This view enables to disable schedules from executing if they are configured but temporary not used. Right side of the window presents names of the schedules and time of their next start.



To pass to the Schedule definition press

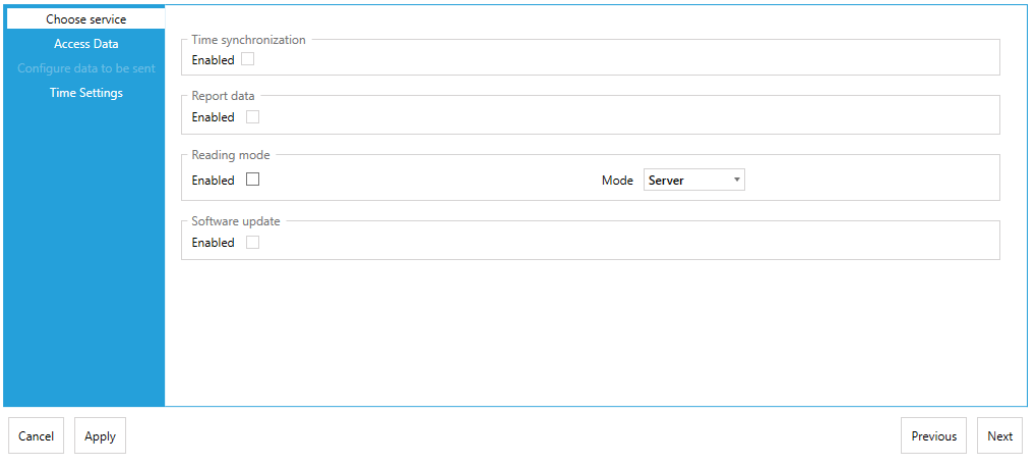
button. Application will pass to new window.



Before proceeding any actions with the Schedules configuration press **Read from device** button. There are three predefined schedules saved in the device. Schedule 7 eWebtel optimal reporting is defined as the one most fitted for data sending.

To configure the schedule press Configure button on the right side.

In next window configuration wizard starts.



Choose service: this window presents definition of available schedule behavior.

- Time synchronization – connection to defined in next step NTP server to adjust the time.
- Report data – mode called PUSH where data is sent automatically to the system. In next step there is definition of server to deliver the data. This is the mode where eWebtel connection is configured.
- Reading mode – mode called PULL where device allows for direct data readout from its memory.
- Sub mode Server – mode described in paragraph **11.1. Configuration of Online mode on External power supply**. Mentioned paragraph described Online mode turned on constantly. This time it is described as time window.
- Sub mode Client – solution fitted when PULL mode is necessary however Static IP is not available for this application. In this mode device connects to the server and does not send any data.

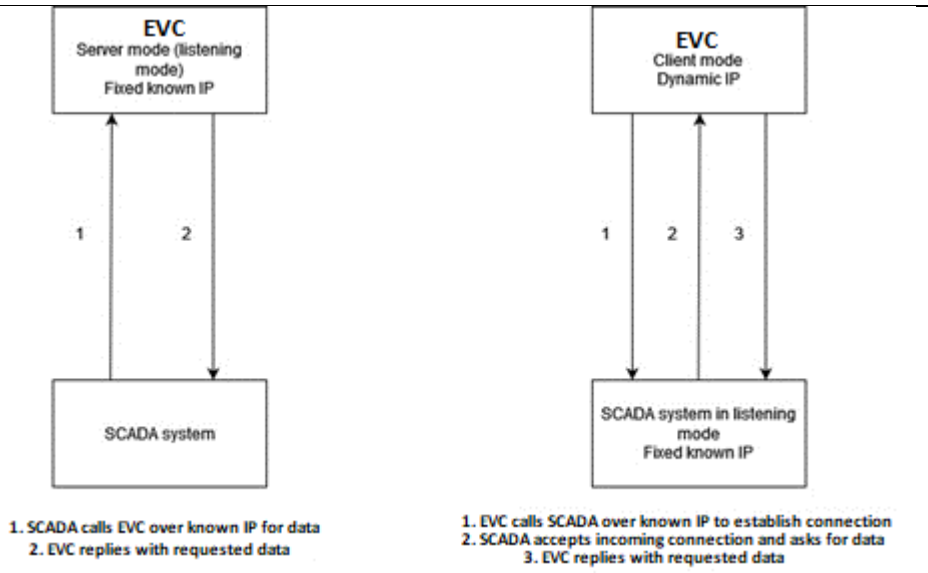


Diagram showing the difference between Client and Server mode in EVC device.

3.1. eWebTel connection

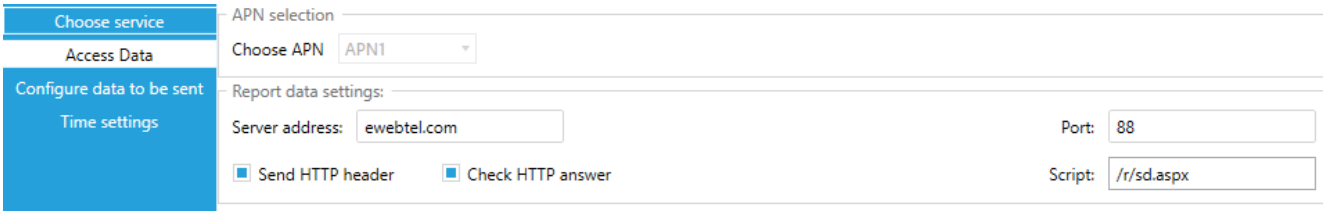
It is possible to use predefined Schedule no.7, turn it on, and device will start working with eWebTel without further actions. It is also possible to define own, more tailored schedule.

Following steps are required to configure EVC connection with eWebTel.

- Choose option “Report data”

Press Next *to pass to new section.*

- Type data of eWebTel server.



For Producer server eWebTel it is:

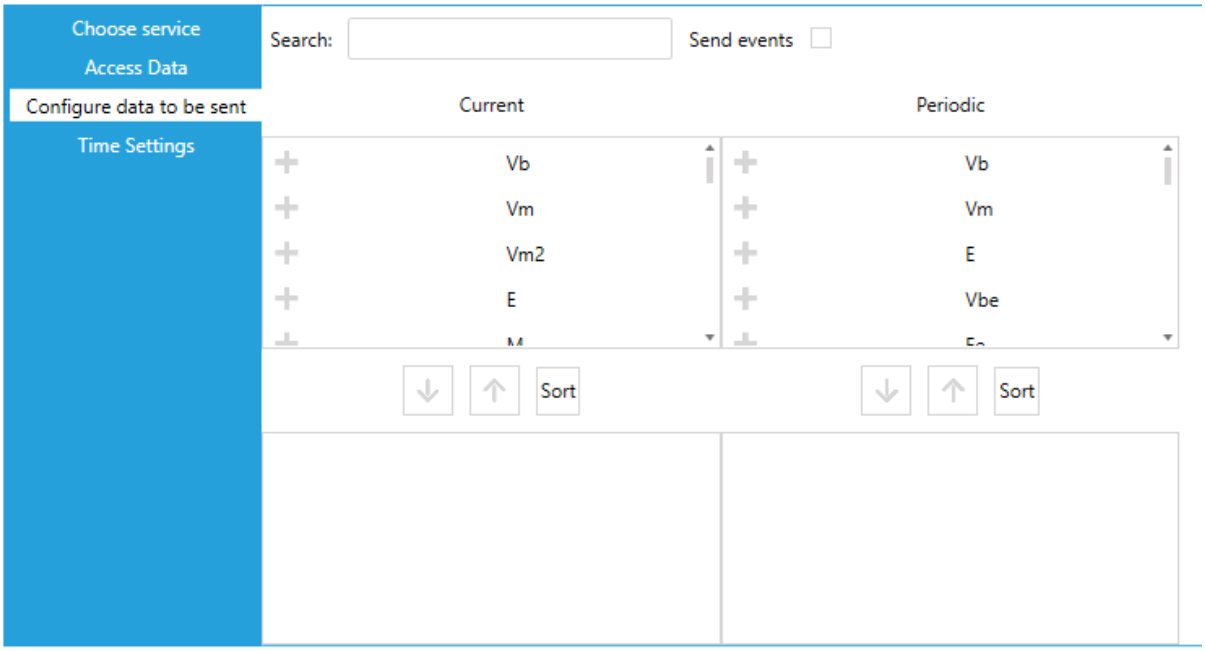
- Address: ewebtel.com
- Port: 88

For eWebtel installed on external servers use parameters delivered by IT department.

Press Next *to pass to new section.*

- Determine which data should be sent to eWebTel

EVC is a device having more than thousand parameters stored in memory. By Current data we understand all these parameters, where significant part of them is not necessary to be transmitted. Reducing amount of transmitted data occurs in saving battery lifetime and SIM card data transfer. Prolonged transmission time due to sending huge amount of data in the area of low mobile network signal strength may occur in transmission breakups and gaps in periodic (billing) data.



Suggested parameters to be sent to eWebTel on daily basis:

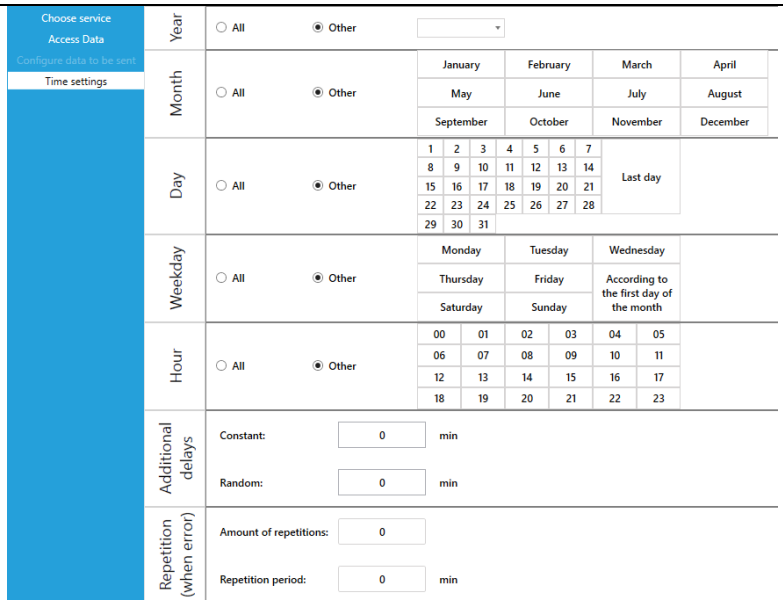
Current data	Periodic data
Parameters related to V Parameters related to Q Battery levels (EVC, modem, backup) Status of power supply Mobile network signal strength Date and time of device Active alarms vector	Every available in eWebTel: Vb, Vm, P, T, Qm, Qb

One schedule can be used for sending whole table of current data in periods once a week or once a month for diagnostic purposes to review all the parameters.

To have the knowledge about meaning of every parameter in the "Current" section refer to the document User Data Structure where all of them are described.

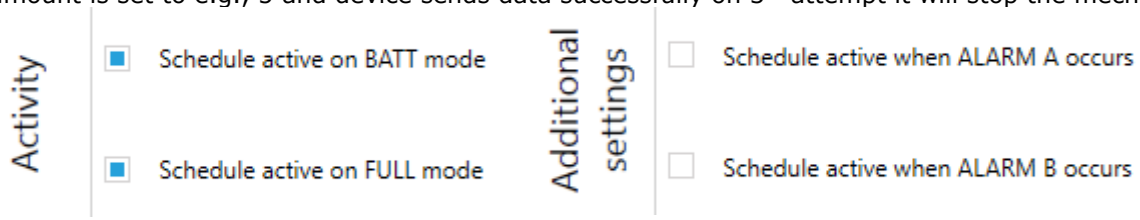
Press Next *to pass to new section.*

- Set the schedule frequency and start time



1. Year of schedule enabling. All – schedule will be turned on every year – so present state. There are possibilities to delay the schedule to next year.
2. Month of the schedule enabling. All – schedule will work every month.
3. Day of the month – the days of the schedule enabling. It is important when user does not want to have device connecting every day but only several selected days.
4. Day of the week. This option is additional to the previous one for the day. For example, if day is set to 5, 15 and 25 day of the month, and additionally – Wednesday; which will be 1; 7; 14; 21; 28 day of the month – device will start the schedule also on these days.
5. Hour. This option determines how often during the day device will connect to the network.
6. Constant and random delay. In previous section 6pm was set to start the schedule.
   - setting in "Constant" i.e., 24 will cause modem turning on always on 6:24pm.
   - Setting in "Random" i.e., 36 will cause modem turning on randomly between 6:00 and 6:36pm.

Repetition when error: when device for some reason interrupt data transfer (lack of access to mobile network or power supply i.e.) device will repeat data transfer "Amount of repetition" times every "Repetition period" minutes. If amount is set to e.g., 5 and device sends data successfully on 3rd attempt it will stop the mechanism.



Activity:
- Schedule active on BATTERY/FULL mode – choice of when schedule must be active. Depending on used power supply mode, proper option should be chosen. Note: leaving this option unchosen causes schedule will not start at all.

Additional settings:
- Schedule active then ALARM A/ALARM B occurs – point related to Collective alarms. This option allows schedule to start i.e., only when Collective alarm starts.

Press Apply to finish schedule configuration. Application will come back to the schedules list.

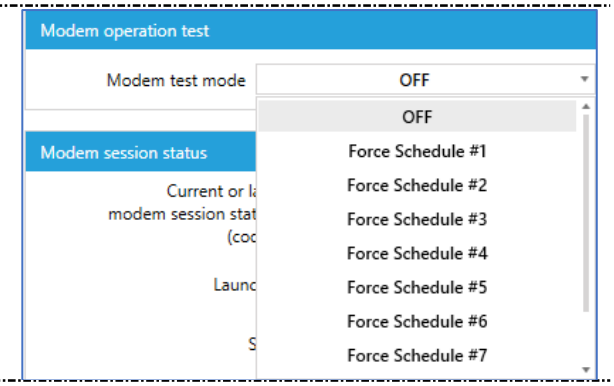
Press Send to device to save changes in the device.

Press Close to come back to the main menu.

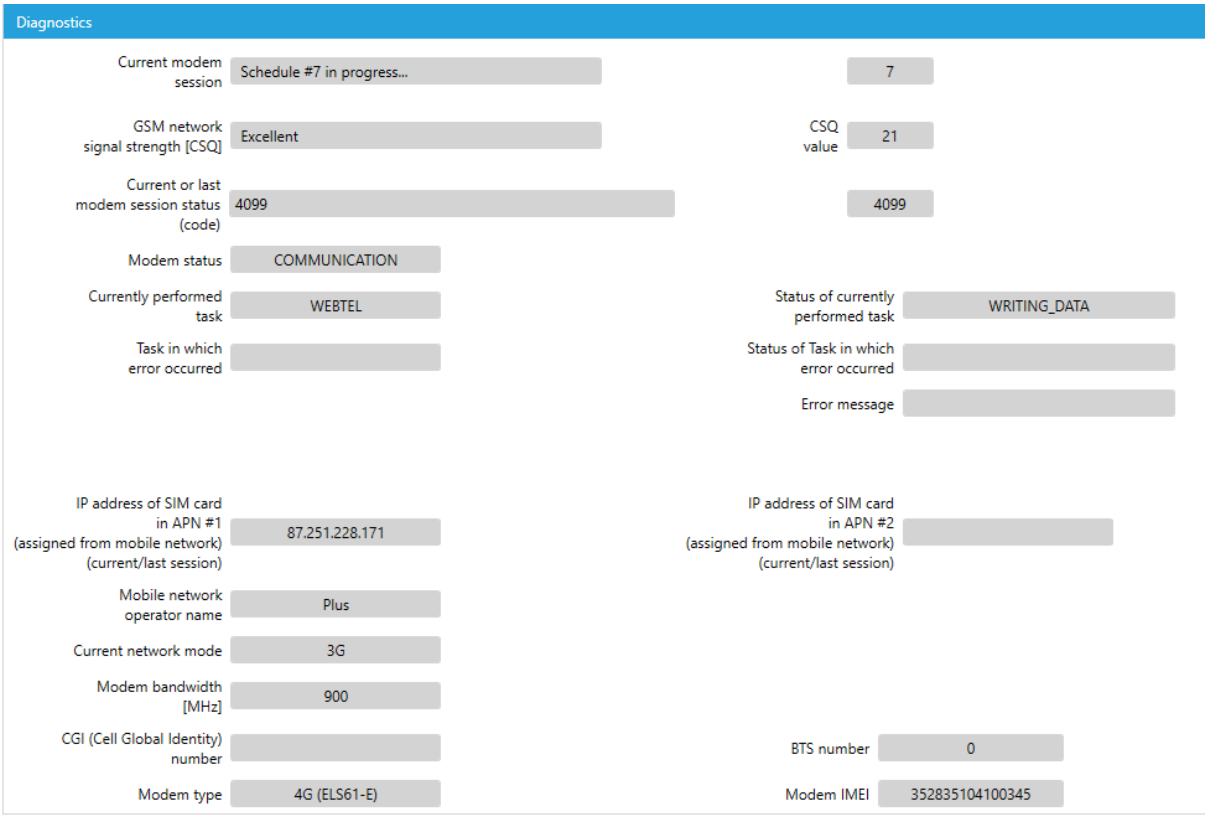
After successful Schedule configuration date of next schedule execution should appear.

When the time of executing schedule comes, menu Diagnostics allows for real time modem operation check.

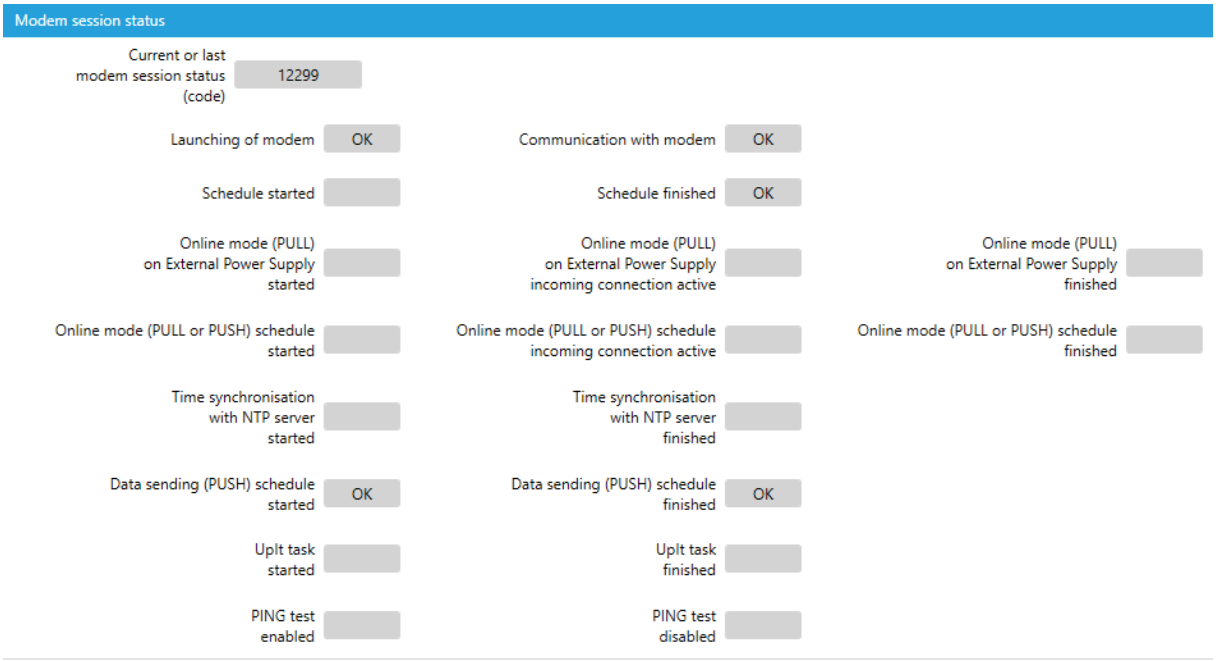
There is also possibility to force the schedule operation on demand to ensure its work correctness. This is especially important when next schedule execution time appears long time from the present moment.



Correct behavior in Diagnostics field when device connects to eWebTel:



11.2.2. Modem session status in Schedules



Successful operations:

1. Modem launched
2. Communication with modem established
3. Data pushing started
4. Data pushing ended
5. Schedule finished

11.3. Configuration of Online mode on External power supply + Schedules

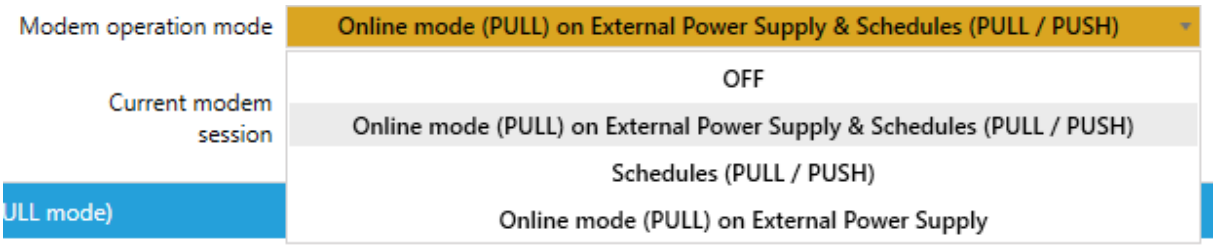
This mode is combination of modes described in 11.1 and 11.2 paragraphs of this manual.

Difference between mode 11.3 and 11.2 is that in 11.2 modem was offline all the time and there was no possibility to establish transmission. EVC could work on battery mode.

Using Online mode + Schedules device must be constantly powered as in mode 11.1. Device modem is constantly online awaiting queried – PULL mode.

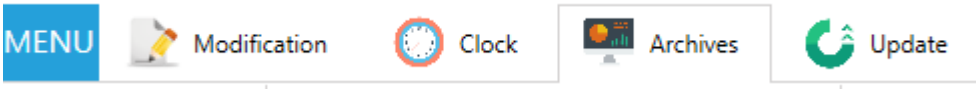
When the defined schedule time comes, device closes PULL mode and passes to schedule execution. When finished, device comes back to Online mode.

Configuration of this mode begins from choosing marked option:



Further configuration is following paragraphs 11.1 and 11.2 of this document together.

12. Archives readout using PC/Windows software

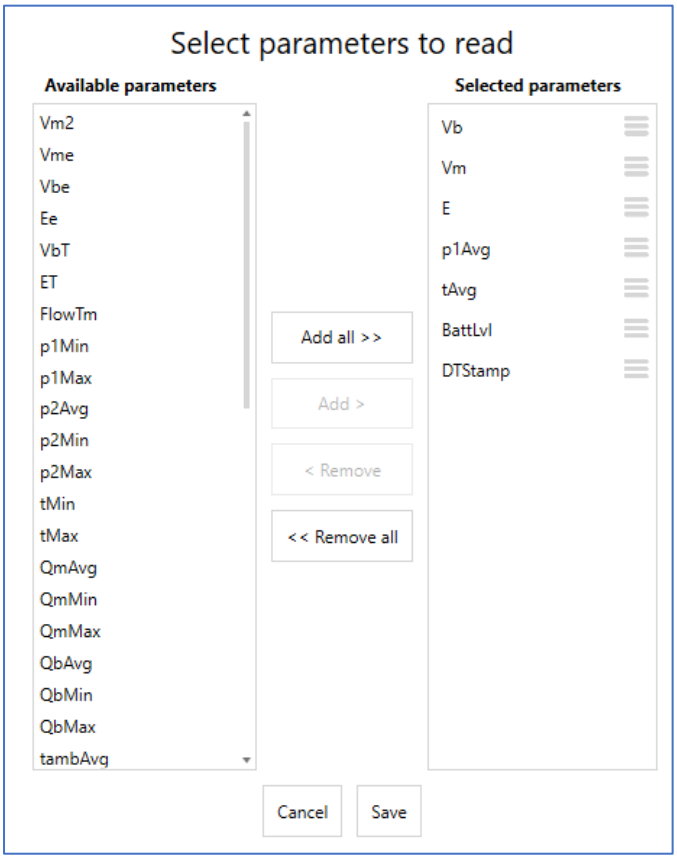


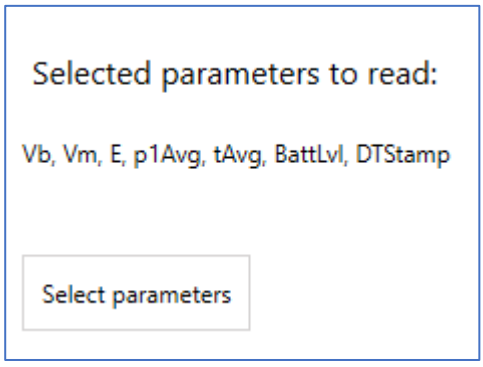
Archives tab allows for periodical, hourly and monthly data reading. There is also possibility to download the list of events in the device.

12.1. Parameters selection

EVC by default registers more than 20 parameters. In report there is possibility to choose only single parameters to make the final report clearer for the responsible person.

To select only single parameters to be downloaded click on Select parameters button to pass to new window.

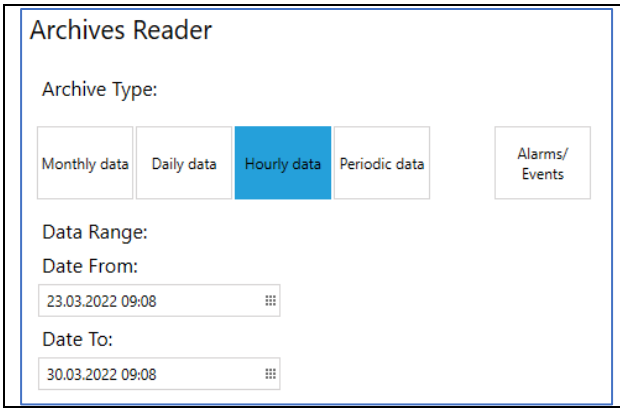




After all necessary parameters are selected, click on Save to go back to previous window.

12.2. Data type selection and readout

Archives:



Performing the readout:

- Choose the data type: periodic, hourly, daily, monthly
- Adjust the data range. To read the data from the beginning, set the beginning date to older than device manufacturing date, i.e., 2016.
- Choose the file path for saving the report by clicking "Save as"
- Click "Read" and wait until the data readout will be completed

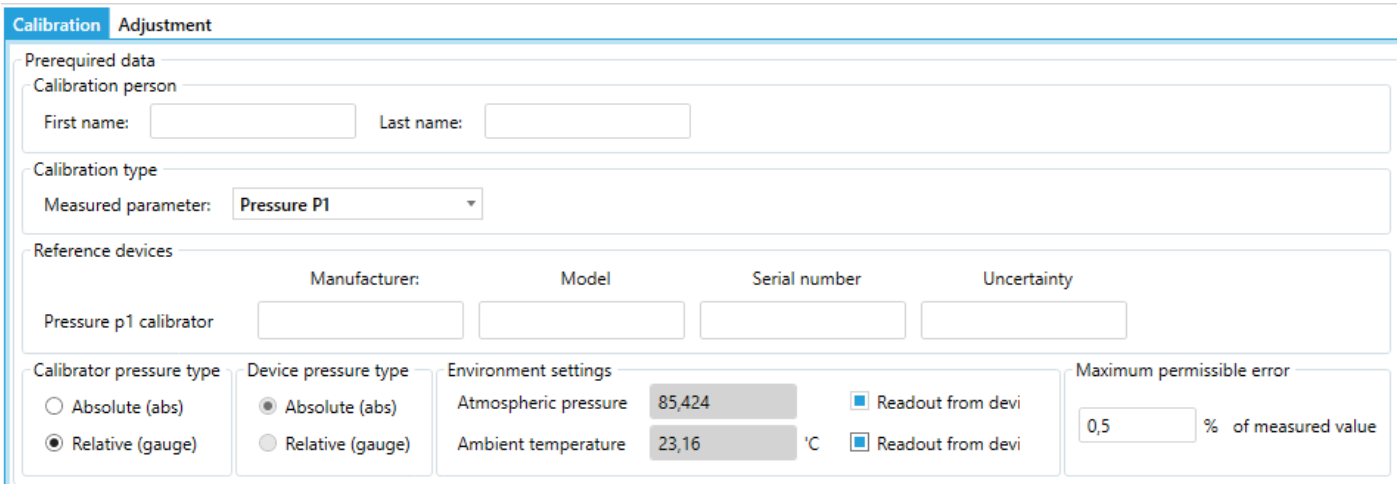
Events:

For events there is only selection of the download place. Events are downloaded without any time range, Software asks for all available.

13. Calibration and adjustment of P/T sensors

PC software allows for calibration check and two point adjustment of the pressure and temperature sensors.

13.1. Accuracy check report



In this window it is possible to do periodical check of pressure or temperature sensor accuracy.

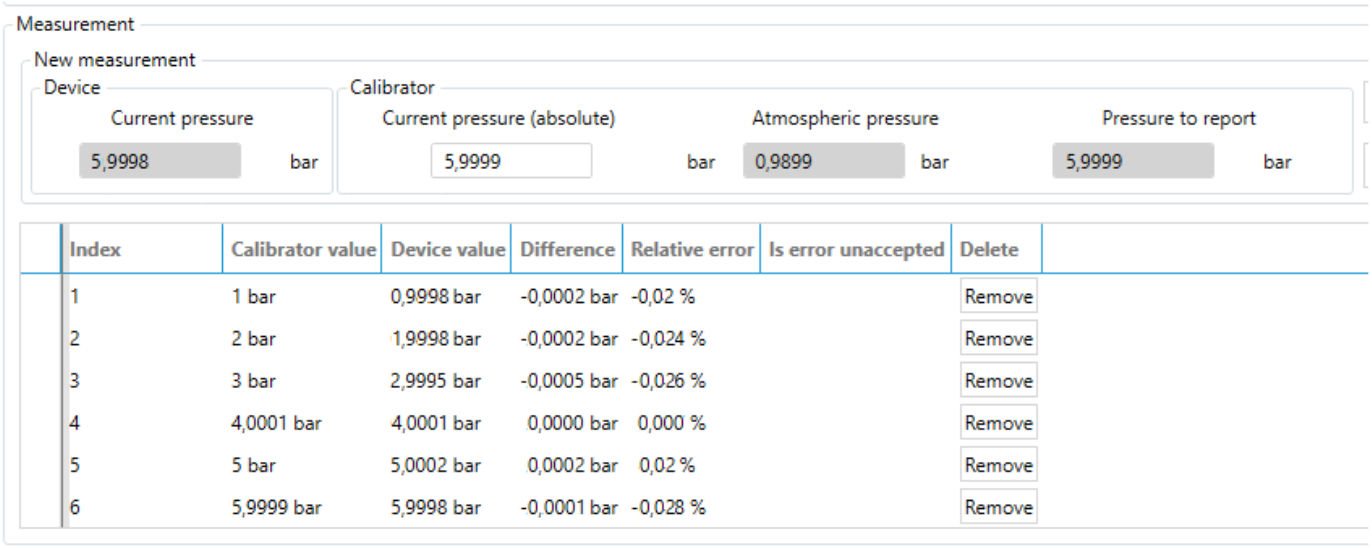
- Personal data of metrologist
- Calibration type: selection of quantity to check – P1/P2/T
- Data of pressure/temperature calibrator

Principle is to ensure expected maximum permissible error for the device – typically it is 0,5 % of measured value for devices with MID conformity.

Rest choices:

- Pressure type to be calibrated: absolute or overpressure
- Ambient pressure – read from device
- Ambient temperature – read from device

Next step is to choose multiple points for accuracy check. Gently raise the pressure or temperature to values expected to check and add next measurements into the report by pressing Add measurement button.



Index	Calibrator value	Device value	Difference	Relative error	Is error unaccepted	Delete
1	1 bar	0,9998 bar	-0,0002 bar	-0,02 %		Remove
2	2 bar	1,9998 bar	-0,0002 bar	-0,024 %		Remove
3	3 bar	2,9995 bar	-0,0005 bar	-0,026 %		Remove
4	4,0001 bar	4,0001 bar	0,0000 bar	0,000 %		Remove
5	5 bar	5,0002 bar	0,0002 bar	0,02 %		Remove
6	5,9999 bar	5,9998 bar	-0,0001 bar	-0,028 %		Remove

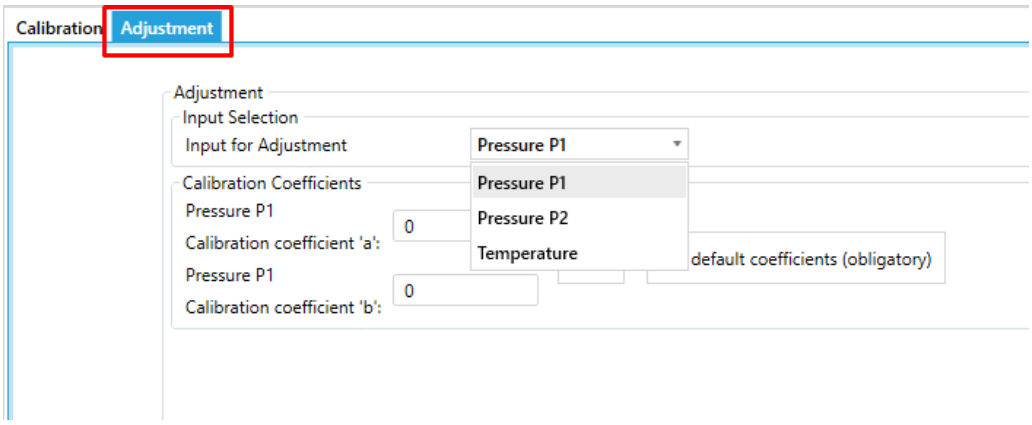
When every measurement is under assumed MPE report can be saved for records using Export to PDF button.

When measurement error is close to MPE or exceeds it, it is required to pass to the Adjustment window.

Index	Calibrator value	Device value	Difference	Relative error	Is error unaccepted	Delete
1	3,5001 bar	3,4152 bar	-0,0849 bar	-2,48 %	YES	Remove

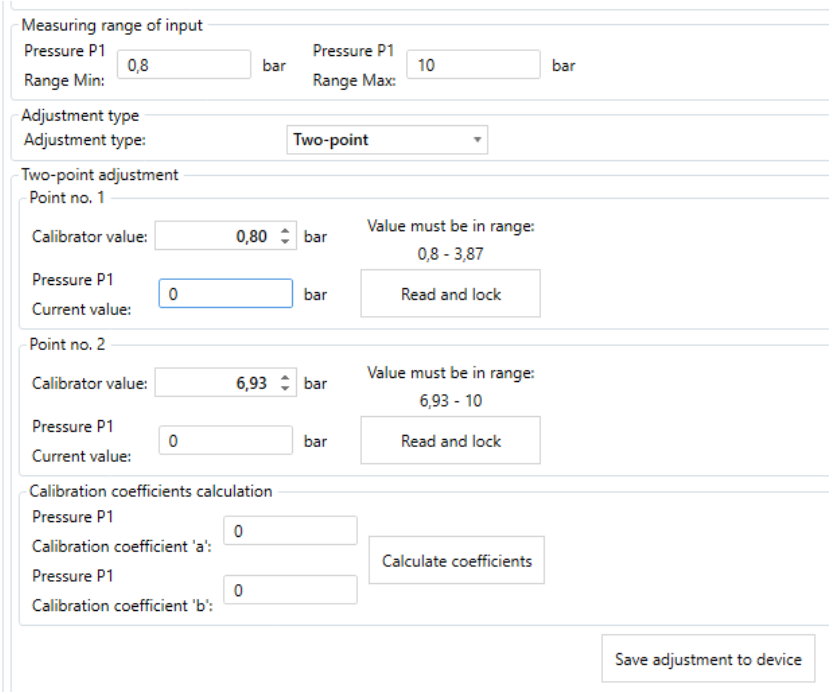
13.2. Two point adjustment of pressure or temperature sensor

When pressure or temperature indication show signs of losing accuracy and there is a confirmation by the accuracy report check described in 13.1., it is possible to proceed with two points calibration of the sensor.



Steps to follow:

- Choose input for adjustment from the list: P1/P2/T
- Reset the calibration coefficients by pressing Set default coefficients (obligatory)
- Read the device using Read



- On the calibrator set pressure from the range 0 – 1/3 of max range – read indication of EVC and lock it in the field
- Raise the pressure to one from the range 2/3 – max range – read indication of EVC and lock it in the field
- Once this is done, press Calculate coefficients. Coefficients should appear in the lines.
- Press Save adjustment to device. Device will automatically save coefficients.

To ensure adjustments are done correctly repeat the accuracy check from paragraph 13.1.

14. Master mode configuration – external modules readout

Introduction: EVC can work in one of two Master modes: Universal and Gas Chromatograph. ***Attention***, only one mode can work at a time. Master modes allow you to read data from external devices connected to the COM2 serial port in the ModBUS RTU protocol. Such devices can be:

- Pressure transducers supplied from 3,6 V
- Temperature transducers supplied from 3,6 V
- EM-1 extension module equipped with 4 relay outputs and 2 analogue 4-20 mA outputs
- EM-2 extension module equipped with 8 NAMUR digital inputs
- EM-2 Ex extension module equipped with 8 NAMUR Ex-type digital inputs
- External devices with known structure of Modbus registers, i.e., flowmeters
- Gas chromatographs

First step to do is to turn on the COM2 functionality of Master mode according to procedure from **8.13. Transmission settings** or **10.9. Transmission**.

14.1. Master mode: Universal

14.1.1. Extension module EM-1 – read/write configuration

Analog 4-20 mA output configuration

1. Define which value will be reproduced on current output. To do this, find in parameters table following values:

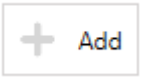
1059	AO1ParamIdx	131		AO1, output control parameter; -1; 1215
1060	AO1InMin	19		AO1, MIN input value; -1000; 5000000
1061	AO1InMax	26		AO1, MAX input value; -1000; 5000000
1062	AO1OutMin	4		AO1, MIN output value; 0; 1000
1063	AO1OutMax	20		AO1, MAX output value; 0; 1000
1064	AO1Out	18,2747		AO1, output value;

Configuration is similar to the one defined for frequency output described in paragraphs Digital outputs configuration or Digital outputs DO wherein the work way is as follows:

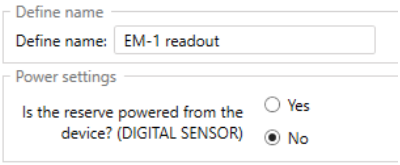
- AO1ParamIdx – index of parameter to control AO. Example: 131. t - temperature
- AO1InMin / Max – values of parameter in AO1ParamIdx. Example: 19-26
- AO1OutMin / Max – current values adjusted to peak values above. Example – 4 mA for 19 °C and 20 mA for 26 °C
- AO1Out – current output value on AO – this value is crucial and must be written into EM-1 module. Note the index of this parameter – in this case 1064.

Configuration procedure of AO2 is the same as AO1, does not require any additional comments.

Parameters indexes may differ in various firmware revisions. Always use parameters names for navigation.

2. Go to Master configuration tab. Press 

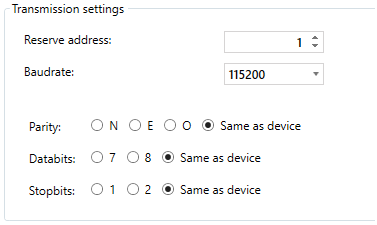
to start configuration of a new task.



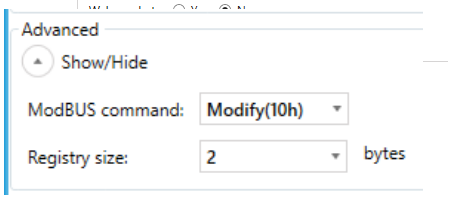
3. Start from naming the task name and selecting is it supplied from internal 3,6V power source. In case of EM-1 and EM-2 modules it is not applicable. Modules must be sourced externally. Press

when finished.

4. Fill the information about the connected module. By default extension modules EM-1 and EM-2 have set parameters
   a. Baudrate: 115200 b/s
   b. Parity settings: 8N1
   c. Address: 4 last digits of SN
   d. Advanced: timeouts, wakeup byte



5. Choose the option „Modify (10h)" from the list, as EVC will be writing current value to the EM-1.



6. Choose the register to which the value should be written.

For Analog Outputs choice is simple and always the same:

In EM-1 module output current for AO1 is written to registers 5067-5068 and for AO2 it is written to 5069-5070.

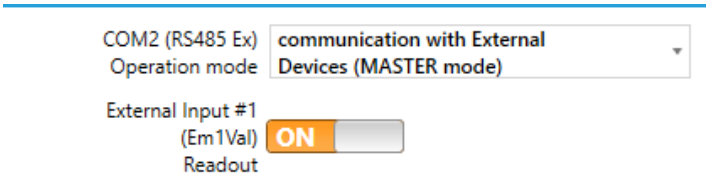
7. Press

to confirm changes. Application will pass to the list of currently visible tasks. Press

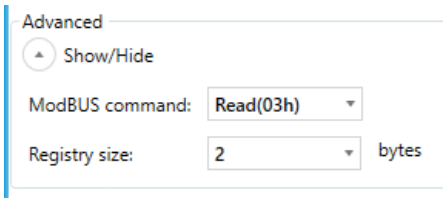
to save the task into the EVC.

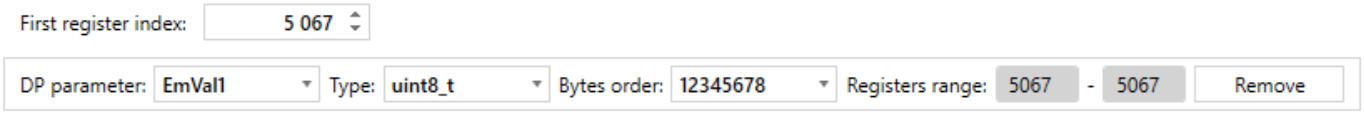
14.1.2. Extension module EM-2 – read/write configuration

1. Enable any of External Input readout tasks in menu Flow meter / Measuring inputs:



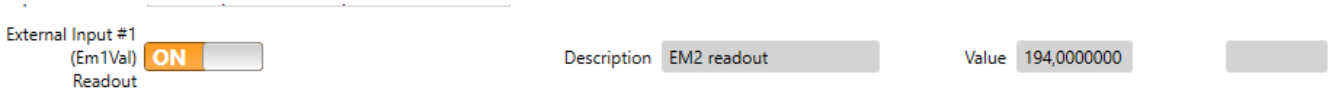
2. Go to MASTER configuration and start procedure of adding new task according to section 14.1.1. and 14.1.2. up to sub-point 4. included.
3. Choose the option „Read(03h)" from the list, as EVC will be reading current value from the EM-2
4. Choose the parameter which in the DI status from EM-2 module should be stored. For the purpose of this manual, it is EmVal1.



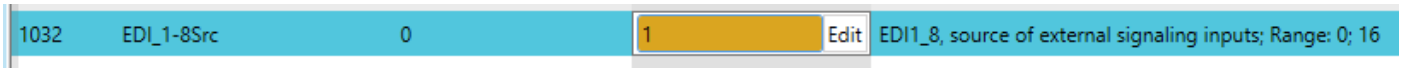


For digital inputs in EM-1 choice is always the same. Status of DI is stored in register 5067 in EM-2 and variable type is uint8_t.

5. Press Apply to confirm changes. Application will pass to the list of currently visible tasks. Press to save the task into the EVC.
6. Go back to the section described in sub-point 1. Ensure if the value from range 0-255 is presented in field Value.



7. Pass to the Table View and find parameter EDI_1-8Src or EDI9-16Src if using two modules



Depending on the chosen EmXVal in previous step (from 1 to 16) program the number of external value to this parameter. For Em1Val it is 1, for Em13Val it is 13.

EVC can work with 2 EM-2 modules simultaneously.

8. Status of digital inputs from EM-2 module is stored now in the parameter EDI_1-8.
9. Define the polarity – NC/NO of the External Digital Inputs using parameter EDI_1-8Pol in the same way as internal Digital Inputs in EVC what is described in Digital inputs configuration or Digital inputs DI
10. Depending on inputs polarity and current status of the inputs in EM-2 module, EVC now presents additional alarms by default named as EDI1-EDI8. Names of these events can be changed in parameters EDIxDesc:

14.1.3. Other external devices readout

External devices readout is done with the same procedure as the Extension module EM-2 – read/write configuration up to sub-point 6, where value of external parameter is presented in parameters Em1Val to Em16Val.

14.2. Master mode: Gas chromatograph

To start configuration switch to Table view mode and find proper parameters showed below.

For the correct operation of the mode, the following parameters must be configured:

1. Set ModBUS registers of a gas composition (of a gas properties);

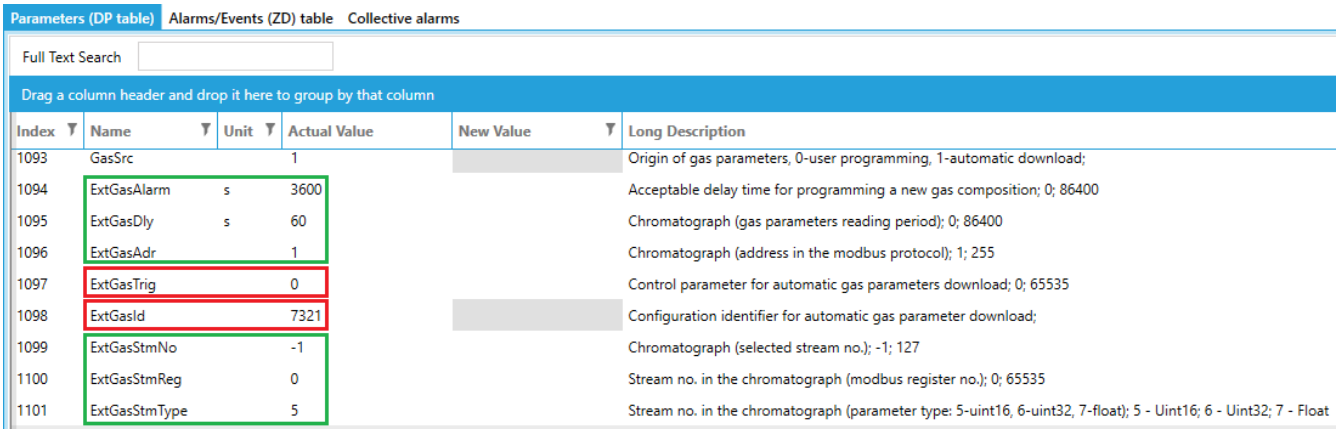
Parameters (DP table) | Alarms/Events (ZD) table | Collective alarms

Full Text Search

Drag a column header and drop it here to group by that column

Index	Name	Unit	Actual Value	New Value	Long Description
1102	ExtXH2Reg		0		ProgXH2 (modbus register no.); 0; 65535
1103	ExtXCO2Reg		0		ProgXCO2 (modbus register no.); 0; 65535
1104	ExtXN2Reg		0		ProgXN2 (modbus register no.); 0; 65535
1105	ExtHsReg		0		ProgHs (modbus register no.); 0; 65535
1106	ExtdReg		0		Progd (modbus register no.); 0; 65535
1107	ExtC1Reg		0		C1 (modbus register no.); 0; 65535
1108	ExtC2Reg		0		C2 (modbus register no.); 0; 65535
1109	ExtC3Reg		0		C3 (modbus register no.); 0; 65535
1110	ExtnC4Reg		0		nC4 (modbus register no.); 0; 65535
1111	ExtiC4Reg		0		iC4 (modbus register no.); 0; 65535
1112	ExtnC5Reg		0		nC5 (modbus register no.); 0; 65535
1113	ExtiC5Reg		0		iC5 (modbus register no.); 0; 65535
1114	ExtneoC5Reg		0		neoC5 (modbus register no.); 0; 65535
1115	ExtC6+Reg		0		C6+ (modbus register no.); 0; 65535
1116	ExtN2Reg		0		N2 (modbus register no.); 0; 65535
1117	ExtCO2Reg		0		CO2 (modbus register no.); 0; 65535
1118	ExtC6H14Reg		0		C6H14 (modbus register no.); 0; 65535
1119	ExtC7H16Reg		0		C7H16 (modbus register no.); 0; 65535
1120	ExtC8H18Reg		0		C8H18 (modbus register no.); 0; 65535
1121	ExtC9H20Reg		0		C9H20 (modbus register no.); 0; 65535
1122	ExtC10H22Reg		0		C10H22 (modbus register no.); 0; 65535
1123	ExtH2Reg		0		H2 (modbus register no.); 0; 65535
1124	ExtH2OReg		0		H2O (modbus register no.); 0; 65535
1125	ExtH2SReg		0		H2S (modbus register no.); 0; 65535
1126	ExtCOReg		0		CO (modbus register no.); 0; 65535
1127	ExtHeReg		0		He (modbus register no.); 0; 65535
1128	ExtArReg		0		Ar (modbus register no.); 0; 65535
1129	ExtO2Reg		0		O2 (modbus register no.); 0; 65535

2. Set the parameters - ExtGasAlarm, ExtGasDly, ExtGasAdr, ExtGasStmNo, ExtGasStmReg, ExtGasStmType.



Parameters (DP table) | Alarms/Events (ZD) table | Collective alarms

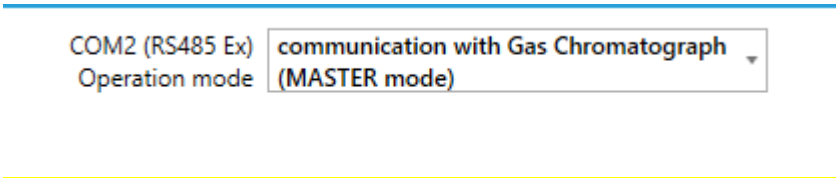
Full Text Search

Drag a column header and drop it here to group by that column

Index	Name	Unit	Actual Value	New Value	Long Description
1093	GasSrc		1		Origin of gas parameters, 0-user programming, 1-automatic download;
1094	ExtGasAlarm	s	3600		Acceptable delay time for programming a new gas composition; 0; 86400
1095	ExtGasDly	s	60		Chromatograph (gas parameters reading period); 0; 86400
1096	ExtGasAdr		1		Chromatograph (address in the modbus protocol); 1; 255
1097	ExtGasTrig		0		Control parameter for automatic gas parameters download; 0; 65535
1098	ExtGasId		7321		Configuration identifier for automatic gas parameter download;
1099	ExtGasStmNo		-1		Chromatograph (selected stream no.); -1; 127
1100	ExtGasStmReg		0		Stream no. in the chromatograph (modbus register no.); 0; 65535
1101	ExtGasStmType		5		Stream no. in the chromatograph (parameter type: 5-uint16, 6-uint32, 7-float); 5 - Uint16; 6 - Uint32; 7 - Float

3. The parameters ExtGasId represents the whole composition of a gas composition registers settings. To activate the gas composition readings simply copy ExtGasId to ExtGasTrig parameter. Important, if the gas composition registers are changed, the ExtGasId parameter will change! Therefore, the ExtGasTrig parameter will have to be adjusted.

After configuration, you can turn on the mode in menu Flow meter / Measuring inputs:



15. Modbus maps configuration

Introduction: EVC offers modification of Modbus maps according to the instant needs, such as already programmed Modbus structure readout in the reading system, prepared for readout of specific EVC brand. When EVC is decommissioned, and it is replaced with a new brand it is easier to modify device Modbus structure rather than long-time working system. For this purpose, Modbus maps configurator has been created.

Modbus map creator provides following actions:

- Read from device – read existing map from device including its version and list of all registers. Whole structure is displayed in window below.
- Read from file – read map downloaded from another device and display it in window below.
- Save to device – save map created or read from other device to current device.
- Save to file – save map to file to upload it to another device using function "Read from file"
- Generate document – Software creates complete documentation of created Modbus Map.
- Generate from DP – this function creates a mirror of the full available parametr's table represented by Modbus Map. Registers are assigned by default and whole DP table – more than 1000+ parameters are used and available. This functionality is not suggested to use.

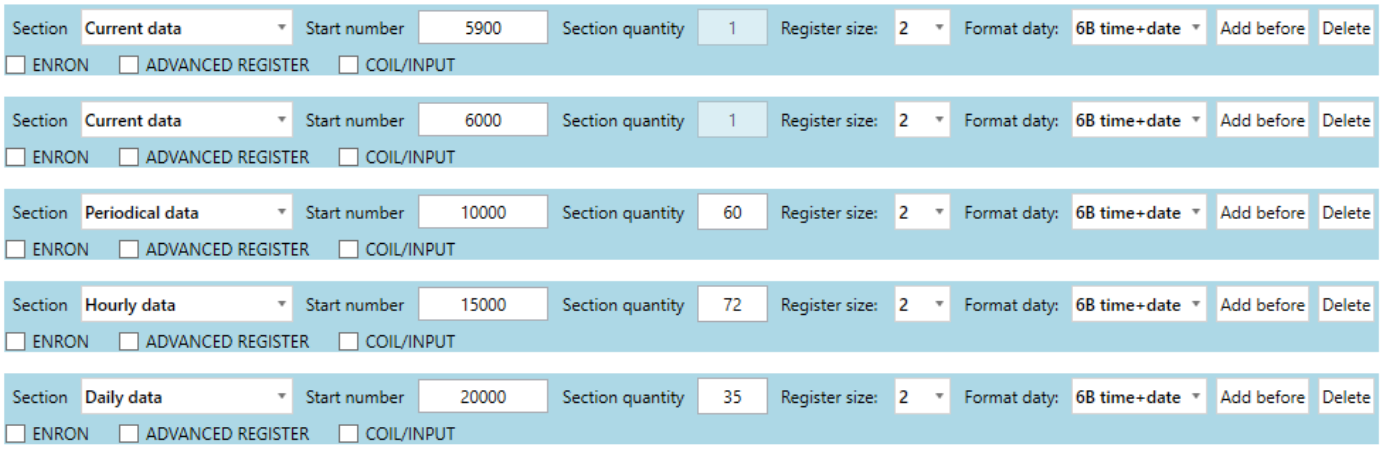
To use Modbus map generator, it is mandatory to have the device physically connected. There is no possibility to create Modbus map without real device.

15.1. Modbus map creation

Introduction: To start work with Modbus map creation it is mandatory to have the registers number, parameters names and variables types. Principle structure can be seen in document Default Modbus Map. Structure must be known before to organize the map correctly.

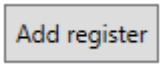
1. In blank window press

to add new section of registers. It is necessary especially when registers list has significant gaps – part of registers beginning from 300, part of registers beginning from 5000. Define which registers section should be assigned to current data and billing data. There is also possibility to define the register size. Default size is 2 bytes per register.



For section Current data the "Quantity" option is always blank. For any other section there is possibility to define the section quantity which means the section will be repeated as many times as in this field due to the amount of available archive data. For instance, 30 times repetition of section "Daily data" enables readout up to 30 days back readout.

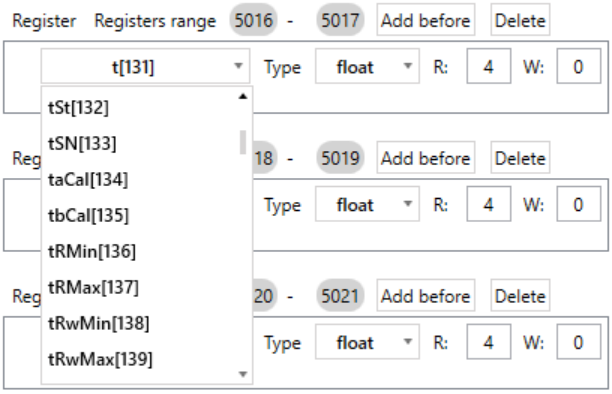
2. Pass to the

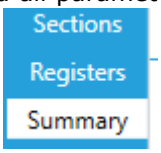
tab and in defined sections in step 1. start adding the registers according to required number using 

button. Add registers in advance.

3. When added, choose from the list of parameters which one shall be assigned to the register. In this step document User Data Structure is helpful to navigate through the list of parameters. Also choose the variable type.

Ensure that variable type is correct and recognizable by the readout software. Wrong variable type may occur in parameter readout difficulties or even impossible. If chosen wrong variable has different length than one should be used, whole registers list may reallocate as an unexpected result. Always ensure if the choice is good.



4. When finished and all parameters are assigned, ensure all registers are correct. To review the correctness of the map, go to 

tab.

Registers	Parameter	Type	Description
806 - 807	Vm[1]	uint32_t	Volume counter at measurement conditions; Range: 0; 10000000
810 - 811	Vb[0]	uint32_t	Volume counter at base conditions; Range: 0; 1000000000
824 - 825	Qm[57]	float	Flow rate at measurement conditions
834 - 835	t[131]	float	Temperature t
836 - 837	p1[89]	float	Pressure p1
838 - 839	p2[112]	float	Pressure p2
840 - 841	E[3]	float	Energy counter; Range: 0; 1000000000
842 - 843	C[153]	float	Conversion factor (calculations for base conditions)
844 - 845	W[159]	float	Wobbe index. W=Hs/sqrt(d)
846 - 847	d[173]	float	Relative density
848 - 849	Hs[172]	float	Superior calorific value
850 - 851	Hi[156]	float	Inferior calorific value
852 - 853	BattLvl[622]	float	Current level of the device's batteries; Range: 0; 100
854 - 855	MBattLvl[623]	float	Current level of the modem's batteries; Range: 0; 100
856 - 857	VInfo1[609]	float	Power supply voltage
858 - 859	MCsq[853]	float	Network signal level from current/last session
860 - 861	DI[736]	float	Binary state of activity on digital inputs 1-8. Bit=1 - specific input is active; Range: 0; 255
862 - 865	Alarm1Sum[281]	uint64_t	Binary state of alarms with codes 0..63 (during the data analysis period)

5. Save map to file using button "Save to file" described in the introduction. File with *.bin extension will create.
6. Save the document with map structure using "Generate document". This will prepare complete documentation of the ModBUS registers structure.

16. Mobile application overview

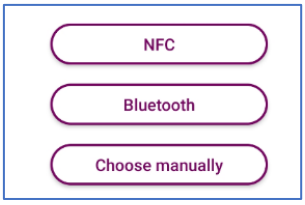
Download App: Click here

Another way of device configuration is mobile application designed for smartphones with Android system.

Mobile app allows for device configuration using Optical interface OptoBTEx using Bluetooth communication or interface-free mode using NFC.

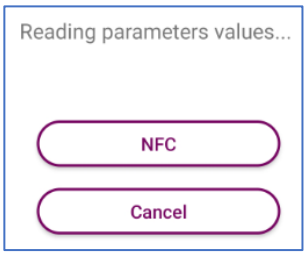
16.1. First connection

Connection with the device is done in following steps:



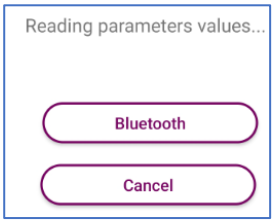
Start the app. Choose NFC option in the main window.

Close the phone to the area on the device housing marked as NFC and wait until the device will be found and read.



When the progress bar will reach the end, app will pass to the main window showing all the parameters.

Once the readout is done, phone can be took out from the carried away.



Start the app. Choose Bluetooth option in the main window.

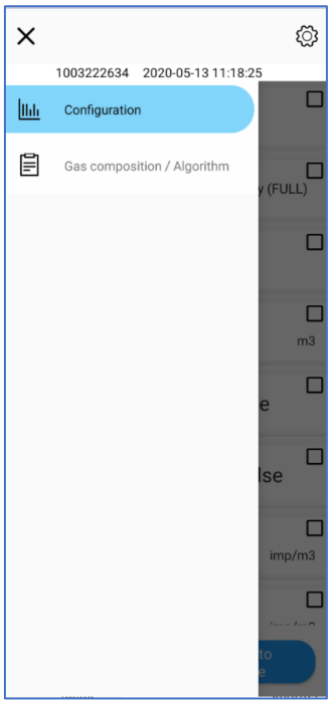
Turn on OptoBTEx and place it on the Optical interface area on the device housing.

If the OptoBTEx is not paired with the phone proper notification window will appear to pair the phone. Use proper PIN code for pairing.

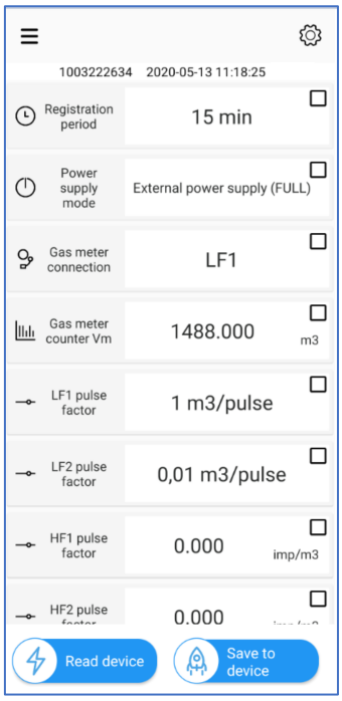
When the progress bar will reach the end, app will pass to the main window showing all the parameters.

16.2. App overview

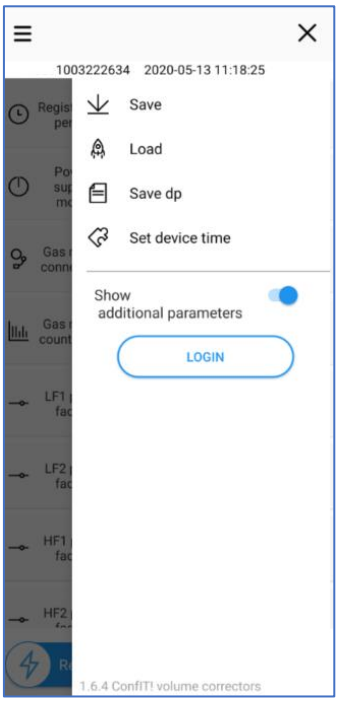
Regardless the communication method, app will pass to the main window.



Swipe from the left – categories section. Parameters grouped thematically.



Main window with parameters to modify in the device.

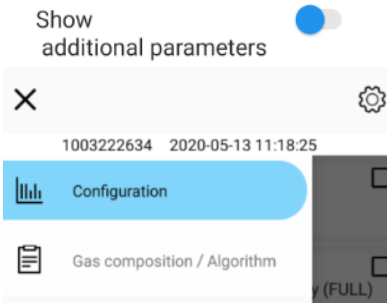


Swipe from the right – options section. Account choosing, advanced view, time settings and save/load configuration.

16.3. Basic and advanced view

App allows for two variants of interface – basic and advanced. In basic one there is possibility to configure only parameters related to gas meter and gas composition. Simple configuration on the object. Advanced view allows for configuration like the one available with PC software excluding modem schedules settings and modem full diagnostics.

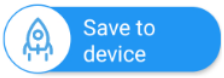
To switch between the views, it is necessary to switch the "Additional parameters" slider.



16.4. Parameters modification

To modify the parameter, click on its value and make the change.

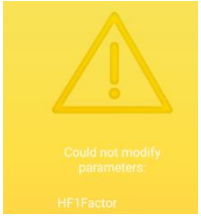
Changed, but not saved parameter is marked on blue:

Click 

and depending on the configuration type follow proper action:

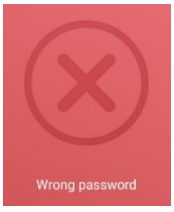
- NFC – close the phone to the NFC area on the device
- Bluetooth – wait for confirmation of the success

Possible errors during configuration:



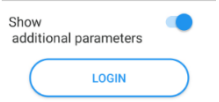
Modification was unable to success. Possible reasons:

- Parameter out of programming range
- Optical head turned off – when using Bluetooth



Modification failed due to wrong password.

Check used login and password.

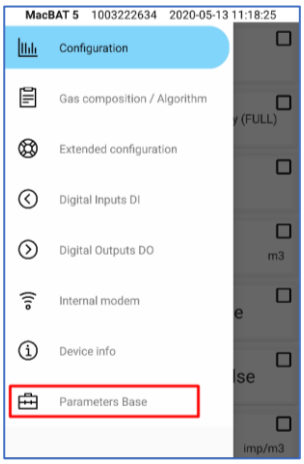


16.5. Table view

Mobile app provides similar functionality as desktop configuration tool to review and configure the device using table of parameters with raw numeric values instead of graphic profile.

Table view is available in two ways:

- No graphic profile defined for read device
- Manual choice



If the profile to read device exists, it is necessary to manually go to the table view

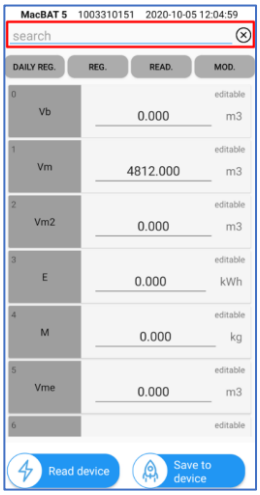
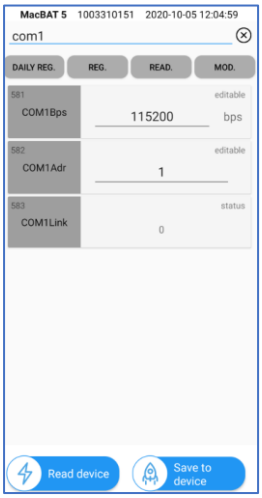


Table view supports search bar which uses names of the parameters



Navigate to desired parameter using its name from data structure and edit it by putting numeric parameters values.

17. Device maintenance

17.1. Battery replacement

The battery replacement procedure must be carried out in accordance with the instructions given in this chapter.

EVC is the intrinsically safe equipment. The housing of the device should be sealed – replacement of the battery can only be carried out by an authorized person, i.e., a factory or authorized service representative or other persons authorized by the manufacturer.

It is permissible to replace the batteries in the explosion hazard zone.

For power supply of EVC only batteries of the types accepted in ATEX certificate may be used. Please find the list of accepted types of batteries in point Technical data, section Internal supply of this document.

It is prohibited to combine different types of batteries in one device.

Opening of device's housing is forbidden under conditions that allow ingress of water (for example rain, snow) or dirt inside the unit.

Always replace the battery with a new, full charge batteries.

Battery replacement causes break in measurements of pressure and temperature but allows working of real time clock. Settings and registered data are not affected. To prevent against data loss it is recommended to save the recent counters to flash memory. Set parameter BattReplace=1 to activate saving current data on demand.

Inserting of „old", partly discharged batteries will cause incorrect readouts of charge level and may lead to unexpected device operation (such as restarting, errors in counting, errors in archives and in current values).

Discharged batteries are in the hazardous waste category, therefore they must not be disposed together with common waste.

Device can be equipped with up to 3 main batteries of following parameters:

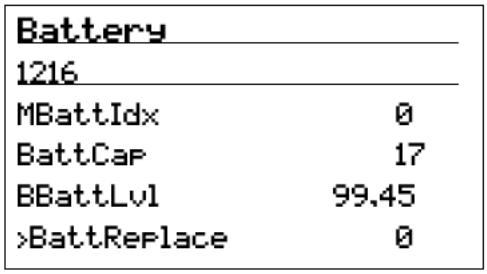
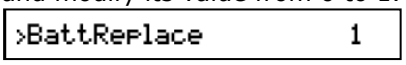
Voltage: 3,6 V
Nominal capacity: 17 Ah
Battery amount: 1 to supply EVC + up to 2 to supply internal modem (optional)
Estimated lifetime: 5 years

BATTERY REPLACEMENT PROCEDURE:

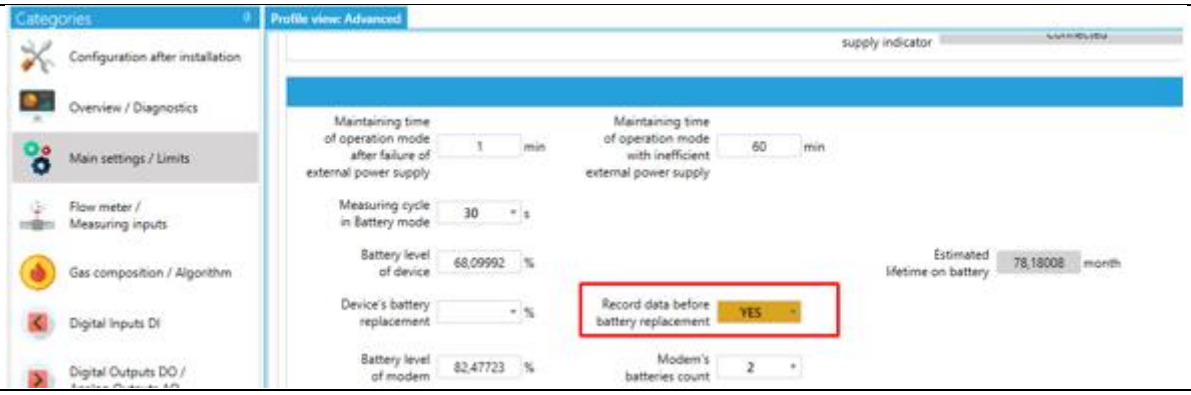
STEP1 – initial step

Begin from following action, which is data saving to memory.

Steps to follow – keyboard:

	Navigate to menu: Main menu > Configuration > Power source > Battery Using arrows navigate to parameter BattReplace and modify its value from 0 to 1. 

Steps to follow – software:

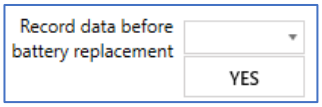
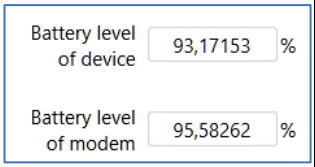


Modify following field in the profile, in highlighted category Main settings / Limits.

Manufacturer recommendation is that battery is replaced in considerably short time after the BattReplace parameter is modified or the device front cover is opened.

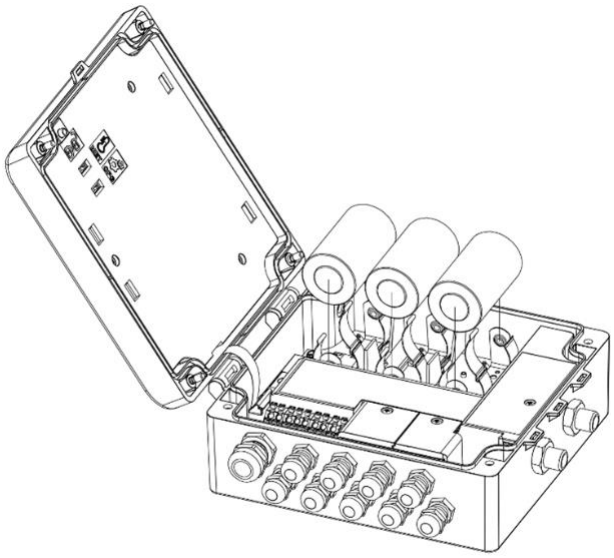
Next automatic data saving is done when the device front cover is opened and event Case Open is generated.

STEP2 Battery replacement procedure for the devices with hardware H1.8.0

KEYBOARD	SOFTWARE
• Press Enter on parameter BattReplace and change it to 1, device will save new data backup • Replace old battery (-ies) • Go to main menu by pressing Enter • Navigate to Configuration → Power source • Press Enter on parameter BattLvl and change it to 100 % • Press Enter on parameter MBattLvl and change it to 100 % - optional, when replacing Modem batteries	• In section Main settings / Limits Scroll down to parameters related with battery and set "record data before battery replacement"  • Replace old battery (-ies) • Run the software • Go to section Main settings / Limits scroll down to parameters related to battery levels set them to 100 % and confirm modification 

There is possibility to supply modem from 1 or 2 batteries. Remember to choose amount of used batteries. Wrong settings may show discharged batteries when there will be around 50 % of capacity, or opposite way – device can indicate 50 % and the modem will not be able to start up.

When replacing insert the battery beginning from positive pole (+). Once the (+) of the battery touches the holder press the (-) of the battery to place it rigidly inside.



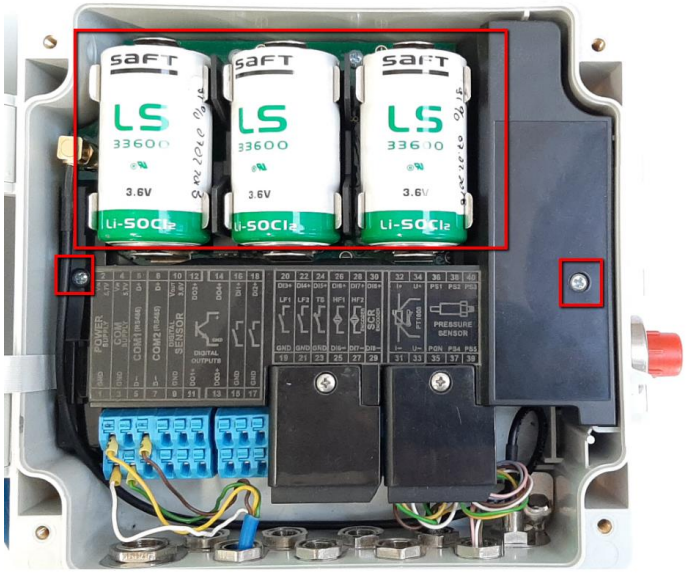
17.2. Backup battery replacement

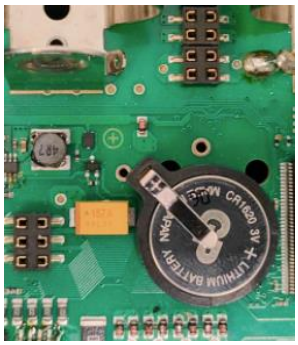
Device can be equipped with backup battery. The proper type depends on hardware version of the EVC. Types and parameters of batteries – see the point Technical data section Internal supply.

Its main functionality is to keep device's crucial parameters for the time when the main battery is empty and it has no sufficient energy for keeping a device working. On hardware version H1.3.0 of main board the backup battery is responsible for powering the memory to keep the settings and the real time clock. On hardware version H1.8.0 of main board, only real time clock is maintained. It is not used while the main batteries are operating.

Replacement of this battery can be done in Manufacturers technical staff. Replacing battery by oneself will cause loss of warranty or MID conformity check. It is necessary to remove the plastic cover inside the device housing.

Once the backup battery is discharged device will not be keeping the configuration in its internal memory in the situation of power supply disappearing.





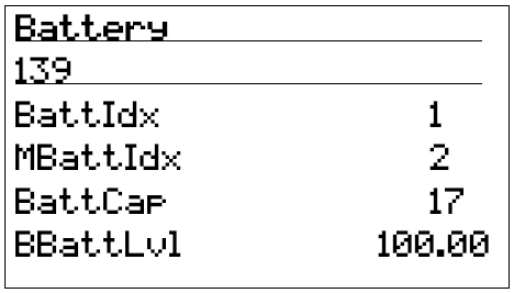
hardware ver. H1.8.0

Remove the batteries from the device. Remove the manufacturer seals from the plastic cover inside the device.

Unscrewing the plastic internal enables access to device interior. Revert all the steps to assemble back the device.

SETTING BACKUP BATTERY CAPACITY

Steps to follow – keyboard:



- Go to main menu
- Navigate to menu Configuration → Power Source → Battery
- Edit parameter BBattLvl – set it to 100 %

Steps to follow – software:

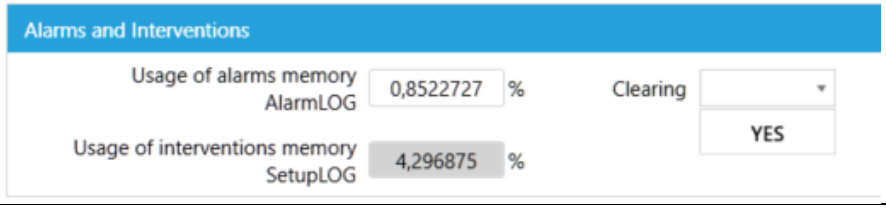
- Start the software and read out the device
- Use the Table view button and navigate to parameter 580. BBattLvl
- Change it to 100 and save the changes using Modify all button

17.3. Alarms confirmation

Device with MID conformity check is designed when the list of unconfirmed alarms will reach 100 % of memory capacity, device will start counting to Error counters and proper event will be started.

It is highly recommended to confirm the alarms periodically.

Alarms confirmation procedure:

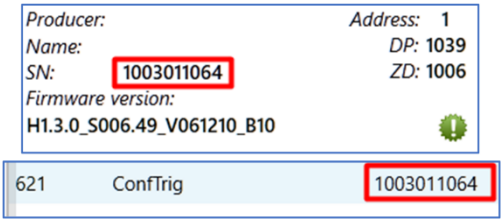
KEYBOARD	SOFTWARE
• Go to main menu by pressing Enter • Navigate to menu Alarms → Configuration • Press Enter on parameter AlarmLOG and set it to 0	• Run the software • Read the device • Go to section Main settings / Limits • Scroll down to parameters related to the Alarms and Events • Choose option Clearing and confirm modification 

17.4. Device erasing

Device erasing can be done using software. Erasing requires additional authorization and unlocking the MET switch.

Steps to follow:

- Start the software, go to the Table view
- Find parameter ***ConfTrig***
- In this parameter type Serial number of the device the erasing is being done – 10 digits number visible on the device physical nameplate, on electronic nameplate in software or in menu: Device info available from keyboard
- From now on – for 1 minute the parameter ***Erasing*** or ***ErasingBase*** will accept the changes.



Possible "Erasing" values to set:

1	Factory reset – device erases whole configuration and archives for data and events – including system logs
2	Archives reset – device erases archives for data, alarms, and events
3	Settings reset – only settings are erased without any archives
4	SetupLOG memory field erasing

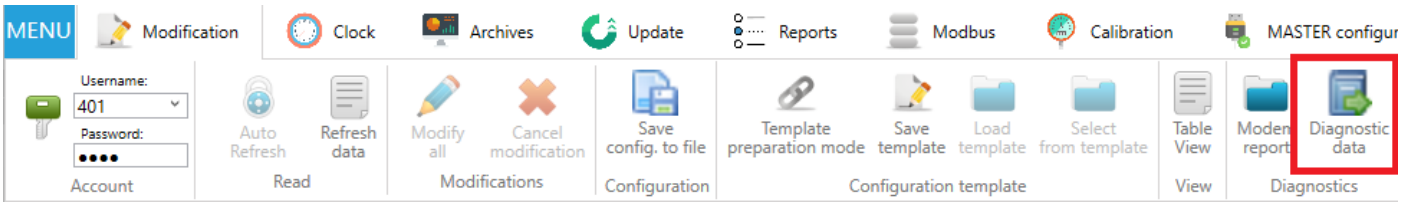
Possible "ErasingBase" values to set:

1	Device erases event log, momentary and periodic archive. Parameters from level 4 are set in default values. Increments and average values will be reset to zero.
2	Device erases event log, momentary and periodic archive. Increments and average values will be reset to zero.
3	Parameters from level 4 are set in default values.

17.5. Diagnostics data for Technical Staff

EVC is an electronic device which may affect damage or malfunction. For Technical Staff it is mandatory to receive following data for the diagnosis. Lack of any file may occur in diagnosis process difficult or impossible.

- **Device report**



Diagnostic data contains files with list of all parameters, list of alarms, registered data (periodic registration) and modem schedules.

Example filenames:

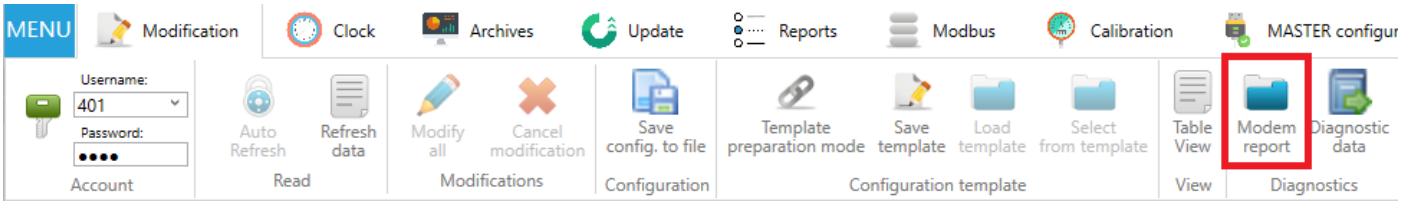
EVC_2553_1004178176_config_20220412124044

EVC_1004178176_alarms_20220412123546.csv

EVC_1004178176_periodical_20220412124044.csv

EVC_2553_1004178176 modem_schedules_20220412124044.bin

- **Modem Report** – if device is equipped with internal modem



Output file contains log from internal modem from last connection in *.bin format.

Modem Report buffer has limited capacity. It should be downloaded shortly after failed connection.

Example Filename: EVC_2553_1004178176.bin

- **SUMMARY**

Producer Technical Staff shall receive 3 to 5 files depending on hardware version – with or without modem.

  - Device Parameters table: EVC_2553_1004178176_**config**_20220412124044
  - Device Events table: EVC_1004178176_**alarms**_20220412123546.csv
  - Device archives (at least 6 months back): EVC_1004178176_**periodical**_20220412124044.csv
  - Device Modem Report: EVC_2553_1004178176.bin
  - Device Schedule List: EVC_2553_1004178176 modem_schedules_20220412124044.bin

18. Device principles overview

18.1. Measurement – calculation cycles

EVC device operates by default in measurement-calculation cycle:

- Every 30 seconds – when running in BATT mode (powered from internal battery),
- Every 1 second – when running in FULL mode (powered from external power source),
- Every 1 second – when display is turned on (in all power modes),
- Frequency of mentioned cycles in BATT mode could be set in range of (6 ÷ 30) s (up to 60 s when device is non-MID version);
- In every cycle, at first step device performs read of information about values of all measuring inputs and calculates increments from chosen counting input. Basing on this input data EVC calculates increment of volume at measurement conditions ***dVm***, adds it up to counter ***Vm*** and computes value of flow at measurement conditions ***Qm***. At the same time, device checks, whether new alarms have occurred, or earlier alarm situations have been closed.
- In next step, basing on the current values of pressure ***p1***, temperature ***t*** and programmed gas parameters, unit calculates conversion factor ***C*** and then increment of volume at base conditions ***dVb*** and flow ***Qb***. Simultaneously there are calculated values of: ***dE***, ***dM***, ***QE***, ***QM***.

18.2. Emergency state

During typical usage of the device, depending on the appearance of alarm situation, it can operate either in normal state or in emergency state. All parameters listed before are active in both states of device operation (calculation of temporary values of flows and counters increments).

If the unit operates in normal state, all calculated increments are added up to main counters („n" - new value of parameter, „p" - value from previous calculation cycle):

$\mathbf{Vm_n} = Vm_p + dVm$

$\mathbf{Vb_n} = Vb_p + dVb$

$\mathbf{E_n} = E_p + dE$

$\mathbf{M_n} = M_p + dM$

During normal state, emergency counters are stopped.

If the unit operates in emergency state, all calculated increments are added up to emergency counters:

$\mathbf{Vme_n} = Vme_p + dVm$

$\mathbf{Vbe_n} = Vbe_p + dVb$

$\mathbf{Ee_n} = Ee_p + dE$

$\mathbf{Me_n} = Me_p + dM$

During emergency state, the main counters Vb, E and M are stopped. Vm counter is always active.

Emergency state of EVC is active if an alarm from a system group is active.

18.3. Calculation of conversion factor C

The main objective of the gas volume conversion device is to calculate conversion factor to base conditions ***C***, which is later used to convert values obtained at the measurement conditions into values at the base conditions.

To calculate coefficient ***C***, following values are used:

- pressure ***p1*** and temperature ***t***

- compressibility factors: at measurement conditions ***Z*** and at base conditions ***Zb*** – computed basing on measured values of gas pressure, temperature, and current gas composition.

  If values of pressure or temperature will exceed the ranges determined for currently used algorithm, an alarm of algorithm error will be generated, and further results will be saved into emergency counters. Calculation of compressibility factors is possible even if values of ***p1*** and ***t*** will be out of ranges (however, keep in mind, that uncertainty of performed calculations in this conditions will be increased). If chosen calculation algorithm is unable to perform further computation, then values of ***Z*** =1 and ***Zb*** =1 are used.

- base pressure ***pb*** and base temperature ***Tb***.

  Both of those values are describing the base conditions, on which values obtained at measurement conditions are going to be converted. Additionally, combustion temperature for computation of the superior calorific value Hs (***T1***).

  Basing on parameters presented before, a Conversion factor to base conditions ***C*** is calculated (2 alternative formulas – the same calculation in both, where Fp – pressure factor (multiplier), Ft – temperature factor (multiplier), Fpv2 – supercompressibility factor):

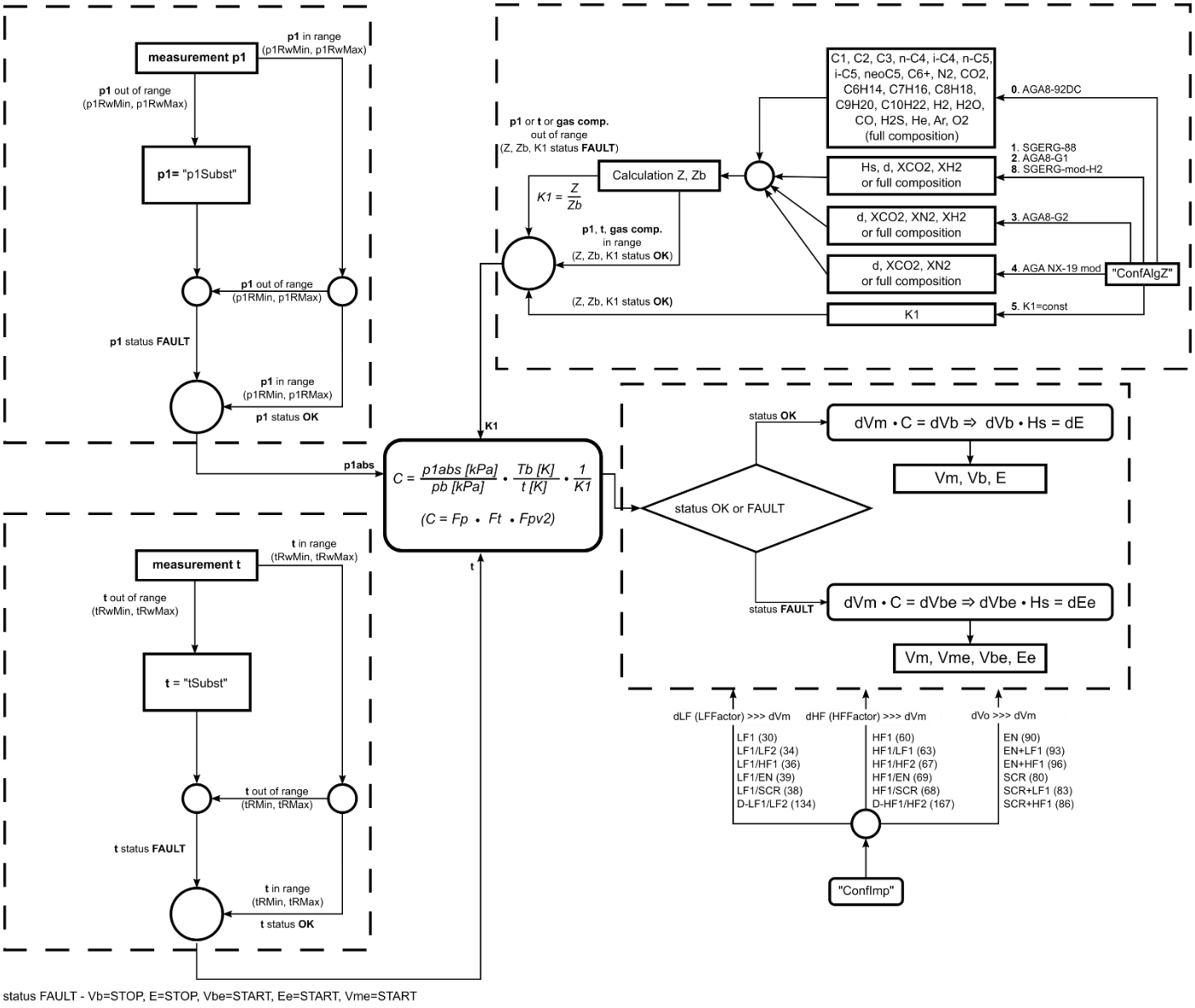
$$C = \frac{p1abs\,[kPa]}{pb\,[kPa]} \times \frac{Tb\,[K]}{t\,[K]} \times \frac{1}{K1} \quad \textbf{(1a)}$$

$$K1 = \frac{Z}{Zb} \quad \textbf{(1b)}$$

$$C = Fp \times Ft \times Fpv2 \quad \text{where:} \quad \textbf{(1c)}$$

$$Fp = \frac{p1abs\,[kPa]}{pb\,[kPa]} \qquad Ft = \frac{Tb\,[K]}{t\,[K]} \qquad Fpv2 = \frac{1}{K1} \quad \textbf{(1d)}$$

In algorithms SGERG-88, SGERG-mod-H2, AGA8-G1, AGA8-G2, AGA NX-19-mod and K1-const device requires to program values of superior calorific value Hs and relative density d specified for used base conditions Tb and pb and combustion process T1 and P1 (always P1=pb). If given values of Hs and d are known for different base conditions than ones used in the device, they must be recalculated for those base conditions before programming. Methods for recalculations of Hs and d between different base conditions are described in standard EN ISO 6976:2005, annex J and in standard EN ISO 12213-3:2010, annex D. When programming full gas composition, no further recalculations are necessary.



18.4. Increment of volume at measurement conditions

Device's configuration allows to choose method of obtaining volume at measurement conditions basing on data from pulse inputs LF and HF, additionally from digital input of encoder.

In configurations with LF as main counting input (configurations: LF1, LF1/LF2, LF1/HF1, LF1/SCR, LF1/EN) increment of volume at measurement conditions ***dVm*** is calculated with formula:

$$dVm = \frac{dLF}{LF\ factor} \quad \textbf{(2a)}$$

where:
dLF – increment of pulses on LF input during measurement-calculation cycle
LF factor – LF input pulse rate

In configurations with HF as main counting input (configurations: HF1, HF1/LF1, HF1/HF2, HF1/SCR, HF1/EN) increment of volume at measurement conditions ***dVm*** is calculated with formula:

$$dVm = \frac{dHF}{HF\ factor} \quad \textbf{(1b)}$$

where:
dHF – increment of pulses on HF input during measurement-calculation cycle
HF factor – HF input pulse rate

In configurations with EN and SCR as main counting input (configurations: EN, EN/LF1, EN/HF1, SCR, SCR/LF1, SCR/HF1) increase of volume at measurement conditions ***dVm*** is calculated with formula:

$$dVm = dVo \quad \textbf{(2c)}$$

where:
dVo – increment of auxiliary counter ***Vo***, derived from direct reading of encoder.

Increments ***dVm*** are summed in ***Vm*** counter during normal and emergency mode. During emergency mode, additional auxiliary emergency counter of volume at measurement conditions ***Vme*** is driven.

18.5. Averaged conversion factor

A value of arithmetic average of conversion factor ***C*** is calculated in the device. By default, averaged value is equal to momentary value from current measurement-calculation cycle. Averaging of conversion factor covers the period in which flow of gas has been observed (flow rate ***Qm***>0), but in following measurement-calculation cycles increment of volume at measurement conditions counter value ***dVm*** was not detected. When finally increment of that counter is detected – period of averaging value of ***C*** ends.

E.g., measurement-calculations cycle period is 30 seconds and increment of volume at measurement conditions ***dVm*** occurs e.g., every 180 seconds (it could be correct period of incoming low frequency pulses LF or readouts of encoder's counter state). Counting from 0 second – every 30 seconds device calculates momentary value of conversion factor ***C*** and its averaged value. In 180th second, increment of ***dVm*** counter will be detected and calculation of increased volume at base conditions will be carried with use of averaged ***C***. This allows to consider of following calculations possible dynamic changes of pressure or temperature or gas composition during period of volume increment.

18.6. Increment of volume at base conditions

$$dVb = dVm \times C \quad \textbf{(3)}$$

where:
dVm – increment of volume at measurement conditions
C – conversion factor to base conditions averaged for increment period of ***dVm.***

Increments ***dVb*** are summed up to ***Vb*** counter during normal operation and to ***Vbe*** during emergency mode.

18.7. Increment of energy

$$dVb \times Hs = dE \quad \textbf{(4)}$$

where:
dVb – increment of volume at base conditions
Hs – superior calorific value.

Increments ***dE*** are summed up to ***E*** counter during normal operation and to ***Ee*** during emergency mode.

18.8. Increment of mass

$$dVb \times rob = dM \quad \textbf{(5)}$$

where:
dVb – increment of volume at base conditions
rob – gas density at base conditions

Increments ***dM*** are summed up to ***M*** counter during normal operation and to ***Me*** during emergency mode.

18.9. Flow of volume at measurement conditions

Flow of gas volume at measurement conditions ***Qm*** (without enabled correction) is calculated using formula:

- based on *HF* pulses measurement:

$$QmHF = \frac{fHF}{HFFactor} \times 3600 \quad \textbf{(6a)}$$

typically:

$$Qm = QmN = QmHF \quad \textbf{(6b)}$$

where:
QmN – uncorrected flow of volume at measurement conditions,
fHF – frequency of pulses on HF input,
HFFactor – gas meter HF pulse rate (number of pulses per 1 m^3).

- based on *LF* pulses measurement:

$$QmLF = \frac{\frac{1}{LFtm}}{LFFactor} \times 3600 \quad \textbf{(7a)}$$

typically:

$$Qm = QmN = QmLF \quad \textbf{(7b)}$$

where:
QmN – uncorrected flow of volume at measurement conditions,
LFtm – time between successive pulses at the LF input [s],
LFFactor – gas meter LF pulse rate (number of pulses per 1 m^3).
based on readouts of encoder: Value of flow is calculated based on the data read from the encoder.

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18.10. Flow of volume at base conditions

$$Qb = Qm \times C \quad \textbf{(8)}$$

where:
Qm – flow of volume at measurement conditions (may be corrected by gas meter correction error curve),
C – averaged conversion factor to base conditions

18.11. Flow of energy

$$QE = \frac{Qb \times Hs}{3{,}6} \quad \textbf{(9)}$$

where:
Qb – gas volume flow at base conditions
Hs – superior calorific value

18.12. Flow of mass

$$QM = Qb \times rob \quad \textbf{(10)}$$

where:
Qb – gas volume flow at base conditions
rob – gas density at base conditions

18.13. Correction of flow from error curve of the gas meter (flowmeter)

Switching of correction function is controlled by parameter ***CurveCorr***, where
Value **0** – correction function disabled;
Value **1** – correction function enabled.
Switching of correction function generates event "*Configuration changed*" which saves status of function before and after modification.
Corrected flow ***Qm*** from error curve of the gas meter is calculated with formula:

$$Qm = QmN \times FQ \quad \textbf{(11)}$$

$$FQ = 1 - \frac{f'(Q)}{100\%} \quad \textbf{(12)}$$

$$f'(Q) = \frac{fP_{i+1} - fP_i}{QP_{i+1} - QP_i} \times (QmN - QP_i) + fP_i \quad \textbf{(13)}$$

where:

QmN – uncorrected flow of volume at measurement conditions,

FQ – correction function, calculated basing on points ***FP1*** ÷ ***FP10*** and ***QP1*** ÷ ***QP10***

$\boldsymbol{fP_{i+1}}$, $\boldsymbol{fP_i}$ – values of gas meter errors at specific points,

$\boldsymbol{QP_{i+1}}$, $\boldsymbol{QP_i}$ – values of flow for which error value was determined

WARNING: In accordance with standard EN 12405-1 correction function can be used only when gas meter at Qmin generates at least 10 pulses per second, this means that correction function can be used in configurations of pulse inputs with *HF* signal as main.

Below value of Qmin, correction function is not used, while above Qmax, value of correction function is the same as for the one obtained for Qmax.

Correction is also used to calculate volume, energy and mass, parameters after correction are: ***Vc***, ***Vb***, ***E, M***.

plum GAS

gas.plum.pl

PLUM Sp. z o.o.
Wspólna st. 19, Ignatki 16-001 Kleosin, Poland
Registration number BDO: 000009381

Service:
Tel.: 85 749 70 08; service.gas@plum.pl