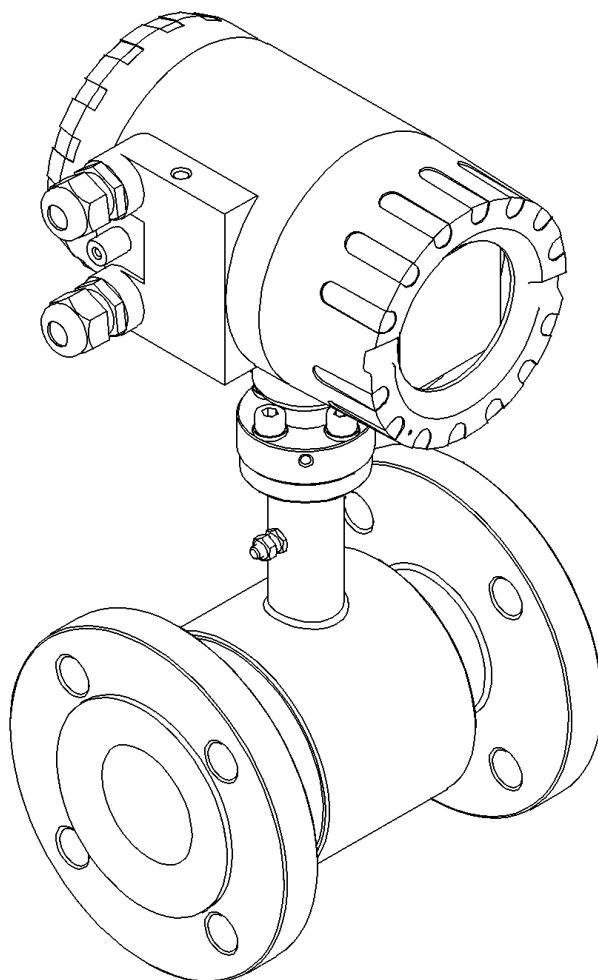


APLISENS[®]

USER'S MANUAL

ELECTROMAGNETIC FLOWMETER **PEM-1000**



PRODUCT CODE – see: → [5.2. Flowmeter identification.](#)

The QR code or ID number identifies the transmitter and provides quick access to the following documentation on the manufacturer’s website: user’s, configuration, Modbus, Pulse output interfacing and HMI manuals, declarations of conformity and copies of certificates.

PEM-1000ALW

ID: 0073 0005 0001 0000 0000 0000 0003 06

<https://id.aplisens.pl/007300050001000000000000000306>



PEM-1000ALW 230 v

ID: 0073 0006 0001 0000 0000 0000 0003 72

<https://id.aplisens.pl/007300060001000000000000000372>



PEM-1000NW

ID: 0073 0007 0001 0000 0000 0000 0003 41

<https://id.aplisens.pl/007300070001000000000000000341>






PEM-1000NW 230 v

ID: 0073 0008 0001 0000 0000 0000 0003 10

<https://id.aplisens.pl/007300080001000000000000000310>



Symbols used

Symbol	Description
	Warning to proceed strictly in accordance with the information contained in the documentation in order to ensure the safety and full functionality of the device.
	Information particularly useful during installation and operation of the device.
	Information on disposal of used equipment.

BASIC REQUIREMENTS AND SAFE USE



The manufacturer will not be liable for damage resulting from incorrect installation, failure to maintain a suitable technical condition of the device or use of the device other than for its intended purpose.

Installation should be carried out by qualified staff. The installer is responsible for performing the installation in accordance with manual as well as with the electromagnetic compatibility and safety regulations and standards applicable to the type of installation.

In systems with I&C equipment, in case of leakage, there is a danger to staff due to the medium under pressure. All safety and protection requirements must be observed during installation, operation and inspections.

If a malfunction occurs, the device should be disconnected and return to the manufacturer for repair.



In order to minimize the risk of malfunction and associated risks to staff, the device is not to be installed or used in particularly unfavourable conditions, where the following hazards occur:

- possible mechanical impacts, excessive shocks and vibration;
- excessive temperature fluctuation;
- water vapour condensation, dusting, icing.

Changes made to the manufacturing of products may be introduced before the paper version of the manual is updated. The up-to-date manuals are available on the manufacturer's website: www.aplisens.com.

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1. INTRODUCTION

1.1. Purpose of the document

The subject of manual are electromagnetic flowmeters in two versions:

- compact version designated **PEM-1000ALW** - with transmitter placed directly on the measuring sensor;
- remote version designated **PEM-1000NW** - with transmitter connected via cable and placed up to 50 m from measuring sensor.

The manual contains data, guidelines and recommendations for connection, startup and configuration, as well as procedure in the event of a failure. Before installing the flowmeters, please read the instruction carefully.



The description of device configuration can be found in the Configuration manual, and the Modbus® communication is described in the Modbus manual. They are available on the manufacturer's website www.aplisens.com

1.2. Trademarks

Modbus® is a registered trademark of SCHNEIDER AUTOMATION, INC.

2. SAFETY



- The installation and start-up of the device and any activities related to operation shall be carried out after thorough examination of the contents of user's manual.
- Installation and maintenance should be carried out by qualified staff.
- The device shall be used according to its intended purpose in line with the permissible parameters specified on the nameplate → [5.2. Flowmeter identification](#).
- The protection elements used by the manufacturer to ensure transmitter safety may be less effective if the device is operated in a manner not consistent with its intended purpose.
- Before installing or disassembling the device, it is absolutely necessary to disconnect it from the power source.
- No repairs or alterations to the transmitter electronic system are permitted. Assessment of damages and possible repair may only be performed by the manufacturer after sending the device for service.
- Do not use instruments if damaged. In case of malfunction, the device must be put out of operation.

3. TRANSPORT AND STORAGE

3.1. Delivery check

After receiving the delivery of the equipment, it is necessary to:

- make sure that the packaging and its contents were not damaged during transport;
- check the completeness and correctness of the received order.

3.2. Transport

Transport of flowmeters shall be carried out with the use of covered means of transport, in original packages. The packaging shall be protected against movement and direct impact of atmospheric factors.

3.3. Storage

Flowmeters shall be stored in a factory packaging, in a room without vapours and aggressive substances, protected against mechanical impact.

Allowable environmental parameters for storage facilities parameters:

Allowable range of ambient/storage temperature	-20 ... 60°C (-4 ... 140°F)
Relative humidity	to 80%
Surrounding atmosphere	no aggressive ingredients

4. GUARANTEE

General terms and conditions of guarantee are available on the manufacturer's website:

www.aplisens.com/ogolne_warunki_gwarancji



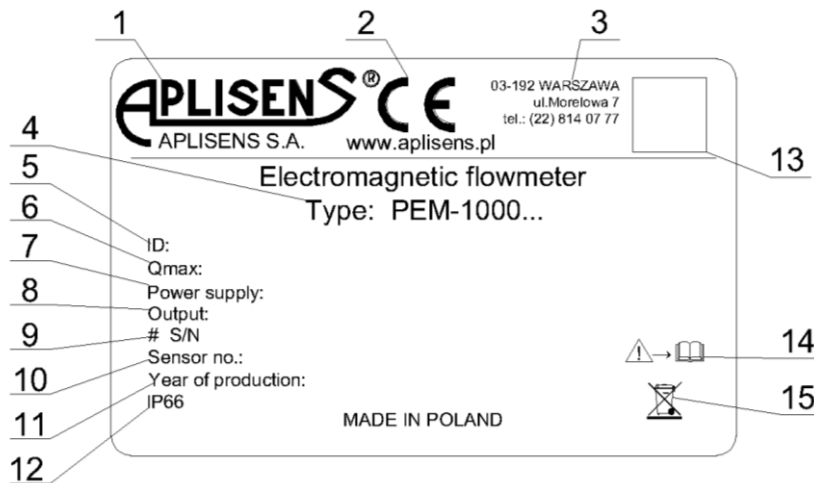
The guarantee shall be repealed if the device is used against its intended use, failure to comply with user's manual or interference with the structure of the device.

5. IDENTIFICATION

5.1. Manufacturer's address

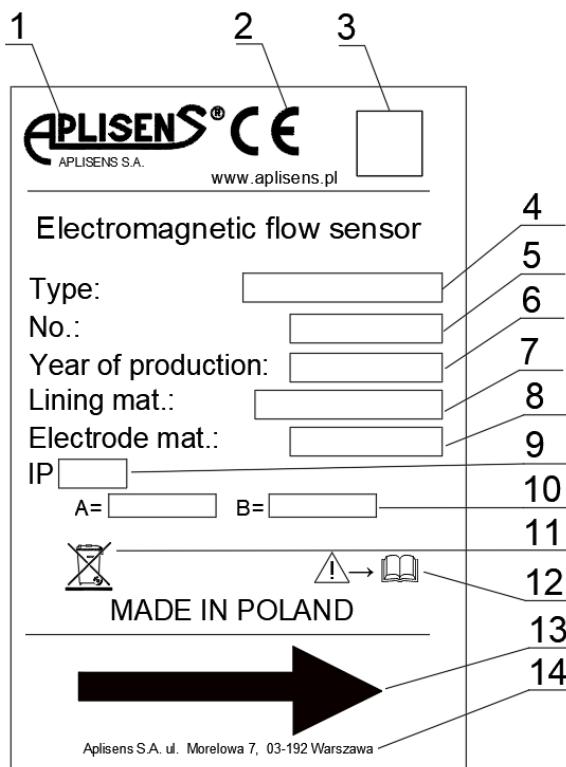
APLISENS S.A.
03-192 Warsaw
Morelowa 7 St.
Poland

5.2. Flowmeter identification



1. Logo and name of manufacturer.
2. CE mark.
3. Manufacturer's address.
4. Flowmeter type.
5. Flowmeter model ID.
6. Max of flow value.
7. Supply voltage parameters.
8. Output signal.
9. Serial number of flowmeter.
10. Serial number of sensor.
11. Year of production.
12. IP protection rating.
13. QR code.
14. Note about the obligation to read the manual.
15. Reference to dealing with worn-out equipment.

Figure 1. Symbols appearing on the flowmeter's nameplate



1. Logo and name of manufacturer.
2. CE mark.
3. QR code.
4. Sensor type.
5. Serial number of sensor.
6. Year of production.
7. Sensor lining.
8. Electrode material.
9. IP protection rating.
10. Values of calibration coefficient A and B.
11. Reference to dealing with worn-out equipment.
12. Note about obligation to read the manual.
13. Medium flow direction.
14. Manufacturer's address.

Figure 2. Symbols appearing on the sensor's nameplate

5.3. CE mark, declaration of conformity

The device has been designed to meet the highest safety standards, has been tested and has left the factory in a condition that is safe for operation. The device complies with the applicable standards and regulations listed in the EU Declaration of Conformity and has CE marking on nameplate.

6. INSTALLATION

6.1. General recommendations

- It is recommended that the flow direction is in the direction of the arrow on the sensor, the transducer is also factory set to work in this direction. The flow in the opposite direction to the arrow is shown as a negative value. If reverse installation is necessary, please contact the manufacturer.
- During the measurements, the entire space inside the sensor should be filled with the liquid.
- Fix the pipework on both sides of the flowmeter to avoid vibration and sag in the pipe-work from affecting the measurements.
- If the flowmeter is installed in a pipeline with a larger ID, use a reducer that ensures axial fixation of the sensor. Remember to keep straight sections with lengths of at least 5DN before and 3DN after the sensor.
- When installing on an insulated pipe (e.g. glass, plastics etc.) please insulate the system with earthing rings connected with ground terminal of the sensor → [Figure 15. Example of a functional earthing connection for a metal pipeline and for an insulated pipeline using earthing rings.](#)
- Conductive connection between enclosure of the sensor and liquid is necessary for correct measurements.
- During installation, it is essential to place a gaskets between the flange faces of the sensor and pipeline according to → [Figure 4. Installation of the gaskets between the flange faces of the sensor and pipeline](#)
- a) front view, b) isometric view, c) isometric view with grounding ring. If grounding rings are used, the gaskets must be installed on both sides of the rings.
- Do not use gaskets made of hard materials as they may damage the lining.
- Make sure that no sealing element enters the lumen of the pipeline as this may introduce turbulence into the flow and disrupt the measurements of the flowmeter.



6.2. Recommended installation methods for flow sensor

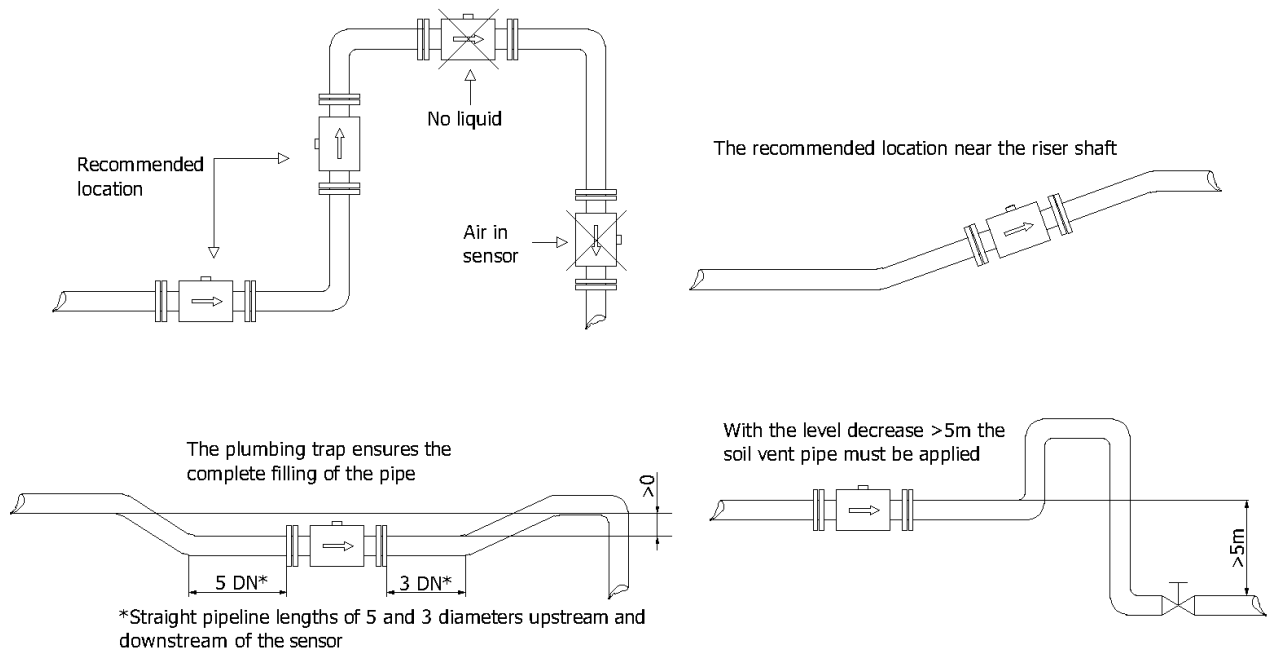


Figure 3. Recommended locations of sensor installation

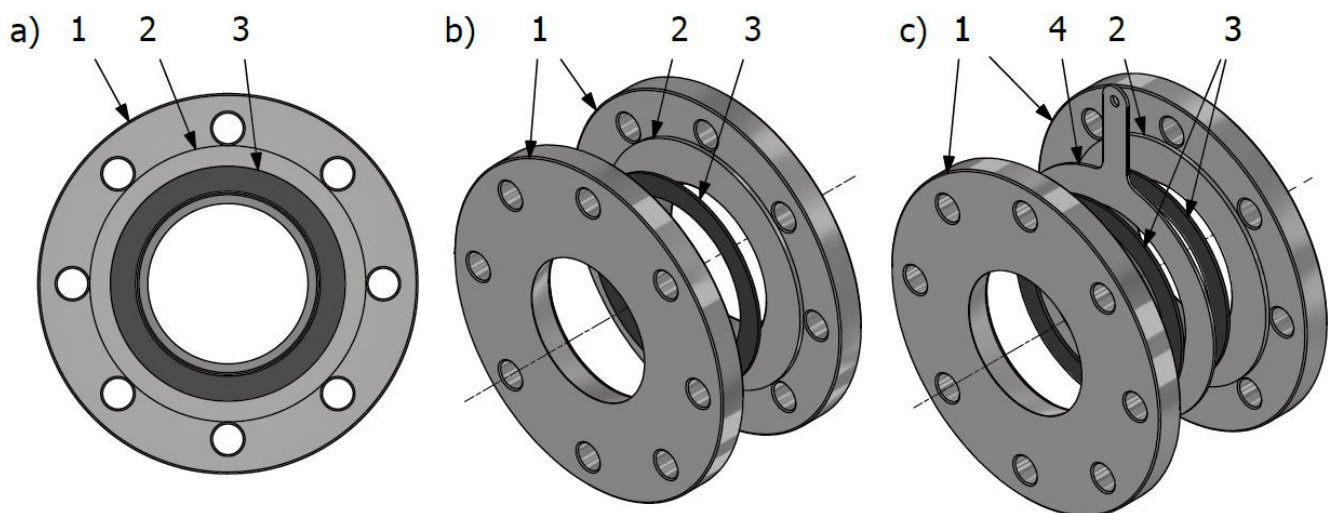


Figure 4. Installation of the gaskets between the flange faces of the sensor and pipeline

a) front view, b) isometric view, c) isometric view with grounding ring

1. Flange.
2. Flange face.
3. Gasket.
4. Grounding ring.

To avoid metrological errors caused by air bubbles or damage floor covering, follow the recommendations below:

- Make sure to position the sensor correctly and tighten the flange bolts simultaneously on both sides.
- The flowmeter should be installed in the way that the electrode axis is as horizontal as possible, in accordance with the examples → [Figure 6. Installation of the PEM-1000 flowmeter - examples](#).
- Teflon lining requires special care during handling and assembly. During installation (operation), avoid under pressure in the pipeline. Do not damage liner leads to the outer flange surfaces on both sides of the sensor. Teflon lining covers, if mounted, should be removed immediately before installation.
- Ensure that no seal element enters the lumen of the pipeline, as this introduce turbulence into the flow and disturb measurements.

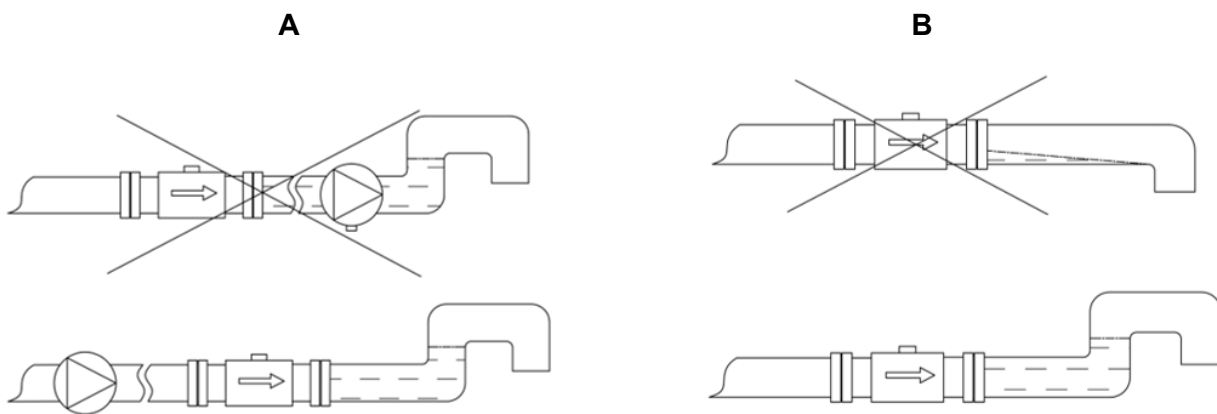


Figure 5. Examples of correct and incorrect sensor installation on the sites

The figure above shows the two most common cases of incorrect installation of a flowmeter sensor on a facility.

Case A shows incorrect installation of the pump (behind the sensor). This type of mounting cause distortion of the flow values and also expose the electrodes, which can result in an error of empty pipe detection. In extreme cases the vacuum generated by the pump can cause the sensor lining to come loose.

Case B shows the sensor mounted at the end of the pipeline. This type of mounting also cause the electrodes to be exposed and related problems. To avoid errors with the functioning of the flowmeters, it is recommended to use a siphon as shown in the picture.

6.3. Installation of the PEM-1000 flowmeter

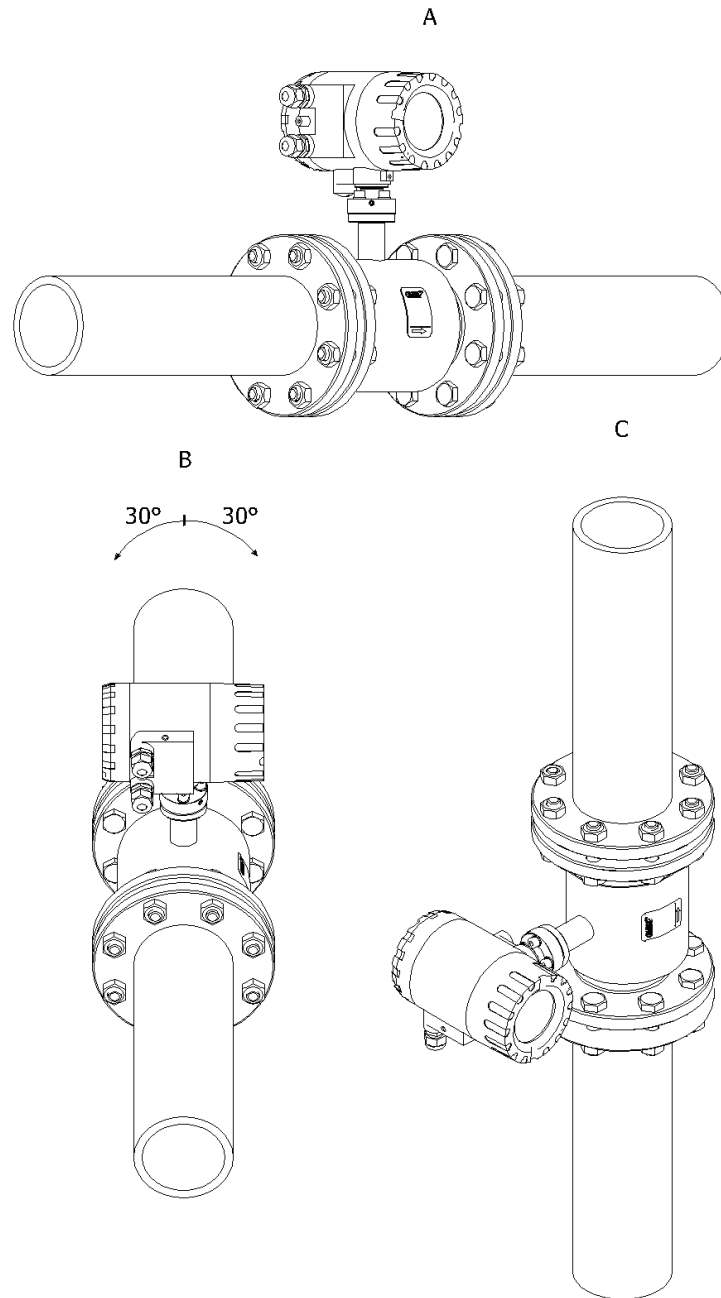


Figure 6. Installation of the PEM-1000 flowmeter - examples



It is recommended to install the flowmeters in a horizontal position (A), with the tilting it up to 30° (B) and in a vertical position (C) - according to the examples shown in the figure.

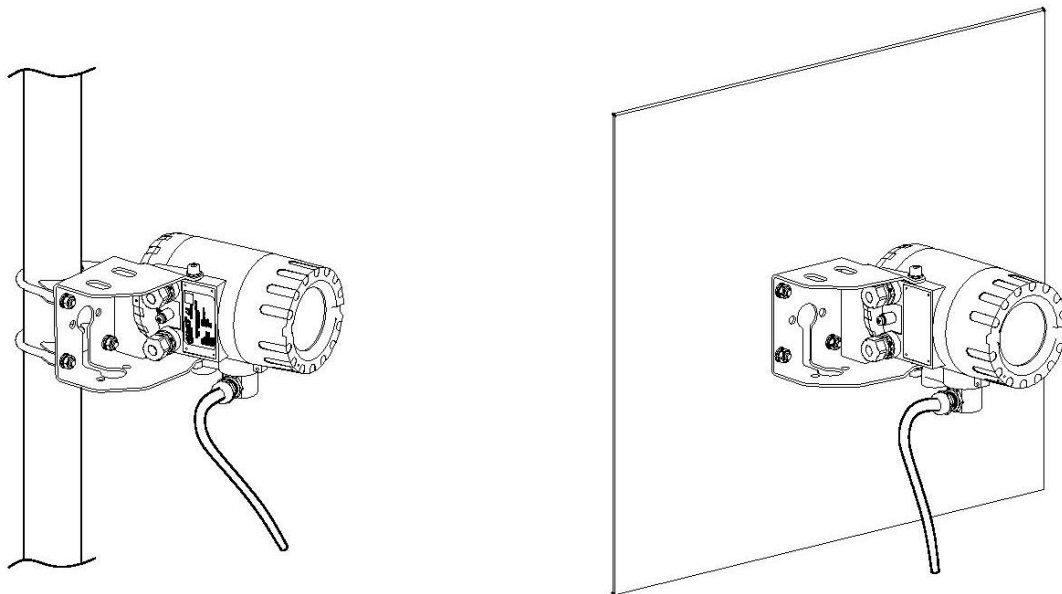


Figure 7. Examples of installation of the flowmeter transmitter for PEM-1000NW version on a pipe and on the wall

6.4. ALW flowmeters transmitter rotation

The ALW transmitter features a rotatable housing. To rotate the housing, loosen the screw (item 1), position the transmitter housing as needed (item 2), and then tighten the set screw (item 1).

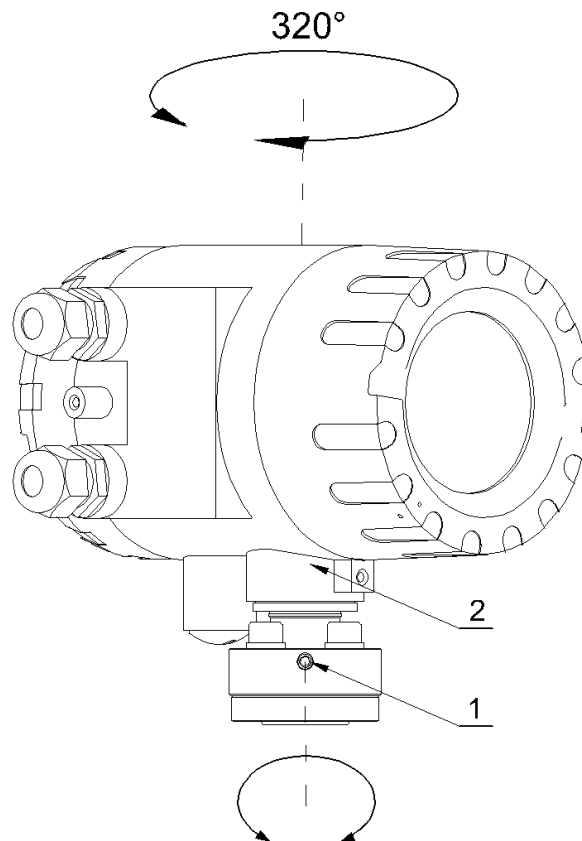


Figure 8. Housing rotation

7. ELECTRICAL CONNECTION



All connection and assembly operations must be performed with the supply voltage and other external voltages, if used, disconnected. Install a circuit breaker with protection in the close vicinity of the flowmeter transmitter, in the same room, on the flowmeter supply line. It should be easily accessible and clearly marked with symbols complying with local regulations for safety of electrical equipment.

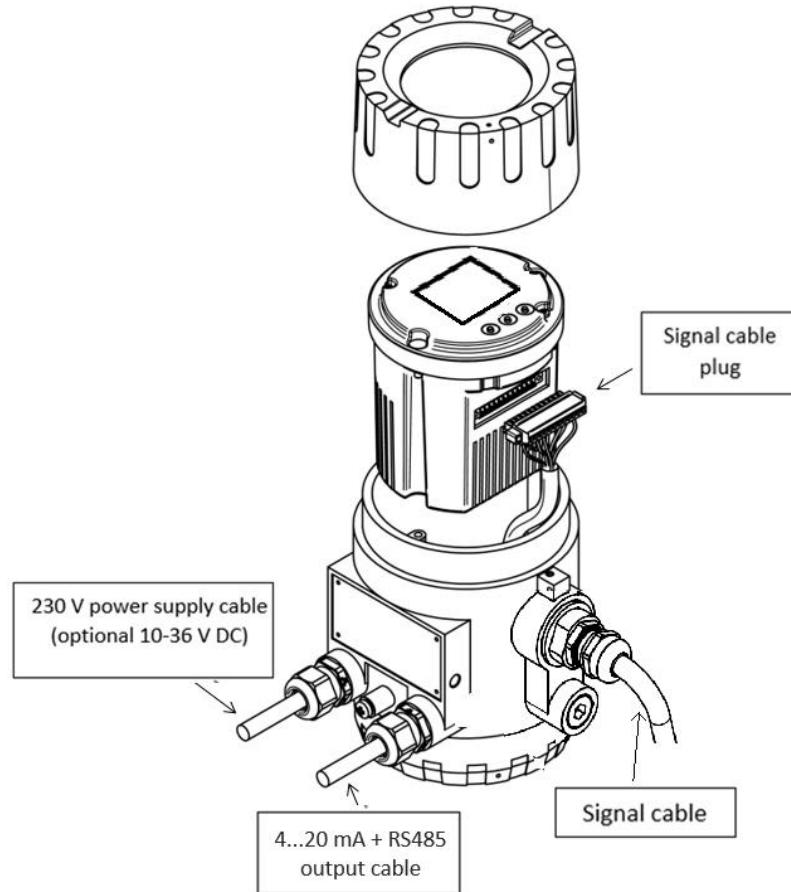


Figure 9. Electrical wiring from the PEM-1000 flowmeter transmitter

Electrical terminals of the flowmeter can be accessed by unscrewing the side cover of the side cover of the transmitter casing. The figure and table below show the arrangement and purpose of the individual terminals.

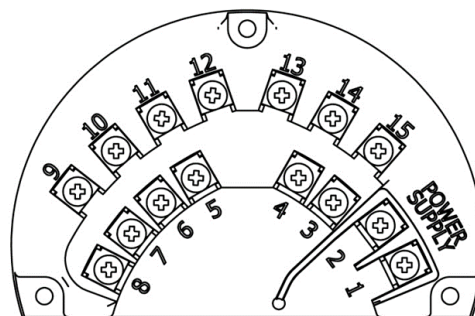


Figure 10. View of electrical terminals of the PEM-1000 flowmeter

Table 1. Designation of connection terminals of the PEM-1000 flowmeter

	Terminal No	Description		
Power supply	1	mains supply	(-)	low voltage power supply DC (option)
	2		(+)	
Binary output 1*	3	any polarization		
	4	galvanically isolated, passive		
Pulse output/ frequency output	5	passive		
	6	any polarization, galvanically isolated		
Analog current output 4 ... 20 mA	7	(+)	active / passive (default active)	
	8	(-)		
Communication	9	RS 485 A		
	10	RS 485 B		
	11	RS 485 SGND/shield		
Binary input passive*	12	any polarisation		
	13	galvanically isolated		
Binary output 2*	14	any polarisation, galvanically isolated		
	15	passive		

*) Optional functions.



In order to maintain security of the supply lines and output lines should be carried within the housing separate glands.

The cables attached to the screw terminals should be terminated with end sleeves 0.75 mm². When connecting the flowmeter to the power supply, observe the rules:

- connections of electrical appliances;
- protection against electric shock;
- principles of safe operation of electrical installations by personnel.

The electrical protections of the device allows it to be used in various environments, and in consultation with the manufacturer, it is possible to make additional modifications that allow flowmeter to be used in specific user environmental conditions. The output cables from the converter should not be led next to power cables and other cables that may generate interference. Devices cooperating with the flowmeter should be resistant to electromagnetic disturbances generated in the environment, in accordance with the electromagnetic compatibility requirements in the place of use.



Power supply of the transducer with a low-voltage power supply (optional version) is connected to the same POWER SUPPLY terminals as the mains power supply (plus terminal no. 2). Do not connect the mains power to the POWER SUPPLY terminals of the flowmeter in the version with a low-voltage power supply, as this will damage it.



The flowmeter is equipped with an active current output, which means that the current loop is powered from the flowmeter. The loop must not be powered from an external power supply. The flowmeter with passive loop 4 ... 20 mA is available as a special version. The passive loop must be powered with a voltage between 6 V and 36 V.

7.1. Connecting the sensor signal cable for PEM-1000NW

The signals are transmitted from the sensor electrode circuit to the transmitter are very sensitive to magnetic and electrostatic interference that come from adjacent power cables and power lines feeding high power electrical equipment. The interference is compensated for by the flowmeter's internal noise filter; nevertheless, these signal sources should be avoided.

For the PEM-1000NW flowmeter it is recommended to locate the signal cable from the sensor in separate cable ducts.

The signal cable coming out of the sensor has a special design and is part of the order, therefore its length should not be changed (for a flowmeter with calibration certificate it must not be changed).

The cable sheath (insulation) should remain intact along its entire length. The wires of the sensor cable should be connected according to → [Figure 11. Marking the leads of the sensor cable cores from the](#)

sensor junction box side for PEM-1000NW and connection board terminals description → Table 2.

Connection terminals

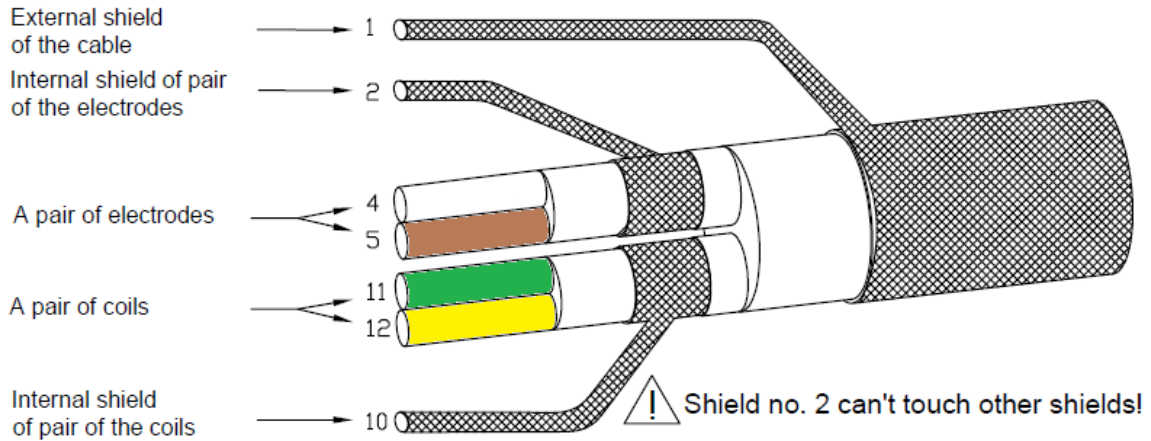


Figure 11. Marking the leads of the sensor cable cores from the sensor junction box side for PEM-1000NW

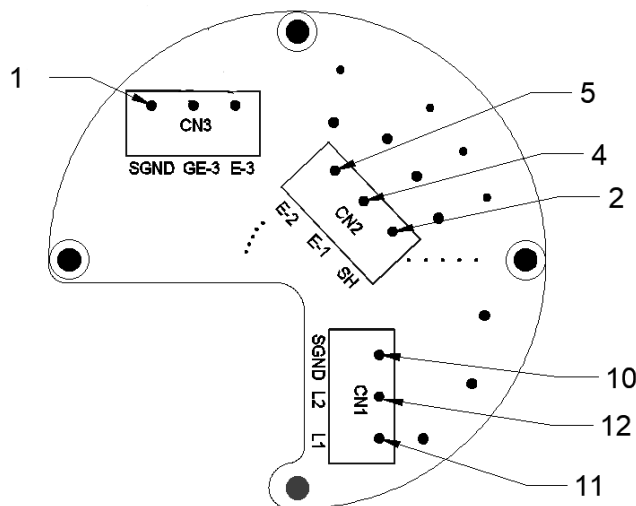


Figure 12. Sensor board connector input designation for PEM-1000NW

Access to the sensor board available in the PEM-1000NW version is obtained by unscrewing the cover of the junction box located directly on the sensor.

Table 2. Connection terminals

Cable core type	Cable core colour	Board connector input marking (for PEM-1000NW only)
Cable outer shield	-	SGND
Internal shield of the electrode pair	-	SH
Electrode pair	White	E-1
Electrode pair	Brown	E-2
Internal screen of the coil pair	-	SGND
Coil pair	Green	L1
Coil pair	Yellow	L2



Incorrect connection of the signal cable cores will cause many measurement errors.



If the sensor is mounted below the ground or water surface and if the sensor is exposed to flooding, it is necessary, after connecting the cable, to fill the inside of the junction box with protective silicone gel, available on request or another with similar sealing and insulation properties.

7.2. Grounding



The flowmeter must be earthed according to the rules in force at the place of installation. The lack of functional grounding can cause significant disturbances in the measurements.



Marking of the connection point of the SGND earth of the sensor and flowmeter.

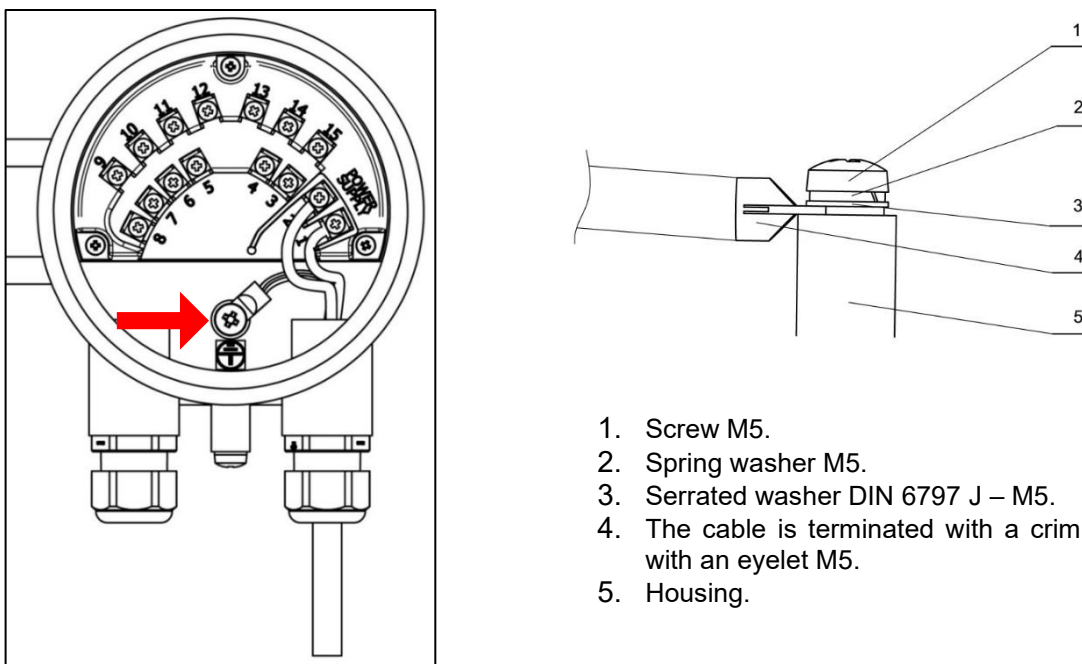


Marking of the protective ground connection in the transmitter housing.

7.2.1. Protective grounding



Protective grounding is an element ensuring safety against electric shock in accordance with the standards and must always be connected.



1. Screw M5.
2. Spring washer M5.
3. Serrated washer DIN 6797 J – M5.
4. The cable is terminated with a crimp terminal with an eyelet M5.
5. Housing.

Figure 13. Location and method of connecting the protective earth to the transmitter

Use a power cable suitable for the cable gland, with certified cables with a working voltage of 300/500 V.

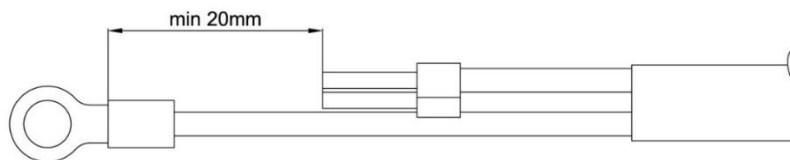


Figure 14. Ring terminal preparation on the power cable



In order to maintain safety, the power cable should be prepared in such a way that the earth wire (yellow-green) is longer than the other wires by min. 20mm. The end of the earthing wire should be extended with a tip with an eyelet to the M5 screw. Crimp the end on the earthing conductor with a cable crimper.

7.2.2. SGND functional grounding



Functional grounding ensures the equalization of the potentials of the transmitter, sensor, pipeline and liquid, enabling the correct performance of measurements.

The transmitter housing should always be connected to the sensor housing and connected to the sensor grounding point as shown in the figures below. This is particularly important when installing the flowmeter in a remote version (NW). The grounding point of the sensor should be connected to the metal pipeline or to the grounding rings in the case of non-conductive pipelines.

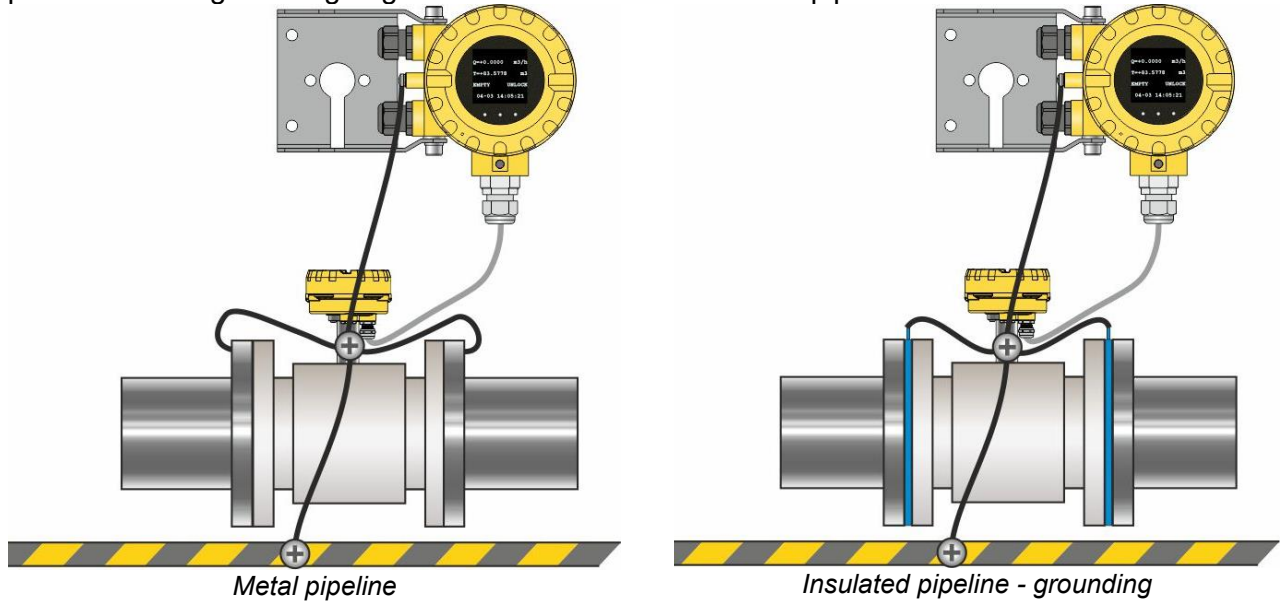


Figure 15. Example of a functional earthing connection for a metal pipeline and for an insulated pipeline using earthing rings



To properly ground the flowmeter, refer to the graph in → [Figure 18](#). Correct functional grounding of the PEM-1000 flowmeter.

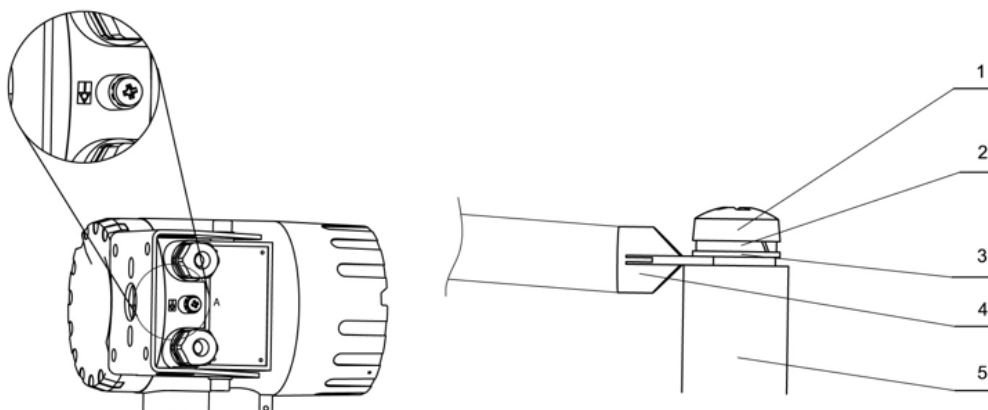
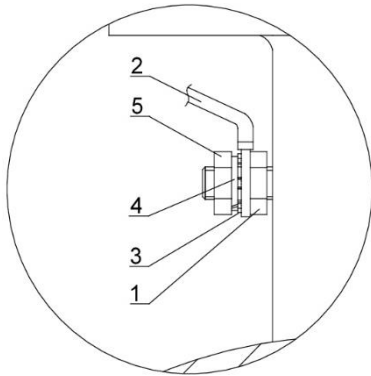


Figure 16. Connecting the functional ground to the transmitter housing

The sequence of elements in the properly made earth connection of the transmitter:

1. Screw M5.
2. Spring washer M5.
3. Serrated washer acc. to DIN 6797 J – M5.
4. The cable is terminated with a crimp terminal with an eyelet M5.
5. Housing.



Connection elements in the order of assembly:

1. Screw M6.
2. The cable is terminated with a crimp terminal with an eyelet M6.
3. Serrated washer acc. To DIN 6797 J – M6.
4. Spring washer M6.
5. Nut M6.

Figure 17. Connecting functional grounding to the sensor housing

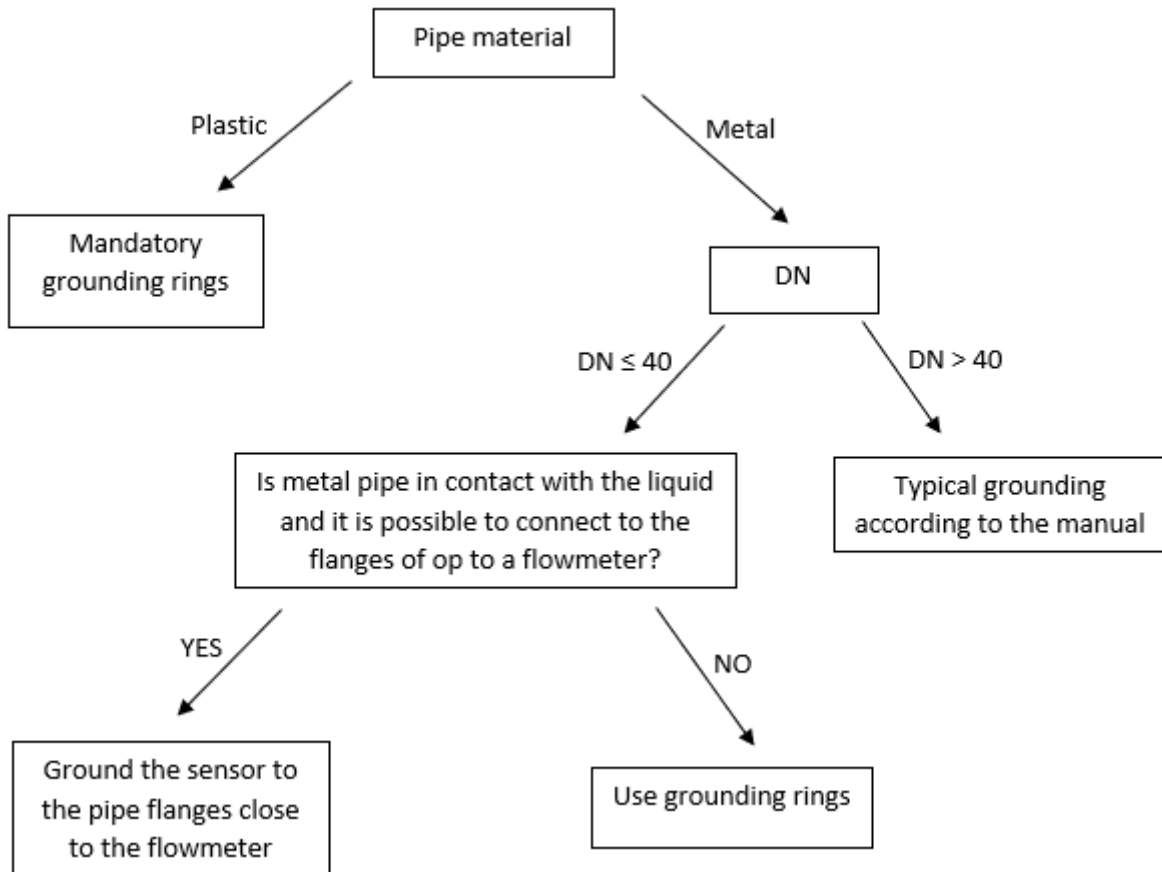


Figure 18. Correct functional grounding of the PEM-1000 flowmeter

7.3. Cable connection

Current flow values and totalizers can be read by external devices such as local indicators, counters, displays. Connecting local indicators using an analogue current output of 4 ... 20 mA or pulse output does not allow access to the flowmeter menu and configuration, only the local indicator can be configured.

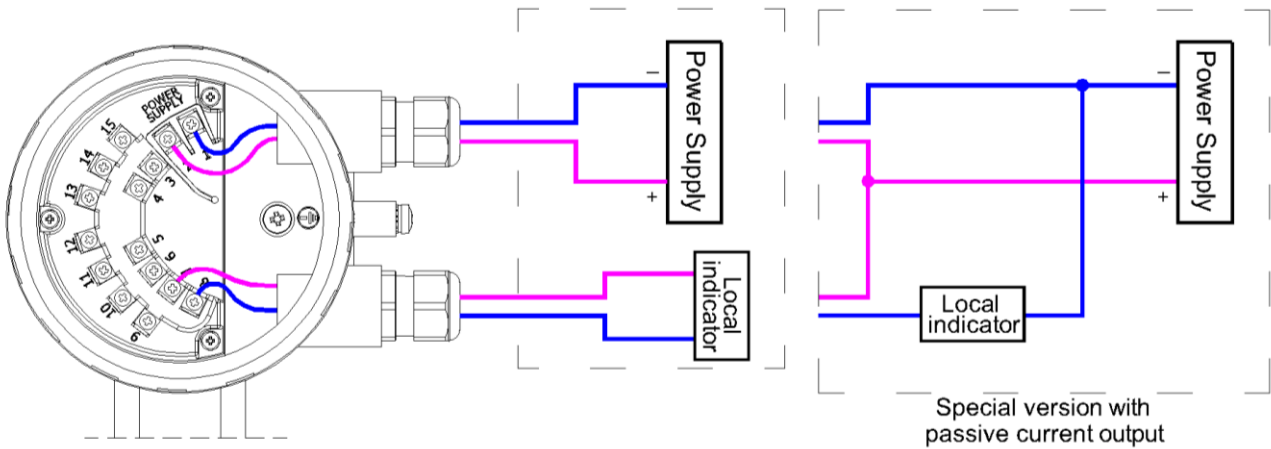


Figure 19. Connection using an analog current output of 4 ... 20 mA for low-voltage power supply

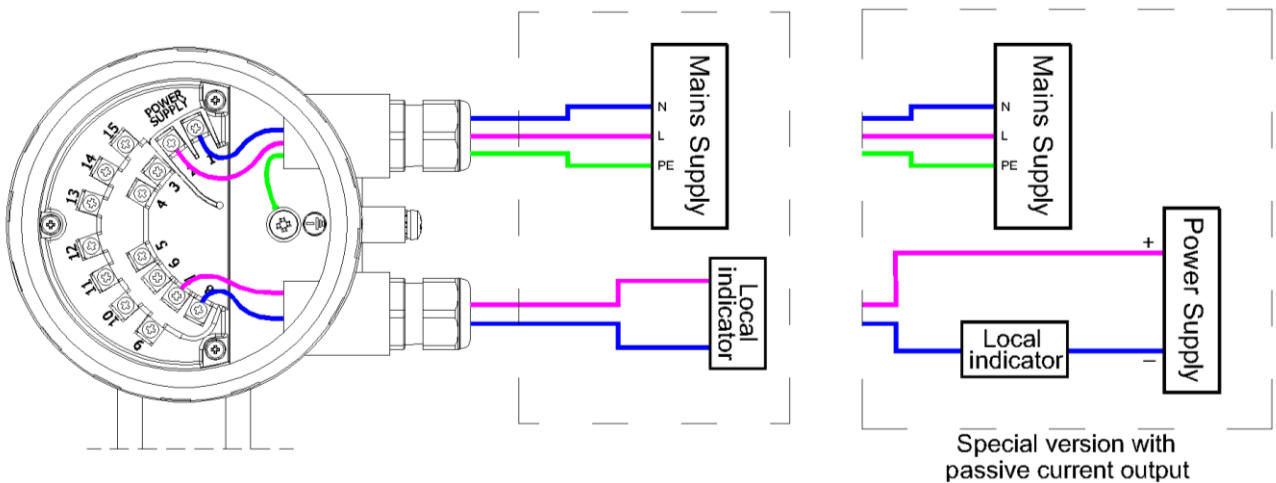


Figure 20. Connection using an analog current output of 4...20 for 230 V mains supply

7.3.1. Connecting the pulse/frequency output

The PEM-1000 flowmeter is equipped with a pulse/frequency output, which is galvanically isolated passive circuit with characteristics similar to an optocoupler. Depending on the type of input of the external device, different connection methods are possible, requiring appropriate circuit adaptation. The voltage applied to the pulse/frequency output must not exceed 36 V, and the current must not exceed 30 mA. Detailed information and example connection diagrams are available in a EN.IO.OWI.PEM.1000 manual, on the manufacturer's website.

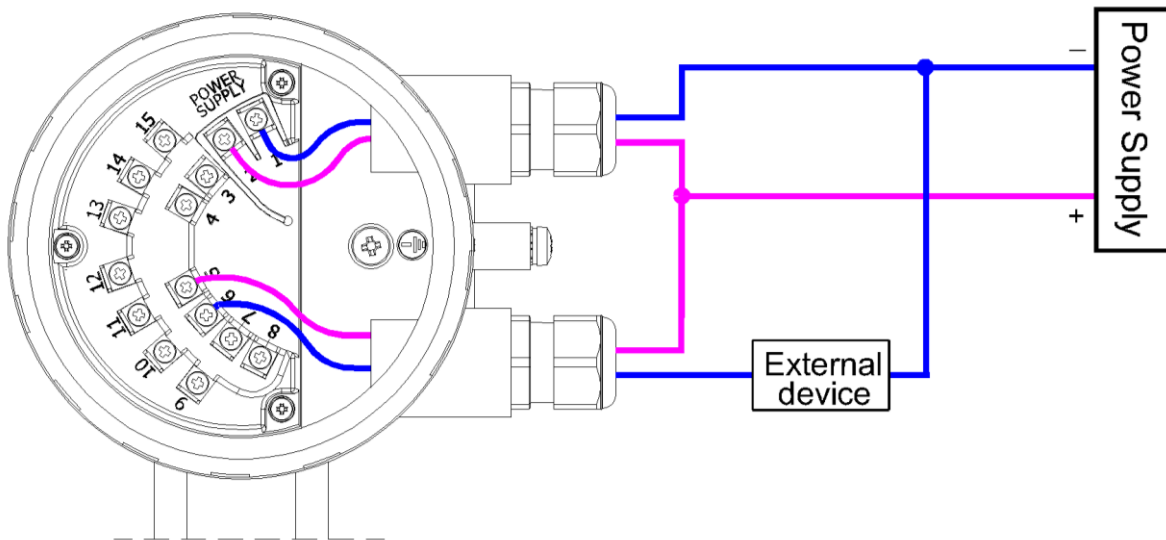


Figure 21. Example connection of the pulse/frequency output with low-voltage power supply

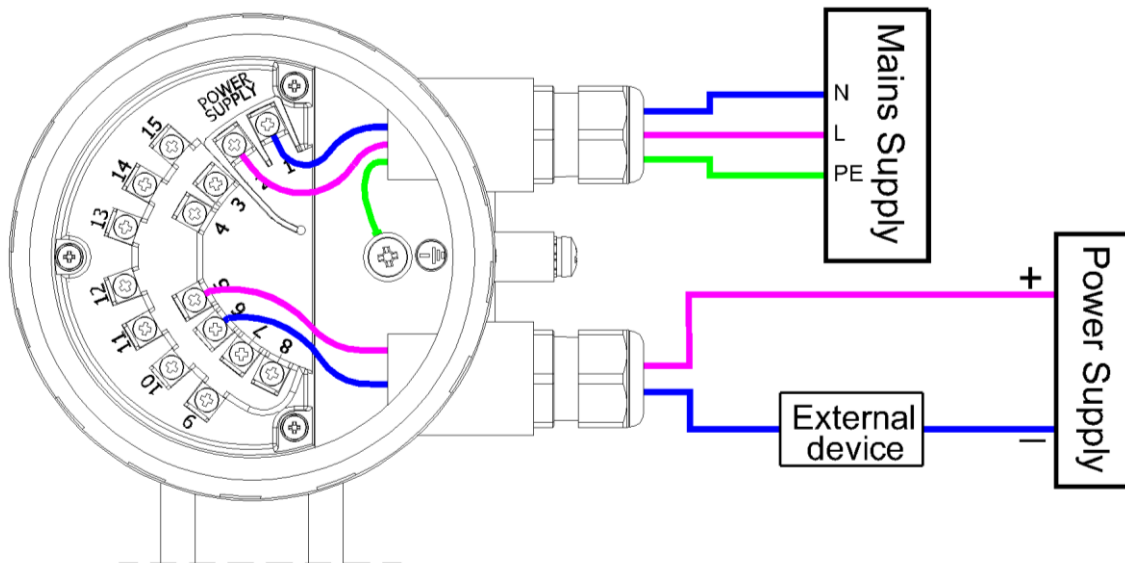


Figure 22. Example connection of the pulse/frequency output with mains supply

7.3.2. Connecting for Modbus communication

Remote configuration of the flowmeter is performed via Modbus communication using external devices such as: control systems, computers with installed service program and local indicators with Modbus RTU support.

Terminals 9 and 10 are designated for connecting a two-wire RS485 bus (Modbus RTU). To connect to the operating software, a USB/RS485 converter must be used. More information on Modbus RTU communication can be found in the EN.IM.PEM.1000 manual, on the manufacturer’s website.

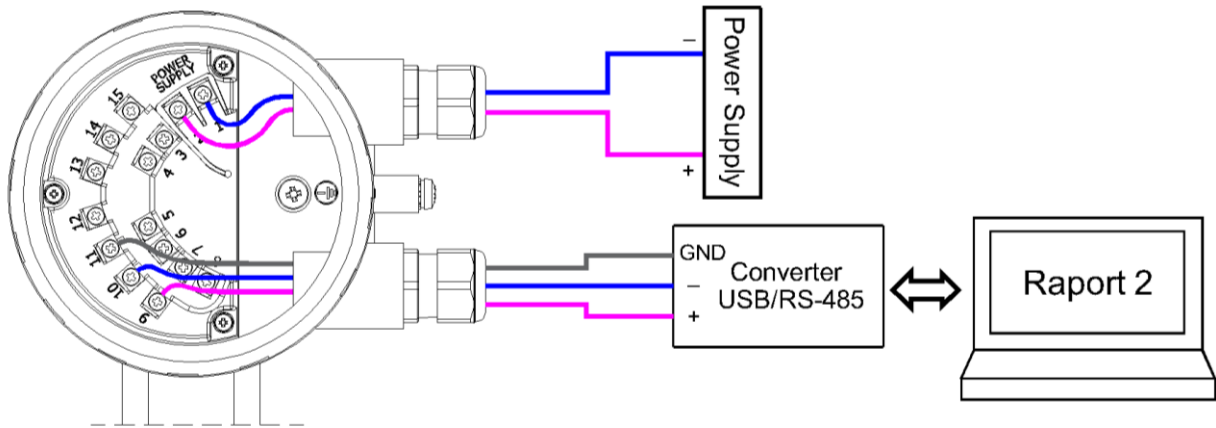


Figure 23. Connection using Modbus communication for low-voltage power supply

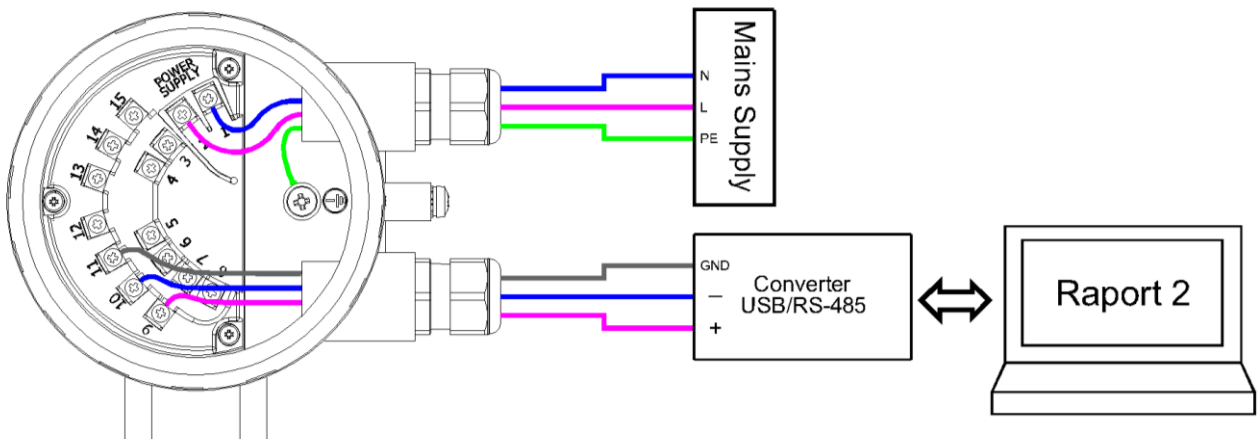


Figure 24. Connection using Modbus communication for mains supply

8. START-UP

Before starting, make sure to:

- check the electrical and signal connections, the ground connection, and the safety measures in place to prevent electric shock;
- check that the flowmeter is properly installed in the pipeline, fill the pipeline with fluid, and verify that it is leak-free. After a brief flush, turn on the system, configure the instrument at the workstation, and start the measurements;



The description of the device configuration can be found in the EN.IK.PEM-1000 manual, and the description of Modbus communication in the IM.PEM-1000(ENG) manual. The documentation is available on the manufacturer's website www.aplisens.com

9. TECHNICAL PARAMETER

9.1. Protection class

The flowmeter has class I protection. The measuring circuits are separated from hazardous voltages by reinforced insulation in accordance with the requirements of PN-EN 61010-1 standard.

9.2. Technical specification

Table 3. Technical data of the sensor and transmitter

Technical data	
Transmitter	Sensor
Electrical conductivity of the medium	$\geq 5 \mu\text{S/cm}$
Input resistance	$\geq 10^{10} \Omega$
Accuracy*	Nominal size
Spec. ver.: $\pm 0.5\%$ of reading at 20...100% $Q_{(10\text{m/s})}$ $\pm 0.2\%$ of reading at 20...100% $Q_{(10\text{m/s})}$	DN 10...1000, (ANSI 0.5"...40")
Low flow rejection	Max static pressure
Adjustable value	Standard 1.6 MPa (1 MPa, 2.5 MPa, 4 MPa - on request)
Actual flow	Process connection
both directions (l/s, m ³ /h, m ³ /s, other)	Flange DIN, ANSI
Totalizer	Ambient temperature
3 counters, total, positive, negative and 3 identical counters with the option of resetting (m ³ , other)	-20...60°C
Low flow alarm	Liner temperature range
Adjustable, any value	Rubber: -5...90°C Teflon: -25...90°C; (-25...130°C – on request)
Configuration	Connection cable (PEM-1000NW)
LCD display/3 buttons or Modbus RTU via RS485	8 m (12, 24, 32, 40, 48 m – on request)
Empty pipe detection	Electrodes material
Cyclic, configurable	Stal 316L (Hastelloy, Tantal – on request)
Analog output	Insulation lining
Active output (passive – on request)	Rubber, Teflon on request: Neoprene
Pulse/frequency output	Casing and flange material
Max. 30 V/10 mA DC; 0.1...2000 Hz in frequency mode; up to 500 Hz in pulse mode. Passive output; Galvanic insulation; Any polarity	Carbon steel covered with protection lacquer (steel 304 on request)
2-state output OC	Accessories
2; open collector Max. 35 V DC / 100 mA for each Galvanic insulation; Any polarity	Grounding rings (stainless steel) for plastic pipes
Communication output	Excitation of coils isolation class
Modbus RTU/RS 485 Galvanic insulation	E
2-state input	Protection class**
5...35 V DC / 2 mA Passive output; Galvanic insulation; Any polarity	IP67 (IP68 - on request)
Power supply	Measuring principle
90...260 V AC/ 50 Hz (60 Hz- on request) / 15 VA Low voltage (reverse polarity protection): 10...36 V DC / 15 W	Electromagnetic
Protection class	Weight
IP66 (IP67 - on request)	According to data in the catalogue
Ambient temperature	
-20...60°C	
Weight	
3.5 kg	

* Reference conditions according to PN-EN ISO 20456:2020-03.

**For IP67 it is recommended (for IP68 required) to fill the inside of the junction box of the sensor in the remote version (PEM-1000NW) with a MAGIC-POWER-GEL RayTech protective gel (available on additional order) or another with similar sealing and insulation properties.

9.3. Reference conditions

Flow	0.3 – 10 m/s
Measured medium	Water 10 – 30°C
Conductivity	> 300 μ S/cm
Supply variability	$U_n \pm 2\%$ (U_n – power supply voltage)
Ambient temperature	18 - 25°C
Stabilization time after switching on power	Min. 20 min
Straight flow sections	5DN in front of the sensor, 3DN behind the sensor

9.4. Metrological parameters

The size of flange connections defined by the DIN standard in the range of DN10 ... DN1000 or, optionally, in the size range of flange connections according to the ANSI or BS standard. Standard flow rates for individual versions of the flowmeter with flange connections in accordance with DIN are presented in the table below. It is possible to set other values of the Q_{max} flow for individual versions of the flowmeters.

Table 4. Flow values for the PEM-1000 flowmeters

DN acc. to DIN	Flow values						
	Recommended flow limits		Factory settings				
	$\sim Q_{(min)}$	$\sim Q_{(max)}$	Analog output 4 ... 20 mA		Pulse output		Low flow cut-off ($v \sim 0,1$ [m/s])
[m ³ /h]	[m ³ /h]	Measuring range	Linear flow velocity (to the end of the measuring range)	Volume/pulse	Number of pulse / m ³		
	[m ³ /h]	[m ³ /h]	[m ³ /h]	[m/s]	[m ³ /im-pulse]		[m ³ /h]
10	0,08	2,8	0÷1	3,54	0,0000025	400000	0,03
15	0,19	6,4	0÷2	3,14	0,000005	200000	0,06
20	0,34	11	0÷4	3,54	0,00001	100000	0,12
25	0,5	18	0÷5	2,83	0,0000125	80000	0,15
32	0,9	29	0÷10	3,45	0,000025	40000	0,3
40	1,4	45	0÷15	3,32	0,00004	25000	0,45
50	2,1	71	0÷20	2,83	0,00005	20000	0,6
65	3,6	119	0÷30	2,51	0,0001	10000	0,9
80	5	181	0÷50	2,76	0,000125	8000	1,5
100	8	283	0÷100	3,54	0,00025	4000	3
125	13	442	0÷150	3,40	0,0004	2500	4,5
150	19	636	0÷200	3,14	0,0005	2000	6
200	34	1131	0÷360	3,18	0,001	1000	10,8
250	53	1767	0÷500	2,83	0,00125	800	15
300	76	2545	0÷760	2,99	0,002	500	22,8
350	104	3464	0÷1000	2,89	0,0025	400	30
400	136	4524	0÷1300	2,87	0,004	250	39
500	212	7069	0÷2000	2,83	0,005	200	60
600	305	10179	0÷3000	2,95	0,008	125	90
800	416	13854	0÷5000	2,76	0,0125	80	120
1000	848	28274	0÷8000	2,83	0,025	40	240

9.5. Table of volumetric flows calculated for the flow linear velocities of the medium

The volumetric flow is calculated from the measured linear velocity of the flow and the cross-sectional geometry of the flowmeter. The table below shows the values of volumetric flows for individual DN's at characteristic linear flow velocities.

Table 5. Volumetric flows as a function of the linear velocity of the medium for various pipe diameters acc. DIN

DN	Flow speed V [m/s]							Flow rate [m ³ /h]
	0,300	1,000	2,000	3,000	4,000	5,000	6,000	
10	0,085	0,283	0,565	0,848	1,131	1,414	1,696	
15	0,191	0,636	1,272	1,909	2,545	3,181	3,817	
20	0,339	1,131	2,262	3,393	4,524	5,655	6,786	
25	0,530	1,767	3,534	5,301	7,069	8,836	10,603	
32	0,869	2,895	5,791	8,686	11,581	14,476	17,372	
40	1,357	4,524	9,048	13,572	18,096	22,619	27,143	
50	2,121	7,069	14,137	21,206	28,274	35,343	42,411	
65	3,584	11,946	23,892	35,838	47,784	59,729	71,675	
80	5,429	18,096	36,191	54,287	72,382	90,478	108,573	
100	8,482	28,274	56,549	84,823	113,097	141,372	169,646	
125	13,254	44,179	88,357	132,536	176,714	220,893	265,072	
150	19,085	63,617	127,234	190,852	254,469	318,086	381,703	
200	33,929	113,097	226,194	339,292	452,389	565,486	678,583	
250	53,014	176,714	353,429	530,143	706,858	883,572	1060,287	
300	76,341	254,469	508,938	763,406	1017,875	1272,344	1526,813	
350	103,908	346,360	692,721	1039,081	1385,441	1731,801	2078,162	
400	135,717	452,389	904,778	1357,167	1809,556	2261,945	2714,334	
500	212,057	706,858	1413,716	2120,573	2827,431	3534,289	4241,147	
600	305,363	1017,875	2035,750	3053,625	4071,501	5089,376	6107,251	
800	542,867	1809,556	3619,112	5428,668	7238,223	9047,779	10857,335	
1000	848,229	2827,431	5654,862	8482,293	11309,724	14137,155	16964,586	

Table 6. Flow values corresponding to speed of 1 m/s

DN	m ³ /h	l/min.	l/s
10	0,283	4,712	0,079
15	0,637	10,62	0,177
20	1,131	18,85	0,314
25	1,767	29,452	0,491
32	2,895	48,255	0,804
40	4,524	75,398	1,257
50	7,069	117,81	1,964
65	11,946	199,1	3,318
80	18,096	301,59	5,027
100	28,274	471,23	7,854
125	44,179	736,31	12,272
150	63,617	1060,3	17,671
200	113,10	1885	31,42
250	176,71	2945,2	49,087
300	254,47	4241,2	70,686
350	346,36	5772,7	96,211
400	452,39	7539,8	125,66
450	572,26	9537,5	158,96
500	706,86	11781	196,35
600	1017,9	16965	282,74
700	1384,7	23079	384,65
800	1809,6	30159	502,65
900	2289,1	38151	635,85
1000	2827,4	47124	785,4

9.5.1. Selection of flowmeter diameter and measuring range

The selection of the appropriate diameter of the flowmeter depends on the diameter of the pipeline on which it will be installed, as well as the value of the flow of liquid flowing in this pipeline. The measuring range of a given flowmeter corresponds to a linear liquid flow velocity from 0.3 m/s to 10 m/s. The optimal measuring ranges correspond to the linear velocities of the liquid flow from 2 to 6 m/s. Factory-set measuring ranges taking into account the optimal linear flow velocities are given in → [Table 4. Flow values for the PEM-1000 flowmeter](#). Measurements at liquid linear velocity of less than 0.1 m/s are not recommended.

The flow velocity should also take into account the physical properties of the liquid. For erosive liquids such as water with sand or gravel, milk of lime, speeds below 2 m/s are recommended. Sludge-forming liquids, e.g. sewage sludge, should move at a speed greater than 2 m/s during the measurement.

Selection of the measuring range of the flowmeter (applies to liquid flow in both directions)

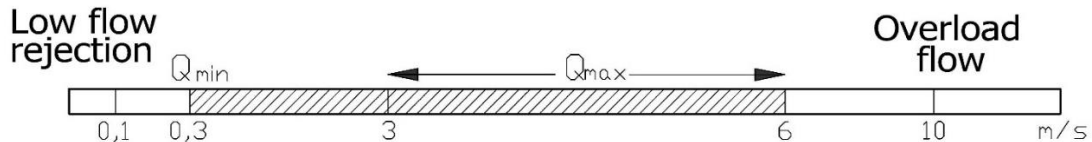


Figure 25. Recommended flow values for the PEM-1000 flowmeters

The mapping of the instantaneous flow value with the 4 ... 20 mA current signal is limited to the flow range determined by the MIN value and MAX value parameters, in the same units as Flow unit option included in the Outputs config parameter subgroup.

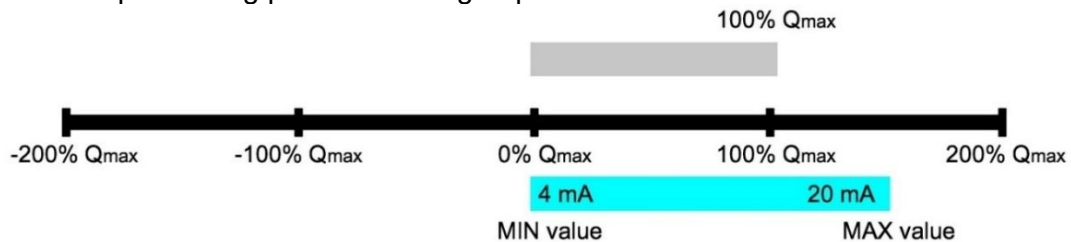


Figure 26. The measuring range of the flowmeter is determined by the Qmax parameter

10. MAINTANANCE

10.1. Periodic inspections

Periodic inspections should be performed in accordance with the requirements applicable to the user.

10.2. Non-periodic inspections

If the flowmeter in the place of installation is exposed to mechanical shocks, electrical surges or incorrect operation is found, it should be inspected. If there is no signal in the measurement line or its value is incorrect, check the condition of the cable and connections on the terminals. Check whether the value of the supply voltage and the load resistance are correct. If the measurement line is in working order, perform a verification test. → [11. FLOWMETER VERIFICATION TEST](#)

10.3. Cleaning/Washing

In most cases, the flowmeters does not require cleaning of the electrodes or sensors linings throughout the lifetime, it is self-cleaning by flowing liquid. This process is particularly effective at flow velocities from 3 m/s.

It is best to use a clean cloth or rag and detergent to clean the electrodes. Damage to the floor covering should be avoided during cleaning. If the electrodes need to be cleaned during operation, mechanical and electrolytic methods can also be used.



In the case of installations intended for the measurement of viscous or heavily contaminated substances, it is suggested to install two oblique tees with inspection covers in front of and behind the flowmeter, which will allow cleaning the sensor without the need to flowmeter disassemble.

11. FLOWMETER VERIFICATION TEST

Verification tests are performed using the Raport 2 software and the MODBUS RTU protocol.



Verification tests can be performed for flowmeters with software version v4.4.1028 or higher, using the Raport 2 application version 1.165 or higher with the *Raport2 PEM Verification Report Plugin* installed. The presence of the plugin in Raport 2 can be verified in *Settings* → *Program Settings* tab.

11.1. General Information

Integrated verification test verifies the correct operation of the flowmeters based on register readings and automatic tests available in the device software. The test result confirms its ability to provide reliable measurements, in accordance with the requirements of EN ISO 9001:2015.

The test consist of two parts:

- Parameter verification – reading selected device registers and comparing them with expected ranges.
- Automated testing – running built-in tests and evaluating the results.



The verification report does not replace flowmeter calibration. Confirmation of compliance with flow specifications can only be achieved through recalibration at a measurement station.

11.2. Performing the test

In the Raport 2 program menu, select the *Converter* → *Verification Report*. The verification test wizard will launch. Follow the instructions. Entering additional information in the second step will update the final report with the data not included in the records (operator/sensor/customer installation data).

The wizard includes the following options:

- Empty Pipe – working with an empty pipe mode; some measurements (e.g., Uem1/Uem2 parameters) are only valid in this mode. DAC correction is skipped.
- Extended – density compensation mode; some verifications e.g., differential resistance Re1–Re2 can be skipped in this mode (configurable in the flowmeter settings, using administrator privileges).
- Tag –informal name for the flowmeter, given by the user

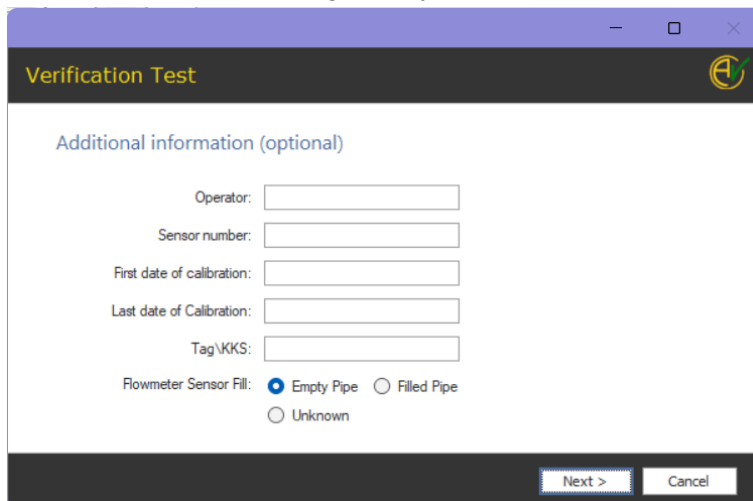


Figure 27. Additional information form to enter



During the test, the measurement is disrupted. It is recommended that you stop the flow measurement. Normally, the test can take up to 1 minute.

The wizard lists the results upon completion.

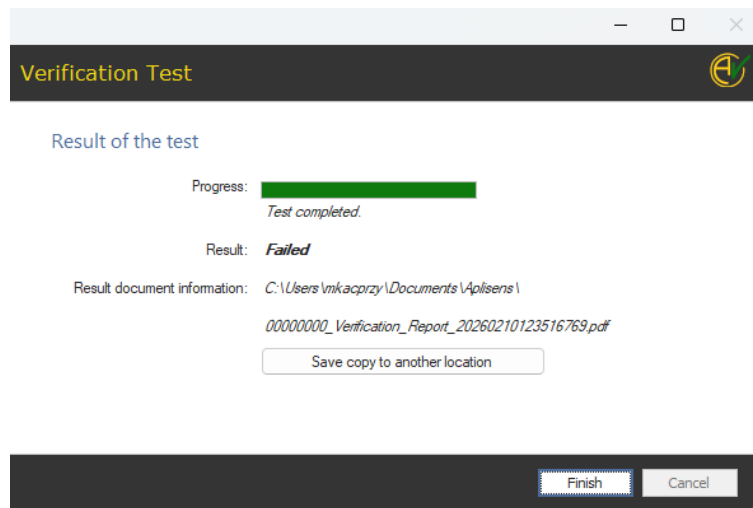


Figure 28. Window confirming the test completion



All tests, including *Self tests*, are performed in one process.

11.3. Report form

Once the process is complete, a PDF report is generated. The wizard indicates where the PDF report was saved. The PDF report only presents the parameters/tests with their final evaluation.

11.4. Interpretation of results

11.4.1. Positive test result

A verification test with a positive result confirms that the values obtained in the verification measurements comply with the manufacturer's technical specifications and that the flowmeter is working properly.

11.4.2. Negative test result

If the verification result is negative, it is recommended to repeat the verification test. This applies in particular to errors in the Sensor modules group, as the test failure may be caused by the process itself. Before repeating the test, it is recommended to:

- A comparison of current process conditions with those of the last successful verification, in order to identify any differences.
- Creating stable process conditions:
 - stabilizing or stopping the flow;
 - maintaining a constant temperature;
 - emptying the sensor.

If you have followed the above recommendations and the test result is still negative, it is recommended that:

- Verify that the installation, grounding connections, etc., are correct.
- Narrow down the cause of the error by identifying the tests that returned negative results and take action based on the verification results and diagnostic information provided by the flow meter, in accordance with the recommendations outlined in the information → 0.

- TROUBLESHOOTING
- Recalibrate the flowmeter.

12. TROUBLESHOOTING

12.1. Measurement board error E_FE_xx

The table below refers to errors reported by the measuring board, signalled on the main screen with the message E_FE_xx, where xx is a hexadecimal number (hexadecimal) denoting the error code. This code consists of eight bits denoting different statuses listed in the table. A single digit of the code corresponds to four consecutive bits (the older digit is bits 7-4, the younger bits 3-0). Successive hexadecimal digit values and corresponding bit combinations are:

digit	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
bits	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111

Table 7. Error descriptions of the PEM-1000 flowmeter and their possible solutions

	Error description	Possible solution
bit 7 (0x80)	Electrode differential voltage (coarse offset) exceeded	<ol style="list-style-type: none"> 1. Check the installation for air lock. 2. Check the grounding system of the sensor and the pipes near the sensor. 3. Check if the liquid in the vicinity of the sensor does not come into contact with metal parts at a potential other than earth. Ground the isolated metal sections (pipes, valves) to the sensor's functional grounding system. 4. Check if the electrodes are not covered with deposits that prevent their contact with the liquid. 5. Verify by visual inspection of the installation if there are no significant stray currents in the fluid or pipes, e.g. from galvanizing equipment, high-power pump motors, protective and neutral earth conductors of high-current wiring, etc. <p>Note! The voltages at the electrodes can be checked in the diagnostic menu, screen 1.</p>
bit 6 (0x40)	ADC flow measurement transducer does not respond	Check for other errors related to voltage overshoots (on bit 7 and/or 1), and if none, return the flowmeter to the manufacturer or authorized representative.
bit 5 (0x20)	Incorrect resistance of the sensor coil	<ol style="list-style-type: none"> 1. Check the sensor wiring, especially the power supply circuit for the coils, including the insulation between the coil wires and their shielding. 2. Measure the insulation resistance between the coil circuit (terminals 11 and 12) and the sensor housing (terminal 10, any housing terminal), with the sensor connector disconnected from the electronics—in a functional sensor, depending on the meter used, the resistance will read “infinity” or hundreds of kilohms. Note that the coil cable shield should also be isolated from the coil wires.
bit 4 (0x10)	Incorrect sensor coil current	Check the resistance of the sensor coil in the diagnostic menu (screen 3, item Rcoil), if it is greater than 140 Ω, proceed as in the case of an incorrect sensor coil resistance error (bit 5). If the resistance is lower and the sensor is DN200 or larger, check the value of parameter “FI” on diagnostic screen 3. The parameter should have four digits and the first digit should be 1. If this is not the case, contact the manufacturer or, if necessary, send the electronic module back to the manufacturer or an authorised representative for reconfiguration.
bit 3 (0x08)	Absolute voltage of electrode 3 (auxiliary) exceeded	-----
bit 2 (0x04)	Absolute voltage of electrode 2 (measuring electrode) exceeded	<ol style="list-style-type: none"> 1. Check the installation for air lock. 2. Check if the electrodes are not covered with deposits that prevent the contact with the liquid.
bit 1 (0x02)	Absolute voltage of electrode 1 (measuring electrode) exceeded	<ol style="list-style-type: none"> 3. Verify if there is no interruption in the electrode circuit (damage to the signal wire in the split version).

bit 0 (0x01)	The differential (measurement) voltage of the electrodes has been exceeded	<ol style="list-style-type: none"> 1. Check the system for air lock and temporary air lock during operation, e.g. due to foam or air bubbles. Check if the flow sensor has been installed in accordance with the instructions to avoid air lock and if it is in the correct position to ensure that the electrodes are immersed. 2. Check the grounding system of the sensor and the pipes near the sensor. 3. Check if the liquid in the vicinity of the sensor does not come into contact with metal parts at a potential other than earth. Ground the isolated metal sections (pipes, valves) to the sensor's functional grounding system. 4. Check if the electrodes are not covered with deposits that prevent their contact with the liquid. 5. Verify by visual inspection of the installation if there are no stray currents in the liquid or in the pipes that reach the sensor from the ground loop, especially when galvanizing devices, high-power pump motors, protective and neutral conductors of high-current wiring, etc. are nearby. Verify if the protective ground of the flowmeter is connected to its functional ground. 6. Verify if no rapid changes in conductivity or ion concentration occur in the measured medium due to dosing of reactive substances into the pipeline in the close vicinity of the flow sensor. <p>Note! This error is virtually always associated with installation problems. The voltages at the electrodes can be checked in the diagnostic menu, screen 1.</p>
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12.2. Sensor error E_SENS_xx

The error is usually related to incorrect results of liquid resistance measurement and may mean a short circuit between one of the measuring electrodes and the ground or reference electrode. An additional effect of this error can be a significant increase in flow measurement error. Contact the service immediately if this error has occurred!

13. SCRAPING, DISPOSAL



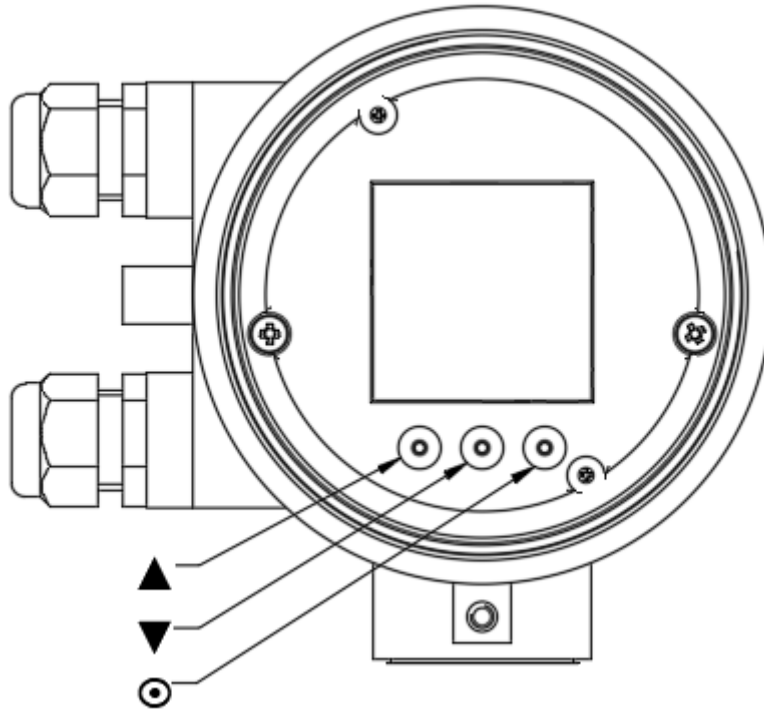
Worn or damaged devices shall be scrapped in accordance with WEEE Directive (2012/19/EU) on waste electrical and electronic equipment or returned to the manufacturer

14. HISTORY OF REVISIONS

Revision No	Document revision	Description of changes
-	01.A.001	First version of the document.
1	01.A.002	Editorial changes.
2	02.A.003	Editorial changes
3	02.A.004/2021.06	First edition of the new version of the document. Editorial changes. Added "Appendix A" Prepared by the DBFD department.
4	02.A.005/2022.12	Editorial changes. New menu options. Menu structure changes.
5	02.A.006/2024.10	Modification of the remote version of the flowmeter. Editorial changes.
6	02.A.007/2025.03	Adding information related to sealing, grounding, and wiring connection.
7	02.A.008/2025.06	Adding information about the pulse output.
8	03.A.001/2026.02	Updated MENU diagrams. New verification test section. New display menu section. Changed QR codes and ID numbers. Editorial changes.
9	03.A.002/2026.03	Addition of a section regarding the rotation of the ALW-type transducer housing. Update of possible solutions for common errors. Addition of a diagram to the description of the local buttons. Editorial changes.

APPENDIX A – Configuration Local MENU Settings

The flowmeter is operated locally by means of three buttons and a display located under the display cover.



The following actions have been assigned to the local buttons marked with respective symbols (depending on the menu item):

- The left button ▲ most often functions as a key to move up, to the left or decrease the value.
- The middle button ▼ most often acts as a key to move down, to the right or increase the value.
- Right button ⊙ is most often used as a selection/accept key (*Enter*) or to change the value.

After commissioning, the flowmeter shows the main screen with the flow measurement result in the selected units, the main counter (totalizer) of the liquid volume, the status and auxiliary information line and the date and time.

Press ▲▼ keys to go to the next screens displaying, among others, totalizers, user totalizers and information about firmware versions. After 3 minutes of inactivity, it automatically returns to the main screen.

Holding down the ⊙ button opens the main menu. The menu is accessible after logging in.

1. Login with different levels of authorization

Logging into the menu is only possible from the main screen. Hold down \odot until the login screen appears, where you enter your PIN. Individual digits are edited with \odot and the cursor moves with the \blacktriangle \blacktriangledown keys. Only the currently edited digit is exposed, the others are replaced by asterisks. After moving the cursor to the extreme right position (where the Enter option appears) and pressing \odot the PIN code is entered, which enables access to the User or Administrator menu. If the PIN is incorrect, you will return to the main screen.

Logging into the flowmeter menu with different levels of function authorization is done by entering the appropriate four-digit PIN:

- **USER** – user with limited functionality not having access to selected menu items, the factory set PIN is “1000”.
- **ADMINISTRATOR [A]** – administrator with full functionality who has no restrictions in access to menu items, the factory set PIN is “1020”.

After logging into the flowmeter menu as **USER** and attempting to select a function with restricted access, the message „**LACK OF ACCESS TO THIS OPTION**” appears on the screen.



Pressing the \blacktriangle and \odot buttons simultaneously for at least 1 second causes a “fast exit” from each menu level directly to the main screen.

The diagrams ([→ APPENDIX B - Structure of the local MENU](#)) show how to navigate through the local menu structure of the PEM-1000 flowmeter.



It is not recommended to make any changes in the “Calibration” tab as this may result in a distortion of the saved settings and the need to send the device to the manufacturer or an authorised representative. Flowmeters are calibrated at the production level, according to the customer’s order.

How to change settings using the local MENU

There are 3 local buttons for changing the settings, e.g. 2 navigation buttons \blacktriangle , \blacktriangledown and the \odot button. Depending on the field/function the change is made by selecting the function in the menu using the navigation buttons. Then select the option you are looking for with the \odot and depending on the field:

- Changes can be made by selecting available variants of a given option (scrolling using navigation buttons). Confirm the selection with the \odot button.
- Changes may require manual entering of numerical values; in order to do that press the \odot in the numerical value field, use the navigation buttons to change the cursor position and subsequent clicks on the \odot button will allow you to select the appropriate character among the available ones. After entering the value, move the cursor as far to the right as possible until the “Set” message appears (in the bottom right corner of the screen) and confirm with \odot .

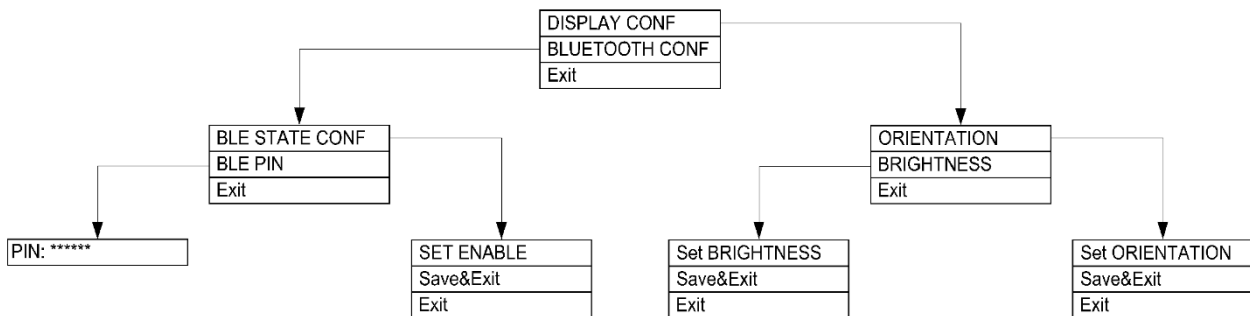
2. Local display MENU

Pressing the ▼ and ⊙ keys simultaneously takes you to the display menu, which allows you to configure display parameters and wireless (Bluetooth) connection settings. Access to the menu is only possible locally using the local buttons.

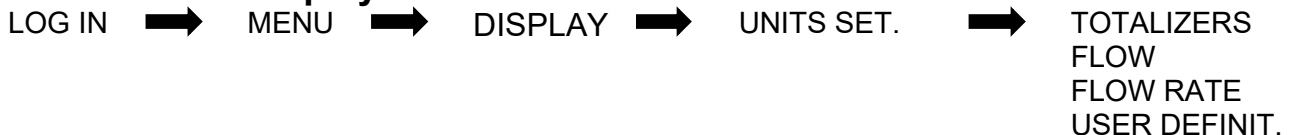
The display menu allows to configure 4 parameters:

- **BRIGHTNESS** - screen brightness setting;
To set the backlight brightness to one of 10 levels, use the **Set BRIGHTNESS** function; the lowest level is 10 and the highest is 100 (step=10).
- **ORIENTATION** - display rotation setting;
To change the display orientation, select the **Set ORIENTATION** function and press ⊙ until the desired display orientation is achieved.
- **STATE - ON/OFF Bluetooth**;
SET ENABLE changes the status and turns Bluetooth on/off.
- **PIN CODE** - setting the pin code for Bluetooth;.
000000 is default.

Saving the selected item in the submenu is done by holding the ⊙ button on the SAVE & EXIT position. The display menu structure diagram is shown below.



3. Units and display



This function allows the user to define the displayed units by selecting among the available units in the flowmeter menu. The selection is made by pressing the ⊙ in the unit field. Use the navigation buttons to find the appropriate unit and then confirm again by pressing the ⊙. Execution of the operation will be confirmed by the “OK” message.

TOTALIZERS – select the volume counter (totalizer) unit.

FLOW – select the flow unit.

FLOW RATE – defining the unit for the linear velocity of fluid flow.

USER DEFINIT. – this function allows you to define your own unit and to assign a user-defined value to it.

4. Filtering

LOG IN ➡ MENU ➡ CONFIGURATION ➡ FILTRATION ➡ FOR LCD
 FOR LOOP 4 ... 20
 FOR PULSE OUT
 FOR MODBUS
 PREFILTER

This function allows you to define filtering parameters. To do this use the navigation buttons and the Ⓞ to select or confirm changes.

Each of the following functions allows you to define the filtering mode (AVERAGE or DUTY) and specify the filtering time (0-60 s, setting the time to “0” means that filtering is disabled). The above settings apply to filtering:

- FOR LCD,
- FOR 4 ... 20 [mA] LOOP,
- FOR PULSE OUTPUT,
- FOR MODBUS.

In the prefilter option, the existing options have been removed and replaced with functions “mode” and “parameters” where user can set filter type and its parameter. To do this select the function by pressing the “Enter” button, and then define the filtering value in the “mode” and “parameter” field. The user can also specify the filtering level for the “PREFILTER” function. The filter type and parameters are set separately for the flow rate presentation channels indicated above. Prefiltration is done independently before the filtration mentioned above, and applies to all channels. Pre-filtering supports the presentation of results under highly disturbed measurement conditions.

5. Units and display

LOG IN ➡ MENU ➡ OPERATIONAL ➡ CONFIGURATION ➡ PIPE DIAMETER [A]
 SENSOR TYPE [A]
 LOW FLOW RATE
 EMPTY PIPE
 ZERO DISCRIM.
 MEASUR. METHOD [A]

The operational configuration allows you to define the operating parameters of the device. To access a specific menu function, select it using the navigation buttons and then confirm with the Ⓞ.

PIPE DIAMETER (MENU ITEM ACCESSIBLE FROM THE ADMINISTRATOR LEVEL) – this function enables setting nominal flow sensor pipe diameter. This value is factory set and should always match the actual diameter of the sensor.

SENSOR TYPE (MENU POSITION AVAILABLE FROM THE ADMINISTRATOR LEVEL) – allows the selection of the type of sensor used (selection of a sensor with two or three active electrodes). To make a selection, use the navigation buttons in the “TYPE” field to make the desired choice and then confirm it with the Ⓞ. Factory set value, typically 2 electrodes.

LOW FLOW RATE– enables switching on/off the function signalling the flow drop below the set value. Detection of this situation results in an indication on the screen and triggering of the internal alarm signal, which can be used to signal an error via e.g. binary outputs. To do this, select the function with the Ⓞ using the navigation buttons in the “ON/OFF” field to enable or disable the function and then confirm with the Ⓞ.

The value should be entered manually in the “VALUE” field using the navigation buttons to change the cursor position and the Ⓞ to change subsequent characters/numbers. Once the value is entered, move the cursor as far to the right as possible until the “Set” message appears and confirm with Enter.

EMPTY PIPE – this function enables setting up the detection of an empty pipe. To do this, select the function with the Ⓞ. Then, in the “ON/OFF” field enable or disable the empty pipe detection using the navigation buttons. The desired selection must be confirmed with the Ⓞ.

ZERO DISCRIM. – this function causes the flow measurement results smaller than the set value to be replaced by zero. It is used to eliminate noise that occurs at very low or zero flow rates, thereby preventing unnecessary volume accrual under these conditions. The recommended value corresponds to approximately 0.1 m/s linear flow velocity and is given in → [Table 4. Flow values for the PEM-1000 flowmeter](#). The function can be turned on or off in the “**ON/OFF**” field using the navigation buttons and the Ⓞ. In addition, the user should define the cut-off value in the “**VALUE**” field using the navigation buttons to move through consecutive characters and the Ⓞ to change consecutive characters/numbers.

MEASUR. METHOD (MENU POSITION AVAILABLE FROM THE ADMINISTRATOR LEVEL) – this function enables selection of the measurement mode. In order to do that, select the options in the “**TYPE**” field by means of the Ⓞ and then, using navigation buttons, choose the appropriate mode from among the available ones, e.g.:

- **Neutral (standard)** – used for low density liquids where there are no measurement value spikes;
- **Extended** – usually used for high density liquids (pulp – can cause high measurement value differences in a short time). Measurement spikes can also be caused by the nature of the installation, so it is recommended to run an extended measurement mode if measurement value spikes or errors occur.

6. MODBUS

LOG IN → MENU → CONFIGURATION → MODBUS [A] → ON/OFF
UNLOCK_WR
ADDRESS
BAUD
PARITY
DATA

To access a specific menu function, select it using the navigation buttons and then confirm with the Ⓞ.

ON/OFF – used to enable or disable MODBUS communication.

UNLOCK_WR – enable or disable the ability to record data via the MODBUS interface on the flowmeter.

ADDRESS – setting the device address in the defined range 1-247.

BAUD – the item is used to select the bus speed from the list of defined speeds in the device.

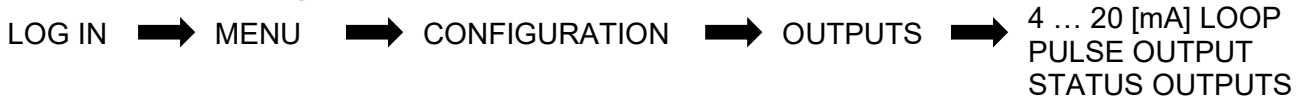
PARITY – this function serves for the selection of bus parameters from among the defined ones:

- **EVEB_1S (EVEN 1 STOP)** – with parity, one stop bit;
- **ODD_1S (ODD 1 STOP)** – with parity, one stop bit;
- **NOPA_2S (NOPAR 2 STOP)** – without parity, 2 stop bits.

DATA – allows you to match the byte layout of the transmitted 32-bit variables to the standard used in the MODBUS Master device. This is useful due to the lack of standardization of multi-byte data transfer. Use this function when the Master device receives data from a flowmeter but the received values are incorrect. The format of the data bytes transmitted over the MODBUS can be selected from those available:

- **AABBCCDD** – “Little Endian” type format (the simplest “order” of byte transfer (data are stored in RAM));
- **DDCCBBAA** – “Big Endian” type format (a natural byte transfer “order” compliant with the format for representing 32-bit hexadecimal numbers);
- **BBAADDCC** – “reversed” type format (“order” of byte transfer is analogous to the “Big Endian” type but with interchanged halves of a 32-bit hexadecimal number);
- **CCDDAABB** – the least used format for MODBUS byte transfer (least intuitive).

7. Output configuration



To access a specific menu function, select it using the navigation buttons and then confirm with the \odot . Change the values using the navigation buttons by selecting and confirming with the \odot . In the case of a manually entered value, the navigation buttons are used to change the cursor position and the \odot to enter the corresponding character/number.

4 ... 20 [mA] LOOP – the function allows to configure the 4 ... 20 mA loop. The user can enable or disable the function in the “ON/OFF” field. Define the mode from among the available options:

- **NORMAL** – currents proportional to flow value settings;
- **INVERTED** – currents inversely proportional to the flow value (multiplied * -1);
- **MODULO** – currents proportional to the absolute value of the flow.

In the “**VALUE**” field, define the flow value for 4 mA and 20 mA current respectively. The value should be entered manually using the navigation buttons to move through the consecutive characters, while the \odot is used to enter the available characters/numbers one by one. To confirm, use the navigation buttons to the right until the command “SET” appears and then press \odot to confirm.

The user can enable or disable alarming in the “**ON/OFF**” field in the “**ALARM**” field. This option is used to signal alarm situations occurring in the flowmeter using a 4 ... 20 mA loop, resulting in a status other than “OK”. You can set the following ways for the output to respond to an alarm:

- **LOW** – alarm current of 3.75 mA (constant, specified by the manufacturer);
- **HIGH** – alarm current of 21.6 mA (constant, specified by the manufacturer);
- **CUSTOM** – user alarm must be entered manually in the “**VALUE**” field (usable) alarm using the navigation buttons to move and the \odot to enter the available characters in sequence (the current defined by the user using the VALUE option will be issued);
- **LAST VAL** – current corresponding to the last recorded flow value before occurrence of the alarm situation (“freezing” of the current for the alarm time).

PULSE OUTPUT – pulse/frequency output configuration. To enable or disable the function, select the “**ON/OFF**” field by pressing the \odot and then use the navigation keys to select the appropriate option. In case of exceeding the maximum threshold of the number of pulses, the POT_SAT state will be displayed on the M1 screen, signaling the occurrence of the event. The message display will disappear when you go from the M1 screen to the login screen and back.

The “**Mode**” option allows you to select the working mode of the output.

- **Pulse** – pulse output. Volume measurement of liquids with high accuracy and resolution. Pulses are issued after measuring a unit volume of liquid, defined by the Value/pulse parameter. The following settings are available for the pulse output:
 - **Volume/imp** – this is the volume of liquid per 1 pulse. The smaller the value the higher the pulse frequency for a given flow rate. The value entered should be between 0.0000001 and 9999999 (with the possibility of setting the value to 0). To enter a value, select the “**VALUE/PULSE**” function and then press \odot in the input field.
 - **Pulse time** – pulse duration in [ms] in the range 1-499 [ms]. The longer the pulse the lower the maximum pulse frequency of the output.
 - **Mode** - the device has 3 defined modes of operation:
 - **POSITIVE** – pulses are generated only for positive flow values. Backflow causes a corresponding reduction in the number of pulses issued for positive flow.
 - **NEGATIVE** – impulses are generated only for negative (reverse) flow, positive flow causes decrease of these impulses.
 - **MODULO** – impulses are generated for both flow directions, while the direction distinction is possible using the binary output set to the “**PULSE DIR.**”) mode.
 - **Polarity** – pulse polarity (positive means activation of the output during the pulse).



The maximum output pulse frequency is 500 Hz as long as a pulse time of 1 ms is set. Exceeding this frequency can cause neighbouring pulses to “stick together” and accuracy to drop. To prevent this the set parameters must satisfy the relation:

$$\frac{Q_{MAX} \left[\frac{m^3}{h} \right]}{Value/pulse[m^3] \cdot 3600} < \frac{1000}{Pulse\ time[ms] + 1}$$

- **FREQUENCY** – frequency output (formerly PWM). The frequency of the output signal is proportional to the flow value, starting at 0.1 Hz. Use the “**POLAR**” setting to set the signal polarity. Two processing characteristic points are defined using the “**VALUE**” menu:
 - Flow value corresponding to a frequency of 2 kHz (the “**Value min.**” parameter).
 - Flow value corresponding to a frequency of 1 Hz (the “**Value max**” parameter).



The pulse mode of the output allows for precise volume measurement, so that the instantaneous frequency of the output signal may vary by steps within certain limits. The frequency mode, on the other hand, provides an accurate representation of instantaneous flow values, but should not be used for precise volume measurements.

STATUS OUTPUTS – the user has two status outputs (“**Status 1**” and “**Status 2**”) available.



The following settings are analogous for both status outputs.

To activate or deactivate the status output, select the appropriate option in the “**ON/OFF**” field.

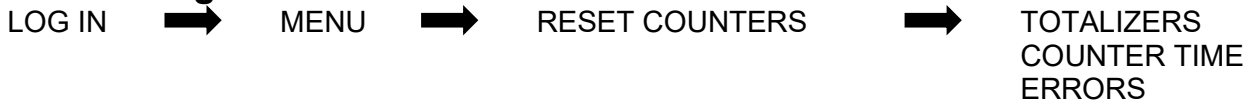
The status field menu allows you to define the function (mode of operation) from among the available options:

- **Empty Pipe** – signalling of an empty pipe;
- **Low flow** – signalling of low flow;
- **Unfil.pipe** – signalling of a pipe that is not full of fluid;
- **Errors all** – error signalling (Front End, sensor, memory);
- **Coil Error** - signalling a coil error;
- **I saturat.** – signalling of the current loop saturation;
- **Direction** – signalling of the fluid flow direction (controlling the output for positive flow);
- **Q > value** – signalling of a flow higher than the assumed value;
- **Q < value** – signalling of a flow lower than the assumed value;
- **TP > value** – signalling of an excess of the assumed flow value by the user’s positive counter (in flow units configured in the menu);
- **TM > value** – signalling of an excess of the assumed flow value by the user’s negative counter (in flow units configured in the menu);
- **Dosing** – dosing function, output controlled for the time of measuring the set flow rate;
- **Pulse dir.** – signalling of the direction of liquid flow for bi-directional pulse output operation mode (output control for positive flow), in this operation mode the status output works in synchronization with the pulse output ignoring the delay times set in the “**DELAY**” field.

The operator can also define polarisation in the “**POLAR**” field from the “**STATUS OUTPUTS**” menu (“**Positive**”, “**Negative**”) and the delay in the “**DELAY**” field in the range of 0-3600 seconds.

The “**VALUE**” field allows you to define a value for the status output. It is available depending on the selected mode; the unit for the field is in accordance with the set mode (e.g. for the selected option “Q < value” the device determines the flow unit: [m³/h]).

8. Deleting user totalizers



Using the navigation buttons and the \odot , select the desired MENU item and confirm. Then select the “DELETE” field and confirm with ENTER. The procedure applies to each of the following MENU items.

TOTALIZERS – the function allows you to delete user counters.

COUNTER TIME – the function enables to delete the working time counter (user).

ERRORS – the function allows you to clear status errors on the device.

9. Diagnostic screens

Flowmeters with software newer than 2.7.0790 have the ability to view important diagnostic data available from the flowmeter menu.

To access the diagnostic screens, log in to the flowmeter menu as the Administrator. Use the navigation buttons to find the “DIAGNOSTICS” menu item (last item in the menu) and select it using the \odot . Then find the item called “Info data” with four consecutive numbers (the tabs contain useful diagnostic information):

“Info data 1” – contains electrode voltages (Ue3 is the voltage of the third active electrode, which is not used in most designs).

- Voltages around ± 0.05000 V are suitable for conventional operation;
- Values higher than ± 0.10000 V are subject to extended measurement mode setting;
- Voltages higher than ± 1.00000 V usually result from improper grounding, sensor malfunction, or extreme dirt on the electrodes. In case of doubt it is recommended to contact the manufacturer.

```

    Ue1= +0.03423
    Ue2= +0.02321
    Ue3= +0.00220
  
```

Figure 2. Example of the diagnostic screen on the “Info data 1” tab

“Info data 2” – contains resistance values of individual electrodes – these parameters are of lesser importance (Re3 refers to the third electrode, which should be ignored). When flags are set to 0x0280 or extended measurement mode, the screen is not refreshed and values displayed may be 0.

- Values higher than 50000 are the result of contamination or high voltage of the electrodes; in this situation use the “Info data 1” instruction.

```

    Re1= 4621
    Re2= 5768
    Re3= 0
  
```

Figure 3. Example of the diagnostic screen on the “Info data 2” tab

“Info data 3” – contains information about the resistance of the sensor coil, the internal system value – “Fd” and the current state of the system – “Fl”.

- The resistance value should be between 100-130 Ω . If the value exceeds these limits there is a problem with the sensor coil or wiring and E_COIL or E_FE_10 errors may occur.
- The internal value of the system usually fluctuates constantly, and in case of problems with the flowmeter it is worth noting down the values read.
- The “Fl” parameter is the current state of the system flag, and system flags should be visible here.

```
Rcoil= 112.254  
Fd= 8025  
Fl= 1280
```

Figure 4. Example of the diagnostic screen on the “Info data 3” tab

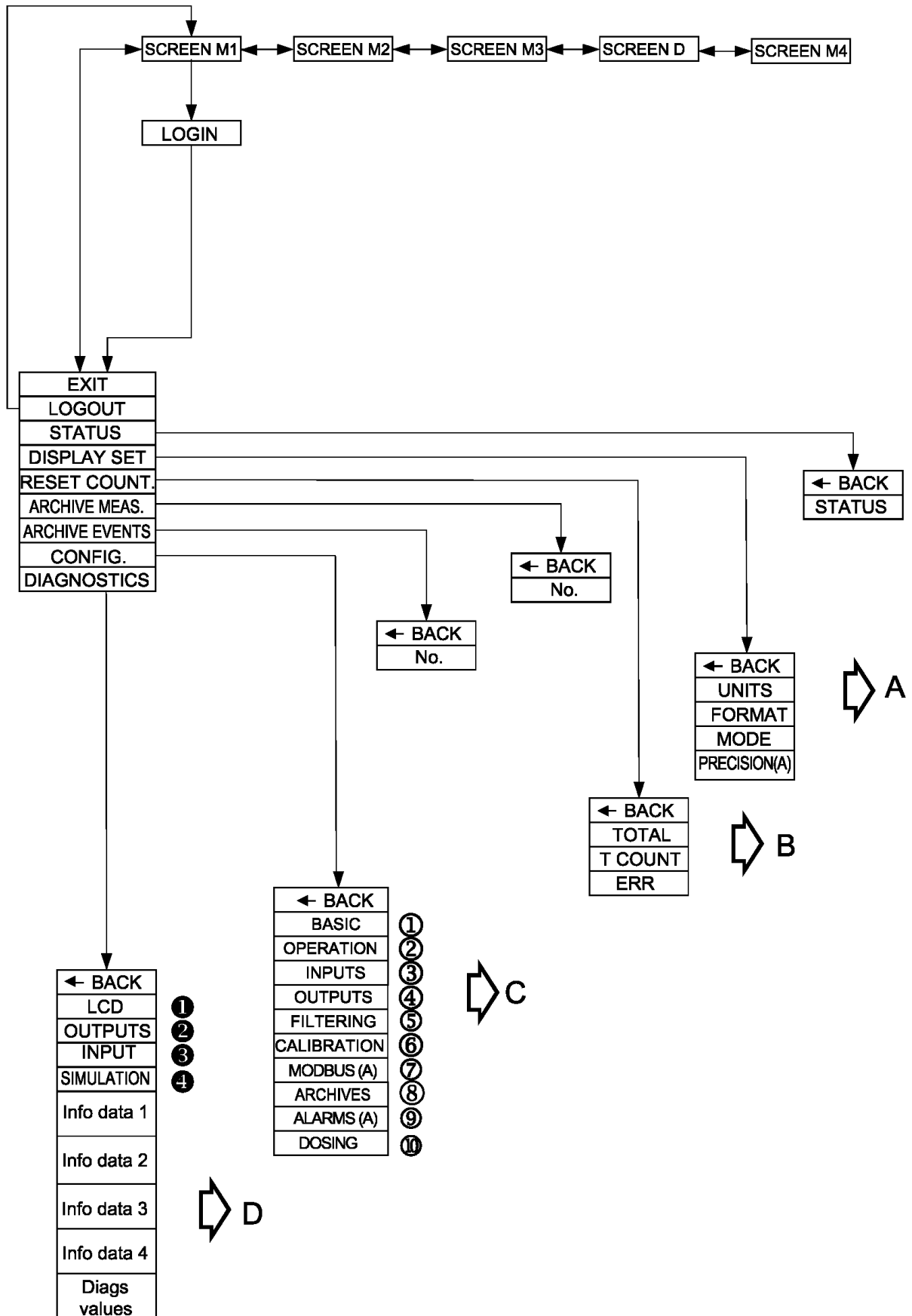
“Info data 4” – shows the voltages of the electrodes – when the empty pipe detection function is enabled. When the function is disabled, the voltage values are equal to 0. In case of inadequate performance of the empty pipe detection function, it is recommended to make a note of the electrode readings.

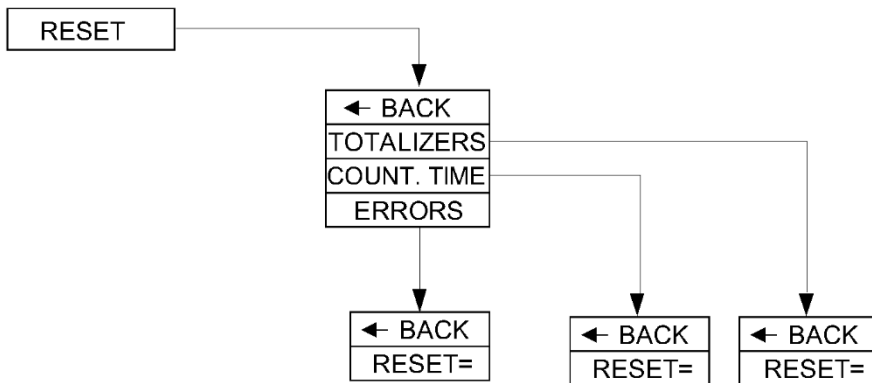
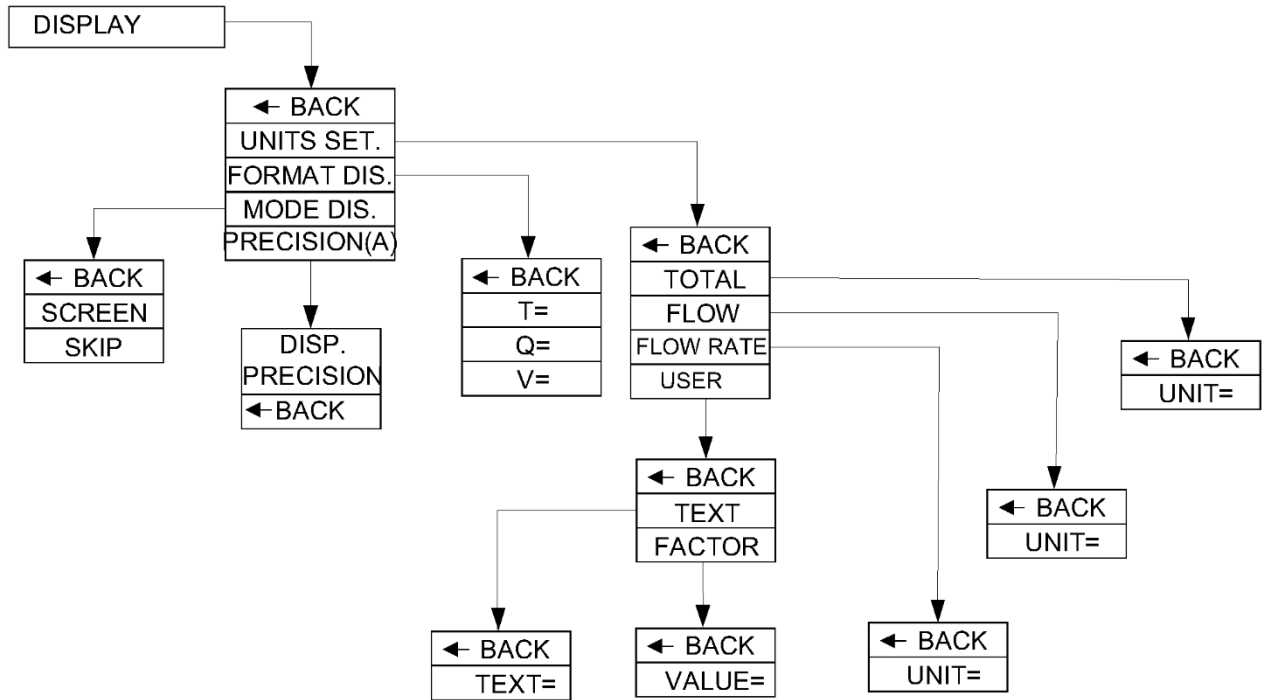
```
Uem1= +0.03123  
Uem2= +0.02721  
Uem3= +0.00220
```

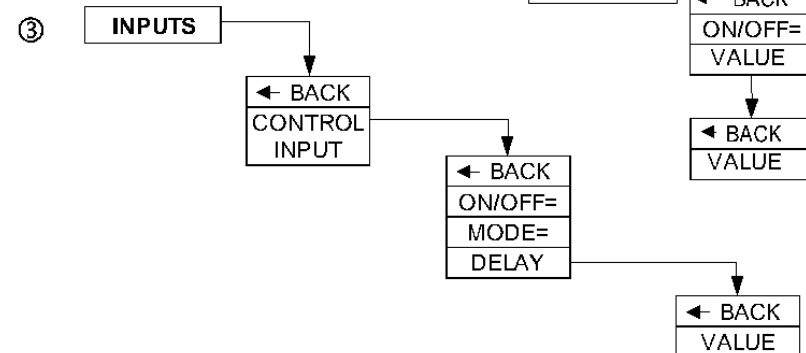
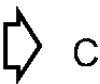
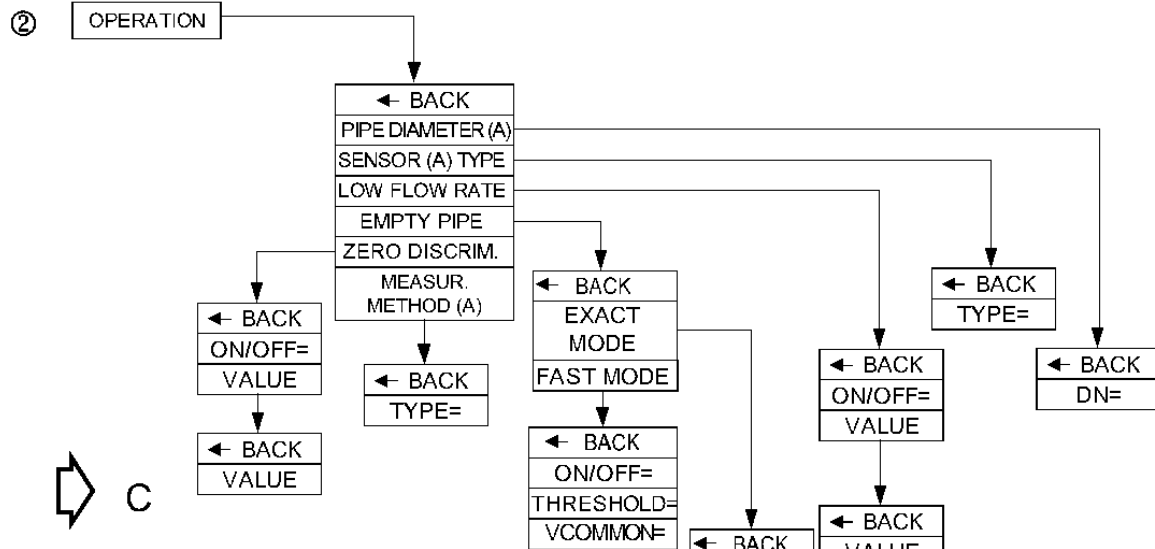
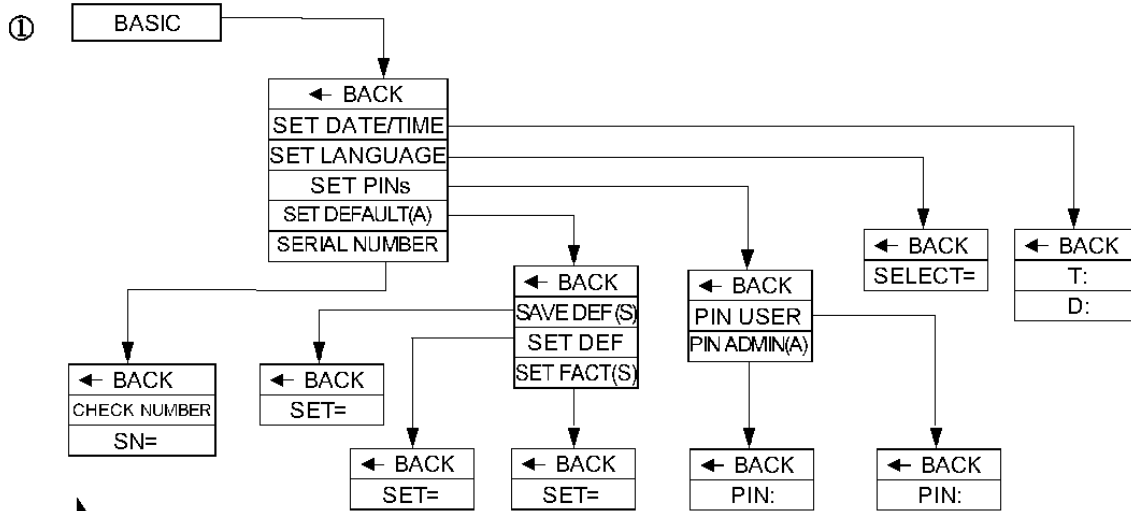
Figure 5. Example of the diagnostic screen in the “Info data 4” tab

Diagnostic values – (new option from version 3.0.1009) this option allows the user to view diagnostic data.

APPENDIX B - Structure of the local MENU









④ **OUTPUTS**

